THE SCOLIOSIS RESEARCH SOCIETY

PRESENTS

IMAST

The 16th International Meeting on Advanced Spine Techniques

JULY 15-18, 2009 • VIENNA, AUSTRIA • HOFBURG CONGRESS CENTER

FINAL PROGRAM

Jointly sponsored by the Scoliosis Research Society and Medical Education Resources

We are pleased to *acknowledge* and *thank* those companies that provided *financial support* to SRS in 2008.

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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SCOLIOSIS RESEARCH SOCIETY
555 E. Wells Street, Suite 1100
Milwaukee, WI 53202
Tel: +1-414-289-9107
Fax: +1-414-276-3349
info@srs.org
www.srs.org

Future Educational Events

44TH ANNUAL MEETING & COURSE
September 23-26, 2009 • San Antonio, Texas, USA

17TH INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES
July 21-24, 2010 • Toronto, Canada

45TH ANNUAL MEETING & COURSE
September 22-25, 2010 • Kyoto, Japan

18TH INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES
July 2011 • Maspalomas, Gran Canaria (tentative)

Welcome

Dear Colleague,

On behalf of the IMAST Committee and the Scoliosis Research Society Board of Directors, it is my pleasure to welcome you to Vienna, Austria, the breathtaking Hofburg Congress Center, and the 16th International Meeting on Advanced Spine Techniques.

We are excited to present a cutting-edge educational program to you over the course of the next three days, including 25 Instructional Course Lectures, three Spine Fundamentals sessions, 150 paper presentations, and more than 400 E-Posters.

A new addition to this year's program are the Hands-On Demonstrations, lead by the SRS Corporate Partner companies highlighting the latest technological advances in the field of spinal deformity. Please refer to the Exhibits and Demonstrations section of this program for complete details. We encourage you to attend the demonstrations to make the most of your IMAST experience, pairing didactic education with personal interaction.

We hope you enjoy the meeting and your time in Vienna! 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

Please fill out the course evaluation and return it to the Registration Desk to complete your CME compliance. CME certificates will be provided by Medical Education Resources by mail following the meeting.

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. Please review the program to identify the times and locations of the ICLs you'd like to attend. For the first time, CME credits will be offered for ICLs.

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 & Demonstrations

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.

NEW this year! – IMAST is pleased to introduce the Hands-On Demonstration (HOD) sessions. 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 and 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 on the Mezzanine Level of the Hofburg Congress Center. Beverages and snacks will be served during the morning HODs and lunch will be available during the afternoon sessions.

Internet Access

Wireless Internet access is available throughout the First and Mezzanine Levels of the Hofburg Congress Center, courtesy of DePuy Spine, a Johnson & Johnson Company. To log on from your laptop, choose "HofburgSecured" from the available wireless networks and enter "SRSimast2009" when prompted for a passcode. The password is case-sensitive.

Delegates traveling without laptops are welcome to check their e-mail at the free Internet stations located in the Registration area on the First Level of the Hofburg Congress Center, courtesy of Medtronic Spinal & Biologics.

General Information

The Scoliosis Research Society gratefully acknowledges Medtronic for their support of the Welcome Reception, coffee breaks, Internet kiosks and the IMAST Newsletter.

Medtronic

Meeting at-a-Glance

WEDNESDAY, JULY 15, 2009

17:00 - 19:30	Registration Opens
	Welcome Reception in Exhibit Hall
	Supported by Medtronic

THURSDAY, JULY 16, 2009

7:00 - 15:30	Registration, E-Posters and Exhibits
7:00 - 7:50	Breakfast and Exhibit Viewing
7:50 – 9:15	General Session
	Supported by K2M
9:15 – 9:45	Refreshment Break and Exhibit Viewing
	Supported by Medtronic
9:45 – 10:45	Instructional Course Lectures – Session 1
10:45 – 11:30	Hands-On Demonstrations 1A-E* (with beverages/snacks)
11:30 – 12:30	Concurrent & Spine Fundamentals Sessions
12:30 – 12:45	Walking Break
12:45 – 13:45	Instructional Course Lectures – Session 2
13:45 – 14:30	Hands-On Demonstrations 2A-E* (with lunch)
14:30 – 15:30	Concurrent & Spine Fundamentals Sessions
15:30	Adjourn

FRIDAY, JULY 17, 2009

7:00 - 15:30	Registration, E-Posters and Exhibits
7:30 - 8:30	Instructional Courses Lectures - Session 3
8:30 - 9:15	Hands-On Demonstrations 3A-E* (with beverages/snacks)
9:15 – 11:15	Concurrent & Spine Fundamentals Sessions
11:15 - 11:45	Refreshment Break & Exhibit Viewing
	Supported by Medtronic
11:45 – 12:45	Instructional Course Lectures - Session 4
12:45 – 13:30	Hands-On Demonstrations 4A-E* (with lunch)
13:30 – 14:30	Concurrent Sessions
14:30 – 15:30	Round Table Case Discussions
15:30	Adjourn

SATURDAY, JULY 18, 2009

7:00 – 13:00	Registration, E-Posters and Exhibits
7:30 - 8:30	Instructional Courses Lectures - Session 5
8:30 - 9:15	Hands-On Demonstrations 5A-E* (with beverages/snacks)
9:15 – 11:15	Concurrent Sessions
11:15 – 13:00	General Session
	Supported by K2M
13:00	Adjourn

* sessions are not CME accredited.

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, and new this year, Hands-On Demonstrations, 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.

Physician Accreditation

Medical Education Resources is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to sponsor continuing medical education for physicians.

CME Credit Designation

Medical Education Resources designates this educational activity for a maximum of 16.17 *AMA PRA Category 1 Credit(s)* ™. Physicians should only claim credit commensurate with the extent of their participation in the activity.

This CME activity was planned and produced in accordance with the ACCME Essentials.

Disclosure Policy

It is the policy of Medical Education Resources, Inc. to ensure balance, independence, objectivity, and scientific rigor in all its sponsored educational programs. All faculty will disclose to the audience any real or apparent conflict(s) of interest related to the content of their presentation(s). Faculty relationships with companies whose products and/or services may be mentioned in their presentations will be indicated in the 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

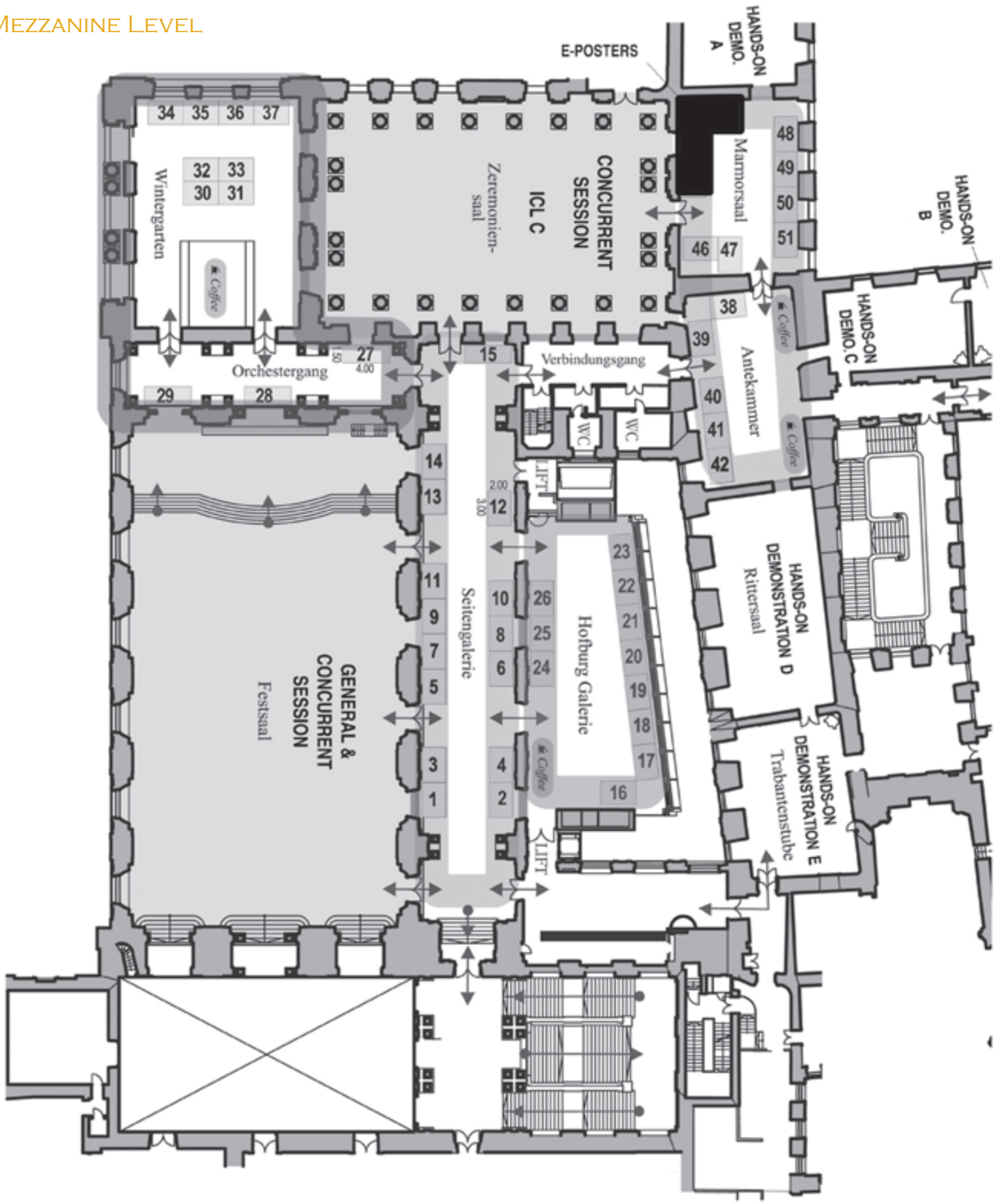
Presentations and course materials will be provided in English.

No Smoking Policy

Smoking is not permitted during any IMAST activity or event.

Hofburg Congress Center Floorplans

Mezzanine Level



Hofburg Congress Center Floorplans

First Level

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Author	Country	Relationships Disclosed
Kuniyoshi Abumi, MD	Japan	No Relationships
Frank L. Acosta, MD	USA	No Relationships
Clayton Adam	Australia	No Relationships
Max Aebi	Switzerland	No Relationships
Emin Aghayev, MD	Switzerland	No Relationships
Neslihan Aksu	Turkey	No Relationships
Hassan Alosh, BS	USA	No Relationships
Ignacio Alvarez, MD		No Relationships
Terry Amaral, MD	USA	No Relationships
Christopher P. Ames		No Relationships
Romney C. Andersen, MD	USA	No Relationships
Paul A. Anderson	USA	No Relationships
Lindsay M. Andras, MD	USA	No Relationships
M. Darryl Antonacci, MD	USA	No Relationships
Vincent Arlet	USA	No Relationships
Jahangir Asghar, MD	USA	DePuy Spine (b)
Geoff Askin, FRACS	Australia	No Relationships
Joshua D. Auerbach, MD	USA	Synthes Spine (a); DePuy Spine (a)
Mehmet Aydogan	Turkey	No Relationships
Ramin Bagheri	USA	NuVasive (b, c, f);
Georgios Bakaloudis	Italy	No Relationships
Richard Balderston	USA	Synthes (b, f)
Christine Baldus, RN MHS	USA	No Relationships
Kelley Banagan	USA	No Relationships
Qian Bang-pin	China	No Relationships
Eli Baron, MD	USA	Globus Medical (d); Styker (d); Trans1 (d)
Carlos Barrios	Spain	No Relationships
Paloma Bas Hermida	Spain	No Relationships
Teresa Bas Hermida, MD PhD	Spain	No Relationships
Tracey Bastrom, MA	USA	DePuy Spine, Inc. (a)
Saumyajit Basu, MS(Orth) DNB(Orth) FRCSEd	India	No Relationships
Nuno Batista	Portugal	No Relationships
Thomas W. Bauer, MD, PhD	USA	Stryker Spine (b)
Carlo Bellabarba		No Relationships
Aleksandar Beric, MD		No Relationships
Jason Bernard, MD FRCS(Orth)	United Kingdom	No Relationships
Therese Berry, BS	USA	Employee (e)
Ernesto Bersusky, MD	Argentina	No Relationships
Shay Bess, MD	USA	DePuy Spine (a,d); Nuvasive (b, f); Stryker Spine (d)

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Vidya M. Bhalodia, MS	USA	No Relationships
Wang Bin	China	No Relationships
Barry D. Birch, MD	USA	No Relationships
John Birknes	USA	No Relationships
Mirza Biscevic	Turkey	No Relationships
Kathy M. Blanke, RN	USA	No Relationships
Scott L. Blumenthal, MD	USA	DePuy Spine (b,e, f) Orthofix (b), Fziomed (b, c, f); Spinal Motion (c); Impliant (c)
Scott Boden, MD	USA	Osteotech (b, e) Medtronic (b, e); Abbott (a); Synthes (a); Johnson & Johnson (a); More than $10,000
Heinrich Boehm, MD	Germany	DePuy Spine (b)
Daniel Bonete		No Relationships
Gerg Bordon		No Relationships
J. A. Bowe, MD	USA	No Relationships
David Bradford, MD	USA	SAB (c); Spinal Motion (c)
Richard J. Bransford, MD	USA	DePuy (a); AO (a,d); Synthes (d)
Kelly R. Bratcher, RN CCRP	USA	No Relationships
Marco Brayda-Bruno		No Relationships
Keith Bridwell, MD	USA	Medtronic (a,b); DePuy (b)
Michael J. Brown, MD	USA	No Relationships
Jacob M. Buchowski, MD MS	USA	Stryker, Inc. (b, f); Medtronic, Inc. (e)
Brandon Bucklen	USA	Globus Medical (a)
Jesus Burgos, MD	Spain	No Relationships
J. Kenneth Burkus, MD	USA	Medtronic (a, b, f)
Douglas C. Burton, MD	USA	DePuy Spine (a, b); Axial Biotech (b), More than $10,000
Patrick J. Cahill, MD	USA	DePuy Spine, Inc. (a); Spine Vision, Inc. (b)
Michelle S. Caird, MD	USA	No Relationships
Mitchell J. Campbell, MD	USA	Medtronic (a, b, e, f); Norton Healthcare (a)
Robert M. Campbell, MD	USA	No Relationships
Leah Y. Carreon, MD MSc	USA	No Relationships
René M. Castelein, MD PhD	Netherlands	No Relationships
David A. Cavanaugh, MD	USA	Blackstone (a)
Donald P. Chan, MD	USA	No Relationships
Michael S. Chang, MD	USA	No Relationships
Jens Chapman		No Relationships
Edouard Chau		No Relationships
Rahul D. Chaudhari, MD	USA	No Relationships
Zhongqiang Chen	China	No Relationships
Joshua J. Chern, MD PhD	USA	No Relationships
Kazuhiro Chiba, MD PhD	Japan	Medtronic Sofamore Danek (b); Styker Japan (b)
Dong-Kyu Chin, PhD	Korea, South	No Relationships

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Randal P. Ching, PhD	USA	No Relationships
Kyu-Jung Cho, MD	Korea, South	No Relationships
Woojin Cho, MD PhD	USA	No Relationships
Yong-Eun Cho		No Relationships
Theodore J. Choma, MD	USA	No Relationships
Kook Jin Chung	Korea, South	No Relationships
Jean-Luc Clement	France	Major (b); Medicrea (b, f)
David H. Clements, MD	USA	DePuy Spine (a, b, f)
Jeffrey D. Coe, MD	USA	Synthes Spine (b); Medtronic (a); NuVasive (a, b)
Alexa Cohen	USA	No Relationships
Amy M. Cohen, MME	USA	No Relationships
David B. Cohen, MD	USA	No Relationships
Patrick B. Cooper, MD	USA	No Relationships
James A. Cordell-Smith, FRCS	United Kingdom	No Relationships
Andrea Corriero		No Relationships
Etevaldo Coutinho		No Relationships
Curtis Cox, MD	USA	Pioneer (a)
Dennis Crandall, MD	USA	Medtronic (a, b); Synthes (b), More than $10,000
Alvin H. Crawford, MD	USA	DePuy Spine (a, b, e)
Charles H. Crawford, MD	USA	No Relationships
Geoffrey A. Cronen, MD	USA	No Relationships
Laury A. Cuddihy, MD	USA	No Relationships
Bryan W. Cunningham, MSc	USA	Cervitech, Inc.(a); DePuy Spine, Inc(a); NuVasive Inc. (a)
Matthew E. Cunningham, MD PhD	USA	K2M (b)
Daniel J. Curry, MD	USA	Aesculap (b)
Timothy B. Curry, MD PhD	USA	No Relationships
John K. Czerwein, MD	USA	No Relationships
Robert C. Dauser, MD	USA	No Relationships
Laura E. Dean, BA	USA	No Relationships
Mursel Debre		No Relationships
H. Gordon Deen	USA	No Relationships
Mark B. Dekutoski, MD	USA	Medtronic (a, b,e, f); DePuy (a); Stryker (a); Synthes (a, f)
Rick B. Delamarter, MD	USA	Stryker (a, e, f); Synthes (a, e, f); Zimmer (e, f)
Rasesh Desai, MD	USA	No Relationships
Vedat Deviren, MD	USA	No Relationships
Mario Di Silvestre	Italy	No Relationships
Mohammad Diab, MD	USA	No Relationships
Peter Diel	Switzerland	No Relationships
John R. Dimar, MD	USA	Medtronic Sofamor Danek (a, b, e, f)
Yu Ding, PhD	China	No Relationships

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Dzung Dinh		No Relationships
Mladen Djurasovic, MD	USA	Medtronic Sofamor Danek (a, b, f)
Pedro Domenech		No Relationships
William Donaldson	USA	Stryker (a, f)
John P. Dormans, MD	USA	No Relationships
Xavier Drevelle	France	No Relationships
Joseph W. Dryer, MD	USA	No Relationships
Jean Dubousset	France	No Relationships
Atiq Durrani, MD	USA	Medtronic (b); DePuy (b); K2M (b)
Marcel Dvorak, MD FRCSC	Canada	Medtronic (b, e); Synthes (e); DePuy (e); More than $10,000
Jason C. Eck, DO MS	USA	No Relationships
Tobin Eckel		No Relationships
Kurt Eichholz, MD	USA	No Relationships
Mohammad El-Sharkawi, MD	Egypt	No Relationships
John Emans, MD	USA	Synthes (a,b, f); Medtronic (b)
Meric Enercan	Turkey	No Relationships
Thomas J. Errico, MD	USA	Stryker (a, b, c, f)
Ismael Escriba Roca	Spain	No Relationships
Justin Esterberg, MD	USA	No Relationships
Jean-Pierre C. Farcy, MD	USA	No Relationships
Frances A. Farley, MD	USA	No Relationships
Ira L. Fedder		No Relationships
Michael Fehlings, MD PhD	Canada	DePuy Spine (a, b); Medtronic (a); Synthes (a)
David S. Feldman, MD	USA	Stryker Spine (a, d); Biomet (a, b, d)
Zhu Feng	China	No Relationships
Pedro M. Fernandes	Portugal	No Relationships
Luis Ferraris	Germany	No Relationships
John M. Flynn, MD	USA	Medtronic Sofamor Danek (d); Biomet (b); Synthes (a); Wolters Kluwer Health - LWW (e)
Madilyne E. Fogarty, BS	USA	No Relationships
Nuria Franco Ferrando, MD	Spain	No Relationships
Mark Freeborn, MD	USA	No Relationships
Brian J. Freeman, DM FRCS (Tr & Orth)	Australia	No Relationships
Michael Frisch		No Relationships
Kaiming G. Fu, MD PhD	USA	No Relationships
Hirokazu Fujiwara		No Relationships
Peter G. Gabos, MD	USA	No Relationships
Melanie Gambassi, NP	USA	No Relationships
Yubo Gao, PhD	USA	No Relationships
Fred H. Geisler, MD, PhD	USA	DePuy Spine (b)
Daniel Gelb, MD	USA	Synthes Spine (b)

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Martin K. Gelbke, MD	USA	No Relationships
Anne Geoffray		No Relationships
Edward J. Gerber, PA-C	USA	Trans1 (e); Exactech (e)
Ziya Gokaslan, MD	USA	No Relationships
Jeffrey D. Gordon, MS Mech Eng	USA	No Relationships
Michael J. Goytan, MD	Canada	No Relationships
Randolph Gray, MBBS FRACS	Canada	No Relationships
Growing Spine Study Group	USA	No Relationships
Steve A. Guillory, PA-C	USA	No Relationships
Zhaoqing Guo, MD	China	No Relationships
Lawrence L. Haber, MD	USA	No Relationships
Regis W. Haid, MD	USA	Medtronic Sofamor Danek (e); Globus Medical, Inc. (e); More than $10,000
In-Ho Han	Korea, South	No Relationships
David Hanscom		No Relationships
Amy Hanson, CCRC	USA	No Relationships
Richard M. Harrington, MS	USA	No Relationships
Nanjundappa S. Harshavardhana, MS(Orth) Dip. SICOT	United Kingdom	No Relationships
Robert A. Hart, MD	USA	Medtronic (a, b, d); DePuy (a, b, d, f); Sea Spine (b); Kyphon (d)
Nicola Hawkinson, NP	USA	No Relationships
Sam Heaton, MBBS, BSc (Hons) MRCS	United Kingdom	No Relationships
Paul F. Heini, MD	Switzerland	No Relationships
Ilkka Helenius, MD PhD	Finland	Medtronic (b); Foundation for Paediatric Research (a)
Melvin D. Helgeson, MD	USA	No Relationships
Axel Hempfing	Germany	No Relationships
Robert N. Hensinger, MD	USA	No Relationships
Eduardo Hevia, MD	Spain	No Relationships
John Hicks, MD		No Relationships
Yoshihiro Hojo, MD	Japan	No Relationships
Jae-Young Hong, MD	Korea, South	No Relationships
William C. Horton, MD	USA	No Relationships
Richard Hostin, MD	USA	DePuy Spine (a)
Jennifer M. Howard, MPH	USA	No Relationships
Patrick C. Hsieh, MD	USA	No Relationships
Nianbin Hu	USA	No Relationships
Paul M. Huddleston, MD	USA	No Relationships
Joshua Hughes, BA	USA	No Relationships
Ludovic Humbert		No Relationships
Leonel A. Hunt, MD	USA	No Relationships
Louis N. Hunter, PT, MS	USA	No Relationships
Kade T. Huntsman, MD	USA	Nuvasive (a, f)

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Jonathan A. Hyde, MD	USA	Nuvasive (a, b,c)
Seung Jae Hyun	Korea, South	No Relationships
Daisuke Ichihara	Japan	No Relationships
Takeshi Ikegami	Japan	No Relationships
Tamás Illés, MD DSc	Hungary	No Relationships
Antti Impinen, Msc	Finland	No Relationships
Aditya Ingalhalikar, MS	USA	Globus Medical (e, f)
Jorge E. Isaza, MD	USA	No Relationships
Manabu Ito, MD	Japan	No Relationships
Akio Iwanami	Japan	No Relationships
Maree T. Izatt, B Phty	Australia	No Relationships
Joshua Jacobs	USA	Medtronics (a, b, f); Zimmer (a, b, f); Wright Medical (a, f), Archus (a); Advanced Spine Technology (a, f); Spinal Motion (a, f)
Sudeep Jain, MBBS MS(ORTH) M.CH(ORTH)	India	No Relationships
Viral V. Jain, MD	USA	No Relationships
Tuomas Jalanko	Finland	The Foundation for Pediatric Research (Finland) (a); The Finnish Orthopaedical and Traumatological Foun (a); Rinnekoti Research Foundation (Finland) (a); HUCH Institute Ltd (Finland) (a)
Michiel Janssen	Netherlands	No Relationships
Ajay Jawahar, MD	USA	No Relationships
Aravind Jayaswal		No Relationships
Andrew Jea, MD	USA	No Relationships
Chang-Won Jeong, MD	Korea, South	No Relationships
Sarah Jernigan, MD	USA	No Relationships
Byung-Ho Jin		No Relationships
John R. Johnson, MD	USA	Medtronic Sofamor Danek (a, b, e, f)
Jae-Hoon Jung		No Relationships
Jonathan R. Kamerlink, MD	USA	No Relationships
James D. Kang, MD	USA	No Relationships
Neha Kantamneni, BS	USA	No Relationships
Selhan Karadereliler	Turkey	No Relationships
Eldin Karaikovic	USA	No Relationships
Omer Karatoprak	Turkey	No Relationships
Kristin E. Kean, BA	USA	No Relationships
Khaled M. Kebaish, MD	USA	No Relationships
Kathryn A. Keeler, MD	USA	No Relationships
Beverly J. Kelly, MS	USA	No Relationships
Eubulus J. Kerr, MD		No Relationships
Kaveh Khajavi, MD	USA	No Relationships
Saif Khalil, PhD	USA	Globus Medical, Inc. (e, f)

Author Disclosures

If noted, the relationships disclosed are as follows: (a)Grants/Research Support; (b)Consultant; (c)Stocks/Shareholder; (d)Speaker's Bureau; (e)Other Financial Support; (f)Support in excess of $10,000

Jun Kikkawa, MD	USA	No Relationships
Hak Sun Kim	Korea, South	No Relationships
Hyung-Suk Kim		No Relationships
Jin-Hyok Kim, MD PhD	Korea, South	No Relationships
Jin-Young Kim		No Relationships
Keun Su Kim, MD PhD	Korea, South	No Relationships
Ki-Tack Kim, MD PhD	Korea, South	No Relationships
Sung-Soo Kim, MD	Korea, South	No Relationships
Whoan Jeang Kim	Korea, South	No Relationships
Eric Klineberg	USA	No Relationships
James Klunk, BS	USA	No Relationships
D. R. Knapp, MD	USA	No Relationships
Reginald Knight, MD	USA	Medtronic (b), Stryker (b, e); pinal Motions (a); Archus (a)
Phebe S. Ko, BS	USA	No Relationships
Linda A. Koester, BS	USA	No Relationships
Heiko Koller, MD	Germany	No Relationships
Daryl J. Kor, MD	USA	No Relationships
Pradeep Koramutla, MD DA	India	No Relationships
Fatih M. Korkmaz		No Relationships
Panagiotis Korovessis, PhD	Greece	No Relationships
Tyler Koski, MD	USA	Medtronic (a, b, f)
Yoshihisa Kotani, MD	Japan	No Relationships
Jan Kryl		No Relationships
Sung-Uk Kuh, MD PhD	Korea, South	No Relationships
Timothy R. Kuklo, MD	USA	Medtronic (a, b, f)
Ramesh Kumar		No Relationships
Vishal Kundnani, MS FASSI	India	No Relationships
Young-Min Kwon, MD	Korea, South	No Relationships
Sakari Kääriäinen	Finland	No Relationships
Robert Labrom, MD	Australia	No Relationships
Virginie Lafage, PhD	USA	No Relationships
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James Langdon, MRCS	United Kingdom	No Relationships
Eugene Lautenschlager, PhD		No Relationships
Michael J. Lee, MD	USA	No Relationships
Sang-Hun Lee, MD PhD	Korea, South	No Relationships
Ronald A. Lehman, MD	USA	No Relationships
Stephen Lewis, MD FRCSC MSc	Canada	Medtronic (b); Stryker (b); More than $10,000
Juliano Lhamby		No Relationships
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Michael Liebschner, PhD	USA	No Relationships
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John C. Liu, MD	USA	Medtronic (b, f)
Francesco Lolli	Italy	No Relationships
Baron S. Lonner, MD	USA	DePuy Spine (a, b, d, e, f); Stryker Spine (d); Axial Biotech (c); K2M (c)
Alessio Lovi		No Relationships
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Thomas G. Luerssen	USA	No Relationships
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Keith D. Luk	China	No Relationships
James R. Malcolm, MD	USA	NuVasive (a, b, c, d, f)
Richard Manos, MD	USA	No Relationships
KeYa Mao		No Relationships
Rex Marco, MD	USA	No Relationships
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Eric M. Massicotte, MD	Canada	No Relationships
Morio Matsumoto, MD	Japan	No Relationships
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Anna M. McClung, RN	USA	No Relationships
Peter McCombe	Australia	Medtronic (b)
Craig McDonald, MD		No Relationships
Mark D. McGinnis, MD	USA	No Relationships
Erin M. Meehan, BS	USA	No Relationships
Amir A. Mehbod, MD	USA	Medtronic, Stryker (a, b)
Hossein S. Mehdian, FRCS (Tr & Orth)	United Kingdom	No Relationships
Oliver Meier, MD	Germany	Stryker (a)
Markus Melloh	New Zealand	No Relationships
Sergio A. Mendoza-Lattes, MD	USA	Medtronic Sofamor-Danek (a, b)
Andrew H. Milby, BS	USA	No Relationships
Akio Minami	Japan	No Relationships
George Miz, MD	USA	Stryker Spine (a, b)
Hitesh N. Modi, MS	Korea, South	No Relationships
Ahmed S. Mohamed, MD	USA	No Relationships
Mark Moldavsky, BS	USA	Coop (e)
Fred Molitor, PhD	USA	No Relationships
David Moller, MD	USA	No Relationships
Sean Molloy, FRCS (Orth)	United Kingdom	See Faculty Listing
Suketaka Momoshima, MD	Japan	No Relationships

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Praveen V. Mummaneni, MD	USA	See Faculty Listing
Gregory M. Mundis, MD	USA	No Relationships
Aditya M. Muzumdar, MS	USA	No Relationships
Ankur Nanda	Korea, South	No Relationships
Ahmad Nassr, MD	USA	No Relationships
Chris J. Neal, MD	USA	No Relationships
Lesa M. Nelson, BS	USA	Axial Biotech, Inc (e, f)
Abhay Nene	India	No Relationships
Peter O. Newton, MD	USA	See Faculty Listing
Quynh Nguyen, MHS PA-C	USA	No Relationships
Yuji Nishiwaki	Japan	No Relationships
Hilali Noordeen, MA BM BCh (Oxon) FRCS(Eng) MChOrth FRCS(Orth)	United Kingdom	See Faculty Listing
Eric W. Nottmeier	USA	No Relationships
Pierce D. Nunley, MD	USA	Biomet(a); Blackstone(a); K2M (a, b, c, d, f); LDR (a, b); Orthovita (a); Spinal Mo (a); Amedica (c); Paradigm (c); Spineology (c); NuVasive (b, d, f)
Joseph R. O'Brien, MD MPH	USA	DePuy (b, f); Stryker Spine (b, f)
Michael F. O'Brien, MD	USA	See Faculty Listing
Brian A. O'Shaughnessy, MD	USA	No Relationships
John O'Toole, MD	USA	Globus Medical, Inc. (b)
James W. Ogilvie, MD	USA	Axial Biotech (b, f)
Donna D. Ohnmeiss		No Relationships
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Eijiro Okada, MD	Japan	No Relationships
David O. Okonwko, MD		No Relationships
Daniel d. Oliveira, MD	Brazil	No Relationships
Leonardo Oliveira, BSc	Brazil	No Relationships
Stephen Ondra, MD	USA	Medtronic (a, b, e, f)
Kimihiko Onoue	Japan	No Relationships
Ibrahim Ornek		No Relationships
Timothy S. Oswald, MD	USA	No Relationships
Jean Ouellet, MD	Canada	AO Spine North America (a); DePuy Spine (b)
Cagatay Ozturk	Turkey	No Relationships
Mikko P. Pakarinen, MD PhD	Finland	No Relationships

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Cate Pandiscio, PA-C	USA	No Relationships
Stefan Parent, MD PhD	Canada	No Relationships
Hyung-Soon Park, PhD	USA	No Relationships
Andrew B. Parkinson	USA	No Relationships
Timo J. Parkkila, PhD	Finland	No Relationships
Alpesh Patel, MD	USA	Amedica (b); Stryker Spine (b)
Amar Patel		No Relationships
Ashish Patel, MD	USA	No Relationships
Naresh P. Patel, MD	USA	Kyphon (b); Stryker (b)
Uday M. Pawar, D'orthDNB orth	India	No Relationships
John H. Peloza, MD	USA	No Relationships
Chan W. Peng, MD	Singapore	No Relationships
Luis Perez Millan	Spain	No Relationships
Joseph H. Perra, MD	USA	Medtronic (b); Abbott Northwestern Hospital (e); Abbott Spine (b); Bethseda Spine Course (d); Stryker (d); More than $10,000
Oma D. Persaud, MSc	Canada	No Relationships
Mark D. Peterson, MD	USA	Nuvasive (b, c, f)
Mark A. Pichelmann, MD	USA	No Relationships
Luiz Pimenta, MD PhD	Brazil	See Faculty Listing
Manuel R. Pinto, MD	USA	Proctor (e)
Gabriel Piza	Spain	Medtronic (b)
Avraam Ploumis, MD PhD	Greece	No Relationships
Vinod K. Podichetty, MD	USA	No Relationships
Kornelis Poelstra, MD PhD	USA	No Relationships
Seng Yew Poh	Singapore	No Relationships
David W. Polly	USA	See Faculty Listing
Ravi Ponnappan, MD	USA	No Relationships
Ville T. Puisto, MD	Finland	No Relationships
Albert Pull ter Gunne, MD	USA	No Relationships
Rolando M. Puno, MD	USA	Medtronic Sofamor Danek (a, b, e)
Qiang Qi		No Relationships
Martin Quirno, MD	USA	No Relationships
Felipe Ramirez, MD		No Relationships
Norman Ramirez, MD	USA	No Relationships
Y. R. Rampersaud, MD FRCS	Canada	Medtronic Sofamor Danek (b, f)
Arun Ranganathan, MRCS DM	United Kingdom	No Relationships
Sreeramalingam Rathinavelu	India	No Relationships
Vasantha Reddi, PhD	USA	No Relationships
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Seung Chul Rhim, MD PhD	Korea, South	No Relationships
B. Stephens Richards, MD	USA	See Faculty Listing
Mark A. Rieger, MD	USA	No Relationships
Zachary Ries, BSc	USA	No Relationships
K. Daniel Riew, MD	USA	See Faculty Listing
David Roberts, MD	USA	No Relationships
W. B. Rodgers, MD	USA	NuVasive (a, b, c, e, f); Trans1 (a, b, e, f); Exactech (a, b, f)
Eduardo S. Rodrigues, MD	USA	No Relationships
Juan Carlos Rodriguez Olaverri, MD	USA	No Relationships
Sung Woo Roh		No Relationships
Peter S. Rose, MD	USA	No Relationships
Steven H. Rose, MD	USA	No Relationships
Dike Ruan, PhD	China	No Relationships
Steven A. Rundell	USA	No Relationships
Anthony Russo, MD	USA	No Relationships
Christoph Röder, MD MPH	Switzerland	No Relationships
Sam Saidy, MD	USA	No Relationships
Pooria Salari	USA	No Relationships
Amer Samdani, MD	USA	DePuy Spine (b); Spine Vision (b); Synthes Spine (a, b)
James O. Sanders, MD	USA	Medtronic (a)
Ignacio Sanpera, MD PhD	Spain	No Relationships
Charles A. Sansur, MD	USA	No Relationships
John Sarbello	USA	No Relationships
Vishal Sarwahi, MD	USA	No Relationships
John Sarwark, MD	USA	No Relationships
Rick Sasso, MD	USA	See Faculty Listing
Jason Savage, MD	USA	No Relationships
Frank Schwab	USA	See Faculty Listing
Daniel Schwartz, MD	USA	No Relationships
Daniel M. Schwartz, PhD	USA	No Relationships
John Seaburg, MD	USA	No Relationships
Petr Sebesta		No Relationships
S. A. Sems, MD	USA	No Relationships
Anthony K. Sestokas, PhD	USA	No Relationships
Christopher I. Shaffrey, MD	USA	See Faculty Listing
Suken A. Shah, MD	USA	DePuy Spine, Inc. (a, b, e, f); Axial Biotech, Inc. (a)
Deep Sharma		No Relationships
Vivek Sharma, MD	USA	No Relationships
Ahmed M. Shawky, MD	Germany	No Relationships

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Alexis P. Shelokov, MD	USA	DePuySpine (a, b); Osteotech (b); K2M (b); Stryker (b), More than $10,000
Francis H. Shen	USA	See Faculty Listing
Jeffrey Shilt, MD	USA	No Relationships
Dong-Eun Shin, MD	Korea, South	No Relationships
Osamu Shirado, MD	Japan	No Relationships
Brenda Sides, MA	USA	No Relationships
Ryan Sieg	USA	No Relationships
Krzysztof B. Siemionow	USA	Synthes Spine (b); Mazor Surgical Technologies (e)
James P. Sieradzki, MD	USA	No Relationships
Marc V. Singleton, MS	USA	No Relationships
Wafa Skalli, PhD	France	No Relationships
Richard L. Skolasky, ScD	USA	No Relationships
Nicholas Slimack	USA	No Relationships
Jennifer Smail, MD	USA	No Relationships
James D. Smith, MD	USA	No Relationships
John T. Smith, MD	USA	Synthes Spine, USA (b, f)
Justin Smith, MD PhD	USA	No Relationships
William D. Smith, MD	USA	NuVasive, Inc. (b, c, d, f) Medtronic, Inc. (b), Spineology (b), TranS1 (b, d, f)
Rolf Sobottke	Germany	No Relationships
Susana Soler	Spain	No Relationships
Szabolcs Somoskeoy, MD	Hungary	No Relationships
Kit Song, MD MHA	USA	No Relationships
Spinal Deformity Study Group	USA	Medtronic (e)
Jeffrey M. Spivak, MD	USA	Paradigm Spine (c); Titan Spine (b); Synthes Spine (b); More than $10,000
Paul Sponseller, MD	USA	DePuy Spine (a, e, f); Globus (e, f)
Jonathan R. Stieber, MD	USA	Stryker Spine (b)
Harms Study Group	USA	DePuy Spine (a, f)
International Spine Study Group	USA	DePuy Spine (a, f)
Spinal Deformity Study Group		No Relationships
Jan Stulik	Czech Republic	No Relationships
Peter Sturm, MD	USA	DePuy Spine (b); Pioneer Surgical (c)
Daniel J. Sucato, MD MS	USA	See Faculty Listing
Hideki Sudo, MD	Japan	No Relationships
Patrick A. Sugrue, MD	USA	No Relationships
Seung-Woo Suh, MD PhD	Korea, South	No Relationships
Se-Il Suk, MD, PhD	Korea, South	No Relationships
Chuiguo Sun		No Relationships
Shozo Suzuki	Japan	No Relationships
Richard A. Sweet, BS	USA	No Relationships

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Takeshi Takahata		No Relationships
Seang Beng Tan		No Relationships
Brett A. Taylor	USA	No Relationships
Marco G. Teli, MD	Italy	No Relationships
Honglin Teng	China	No Relationships
Mehmet Tezer	Turkey	No Relationships
John S. Thalgott, MD	USA	Surgicraft (b, c); Centinel Spine (b, c)
Beverly Thornhill, MD	USA	No Relationships
Antoine G. Tohmeh, MD	USA	Nuvasive (a, b, c, f)
Justin P. Tortolani, MD		No Relationships
Yoshiaki Toyama		No Relationships
Ensor E. Transfeldt, MD	USA	See Faculty Listing
Vincent Traynelis, MD	USA	Medtronic (a, b, e, f); United HealthCare (b)
Joseph L. Turner, MS	USA	Medtronic (c, e, f)
Robert M. Urban	USA	Spinal Motion, Inc (b)
Alexander R. Vaccaro, MD PhD	USA	Medtronic (a, b, e, f)
Marie-José Vallade		No Relationships
Kelly Vanderhave, MD	USA	No Relationships
Vikas Varma, MD	USA	No Relationships
Erkki A. Vartiainen	Finland	No Relationships
David Vecchione, BA	USA	No Relationships
Venu Vemuri, MD		No Relationships
Kushagra Verma, MS	USA	No Relationships
Lawrence C. Vogel	USA	No Relationships
Ildemaro J. Volcan, MD	USA	Nuvasive (b, d); Globus (b); Orthovita (b), More than $10,000
Frank Vrionis	USA	No Relationships
Tomas Vyskocil		No Relationships
Vincent Y. Wang, MD PhD	USA	No Relationships
Yan Wang, MD	China	No Relationships
Zheng Wang, MD		No Relationships
Kenneth Ward	USA	Axial Biotech (c, e)
Matthew A. Warner	USA	No Relationships
Ma Wei-wei	China	No Relationships
Stuart Weinstein, MD	USA	No Relationships
Camden Whitaker, MD	USA	Stryker Spine (b, f)
William E. Whitehead, MD	USA	No Relationships
Reed C. Williams	USA	No Relationships
Nicholas J. Wills, MD	USA	No Relationships
Greg C. Wilson	USA	No Relationships

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Adam L. Wollowick, MD	USA	No Relationships
Erika D. Womack	USA	No Relationships
Kirkham B. Wood, MD	USA	Inion Inc. (c); TranS1 (c); Medtronic (a); DePuy Spine (e); Globus Inc. (e)
Chunhui Wu, PhD	USA	No Relationships
Shaun Xavier, MD	USA	No Relationships
Sun Xu	China	No Relationships
Takayuki Yamashita, MD	USA	No Relationships
Tomoya Yamashita	Japan	No Relationships
Jae-Hyuk Yang, MD	Korea, South	No Relationships
Yu Yang	China	No Relationships
Michael J. Yaszemski, MD PhD	USA	No Relationships
William Yeo	Singapore	No Relationships
Qiu Yong	China	No Relationships
Sang-Phil Yoon		No Relationships
Sangwook Yoon, MD	USA	Nuvasive (a)
Wai Mun Yue	Singapore	DePuy (e); Medtronics (e)
Antonino Zagra		No Relationships
Rami R. Zanoun	USA	No Relationships
Thomas Zdeblick		No Relationships
Zhu Ze-zhang	China	No Relationships
Lukas P. Zebala, MD	USA	No Relationships
Reinhard Zeller, MD FRCSC	Canada	Spinevision (e); Paradigm Spine (e); More than $10,000
Yan Zeng, MD	China	No Relationships
Juliane Zenner	Germany	No Relationships
Li-Qun Zhang, PhD	USA	No Relationships
Xuesong Zhang, MD	China	No Relationships
Yonggang Zhang, MD	China	No Relationships
Guoquan Zheng		No Relationships
Xiujun Zheng, MD	USA	No Relationships
Wu Zhuge, MD	USA	No Relationships
Jack Zigler, MD	USA	Johnson & Johnson (a); Medtronic (a); Synthes (a, b, f); Abbott (a, b); EOI (b); AST (b); Osprey (b); AST (c)
Ryan Zimmerman	USA	No Relationships
Thomas Zweig	Switzerland	No Relationships

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Francis H. Shen MD	University of Virginia	Charlottesville, VA USA	DePuy (a, b, d); AO (a); Musculoskeletal Transplant Foundation (a)
Robert Wienecke MD		Oklahoma City, OK USA	No Relationships

KEYNOTE SPEAKERS:

Oheneba Boachie-Adjei MD	Hospital for Special Surgery	New York, NY USA	DePuy (b,d, e); Osteotech (b, d, e); K2M (b, c, d, e);

INSTRUCTIONAL COURSE LECTURE (ICL) FACULTY:

Behrooz A. Akbarnia MD	San Diego Center for Spinal Disorders	La Jolla, CA USA	Nuvasive (a, b, c, d); Stryker (d); K2M (b, d); DePuy (a, b, d); Ellipse Technologies, Inc (b); Medtronic Sofamor Danek (a); Allez Spine (a)
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Neel Anand MD	Cedar Sinai Medical Center	Los Angeles, CA USA	Globus Medical (b, c, d); Medtronic Sofamor Danek (b, d); Zimmer (a, d); Trans1 (b, c, d); Applied Spine (d) Kyphon, Inc (b); Nuvasive (b, c)
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Rudolph Bertagnoli MD	ECSA First European Center for Spine	Straubing GERMANY	Synthes (b); Paradigm Spine (b)
Sigurd H. Berven MD	University of California-San Francisco	San Francisco, CA USA	DePuy (a, b, d); Kyphon, Inc (b, d); Medtronic Sofamor Danek (a, b, d); Osteotech (b, d)
Randal R. Betz MD	Shriners Hospital	Philadelphia, PA USA	DePuy (a, b, d); Medtronic Sofamor Danek (b, d); Synthes (a, b, d); Spinevision (b, d); Osteotech (b, c, d); Orthovita (b); NuVasive (b); Omrix (b); Spinemedica (b, c); Orthocon (c)
J. Abbott Byrd, III MD	Vann Virginia Center for Orthopaedics	Virginia Beach, VA USA	No Relationships
Kenneth M C Cheung MD	Queen Mary Hospital	HONG KONG	Synthes (a)
H. Alan Crockard, FRCS	The National Hospital for Neurology & Neurosurgery	London UNITED KINGDOM	DePuy (e)

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Steven D. Glassman MD	Spine Institute	Louisville, KY USA	Medtronic Sofamor Danek (a, b)
Jeffrey A. Goldstein MD	NYU - Hospital for Joint Diseases	New York, NY USA	Synthes (a, b, d); K2M (b, c); Medtronic (a, b); AO (a); DePuy (a); Spine Solutions (c); Physicians Fellowship Partners (c)
Matthew F. Gornet MD	The Orthopedic Center of St. Louis	Chesterfield, MO USA	Medtronic Sofamor Danek (a); BioAssets Development Coporation (c); Bonovo (c); K2 (c); Ouroborus (c); Pioneer (c)
Theodoros B. Grivas MD	Thriasion General Hospital	Attica GREECE	No Relationships
Michael W. Groff MD	Beth Israel Deaconess Medical Center- Dept. Neurosurgery	Boston, MA USA	DePuy Spine (a, b); EBI Spine (a, b)
Richard Guyer MD	Texas Back Institute	Plano, TX USA	DePuy (a, b, d); Synthes (a, b, d); Spinal Motion (b); Abbott (a); Medtronic Neuro (a); K2M (c); Spinal Motion (c)
Henry F.H. Halm MD	Klinikum Neustadt	Neustadt GERMANY	DePuy (a, b)
Alan S. Hilibrand MD	Rothman Institute at Jefferson	Philadelphia, PA USA	Medtronic (a); DePuy (a); Stryker (a); Osteotech (a); Synthes (a); Amedica (c); Vertiflex (c); Nexgen (c); Benvenue Medical (c); Pioneer Surgical (c); Lifespine (c); Paradigm Spine (c); PSD (c); Syndicom (c)
Hubert Labelle MD	Hospital Sainte-Justine Ortho Dept	Montreal CANADA	Medtronic Sofamor Danek (a)
Jean-Charles Le Huec MD PhD	Unite Colonne Vertebrale Et Membre Sup.	Bordeaux FRANCE	No Relationships
Isador H. Lieberman MD MBA FRCSC	The Cleveland Clinic Florida	Weston, FL USA	AxioMed (a, b, c, e); MAZOR Surgical Technologies (a, b, c, e); Merlot Orthopaedix (a, b, c, e); Crosstrees (a, b, c, e); Trans1 (a); Kyphon (a); Medtronic (a); Orthovita (a); Stryker (a); DePuy (a)
Steven C. Ludwig MD	University of Maryland-Ortho	Baltimore MD USA	AO (b, d, e); DePuy (b, d, e); Globus Medical (b, c, d, e); Stryker (b, d, e); Synthes (b, d, e); Current Opinion in Orthopaedics (e); Wolets Kluwer Health-Lippincott Williams & Wilkins (e)
David S. Marks FRCS	Royal Orthopaedic Hospital	Northfield UNITED KINGDOM	DePuy Spine (b); Medtronic (b)
Paul C. McAfee MD		Sparks MD USA	No Relationships
Richard E. McCarthy MD	Arkansas Children's Hospital	Little Rock, AR USA	Medtronic Sofamor Danek (b, d); Synthes (b)
Sean Molloy MBBS MSc FRCS DC	Gerrards Cross	UNITED KINGDOM	Medtronic (a)
Praveen V. Mummaneni MD	University of California- San Francisco	San Francisco, CA USA	Medtronic (a, b); DePuy Spine (a, b, e)
Peter O. Newton MD	Rady Children's Hospital and Health Center	San Diego, CA USA	DePuy (a, b, d); National Institutes of Health (NIAMS & NICHD) (a); Axial Biotech (a); Alphatec Spine (a); Zimmer (a); Nuvasive (a)

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Hilali H. Noordeen FRCS		London UNITED KINGDOM	No Relationships
Luiz Pimenta MD	Santa Rita Hospital	Sao Paulo BRAZIL	Nuvasive (b), Globus Medical (b), Apatech (b), Nexgen (b), Impliant (b)
David W. Polly, Jr. MD	University of Minnesota-Department of Orthopaedic Surgery	Minneapolis, MN USA	Medtronic (b, d); Medtronic Sofamor Danek (a, d, e); Biomet (a); DePuy (a); Synthes (a); Zimmer (a)
K. Daniel Riew MD	Washington University School of Medicine	Saint Louis, MO USA	SpineMedica (b); Medtronic Sofamor Danek (a); Osprey (c); Spinal Kinetics (c); Amedica (c); Nexgen Spine (c); Vertiflex (c); Benevenue (c); Paradigm Spine (c); PSD (c); Spineology (c)
Michael Ruf MD	Head of Department, Orthopedics & Traumatology	Suhl GERMANY	DePuy Spine (b)
Rick C. Sasso MD	Indiana Spine Group	Indianapolis, IN USA	Ono Pharmaceutical (d); Medtronic Sofamor Danek (a, b); AO (a); Cerapedics (a); Eli Lilly (a); Stryker (a); Biomet (c)
Frank J. Schwab MD	NYU-Hospital for Joint Diseases	New York, NY USA	DePuy (a, b, e); Medtronic Sofamor Danek (a, b, e)
Christopher I. Shaffrey MD	University of Virginia Medical Center	Charlottesville, VA USA	No Relationships
Harry L. Shufflebarger MD	Miami Children's Hospital	Miami, FL USA	DePuy (b, d)
Daniel J. Sucato MD, MS	Texas Scottish Rite Hospital for Children	Dallas, TX USA	Medtronic (a)
George H. Thompson MD	Rainbow Babies & Children's Hospital	Cleveland, OH USA	DePuy (a, b); Orthopediatrics (b) Journal Of Pediatic Orthopedics (a); Medtronic Sofamor Danek (a); Zimmer (a)
Yan Wang MD	The General Hospital of Chinese	Beijing PEOPLES REPUBLIC OF CHINA	No Relationships
Mark Weidenbaum MD	Columbia University	New York, NY USA	DePuy (d); Medtronic Sofamor Danek (d); Osteotech (d); Arthrex, Inc. (a)
James J. Yue MD	Yale University Medical Center - Orthopaedic Surgery	New Haven, CT USA	Aesculap/B.Braun (a, b, d); Alphatec Spine (a, b, c, d); DePuy (a, b)

Meeting Agenda

The Scoliosis Research Society gratefully acknowledges DePuy Spine, a Johnson & Johnson Company, for their support of the E-Poster CD-ROM, Wireless Internet, and overall meeting support.

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Meeting Agenda

WEDNESDAY, JULY 15, 2009

17:00 – 19:30 **Registration Opens**
Hofburg Congress Center, First Level

Welcome Reception
Exhibit Hall, Mezzanine Level
Supported by Medtronic Spinal & Biologics

THURSDAY, JULY 16, 2009

7:00 – 15:30 **Registration, E-Posters & Exhibits Open**

7:00 – 7:30 **Breakfast & Exhibits Viewing**
Exhibit Hall, Mezzanine Level

7:30 – 9:15
General Session #1: DEFORMITY, LUMBAR, MOTION
Location: Festaal
Moderators: Todd J. Albert MD
Rudolf Bertagnoli MD

Supported by K2M, Inc.

7:30 **Welcome**
Todd J. Albert MD
IMAST Committee Chair

7:40 ****Paper #1: The Cost Effectiveness of Lumbar Fusion at Five Years after Surgery**
Steven D. Glassman MD, David W. Polly, John R. Dimar MD, Leah Y. Carreon MD MSc
**Whitecloud Award nominee – Best Clinical Paper*

7:44 **Paper #2: Direct Economic Impact of Posterior Minimally Invasive Compared to Conventional Open Fusion Procedures for Lumbar Spondylolisthesis**
Randolph Gray MBBS FRACS, Michael Fehlings MD PhD, Stephen Lewis MD FRCSC MSc, Eric M. Massicotte MD, Y. R. Rampersaud MD FRCS

7:48 **Paper #3: SWISSspine National Mandatory Registry for Lumbar Total Disc Arthroplasty: Clinical Results of 427 Patients and 497 Implants**
Emin Aghayev, Thomas Zweig, Patrick Moulin, Group SwissSpine, Christoph Röder MD MPH

7:52 **Discussion**

8:00 **Paper #4: Re-Operations in Lumbar Total Disc Replacement: Experience with Our First 800 Consecutive Cases**
Jack Zigler MD, Andrew B. Parkinson, Richard D. Guyer MD, Scott L. Blumenthal MD, Donna D. Ohnmeiss

8:04 ****Paper #5: Complication Rates of Three Common Spine Procedures and Rates of PE/DVT Following Spine Surgery Based on 108,419 Procedures: A Report from the Scoliosis Research Society Morbidity and Mortality Committee**
Justin Smith MD PhD, Christopher I. Shaffrey MD, Charles A. Sansur MD, Kaiming G. Fu, Sigurd Berven MD, Theodore J. Choma MD, Michael J. Goytan MD, Hilali Noordeen MA BM BCh (Oxon) FRCS(Eng) MChOrth FRCS(Orth), D.R. Knapp MD, Robert A. Hart MD, Reinhard Zeller MD, FRCSC, William Donaldson, David W. Polly, Joseph H. Perra MD, Oheneba Boachie-Adjei MD
**Whitecloud Award nominee – Best Clinical Paper*

Meeting Agenda Thursday, July 16, 2009

8:08 **Paper #6: Radiographic and Clinical Results of L5 and S1 Pedicle Subtraction Osteotomies (PSO) for the Correction of Spinal Sagittal Imbalance**
Hassan Alosh BS, Ahmed S. Mohamed MD, Khaled M. Kebaish MD
**Whitecloud Award nominee – Best Clinical Paper*

8:12 **Discussion**

8:20 **Paper #7: The Incidence of C5 Palsy after Multilevel Cervical Decompression Procedures: A Review of 750 Consecutive Cases**
Jason C. Eck DO MS, Ahmad Nassr MD, Ravi Ponnappan MD, Rami R. Zanoun, William Donaldson, James D. Kang MD

8:24 **Paper #8: Perioperative Complications of rhBMP-2/ACS vs. ICBG for Posterior Cervical Arthrodesis**
Charles H. Crawford MD, Leah Y. Carreon MD MSc, Mark D. McGinnis MD, Mitchell J. Campbell MD, Steven D. Glassman MD

8:28 **Paper #9: Major Complications Following Adult Spinal Deformity Surgery: Is There a High Risk Patient Profile?**
Nicola Hawkinson NP, Frank J. Schwab MD, Beverly J. Kelly MS, Jean-Pierre C. Farcy MD, Gregory M. Mundis MD, Matthew E. Cunningham MD PhD, Behrooz A. Akbarnia MD, Richard Hostin md, Robert A. Hart MD, Oheneba Boachie-Adjei MD, Douglas C. Burton MD, Eric Klineberg, Christopher I. Shaffrey MD, Shay Bess MD, International Spine Study Group
USA

8:32 **Discussion**

8:40 **Keynote Address**
Introduction - Todd J. Albert MD

Combining Excellence with Relevance to Manage Complex Spine Deformities in Underserved Nations: The Case for Orthopaedic Volunteerism and Professional Development
Oheneba Boachie-Adjei MD
SRS President

9:00 **Preview of the 2009 SRS Annual Meeting & Course and 17th IMAST**

9:15 – 9:45 Refreshment Break & Exhibit Viewing
Location: Exhibit Hall, Mezzanine Level
Supported by Medtronic Spinal & Biologics

9:45 – 10:45 Instructional Course Lectures - Session 1

1A – Cervical Pathologies
Location: Erzherzog Karlsaal, First Level
Moderator: K. Daniel Riew MD

9:45 – 9:50 **Introduction** - *K. Daniel Riew MD*

9:50 – 9:58 **Workup and Treatment of Tumors/Lesions of the Cervical Spine** - *Todd J. Albert MD*

10:00 – 10:08 **Update on Rheumatoid Arthritis of the Cervical Spine: How Have Things Evolved with Newer Drug Treatments?** - *H. Alan Crockard FRCS*

10:10 – 10:18 **Treatment of Spondylotic Myelopathy** - *Alan S. Hilibrand MD*

10:20 – 10:28 **Primary Cervical Kyphosis** - *K. Daniel Riew MD*

10:30 - 10:45 **Discussion**

Meeting Agenda THURSDAY, JULY 16, 2009

1B – Spondylolisthesis in the Adolescent and Young Adult

Location: Prinz Eugensaal, First Level
Moderator: Hubert Labelle MD

9:45 – 9:55 **Spino-Pelvic Alignement and Classification** - *Hubert Labelle MD*

9:55 – 10:05 **Low Grade Spondylolisthesis: Indications & Surgical Techniques** - *Michael F. O'Brien MD*

10:05 – 10:15 **High Grade Spondylolisthesis: When and How to Fuse In Situ** - *J. Abbott Byrd MD*

10:15 – 10:25 **High Grade Spondylolisthesis: When and How to Reduce** - *Lawrence G. Lenke MD*

10:25 – 10:45 **Case Discussions** - *Hubert Labelle MD*

1C – Early Onset Scoliosis I

Location: Zeremoniensaal, Mezzanine Level
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 Classification System** - *Richard E. McCarthy MD*

9:50 – 10:00 **Why Do We Treat EOS?** - *David S. Marks FRCS*
- Respiratory Problems—Methods of Evaluation
- Chest Wall Defects—Which are Significant?

10:00 – 10:10 **Non-Operative Treatment—Casts and Braces** - *Ahmet Alanay MD*
- Spinal Growth—How Best to Measure
- Reason for Concern

10:10 – 10:25 **Who Should be Treated Surgically and When?** - *George H. Thompson MD*
- Preoperative Evaluation
- Anterior Release vs. Traction
- What Criteria Do We Use to Measure Success?

10:25 – 10:45 **Case studies/Questions and Answers** - *Richard E. McCarthy MD*

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

Location: Forum, First Level
Moderator: Steven D. Glassman MD

9:45 – 10:00 **Pathophysiology** - *Theodoros B. Grivas MD*
- Adult Idiopathic and De Novo Scoliosis
- X-Ray Predictors of Symptoms and Problems
- Assessing Spinal Balance

10:00 – 10:15 **Limited Interventions for Lumbar Deformities** - *Sigurd H. Berven MD*
- Decompression
- Single Level Fusion within the Curve
- In Situ Fusion
- Single Level Realignment

10:15 – 10:30 **Decision Making for Significant Lumbar Deformity** - *Sean Molloy MBBS MSc FRCS DC*
- When Will Realignment Produce Decompression?
- How Much Correction is Enough? (Coronal vs. Sagittal)
- Choosing the Right Procedure: PSF vs. TLIF vs. XLIF vs. A/P

10:30 – 10:45 **Panel Discussion/Case Reviews** - *Steven D. Glassman MD*

Meeting Agenda Thursday, July 16, 2009

1E – Principles and Practice in the Treatment of Kyphotic Problems
Location: Gartensaal, First Level
Moderator: Christopher I. Shaffrey MD

This session will focus on the evaluation and management strategies for a range of the more common conditions resulting in kyphosis. The evaluation aspect will include natural history, associated medical conditions and the appropriate radiographic studies. The range of surgical strategies available to treat these conditions will be emphasized.

Objectives:
• Describe the normal spinal alignment of the thoracic and lumbar spine and identify common conditions resulting in kyphotic problems
• Detail the natural history of congenital scoliosis and determine the appropriate timing of surgical intervention
• Discuss the range of surgical procedures available for the stabilization/correction of congenital kyphosis
• Determine fracture configurations at greatest risk for the development of post-traumatic kyphosis
• Identify which cases of post-traumatic kyphosis can be approached from a posterior-only approach and when circumferential procedures are preferable
• Describe the range of osteotomy procedures commonly used for the management of iatrogenic kyphosis in the adult
• Detail the common complications and outcomes of iatrogenic kyphosis correction.

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** - *Steven C. Ludwig MD*

10:15 – 10:25 **Evaluation and Management of Latrogenic Kyphosis** - *Chistopher I. Shaffrey MD*

10:45 – 11:30 **Refreshments and Hands-On Demonstrations 1A-E**
See "Exhibits and Hands-On Demonstration" section for more information.

11:30 – 12:30 **Concurrent Sessions #2 A&B & Spine Fundamentals Session**

Concurrent Session #2A: CERVICAL RECONTRUCTION AND DEFORMITY
Location: Festaal, Mezzanine Level
Moderators: H. Alan Crockard FRCS
Michael W. Groff MD

11:30 **Paper #10: Improvement of Neurologic Deficits Following Anterior Cervical Spine Surgery**
Jacob M. Buchowski MD MS, Paul A. Anderson, K. Daniel Riew MD

11:34 **Paper #11: Anterior Cervical Decompression and Fusion Accelerates Adjacent Segment Degeneration - Comparison with Asymptomatic Volunteers in 10-Year MRI Follow-Up Study**
Morio Matsumoto MD, Eijiro Okada MD, Daisuke Ichihara, Hirokazu Fujiwara, Suketaka Momoshima MD, Yuji Nishiwaki, Akio Iwanami, Takeshi Ikegami, Takeshi Takahata, Yoshiaki Toyama, Kazuhiro Chiba MD PhD

11:38 ****Paper #12: Is Laminoplasty Contraidicated Following Single Level Cervical Arthroplasty? An In-Vitro Biomechanical Study**
Jun Kikkawa MD, Bryan W. Cunningham MSc, Osamu Shirado MD, Nianbin Hu, Paul C. McAfee MD
**Whitecloud Award nominee – Best Basic Science Paper*

11:42 **Discussion**

Meeting Agenda THURSDAY, JULY 16, 2009

11:50 **Paper #13: Three and Five Year Results from a Prospective, Randomized US IDE Trial on Cervical Arthroplasty**
Praveen V. Mummaneni MD, Vincent Traynelis MD, Regis Haid, Thomas Zdeblick, J. Kenneth Burkus MD

11:54 **Paper #14: Outcomes of Anterior Cervical Fusion in Patients with Predominant Neck Pain, Predominant Arm Pain or Equal Neck and Arm Pain**
Sarah Jernigan MD, Leah Y. Carreon MD MSc, Mitchell J. Campbell MD, James Smith MD, John R. Johnson MD, Rolando M. Puno MD, Steven D. Glassman MD

11:58 **Paper #15: The Time Course of Range of Motion Loss After Cervical Laminoplasty: A Prospective Study with Minimum Two-Year Follow-Up**
Seung Jae Hyun, Seung Chul Rhim MD PhD, Sung Woo Roh

12:02 **Discussion**

12:10 **Paper #16: Posterior C2 Instrumentation: Accuracy and Risks Associated with Four Techniques**
Richard J. Bransford MD, Anthony Russo MD, Mark Freeborn, Quynh Nguyen, Michael J. Lee MD, Jens Chapman, Carlo Bellabarba

12:14 **Paper #17: Cervico-Thoracic Osteotomy for Anklyosing Spondylitis: A Prospective Clinico-Radiological Analysis**
Hossein S. Mehdian FRCS, Arun Ranganathan DNB, Nanjundappa S. Harshavardhana MS, Dip. SICOT, Brian J. Freeman DM, FRCS

12:18 **Paper #18: Cervical Kyphotic Deformity Correction Using 360-Degree Reconstruction**
Naresh P. Patel MD, Eric W. Nottmeier, H. Gordon Deen, Barry D. Birch MD

12:22 **Discussion**

Concurrent Session #2B: KYPHOSIS & SPONDYLOLISTHESIS
Location: Zeremoniensaal, Mezzanine Level
Moderators: Christopher I. Shaffrey MD
Theodoros B. Grivas MD

11:30 **Paper #19: Sequential-Simultaneous Posterior-Anterior-Posterior vs. Posterior Only Surgery for the Treatment of Posttraumatic Kyphosis**
Meric Enercan, Ahmet Alanay, Cagatay Ozturk, Selhan Karadereliler, Ibrahim Ornek, Azmi Hamzaoglu

11:34 **Paper #20: A New Technique to Prevent Proximal Junctional Kyphosis in the Surgical Treatment of Scheuermann Disease**
Azmi Hamzaoglu, Cagatay Ozturk, Fatih M. Korkmaz, Omer Karatoprak, Meric Enercan, Mehmet Tezer

11:38 **Paper #21: Pedical Subtraction Osteotomy (PSO) in Severe Rigid Post-Tubercular Dorsal Kyphosis**
Saumyajit Basu MS DNB FRCSEd, Sreeramalingam Rathinavelu

11:42 **Discussion**

11:50 **Paper #22: Segmental Resection Osteotomy and Dual Axial Rotation Corrective Technique for Severe Angular Kyphosis**
Zhongqiang Chen, Qiang Qi, Zhaoqing Guo, Weishi Li, Yan Zeng, Chuiguo Sun

Meeting Agenda Thursday, July 16, 2009

11: 54	**Paper #23: Residual Kyphosis After Posterior Vertebral Column Resection For Severe Kyphoscoliosis: Its Risk Factors And Further Surgical Strategy** *Qiu Yong, Zhu Ze-zhang, Qian Bang-pin, Wang Bin, Yu Yang, Zhu Feng, Sun Xu, Ma Wei-wei*
11:58	**Paper #24: How Much Kyphosis Correction Can Be Obtained With Posterior Vertebral Column Resection (VCR)?** *Woojin Cho MD PhD, Lawrence G. Lenke MD, Linda A. Koester BS, Brenda Sides MA, Christine Baldus RN MHS*
12:02	**Discussion**
12:10	**Paper #25: Morbidity and Mortality in the Surgical Treatment of 605 Pediatric Patients with Isthmic or Dysplastic Spondylolisthesis: A Report from the Scoliosis Research Society Morbidity and Mortality Committee** *Kaiming G. Fu MD PhD, Justin Smith MD PhD, Christopher I. Shaffrey MD, Sigurd Berven MD, Theodore J. Choma MD, Michael J. Goytan MD, Hilali Noordeen MA BM BCh (Oxon) FRCS(Eng), MChOrth FRCS(Orth), D.R. Knapp MD, Robert A. Hart MD, Reinhard Zeller MD FRCSC, William Donaldson, David W. Polly MD, Joseph H. Perra MD, Oheneba Boachie-Adjei MD*
12:14	**Paper #26: Comparative Analysis of Minimally Invasive Lumbar Posterolateral Fusion With Transcutaneous Pedicle Screws vs. Conventional Approach for Degenerative Spondylolithesis** *Yoshihisa Kotani MD, Kuniyoshi Abumi MD, Manabu Ito MD, Hideki Sudo MD, Yoshihiro Hojo MD, Akio Minami*
12:18	**Paper #27: Outcomes of Posterolateral Spinal Fusion in Geriatric Patients** *Jennifer Smail MD, Steven D. Glassman MD, Rolando M. Puno MD, John R. Johnson MD, Jennifer M. Howard MPH, Leah Y. Carreon MD MSc*
12:22	**Discussion**

Fundamentals Session: SPINE TRAUMA
Location: Gartensaal, First Level
Moderator: Steven C. Ludwig MD

11:30 – 11:40	**A New Classification of TL Trauma** - *Steven C. Ludwig MD*
11:40 – 11:50	**When to Go Anterior or Anterior-Posterior?** - *D. Greg Anderson MD*
11:50 – 12:00	**When to Go Posterior Only, and When Can a Minimally Invasive Approach Work?** - *Praveen V. Mummaneni MD*
12:00 – 12:30	**Case Discussions** - *Michael F. O'Brien MD*

12:30 – 12:45 Walking Break

12:45 – 13:45 Instructional Courses Lectures - Session 2

2A – Options in Cervical Fixation and Motion
Location: Erzherzog Karlsaal, First Level
Moderator: Rick C. Sasso MD

12:45 – 12: 57	**Options for Occipito Cervical and Cervicothoracic Pathology and Fixation** - *Henry F.H. Halm MD*
12:57 – 13:09	**Current State of Cervical Motion Technology** - *Rick C. Sasso MD*
13:09 – 13:21	**MIS Options for Cervical Fixation** - *Richard G. Fessler MD PhD*
13:21 – 13:33	**Anterior Vs. Posterior Fixation – Subaxial Cervical Spine** - *K. Daniel Riew MD*
13:33- 13:45	**Discussion**

Meeting Agenda THURSDAY, JULY 16, 2009

2B – Lumbar Posterior Motion Sparing
Location: Prinz Eugensaal, First Level
Moderator: James J. Yue MD

12:45 – 12:57 **Overview of Posterior Pathology and Radiologic Findings** - *James J. Yue MD*
12:57 – 13:09 **Devices for Low Back Pain** - *Luiz Pimenta MD*
13:09 – 13:21 **Devices for Patients with Neurogenic Symptoms** - *Matthew F. Gornet MD*
13:21 – 13:33 **Dynamic Scoliosis Systems** - *Jean-Charles Le Huec MD PhD*
13:33- 13:45 **Discussion**

2C – Adolescent Idiopathic Scoliosis I
Location: Zeremoniensaal, Mezzanine Level
Moderator: Peter O. Newton MD

12:45 – 12:55 **How 3-D Information of the Curves Alters My Surgical Plan** – *Hubert Labelle MD*
12:55 – 13:05 **Correction Technigues with Pedicle Screw Constructs in 2009** – *Kenneth M.C. Cheung MD*
13:05 – 13:15 **Minimally Invasive Posterior Approaches for AIS** – *Randal R. Betz MD*
13:15 – 13:45 **Case Based Discussion with the Faculty on AIS Decision Making** - *Peter O. Newton MD*

2D – Adult Deformity II
Location: Forum, First Level
Moderator: Lawrence G. Lenke MD

Objectives:
• To describe spinal osteotomies available to treat various adult spinal deformities, their indications and contraindications
• To provide information on appropriate surgical planning for common adult spinal deformities
• To present detailed step-by-step techniques of SPO, PSO and VCR osteotomies
• To detail results and complications of these various spinal osteotomies used in Adult Spinal Deformity surgery

12:45 – 12:57 **Description of Posterior Spinal Osteotomies Available with their Indications/Contraindications** - *Frank J. Schwab MD*
12:57 – 13:09 **PSO for the Correction of Adult Spinal Deformity** - *Sigurd H. Berven MD*
13:09 – 13:21 **Combined Anterior and Posterior Surgery/Osteotomies for Rigid Adult Spinal Deformity** - *Oheneba Boachie-Adjei MD*
13:21 – 13:33 **VCR for Severe Adult Spinal Deformity** - *Lawrence G. Lenke MD*
13:33 – 13:45 **Discussion**

2E – Principles and Practice in the Treatment of Metastatic Spine Disease
Location: Gartensaal, First Level
Moderator: Steven C. Ludwig MD

12:45 – 13:00 **The Use of Vertebroplasty and Kyphoplasty for Metastatic Tumors to the Spine** – *Mark Weidenbaum MD*
13:00 – 13:15 **Extracavitary Approaches for the Treatment of Metastatic Tumors to the Spine** – *Micheal W. Groff MD*
13:15 – 13:30 **Posteior Lumbopelvic Reconstructive Techniques for Metastatic tumors to the Spine** – *Michael O'Brien MD*
13:30 – 13:45 **Case Discussion with Panel** – *Steven C. Ludwig MD*

13:45 - 14:30 **Lunch and Hands-On Demonstrations 2A-E***
See "Exhibits and Hands-On Demonstration" section for more information.

Meeting Agenda Thursday, July 16, 2009

14:30 – 15:30 Concurrent Sessions #3A&B & Spine Fundamentals Session

Concurrent Session #3A: LUMBAR DEGENERATIVE

Location: Festaal, Mezzanine Level

Moderators: Matthew F. Gornet MD
J. Abbott Byrd, III MD

14:30 ****Paper #28: Does Fusion Status Correlate with Patient Outcomes in Lumbar Spinal Fusion?**
Mladen Djurasovic MD, Steven D. Glassman MD, John R. Dimar MD, Mark Mugavin BS, Jennifer M. Howard MPH, Kelly R. Bratcher RN CCRP, Leah Y. Carreon MD MSc
**Whitecloud Award nominee – Best Clinical Paper*

14:34 **Paper #29: Clinical Outcomes in Worker's Compensation Patients: A Case-Control Study**
Leah Y. Carreon MD MSc, Steven D. Glassman MD, Neha Kantamneni BS, Mark Mugavin BS, Mladen Djurasovic MD

14:38 **Paper #30: Post-Surgical Effects of Smoking on Patients After Circumferential ALIF**
John S. Thalgott MD, Madilyne E. Fogarty BS

14:42 **Discussion**

14:50 **Paper #31: The Far Lateral, Trans-Psoas Approach to the Lumbar Spine: Preliminary Experience in 100 Consecutive Patients**
Nicholas J. Wills MD, Manuel R. Pinto MD, Cate Pandiscio PA-C, Amy Hanson CCRC

14:54 **Paper #32: Clinical and Radiological Outcomes of Minimally Invasive vs. Open Transforaminal Lumbar Interbody Fusion**
Chan W. Peng MD, Wai Mun Yue, Seng Yew Poh, William Yeo Masters (Physiotherapy), Seang Beng Tan

14:58 **Paper #33: Selective Nerve Root Injections in Lumbar Radiculopathy: A Prospective Clinical Outcome Study as a Minimally Invasive Alternative to Surgery. A Five-Year Follow-Up**
Sudeep Jain MBBS MS(ORTH) MCH(ORTH), Deep Sharma, Ramesh Kumar, Aravind Jayaswal

15:02 **Discussion**

15:10 **Paper #34: Complications with rhBMP-2 in Posterior Lumbar Fusion**
Steven D. Glassman MD, Jennifer M. Howard, Mladen Djurasovic MD, Rolando M. Puno MD, John R. Johnson MD, Leah Y. Carreon MD MSc

15:14 **Paper #35: Complications of Posterior Lumbar Interbody Fusions Encountered with Use of Bone Morphogenic Protein 2**
Donald K. Matthews MD

15:18 ****Paper #36: The Effect of Bilateral Laminotomy vs. Laminectomy on the Motion and Stiffness of the Human Lumbar Spine**
Michael J. Lee MD, Richard J. Bransford MD, Jens Chapman, Carlo Bellabarba, Amy M. Cohen MME, Richard M. Harrington MS, Randal P. Ching PhD
**Whitecloud Award nominee – Best Basic Science Paper*

15:22 **Discussion**

Meeting Agenda THURSDAY, JULY 16, 2009

Concurrent Session #3B: ADOLESCENT IDIOPATHIC SCOLIOSIS
Location: Zeremoniensaal, Mezzanine Level
Moderators: David W. Polly, Jr. MD
Hubert Labelle MD

14:30 **Paper #37: Low-Density vs. High-Density Thoracic Pedicle Screw Constructs in Adolescent Idiopathic Scoliosis: Is More Better?**
Joshua D. Auerbach MD, Baron S. Lonner MD, Kristin E. Kean BA

14:34 **Paper #38: Advantage of a Derotation Connector in the Correction of AIS by Simultaneous Translation on Two Rods (ST2R). Preliminary Comparative Results**
Jean-Luc Clement, Edouard Chau, Anne Geoffray, Marie-José Vallade

14:38 **Paper #39: Early Results of a Randomized, Prospective Study Comparing Thoracic Hook and Pedicle Screw Fixation for Adolescent Scoliosis**
Lawrence L. Haber MD, Joshua Hughes BA, Erika D. Womack MS

14:42 **Discussion**

14:50 **Paper #40: Minimally Invasive Scoliosis Surgery In AIS Patients: A Technique and Feasibility Study**
Terry Amaral MD, Adam L. Wollowick MD, Laury A. Cuddihy MD, Melanie Gambassi NP, Vishal Sarwahi MD

14:54 **Paper #41: Minimally Invasive Pedicle Screw Instrumentation for Pediatric Spinal Deformity: Safety and Feasibility in First 30 Cases**
Rasesh R. Desai MD, Vivek Sharma MD, Atiq Durrani MD, Alvin H. Crawford MD

14:58 **Paper #42: Pedicle Screw vs. Hybrid/Hook Instrumentation for Lenke Type 1,2 Adolescent Idiopathic Scoliosis - What Happens When Judges are Blinded to the Instrumentation?**
Vincent Arlet, Jean Ouellet MD, Jeffrey Shilt MD, Francis H. Shen, Kirkham B. Wood MD, Donald P. Chan MD, John Hicks MD, Ernesto Bersusky MD, Vasantha Reddi PhD

15:02 **Discussion**

15:10 **Paper #43: What Radiographic and Clinical Factors Appear Crucial for the Decision to Perform a Selective Thoracic Fusion in Lenke 1C/ King II Adolescent Idiopathic Scoliosis Curves?**
Lawrence G. Lenke MD, Daniel J. Sucato MD MS, Timothy R. Kuklo MD, B. Stephens Richards MD, John B. Emans MD, Keith Bridwell MD, Spinal Deformity Study Group

15:14 **Paper #44: Incidence, Distribution, and Surgical Relevance of Abnormal Pedicles in Normal and Deformed Spines: A CT Based Study of 6354 Pedicles**
Adam L. Wollowick MD, John K. Czerwein MD, Beverly Thornhill MD, Terry Amaral MD, Vishal Sarwahi MD

15:18 **Paper #45: Serum Titanium Levels after Instrumented Spinal Arthrodesis in Patients with Adolescent Idiopathic Scoliosis**
Nuria Franco Ferrando MD, Teresa Bas Hermida Medical Degree. PhD., Paloma Bas Hermida, Susana Soler, Luis Perez Millan, Ismael Escriba Roca, Daniel Bonete, Gerg Bordon

15:22 **Discussion**

Meeting Agenda Thursday, July 16, 2009

Fundamentals Session: CERVICAL SPINE
Location: Gartensaal, First Level
Moderator: Alan S. Hilibrand MD

14:15 **Introduction** - *Alan S. Hilibrand MD*

14:20 **Approach to Radiculopathy: Anterior vs. Posterior** - *Richard C. Sasso MD*
- Radiculopathy due to Spondylosis
- Radiculopathy due to Soft Disc Herniation
- Single Level, Two/Three Level, and Extensive Disease

14:35 **Approach to Myelopathy: Anterior vs Posterior vs. AP** - *K. Daniel Riew MD*
- Myelopathy due to Spondylosis in Older Patients
- Myelopathy in the Setting of Congenital Stenosis (Younger Patients)
- Myeloradiculopathy
- Single Level, Two/Three Level, and Extensive Disease

14:50 **Decision-Making for Surgery in Cervical Spine Trauma** - *Michael Ruf MD*
- Subaxial Fractures (Burst, Facet Fractures, and Facet Dislocation)
- Fractures in DISH and Ankylosing Spondylitis

15:05 **Discussion** - *Alan S. Hilibrand MD*

15:30 Adjourn

Meeting Agenda FRIDAY, JULY 17, 2009

7:00 - 15:30 **Registration, E-Posters and Exhibits Open**

7:30 – 8:30 **Instructional Course Lectures - Session 3**

3A – Cervical Trauma

Location: Erzherzog Karlsaal, First Level
Moderator: Todd J. Albert MD

7:30 – 7:40 **Introduction: Initital Care and Pharmacologic Options** - *Todd J. Albert MD*

7:40 – 7:50 **C1-2 Fractures – Treatment** - *Rick C. Sasso MD*

7:50 – 8:00 **Subaxial Injuries – Current Management** - *Michael Ruf MD*

8:00 – 8:10 **Cervicothoracic Injuries – Options for Treatment** - *Michael O'Brien*

8:10 – 8:30 **Discussion/Case Presentations**

3B – Lumbar Posterior Fusion Options/ Instrumentation (Degenerative)

Location: Prinz Eugensaal, First Level
Moderator: Richard Guyer MD

7:30 – 7:42 **Overview of Posterior Fusions** - *Richard Guyer MD*
- Changes in Last 25 Years
- Do we Need Rigid Fixation?
- Alternatives?

7:42 – 7:54 **MIS Posterior Fusion Techniques** - *Richard G. Fessler MD PhD*
- Indications
- Contraindications
- Learning Curve
- Results

7:54 – 8:06 **Open Posterior Fusion** - *Ensor E. Transfeldt MD*
- Indications for Open Posterior Fusion
- When do we Need Instrumentation and When do Not?
- Results, do Patients do Better with Instrumentation?

8:06 – 8:18 **Multiple Level Fusion Issues** - *Sigurd H. Breven MD*
- How to Determine What Levels to Include?
- Is There a Place for Topping off Fusions with Dynamic Devices?
- Best Fusion Options, Autograft, Local, Growth Factors?

8:18 – 8:30 **Discussion**

3C – Early Onset Scoliosis II

Location: Zeremoniensaal, Mezzanine Level
Moderator: Richard E. McCarthy MD

This lecture will build on session 1C (Early Onset Scoliosis I) 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** - *Behrooz A. Akbarnia MD*
- Advantages and Disadvantages
- When to Lengthen and How
- Complications

7:45 – 7:53 **Distraction Techniques: Other** - *Azmi Hamzaoglu MD*
- Turkey Distraction Techniques
- When to Use Internal Traction
- Complications

7:53 – 8:05 **Growth Guidance Systems: Rib-to-Spine Fixation** - *Richard E. McCarthy MD*
- Spine, Rib-to-Spine Techniques
- Complications

8:05 – 8:15 **Tethering Techniques-Staples, Bands** - *Hilai Nordeen FRCS*
- Outcome Measures—How Best to Measure Success Short-Term and Long-Term
- What is the Endpoint?

8:15 – 8:30 **Questions and Answers** - *Richard E. McCarthy MD*

Meeting Agenda Friday, July 17, 2009

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

Location: Forum, First Level
Moderator: Frank J. Schwab MD

7:30 – 7:35 **Introduction** - *Frank J. Schwab MD*

7:35 – 7:42 **Lumbo-Sacral Fusion Extended Proximally: at What Point is Enhance Pelvic Fixation Necessary?** - *Christopher I. Shaffrey MD*

7:42 – 7:49 **Long Fusion from the Thoracic Spine Extending to the Lumbar Spine: When is Sacro-Pelvic Fixation Necessary?** - *Oheneba Boachie-Adjei MD*

7:49 – 7:56 **Enhanced Fusion Options for Sacro-Pelvic Fusion: Graft Options, Interbody Supplementation and Biologics** - *Steven D. Glassman MD*

7:56 – 8:05 **Question & Answer**

8:05 – 8:20 **Cases Discussion** - *Frank J. Schwab MD*
- Disaster with Poor Bone and Bad Deformity
- Thoracic Fusion Short of Sacrum
- Lumbo-Sacrum Fusion Extended to L1

8:20 – 8:30 **Debate: Long Fusion to Sacrum Must be Augmented with Iliac Screws and Inter-Body Fusion**
Yes - *Christopher I. Shaffrey MD*
No - *Oheneba Boachie-Adjei MD*

3E – Thoracolumbar Trauma

Location: Gartensaal, First Level
Moderator: Steven C. Ludwig MD

7:30 – 7:42 **Classification of TL Trauma and the Determination of Spinal Stability** - *Praveen V. Mummaneni MD*

7:42 – 7:54 **When Anterior vs. Posterior vs. 360 for TL Trauma** - *D. Greg Anderson MD*

7:54 – 8:06 **The Role of MIS Surgery for TL Trauma** - *Steven C. Ludwig MD*

8:06 – 8:18 **The Treatment of Posttraumatic TL Kyphosis** - *James J. Yue MD*

8:18 – 8:30 **Case Discussions with Panel**

8:30 – 9:15 **Refreshments and Hands-On Demonstrations 3A-E***
See "Exhibits and Hands-On Demonstration" section for more information.

9:15– 11:15 **Concurrent Sessions #4A&B and Spine Fundamentals Session**

Concurrent Sessions #4A: ADULT DEFORMITY

Location: Festaal, Mezzanine Level
Moderators: Azmi Hamzaoglu MD
Michael F. O'Brien MD

9:15 **Paper #46: Changes of Sacroiliac Joint Motion After Long Fusion: A Biomechanical Study**
Honglin Teng, Chunhui Wu PhD, Amir A. Mehbod MD, Xiujun Zheng MD, Rahul D. Chaudhari MD, Ensor E. Transfeldt MD

9:19 **Paper #47: Outcome and Surgical Strategies in the Treatment of Sacral Fractures Complicating Long Posterior Spinal Fusion**
Ahmed S. Mohamed MD, Albert Pull ter Gunne MD, Richard L. Skolasky ScD, Khaled M. Kebaish MD, David B. Cohen MD

9:23 **Paper #48: Long Fusion to the Sacrum for Sagittal Imbalance -Sacral Fixation Only, Interbody Structural Graft, and Additional Iliac Screws**
Kyu-Jung Cho MD, Ki-Tack Kim MD, PhD, Whoan Jeang Kim, Sang-Hun Lee MD, PhD, Jae-Hoon Jung, Hyung-Suk Kim

9:27 **Discussion**

Meeting Agenda Friday, July 17, 2009

9:35 **Paper #49: Surgical Correction of Anterior Sagittal Imbalance by Posterior-Only Discectomy, Wedge Osteotomy of Adjacent Vertebral End Plates and Interbody Fusion. Technical Aspects, Clinical and Radiological Outcome**
Jesus Burgos MD, Carlos Barrios, Eduardo Hevia MD, Pedro Domenech, Gabriel Piza, Ignacio Sanpera MD PhD, Ignacio Alvarez MD, Juan Carlos Rodriguez Olaverri MD

9:39 **Paper #50: Male vs. Female Adult Deformity Surgery: Is There A Difference In Complications and Outcomes?**
Geoffrey A. Cronen MD, Lukas P. Zebala MD, Lawrence G. Lenke MD, Daniel S. Mulconrey MD, Peter S. Rose MD, Joshua D. Auerbach MD, Brenda Sides MA, Keith Bridwell MD

9:43 **Paper #51: The Effect of Operative Position During Posterior Spinal Fusion for AIS: Does it Influence Sagittal and Axial Alignment of the Thoracic Spine?**
Jahangir Asghar MD, Patrick J. Cahill MD, Amer Samdani MD, M. Darryl Antonacci MD, David H. Clements MD, Randal R. Betz MD

9:47 **Discussion**

9:55 **Paper #52: Which is a Better ALIF Graft at the Base of a Long Fusion to the Sacrum in Patients Over age 60: Titanium Mesh Cage vs. Patellar Allograft?**
Brian A. O'Shaughnessy MD, Frank L. Acosta MD, Patrick A. Sugrue MD, Jamal McClendon, Tyler Koski MD, Stephen L. Ondra MD

9:59 **Paper #53: The Impact of Reciprocal Regional Alignment Changes Distant from the Site of Spinal Osteotomies Affects Post-Operative Spinal Balance**
Virginie Lafage PhD, Frank J. Schwab MD, Oheneba Boachie-Adjei MD, Jean-Pierre C. Farcy MD, Alexis P. Shelokov MD, Richard Hostin md, Robert A. Hart MD, Behrooz A. Akbarnia MD, Michael F. O'Brien MD, Douglas C. Burton MD, Christopher I. Shaffrey MD, International Spine Study Group

10:03 **Paper #54: Changes in Coronal and Sagittal Plane Alignment Following Minimally-Invasive Direct Lateral Interbody Fusion for the Treatment of Adult Degenerative Lumbar Disease**
Frank L. Acosta MD, John C. Liu MD, Nicholas Slimack, David Moller MD, Stephen L. Ondra MD, Richard G. Fessler MD PhD, Tyler Koski MD

10:07 **Discussion**

10:15 **Paper #55: Pre-Operative Pelvic Parameters Must be Considered to Achieve Adequate Sagittal Balance After Lumbar Osteotomy**
Frank J. Schwab MD, Virginie Lafage PhD, Christopher I. Shaffrey MD, Jean-Pierre C. Farcy MD, Oheneba Boachie-Adjei MD, Alexis P. Shelokov MD, Richard Hostin MD, Robert A. Hart MD, Behrooz A. Akbarnia MD, Michael F. O'Brien MD, Douglas C. Burton MD, International Spine Study Group

Meeting Agenda Friday, July 17, 2009

10:19 **Paper #56: Posterior-Only Multilevel Modified Vertebral Column Resection for Extremely Severe Pott's Kyphotic Deformity with a Konstam's Angle Beyond 90°**
Yonggang Zhang MD, Yan Wang MD, Xuesong Zhang MD, Zheng Wang MD, KeYa Mao, Guoquan Zheng, Gang Li MD, Kirkham B. Wood MD

10:23 **Paper #57: Does Appearance Influence Outcome in Adult Scoliosis?**
Steven D. Glassman MD, Leah Y. Carreon MD MSc, Justin Smith, Frank Schwab, Se-Il Suk MD PhD, William C. Horton MD, Keith Bridwell MD

10:27 **Discussion**

10:35 **Paper #58: Predicting Ideal Spinopelivc Balance in Adult Deformity**
Chris J. Neal MD, Jamal McClendon, Frank L. Acosta MD, Tyler Koski MD, Stephen L. Ondra MD

10:39 **Paper #59: Can Minimally Invasive Lateral Interbody Fusion Replace Open Interbody Approach in Combined Surgery for Complex Adult Spine Deformity?**
Gregory M. Mundis MD, Behrooz A. Akbarnia MD, Richard Manos MD, Vikas Varma MD, Ramin Bagheri

10:43 **Paper #60: Failure and Success of Spinal Surgery in Patients with Parkinson's Disease - A Critical Case Series Review in Light of Sagittal Balance**
Heiko Koller MD, Juliane Zenner, Axel Hempfing, Stephen Ondra MD, Tyler Koski MD, Frank L. Acosta MD, Luis Ferraris, Oliver Meier MD

10:47 **Discussion**

10:55 **Paper #61: An Algorithm for Treating Adult Thoracic Major Spinal Deformity is Helpful in Guiding Surgical Treatment**
Frank J. Schwab MD, Virginie Lafage PhD, Keith Bridwell MD, Steven D. Glassman MD, Christopher I. Shaffrey MD, Jean-Pierre C. Farcy MD

10:59 **Paper #62: Translational vs. Derotational Correction of Adult Scoliosis: A Comparison of Clinical and Radiographic Outcomes**
Dennis Crandall MD, Jan Revella RN

11:03 **Paper #63: Proximal Junctional Kyphosis Following Adult Scoliosis Surgery Results from a Mismatch Between Lumbar Lordosis and Sacral Slope**
Sergio A. Mendoza-Lattes MD, Zachary Ries BSc, Yubo Gao PhD, Stuart Weinstein MD

11:07 **Discussion**

Concurrent Session #4B:
COMPLICATIONS, MISCELLANEOUS
Location: Zeremoniensaal, Mezzanine Level
Moderators: Praveen V. Mummaneni MD
Steven C. Ludwig MD

9:15 **Paper #64: Scoliosis Research Society Morbidity and Mortality of Adult Scoliosis**
Charles A. Sansur MD, Jeffrey D. Coe MD, Justin Smith MD PhD, Christopher I. Shaffrey MD

9:19 **Paper #65: Late-Developing Infection Following Posterior Instrumented Surgery for Adolescent Idiopathic Scoliosis**
Mario Di Silvestre, Georgios Bakaloudis, Francesco Lolli

9:23 **Paper #66: Beneficial Influence of Titanium Mesh Cage on Infection Healing and Spinal Reconstruction in Hematogenous Septic Spondylitis**
Panagiotis Korovessis PhD, Thomas Repantis

Meeting Agenda Friday, July 17, 2009

9:27 **Discussion**

9:35 **Paper #67: TLIF Revision for Failed Posterolateral Spinal Fusion**
Mohammad El-Sharkawi MD

9:39 **Paper #68: Complications in 575 XLIF Surgeries**
W. B. Rodgers MD, Curtis Cox MD, Edward Gerber

9:43 **Paper #69: Longer Surgical Times May Increase Your Complication Rate**
Suken A. Shah MD, Peter O. Newton MD, Baron S. Lonner MD, Randal R. Betz MD, Tracey Bastrom MA, Michelle C. Marks PT MA, Harms Study Group

9:47 **Discussion**

9:55 ****Paper #70: Higher Risk of Dural Tears and Recurrent Herniation with Lumbar Micro-Endoscopic Discectomy**
Marco G. Teli MD, Alessio Lovi, Marco Brayda-Bruno, Antonino Zagra, Andrea Corriero
**Whitecloud Award nominee – Best Clinical Paper*

9:59 **Paper #71: Early Failure of Metal-on-Metal Artificial Discs Due to Metal Hypersensitivity: The Diagnostic and Treatment Approach in 4 Collected Cases**
Richard D. Guyer MD, Jessica Shellock, David Hanscom, Robert Urban, Reginald Knight, Peter McCombe, Josh Jacobs, David Bradford MD

10:03 **Paper #72: Reduction in Spinal Surgery Wound Infection Rates by Minimally Invasive Technique**
Richard G. Fessler MD, PhD, John O'Toole MD, Kurt Eichholz MD

10:07 **Discussion**

10:15 **Paper #73: Vertebral Bone Mineral Density Changes Following Kyphoplasty for Osteoporotic Fresh Vertebral Body Fractures**
Panagiotis Korovessis PhD, Thomas Repantis

10:19 **Paper #74: Secondary Prevention of Osteoporotic Compression Fractures after Cement Augmentation: Comparative Results of Treatment with Alendronate, Risedronate and Calcium Carbonate**
Jin-Young Kim, Sang-Phil Yoon, Ankur Nanda, Dong-Eun Shin MD, Hak Sun Kim

10:23 **Paper #75: Pulmonary Cement Embolism after Multilevel Percutaneous Vertebroplasty**
Cagatay Ozturk, Ahmet Alanay, Selhan Karadereliler, Mursel Debre, Neslihan Aksu, Azmi Hamzaoglu

10:27 **Discussion**

10:35 **Paper #76: Preventive Vertebroplasty in Osteoporotic Patients - Early Outcomes and Subsequent Vertebral Fractures**
Peter Diel, Paul F. Heini MD

10:39 **Paper #77: Is the Intraoperative H-Reflex a Viable Substitute for Transcranial Electric Motor Evoked Potential (tceMEP) Monitoring in Detecting Emerging Spinal Cord Injury During Scoliosis Surgery?**
Daniel M. Schwartz PhD, Vidya M. Bhalodia MS, Anthony K. Sestokas PhD, John M. Flynn MD, Suken A. Shah MD, Peter G. Gabos MD, J. A. Bowe MD, John P. Dormans MD

Meeting Agenda Friday, July 17, 2009

10:43 **Paper #78: Major Intraoperative Neurologic Monitoring Deficits in Consecutive Pediatric and Adult Spinal Deformity Patients at One Institution**
Jonathan R. Kamerlink MD, Thomas J. Errico MD, Shaun Xavier MD, Ashish Patel MD, Amar Patel, Alexa Cohen, Mark A. Rieger MD, Joseph W. Dryer MD, David Feldman MD, Baron S. Lonner MD, Aleksandar Beric MD, Frank J. Schwab MD

10:47 **Discussion**

10:55 **Paper #79: Validation Trials of a DNA-Based Prognostic Test (AIS-PT) Designed to Predict Curve Progression in Adolescent Idiopathic Scoliosis Patients**
Kenneth Ward, Marc V. Singleton MS, Therese Berry BS, Lesa M. Nelson BS, James W. Ogilvie MD

10:59 **Paper #80: Diagnostic Efficacy of CT Guided Percutaneous Biopsy in Spinal Lesions**
Uday M. Pawar Dorth DNB orth, Vishal Kundnani MS,FASSI, Abhay Nene

11:03 **Paper #81: A Prospective Double Blind, Randomised, Placebo Controlled Study to Assess and Compare the Analgesic and Anxiolytic Effects of Pregabalin and Tramadol in Patients Undergoing Lumbar Laminectomy**
Pradeep Koramutla MD DA

11:07 **Discussion**

Fundamentals Session: ADULT DEFORMITY
Location: Gartensaal, First Level
Moderator: Sigurd H. Berven MD

9:15 – 9:25 **Introduction and Classification of Adult Deformity** - *Sigurd H. Berven MD*

9:25 – 9:35 **Coronal Plane Deformity and Correction** - *Sean Molloy MBBS MSc FRCS DC*

9:35 – 9:45 **Sagittal Plane Deformity and Correction** - *Lawrence G. Lenke MD*

9:45 – 9:55 **Adjacent Segment Deformity** - *Henry F. H. Halm MD*

9:55 – 10:15 **Case Discussions**

11:15 – 11:45 **Refreshment Break & Exhibit Viewing**
Exhibit Hall, Mezzanine Level
Supported by Medtronic Spinal & Biologics

11:45 - 12:45 **Instructional Courses Lectures - Session 4**

4A – Infection and Post Infectious Deformity
Location: Erzherzog Karlsaal, First Level
Moderator: Praveen V. Mummaneni MD

11:45 – 11:55 **Cervical Osteomyelitis and Deformity** - *Praveen V. Mummaneni MD*

11:55 – 12:05 **Thoracic Osteomyelitis and Deformity** - *Steven C. Ludwig MD*

12:05 – 12:15 **Thoracolumbar Junction Osteomyelitis and Deformity** - *Azmi Hamzaoglu MD*

12:15 – 12:25 **Lumbar and Lumbosacral Junction Osteomyelitis and Deformity** - *Oheneba Boachie-Adjei MD*

12:25 – 12:35 **Discussion**

12:35 – 12:45 **Case Presentations**

Meeting Agenda FRIDAY, JULY 17, 2009

4B – Lumbar Anterior Fusion Options/ Instrumentation (Including Lateral Anterior Approaches)
Location: Prinz Eugensaal, First Level
Moderator: Paul C. McAfee MD

11:45 – 11:57 **Most Current Data on Lumbar Arthroplasty** - *Matthew F. Gornet MD*
11:57 – 12:09 **Complications of Arthroplasty and Salvage with 360 Arthrodesis** - *Paul C. McAfee MD*
12:09 – 12:21 **X-Stream, X-Scream XLIF** - *Luiz Pimenta MD*
12:21 - 12:33 **New and Innovative Approaches to Traditional ALIF and Arthroplasty** - *James J. Yue MD*
12:33 – 12:45 **Discussion**

4C – Adolescent Idiopathic Scoliosis II
Location: Zeremoniensaal, Mezzanine Level
Moderator: Lawrence G. Lenke MD

Objectives:
• To present various correction methods, rod materials and diameters available in the surgical treatment of AIS
• To provide details to help with selection of fusion levels whether using ASF vs PSF techniques
• To present various posterior osteotomies available to correct large and stiff AIS deformities
• To discuss indications, contraindications, results and complications of using posterior osteotomies in the treatment of AIS

11:45 – 11:57 **Optimal Fusion Level Selection in 2009: Anterior vs Posterior Approaches** – *Randal R. Betz MD*
11:57 – 12:09 **Correction Methods Available for AIS Surgery Utilitzing Pedicle Screw Anchors** - *David W. Polly, Jr. MD*
12:09 – 12:21 **Progression of Posterior Based Osteotomies for Larger and More Rigid AIS Deformities** - *Harry L. Shufflebarger MD*
12:21 – 12:33 **Indications and Technique for Post VCR in Severe Primary and Revison AIS** – *Lawrence G. Lenke MD*
12:33 – 12:45 **Discussion**

4D – Adult Deformity IV: Non-Fusion and MIS Alternatives in Adult Scoliosis
Location: Forum, First Level
Moderator: D. Greg Anderson MD

11:45 – 11:55 **Posterior Surgery for Adult Deformities: How can we Decrease the Morbidity of Traditional Deformity Surgery?** – *Henry F.H. Halm MD*
11:55 – 12:05 **Anterior Surgery for Adult Deformities: How do Lateral Approaches and Trans-Sacral Approaches Change our Treatment Strategies in this Population?** - *Neel Anand MD*
12:05 – 12:15 **What is the Role of MIS Circumferential Surgery in the Adult Deformity Population?** - *D. Greg Anderson MD*
12:15 – 12:25 **Non-Fusion Alternative for the Adult Deformity Population: What are the Options and What is Their Role?** - *Isadore H. Lieberman MD MBA FRCSC*
12:25 – 12:45 **Case Discussions**

4E – The Osteoporotic Spine: Fixation Challenges and Solutions
Location: Gartensaal, First Level
Moderator: Kenneth M.C. Cheung MD

11:45 – 11:55 **Case Presentation – Fixation Challenges** - *Yan Wang MD*
11:55 – 12:05 **Fixation Problems in the Osteoporotic Spine** - *Mark Weidenbaum MD*
12:05 – 12:15 **Strategies and Results of Cement Augmentation** - *Kenneth M.C. Cheung MD*
12:15 – 12:25 **Biomechanical Evaluation and Instrumentation Strategies** - *Sigurd H. Berven MD*
12:25 – 12:45 **Discussion**

Meeting Agenda Friday, July 17, 2009

12:45 – 13:30 **Lunch and Hands-On Demonstrations 4A-E***
See "Exhibits and Hands-On Demonstration" section for more information.

13:30 – 14:30 **Concurrent Sessions #5A & B**

Concurrent Session #5A: MOTION PRESERVATION
Location: Festaal, Mezzanine Level
Moderators: Rick C. Sasso MD
Jacob M. Buchowski MD MS

13:30 **Paper #82: Economic Outcomes in a Worker's Compensation Cohort after Single-Level Lumbar Disc Arthroplasty vs. Anterior Lumbar Interbody Fusion**
Matthew F. Gornet MD, David W. Polly, John H. Peloza MD, J. Kenneth Burkus MD

13:34 **Paper #83: Two-Level vs. One-Level Prospective, Randomized, FDA IDE Clinical Trial on Cervical Arthroplasty**
Jeffrey A. Goldstein MD, Rick Delamarter, Jack Zigler MD, Richard Balderston, Jeffrey M. Spivak

13:38 **Paper #84: SwissSpine: Governmentally Mandated HTA-Registry for Total Disc Arthroplasty. Methodology and Results of 825 Cervical Disc Prostheses in 719 Patients**
Emin Aghayev, Thomas Zweig, Patrick Moulin, Group SwissSpine, Christoph Röder MD MPH

13:42 **Discussion**

13:50 **Paper #85: Intermediate Results of Lumbar Disc Replacement: Clinical and Radiological Analysis with Minimum Two Year Followup**
Chan W. Peng MD, Wai Mun Yue, William Yeo Masters (Physiotherapy), Seang Beng Tan

13:54 **Paper #86: Clinical Outcomes after Cervical Disc Arthroplasty for Axial Neck Pain vs. Radiculopathy/Myelopathy**
Matthew F. Gornet MD, Brett A. Taylor, John H. Peloza MD, Rudolf Bertagnoli

13:58 **Paper #87: In-Vivo Kinematics of the Intervertebral Disc Allograft Transplantation**
Stephen Ka Lok Lam, Dike Ruan PhD, Yu Ding PhD, William Lu, Keith D. Luk

14:02 **Discussion**

14:10 **Paper #88: Incidence of Recurrent Disc Herniation in Patients Treated with Lumbar Discsctomy and Application of Fendstrom Type Disc Spacer; One Year Follow-Up**
Jorge E. Isaza MD, Steve A. Guillory PA-C, Steven A. Rundell, Felipe Ramirez MD

14:14 **Paper #89: Retrospective Measurement Study on the Placement Accuracy of Lumbar Arthroplasty and its Correlation with Patient Outcome Scores**
Madilyne E. Fogarty BS, John S. Thalgott MD

14:18 **Paper #90: Revision Following Lumbar Total Disc Replacement: Analysis of Reoperations in the U.S. IDE Study of Lumbar Arthroplasty**
Sam Saidy MD, Paul C. McAfee MD, Fred H. Geisler MD PhD, Sandy Moore, John Regan MD, Richard Guyer MD, Scott Blumenthal MD, Ira L. Fedder, Justin P. Tortolani MD, Bryan W. Cunningham MSc

14:22 **Discussion**

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Concurrent Session #5B – EARLY ONSET NEUROMUSCULAR SCOLIOSIS
Location: Zeremoniensaal, Mezzanine Level
Moderators: Daniel J. Sucato MD MS
David S. Marks FRCS

13:30 **Paper #91: Selective Treatment of the Thoracic Curve by VEPTR in the Growing Spine: What Happens to the Lumbar Curve?**
Amer F. Samdani MD, John Birknes, Reed C. Williams, Norman Ramirez MD, John M. Flynn MD, Randal R. Betz MD

13:34 **Paper #92: Dual Growing Rod Instrumentation with Pedicle Screw Foundation at a Single Institution: Assessment of Outcomes and Complications**
Lukas P. Zebala MD, Timothy R. Kuklo MD, Lawrence G. Lenke MD, Scott J. Luhmann MD, Joshua D. Auerbach MD, Keith Bridwell MD

13:38 **Paper #93: The Utility of VEPTR in the Older Child (> 10 Years) with Complex Spine and Chest Deformity**
Amer F. Samdani MD, Tricia St. Hilaire BS, John Emans MD, John T. Smith MD, Kit Song MD, MHA, Robert M. Campbell MD, Randal R. Betz MD

13:42 **Discussion**

13:50 **Paper #94: A New Surgical Strategy for the Treatment of Early-Onset Idiopathic Scoliosis**
Cagatay Ozturk, Meric Enercan, Mehmet Tezer, Mehmet Aydogan, Mirza Biscevic, Azmi Hamzaoglu

13:54 **Paper #95: Infantile Idiopathic Scoliosis; Variations in Preferred Treatment Options**
Pooria Salari, Daniel D. Oliveira MD, Behrooz A. Akbarnia MD, Paul Sponseller MD, Gregory M. Mundis MD, Growing Spine Study Group

13:58 **Paper #96: Vertebral Column Resection for Severe Pediatric Deformity: Deformity Correction, Trunk Height and Pulmonary Function Results**
Daniel J. Sucato MD MS, Anna M. McClung RN

14:02 **Discussion**

14:10 **Paper #97: The Effect of Tethered Cord Release on Scoliosis in Tight Filum Terminale**
Andrew Jea MD, Joshua J. Chern MD PhD, Robert C. Dauser MD, William E. Whitehead MD, Daniel J. Curry MD, Thomas G. Luerssen

14:14 **Paper #98: Reliability Testing of the Shriners Pediatric Instrument for Neuromuscular Scoliosis (SPINS): A Quality of Life Questionnaire for Children with Spinal Cord Injury**
Louis N. Hunter PT MS, Fred Molitor PhD, Mary Jane Mulcahey PhD, Randal R. Betz MD, Lawrence C. Vogel, Craig McDonald MD

14:18 **Paper #99: Surgical Correction and Fusion Using Posterior-Only Pedicle Screw Construct for Neuropathic Scoliosis in Patients with Cerebral Palsy - A Three Year Follow-Up Study**
Hitesh N. Modi MS, Seung-Woo Suh MD PhD, Jae-Hyuk Yang MD, Jae-Young Hong MD
Korea, South

14:22 **Discussion**

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14:30 – 15:30 Round Table Case Discussions

Cervical Reconstruction
Moderator: K. Daniel Riew MD
Faculty: Todd J. Albert MD, Alan Crockard MD, Richard Sasso MD
Location: Erzherzog Karlsaal, First Level

Lumbar Degenerative
Moderator: Steven D. Glassman MD
Faculty: Matthew F. Gornet MD, Luiz Pimenta MD PhD, D. Greg Anderson MD
Location: Prinz Eugensaal, First Level

Pediatric Deformity
Moderator: Daniel J. Sucato MD MS
Faculty: Behrooz A. Akbarnia MD, Randal R. Betz MD, David Marks FRCS, Richard E. McCarthy MD, Peter O. Newton MD, Harry L. Shufflebarger MD, George H. Thompson MD
Location: Zeremoniensaal, Mezzanine Level

Adult Deformity
Moderator: Lawrence G. Lenke MD
Faculty: Sigurd H. Berven MD, Oheneba Boachie-Adjei MD, Henry Halm MD, Christopher I. Shaffrey MD, Ensor E.Transfeldt MD
Location: Forum, First Level

Tumor / Trauma / Infection
Moderator: Steven C. Ludwig MD
Faculty: Steven C. Ludwig MD, Praveen Mummaneni MD, Mark Weidenbaum MD
Location: Gartensaal, First Level

15:30 Adjourn

Meeting Agenda SATURDAY, JULY 18, 2009

7:00 - 13:00 Registration, E-Posters and Exhibits

7:30 – 8:30 Instructional Course Lectures - Session 5

5A – Cervical Degenerative Techniques
Location: Erzherzog Karlsaal, First Level
Moderator: Jeffrey A. Goldstein MD

This ICL will focus on cervical degenerative techniques for myelopathy. More specifically, the faculty will discuss motion preservation techniques, skip laminectomy, laminoplasty and fusion, and laminectomy and fusion. Evaluating outcome of surgery for degenerative cervical myelopathy using the walking test will be presented. There will be dedicated time for case presentations by the faculty and audience participation.

7:30 – 7:45 **Evaluating Outcome of Surgery for Degenerative Cervical Myelopathy Using the Walking Test** – *H. Alan Crockard MD*

7:45 – 8:00 **Posterior approaches** - *Todd J. Albert MD*
- Positioning/Monitoring
- Laminectomy/Fusion-Technique
- Laminoplasty –Technique
- Results

8:00 – 8:15 **Motion Sparing: Non-Traditional Options for Myelopathy** - *Dan Riew MD*
- Positioning/Monitoring
- Arthroplasty for Myelopathy
- Skip Laminectomy
- Laminoplasty and Fusion

8:15 – 8:30 **Case Discussion Review with Faculty Panel** - *Jeffrey Goldstein MD*

5B – Lumbar Disc Replacement
Location: Prinz Eugensaal, First Level
Moderator: Rudolf Bertagnoli MD

7:30 – 7:41 **Multi Level TDR: Useful Treatment in Degenerative Disc Disease (DDD)** – *Rudolf Bertagnoli MD*

7:41 – 7:52 **Importance of Preservation of ALL in LTRD** – *Luiz Pimenta MD*

7:52 – 8:03 **Can Society Afford TDR?** – *Richard Guyer MD*

8:03 – 8:14 **Maverick Total Disc Replacement: Advanced Concepts and Complications** – *Matthew F. Gornet MD*

8:14 – 8:30 **Discussion**

5C – Adolescent Idiopathic Scoliosis III
Location: Zeremoniensaal, Mezzanine Level
Moderator: Daniel J. Sucato MD MS

This session will be a case-based discussion, as the faculty will address each of the following key points:
1. AIS Surgery Can be Performed Predominantly Using the Posterior Approach
2. Identifying Those Patients Where a Selective Thoracic Fusion can be Performed Relies on Good Radiographic and Clinical Assessment of the Patient - *David W. Polly, Jr. MD*
3. Anterior Surgery is Still Effective for Single Thoracic Curves and Thoracolumbar/Lumbar Curves - *David S. Marks FRCS*
4. Axial Plane Correction Strategies can be Used to Significantly Improve Radiographic and Clinical Deformity - *Richard E. McCarthy MD*
5. Avoiding Complications, Especially Neurologic Deficits, Relies on Good Baseline Intraoperative Neuromonitoring and Thoughtful Decisions when Critical Changes Occur During Surgery - *Daniel J. Sucato MD MS*

Meeting Agenda Saturday, July 18, 2009

5D - Treatment of Vertebral Compression Fractures
Location: Forum, First Level
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 **Bone Cements other than PMMA for Osteoporotic Fractures** - *Kenneth M.C. Cheung MD*

7:54 – 8:06 **Vertebral Augmentation for Osteolytic Fractures** - *Isadore H. Lieberman MD MBA FRCSC*

8:06 – 8:18 **Role of Vertebral Augmentation in Trauma and for Pedicle Screw Augmentation** - *Michael W. Groff MD*

8:18 – 8:30 **Discussion**

5E - Adult/Pediatric Deformity: My Worst Complication and How I Treated It
Location: Gartensaal, First Level
Moderator: Lawrence G. Lenke MD

Objectives:
• To describe various potential complications in the surgical treatment of pediatric and adult spinal deformity
• To detail methods to minimize impact and treatment of various complications on ultimate clinical outcome of spinal deformity surgery
• To discuss various methods to avoid complications in deformity surgery

7:30 – 7:40 **Overview of Potential Complications and Their Potential Clinical Impact** – *Lawrence G. Lenke MD*

7:40 – 8:22 **My Worst Complication**
Oheneba Boachie-Adjei, MD
Steven D. Glassman MD
Sean Molloy MBBS MSc FRCS DC
Peter O. Newton MD
Yan Wang MD
Lawrence G. Lenke MD

8:22 – 8:30 **Discussion**

8:30 – 9:15 **Refreshments and Hands-On Demonstrations 5A-E***
See "Exhibits and Hands-On Demonstration" section for more information.

9:15 – 11:15 **Concurrent Sessions #6A & B**

Concurrent Session #6A: TRAUMA / TUMOR
Location: Festaal, Mezzanine Level
Moderators: D. Greg Anderson MD
Jeffrey A. Goldstein MD

9:15 **Paper #100: Incidence of Spinal Injuries and Their Surgical Treatment in Children and Adolescents: A Population Based Study from 1997 to 2006 in Finland**
Ville T. Puisto MD, Sakari Kääriäinen, Antti Impinen Msc, Timo J. Parkkila PhD, Erkki Vartiainen, Tuomas Jalanko Medical Student, Mikko P. Pakarinen MD PhD, Ilkka Helenius MD PhD

9:19 **Paper #101: Isolated Alar Ligament Disruption in Children: Cause of Persistent Torticollis and Neck Pain After Injury**
Michelle S. Caird MD, Frances Farley, Kelly Vanderhave MD, Martin K. Gelbke MD, Robert N. Hensinger MD

9:23 **Paper #102: Dens Fractures in Patients Over 65 Years of Age: Anterior Screw Fixation of the Dens vs. Posterior Fixation of C1-C2**
Jan Stulik, Petr Sebesta, Jan Kryl, Tomas Vyskocil

9:27 **Discussion**

Meeting Agenda Saturday, July 18, 2009

9:35 ****Paper #103: A Biomechanical Comparison of Two Constructs in a C5 Burst Fracture Model: Pedicle Screw-Rod vs. Lateral Mass Screw-Rod and Anterior Plating**
James P. Sieradzki MD, Jason Savage MD, Hyung-Soon Park PhD, Li-Qun Zhang PhD, Eugene Lautenschlager PhD, Eldin Karaikovic Assistant Professor of Orthopaedic Surgery
**Whitecloud Award nominee – Best Basic Science Paper*

9:39 **Paper #104: Lumbosacral Dissociation Injuries in High Energy Blast Injuries**
Ronald A. Lehman MD, Melvin D. Helgeson MD, Romney C. Andersen MD, Carlo Bellabarba, Michael Frisch

9:43 **Paper #105: Complications of High Thoracic Spinal Fractures**
Pedro M. Fernandes, Nuno Batista, Jacinto Monteiro

9:47 **Discussion**

9:55 **Paper #106: Ten Years Follow Up of Thoracoscopically Assisted Treatment of Thoracolumbar Fractures**
Heinrich Boehm MD, Ahmed M. Shawky MD

9:59 **Paper #107: Low Lumbar Burst Fractures: A Unique Fracture Mechanism Sustained in Our Current Overseas Conflicts**
Ronald A. Lehman MD, Tobin Eckel, Melvin D. Helgeson MD, Patrick B. Cooper MD, Ryan Sieg, Carlo Bellabarba

10:03 **Paper #108: Thromboprophylaxis in Spinal Trauma: State of the Art with Analysis of Questionnaire Response**
Avraam Ploumis MD PhD, Ravi Ponnappan MD, John Sarbello, Marcel Dvorak MD FRCSC, Michael Fehlings MD PhD, Eli Baron MD, Neel Anand MD, David O. Okonwko MD, Alpesh Patel MD, Alexander R. Vaccaro MD PhD

10:07 **Discussion**

10:15 **Paper #109: Total Spondylectomy of C2: A New Surgical Technique**
Jan Stulik, Petr Sebesta, Jan Kryl, Tomas Vyskocil

10:19 **Paper #110: Posterior Transpedicular Corpectomy and Reconstruction of the Axis Vertebra for Metastatic Tumor: Report of 3 Cases and Review of the Literature**
Vincent Y. Wang MD PhD, Christopher P. Ames, Vedat Deviren, Frank Vrionis

10:23 **Paper #111: Relation Between Health-Related Quality of Life Score And Survival in The Patients With Spinal Metastases -A Prospective Analysis-**
Takayuki Yamashita MD, Krzysztof B. Siemionow, Thomas E. Mroz, Vinod K. Podichetty MD, Isador H. Lieberman MD MBA FRCSC

10:27 **Discussion**

10:35 **Paper #112: Percutaneous Transsacral Screw Fixation and Sacroplasty for Treatment of Pathologic Sacral Fractures**
Peter S. Rose MD, S. A. Sems MD, Ahmad Nassr MD, Mark A. Pichelmann MD, Paul M. Huddleston MD, Michael J. Yaszemski MD PhD, Mark B. Dekutoski MD

Meeting Agenda Saturday, July 18, 2009

10:39 **Paper #113: Balloon Kyphoplasty as an Adjunct to Stabilization in the Treatment of Metastatic Spinal Disease**
James Langdon MRCS, Sam Heaton, Jason Bernard MD FRCS(Orth), Sean Molloy FRCS (Orth)

10:43 **Paper #114: Posterolateral Approach for Thoracic Corpectomy with Circumferential Decompression and Instrumented Fusion using Expandable Cages: A Prospective Case Series of 15 Consecutive Patients**
Patrick C. Hsieh MD, Ziya Gokaslan MD, John C. Liu MD

10:47 **Discussion**

10:55 **Paper #115: A Novel Muscle Sparing High Thoracotomy Approach for Upper Thoracic Spine Resection and Reconstruction**
Rex Marco MD, Wu Zhuge MD

10:59 **Paper #116: Effect of Surgical Staging on Patient Outcomes, Resource Utilization, and Institutional Costs in Oncologic Sacral Resections with Spinopelvic Reconstruction**
Peter S. Rose MD, Michael J. Brown MD, Daryl J. Kor MD, Timothy B. Curry MD PhD, Matthew A. Warner, Eduardo S. Rodrigues MD, Mark B. Dekutoski MD, Steven H. Rose MD

11:03 **Paper #117: Circumferential Spinal Reconstruction Using False Pedicles after Total en bloc Spondylectomy: A Biomechanical in vitro Study**
John Seaburg MD, Michael Liebschner PhD, Rex Marco MD

11:07 **Discussion**

Concurrent Session #6B:
MISCELLANEOUS, INNOVATIVE TECHNIQUES
Location: Zeremoniensaal, Mezzanine Level
Moderators: Robert Wienecke MD
Isador H. Lieberman MD MBA FRCSC

9:15 **Paper #118: Grade II Spondylolisthesis Treated by XLIF**
W. B. Rodgers MD, Curtis Cox MD, Edward Gerber

9:19 **Paper #119: Reduction of High Grade Adolescent Isthmic Spondylolisthesis Using a Three-Stage Shortening Procedure**
Hossein S. Mehdian FRCS (Tr & Orth), Arun Ranganathan DNB (Orth), Nanjundappa S. Harshavardhana MS(Orth), Dip. SICOT, Brian J. Freeman DM FRCS (Tr & Orth)

9:23 **Paper #120: Single Level Lumbar Fusion for Grade I and II Spondylolisthesis Correction Using the AXIALIF Rod System**
W. B. Rodgers MD, Curtis Cox MD, Edward Gerber

9:27 **Discussion**

9:35 **Paper #121: Mini Open PLIF with Minimal Invasive Pedicle Screw Insertion**
Tetsuo Ohwada, Shozo Suzuki, Kimihiko Onoue, Tomoya Yamashita

9:39 **Paper #122: Extreme Lateral Interbody Fusion (XLIF) for the Treatment of Degenerative Spondylolisthesis**
Luiz Pimenta MD PhD, Juliano Lhamby, Etevaldo Coutinho, Leonardo Oliveira BSc

9:43 **Paper #123: Anatomic Mapping of Lumbar Nerve Roots Using a Direct Lateral Transpsoas Approach to the Spine**
Kelley Banagan, Kornelis Poelstra MD PhD, Steven Ludwig, Daniel Gelb MD

Meeting Agenda Saturday, July 18, 2009

9:47 **Discussion**

9:55 **Paper #124: Local Application of Low-Dose Depo-Medrol is Effective in Reducing Immediate Postoperative Back-Pain- A Prospective Randomized Case-Control Study in 59 Patients with Single Level Lumbar Disc Herniation**
Kook Jin Chung

9:59 **Paper #125: Reduction of Mean Arterial Pressure During Surgical Exposure Safely Reduces Operative Blood Loss and Transfusion Requirements**
Kushagra Verma MS, David Vecchione BA, Laura E. Dean BA, Joshua D. Auerbach MD, Baron S. Lonner MD

10:03 **Paper #126: Differences in Male and Female Spino-Pelvic Alignment in Asymptomatic Young Adults - A Three-Dimensional Analysis Using Upright Low-Dose Digital Biplanar X-Rays**
Michiel Janssen, Xavier Drevelle, Ludovic Humbert, Wafa Skalli PhD, René M. Castelein MD PhD

10:07 **Discussion**

10:15 **Paper #127: Outcomes of Minimally Invasive Surgery (MIS) Compared to Open Fusion for Spondylolisthesis**
Y. R. Rampersaud MD FRCS, Mladen Djurasovic MD, Leah Y. Carreon MD MSc, Oma D. Persaud MSc, Paul A. Anderson, Steven D. Glassman MD

10:19 **Paper #128: Restoration of Lumbar Lordosis: A Comparative Study of Four Commonly-Used Surgical Techniques**
John R. Dimar MD, Steven D. Glassman MD, Venu Vemuri MD, Justin Esterberg MD, Jennifer M. Howard MPH, Leah Y. Carreon MD MSc

10:23 **Paper #129: Evaluative Comparison of Patient Based vs. Physician Based Outcome in Posterior Lumbar Fusion**
Thomas Zweig, Emin Aghayev, Markus Melloh, Rolf Sobottke, Max Aebi, Christoph Röder MD MPH

10:27 **Discussion**

10:35 **Paper #130: A Survey of Bone Grafting Options Selected by Surgeons for Combined Anterior and Posterior Procedures**
John R. Dimar MD, Steven D. Glassman MD, J. Kenneth Burkus MD, Timothy R. Kuklo MD, Scott Boden MD, Sigurd Berven MD

10:39 **Paper #131: Prospective, Non-Randomized, Multi-Center Clinical Evaluation of Extreme Lateral Interbody Fusion (XLIF) in the Treatment of Adult Scoliosis**
W. B. Rodgers MD, Antoine G. Tohmeh MD, Jonathan A. Hyde MD, Kaveh Khajavi MD, Mark D. Peterson MD, Vedat Deviren, Dzung Dinh, Kade T. Huntsman MD, Leonel A. Hunt MD, James R. Malcolm MD, William D. Smith MD, Sangwook Yoon MD, Ildemaro J. Volcan MD

Meeting Agenda Saturday, July 18, 2009

10:43 **Paper #132: A New Low Profile Sacro-Pelvic Fixation Using S2 Alar Iliac (S2AI) Screws in Adult Deformity Fusion to the Sacrum: A Prospective Study with Minimum Two-Year Follow-Up**
Khaled M. Kebaish MD, Albert Pull ter Gunne MD, Ahmed S. Mohamed MD, Ryan Zimmerman, Phebe S. Ko BS, Richard L. Skolasky ScD, Joseph R. O'Brien MD MPH, Paul Sponseller MD

10:47 **Discussion**

10:55 ****Paper #133: What is the Mechanical Effect of CP Titanium vs. PEEK Rods on the Spinal Implants and the Operative and Adjacent Levels after TLIF?**
Timothy R. Kuklo MD, Joseph L. Turner MS, David Paller
**Whitecloud Award nominee – Best Basic Science Paper*

10:59 **Paper #134: The Role of Vertebra Vector in Characterization and Quantification of Vertebral Position and Orientation in the Horizontal Plane**
Tamás Illés MD DSc, Jean Dubousset, Szabolcs Somoskeoy MD

11:03 ****Paper #135: Multi-Directional Flexibility Properties and Abrasion Assessment of an in Situ Cured Polyurethane for Nucleoplasty Reconstruction. An In-Vitro Human Cadaveric Model**
Bryan W. Cunningham MSc, Nianbin Hu, Jun Kikkawa MD, James Klunk BS, Jeffrey D. Gordon MS Mech Eng., Paul C. McAfee MD
**Whitecloud Award nominee – Best Basic Science Paper*

11:07 **Discussion**

11:15 – 13:00 **General Session #7 – MISCELLANEOUS, INTERBODY**
Location: Festaal, Mezzanine Level
Moderators: Luiz Pimenta MD
Francis H. Shen MD

Supported by K2M, Inc.

11:15 **Presentation of Whitecloud Awards**

11:20 **Paper #136: Are There Preoperative Parameters Which Correlate to Worse Preoperative SRS Scores That Surgeons Can Strategize to Correct to Maximize Outcome?**
Daniel J. Sucato MD MS, Leah Y. Carreon MD MSc, James O. Sanders MD, Mohammad Diab MD, Peter Sturm MD, Spinal Deformity Study Group

11:24 **Paper #137: Distal Fusion Levels in Thoracolumbar and Lumbar Adolescent Idiopathic Scoliosis: L3 or L4 ?**
Se-Il Suk MD PhD, Jin-Hyok Kim MD PhD, Sung-Soo Kim MD, Dong-Ju Lim MD, Chang-Won Jeong MD

11:28 **Paper #138: Cost Analysis of Adolescent Idiopathic Scoliosis Correction Surgery in 125 Consecutive Cases**
Jonathan R. Kamerlink MD, Martin Quirno MD, Joshua D. Auerbach MD, Andrew H. Milby BS, Laura E. Dean BA, Joseph W. Dryer MD, Thomas J. Errico MD, Baron S. Lonner MD

11:32 **Discussion**

11:40 **Paper #139: Outcomes of Vertebral Body Stapling in Juvenile and Adolescent Idiopathic Scoliosis: A Two Year Radiographic and Clinical Follow-Up**
Timothy S. Oswald MD, Lindsay M. Andras MD, Erin M. Meehan BS

Meeting Agenda SATURDAY, JULY 18, 2009

11:44 **Paper #140: Computed Tomography Evaluation of Axial Vertebral Derotation in Endoscopic Anterior Instrumentation for Scoliosis**
James A. Cordell-Smith FRCS, Clayton Adam, Maree T. Izatt B Phty, Robert Labrom, Geoff Askin FRACS

11:48 **Paper #141: Clinical and Radiographic Predictors of Coronal Balance at Two-Years after Surgery for Adolescent Idiopathic Scoliosis with Lenke Type I Curves**
John Sarwark MD, B. Stephens Richards MD, Daniel J. Sucato MD MS, Lawrence G. Lenke MD, James O. Sanders MD, John B. Emans MD, Stefan Parent MD PhD, Daniel Schwartz MD, David Roberts MD, Jason Savage MD, Study Group Spinal Deformity

11:52 **Discussion**

12:00 **Paper #142: Adolescent Idiopathic Scoliosis Patients Treated with Pedicle Screw Constructs: Do the Favorable Two Year SRS-30 Outcomes Hold Up at Five Year Follow-Up?**
Charles H. Crawford MD, Lawrence G. Lenke MD, Woojin Cho MD PhD, Ronald A. Lehman MD, Kathryn A. Keeler MD, Timothy R. Kuklo MD, Brian A. O'Shaughnessy MD, Michael S. Chang MD, Josh D. Auerbach, Brenda Sides MA, Christine Baldus RN MHS, Keith Bridwell MD

12:04 **Paper #143: Comparison of Three Surgical Treatments for Degenerative Lumbar Scoliosis with Symptomatic Spinal Stenosis**
Kathy M. Blanke RN, Linda A. Koester BS, Lawrence G. Lenke MD, Ronald A. Lehman MD, Melvin D. Helgeson MD, Dennis Crandall MD, Jan Revella RN, Keith Bridwell MD, Christine Baldus RN MHS

12:08 **Paper #144: Posterior Vertebral Column Resection in Severe Congenital Kyphosis, Scoliosis and Kyphoscoliosis**
Selhan Karadereliler, Cagatay Ozturk, Ahmet Alanay, Neslihan Aksu, Omer Karatoprak, Azmi Hamzaoglu

12:12 **Discussion**

12:20 **Paper #145: An Innovative Biomechanical Technique to Reduce Adjacent Caudal Level Motion in Scoliosis Surgery**
Atiq Durrani MD, Viral V. Jain MD, Rasesh Desai MD, Aditya M. Muzumdar MS, Brandon Bucklen Bioengineering, Mark Moldavsky BS, Aditya Ingalhalikar MS, Saif Khalil PhD

12:24 **Paper #146: Blood Metal Ion Levels Following Implantation of an All-Metal Lumbar Intervertebral Disc Replacement**
Jonathan R. Stieber MD, Thomas J. Errico MD, Thomas W. Bauer, Camden Whitaker MD, George Miz MD, Rick Sasso MD

12:28 **Paper #147: Device Displacement Following Cervical Total Disc Arthroplasty: Analysis of Probable Causes**
Pierce D. Nunley MD, Ajay Jawahar MD, Eubulus J. Kerr MD, David A. Cavanaugh MD

12:32 **Discussion**

Meeting Agenda Saturday, July 18, 2009

12:40 **Paper #148: Comparison of Outcomes in Mono Segmental Lumbar Total Disc Replacement Regarding Preoperative Nucleus Pulposus Status(Herniated/Non Herniated) and Sciatica - Analysis of 358 Patients from an Observational Multi Center Study, SWISSspine**
Thomas Zweig, Emin Aghayev, Rolf Sobottke, Max Aebi, Christoph Röder MD MPH

12:44 **Paper #149: Surgical Treatment of Primary Spinal Tumors in the Conus Medullaris**
Sung-Uk Kuh MD PhD, In-Ho Han, Young-Min Kwon MD, Dong-Kyu Chin, Keun Su Kim MD PhD, Yong-Eun Cho, Byung-Ho Jin

12:48 **Paper #150: A Prospective Analysis of Prognostic Factors in Patients With Spinal Metastases - Use of The Revised Tokuhashi Score -**
Takayuki Yamashita MD, Krzysztof B. Siemionow, Thomas E. Mroz, Vinod K. Podichetty MD, Isador H. Lieberman MD MBA FRCSC

12:52 **Discussion**

13:00 **Adjourn**

Paper Abstracts

The Scoliosis Research Society gratefully acknowledges K2M, Inc. for their support of the General Sessions and Registration Area.

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Paper Abstracts

★ *Whitecloud Award Nominee - Clinical*
☐ *Whitecloud Award Nominee - Basic Science*

★ **1. The Cost Effectiveness of Lumbar Fusion at Five Years after Surgery**

Steven D. Glassman MD, David W. Polly, John R. Dimar MD, Leah Y. Carreon MD,MSc
USA

Summary: Surgeons need to demonstrate cost effectiveness as well as clinical efficacy to justify payment for interventions, including lumbar spine fusion. In this study, the five year cumulative cost and SF-6D were determined in 63 patients who underwent single-level posterolateral fusion. Single-level instrumented posterolateral fusion is both effective and durable, with a Cost per QALY gained of $47,606.

Introduction: Economic value is an increasingly important component of healthcare policy decision making. The primary currency for comparing the value of competing healthcare interventions is the Cost per Quality Adjusted Life Year (QALY) gained. Interventions with a Cost/QALY gained < $50,000 are generally considered cost effective. This study determines the cost/QALY gained for single-level instrumented posterolateral lumbar fusion (PSF) over five years.

Methods: Five year cumulative cost and SF-6D were determined in both the control and investigational cohorts from an IDE trial for ICBG vs. rhBMP-2 in single-level PSF. Measured costs included all in-patient and subsequent out-patient events over five years. Cost for medical and surgical treatment within the 6 month post-op window was attributed to the surgical procedure. Beyond 6 months, any additional treatment related to the lumbar spine was included as a surgical cost. Direct costs for each intervention were determined by a healthcare system coder using recorded cost and the contemporaneous Medicare Fee schedule. Health utility was determined using SF-6D, calculated by transformation from the SF-36.

Results: There were 63 patients (38 females, 25 males) with a mean age of 51.5 years (19 to 78) years. There was no statistically significant difference in HRQOL and SF-6D at any time point and no difference in reimbursements between the ICBG and rhBMP-2 groups. Of the 63 patients, 11 patients required a subsequent lumbar spine intervention. Mean cost for the initial intervention was $15,829 ± $3.638 and mean total reimbursements including treatment for five years after surgery was $16,595 ± $7,742. Mean QALY gained in each of the five years post-op was 0.06, 0.07, 0.06, 0.08 and 0.08, for a cumulative 0.35 QALY improvement over the five year interval. The resultant Cost/QALY gained at five years post-op was $47,606.

Conclusion: Surgeons need to demonstrate cost effectiveness as well as clinical efficacy to justify payment for interventions, including lumbar spine fusion. This study indicates that at 5 year follow-up, single-level instrumented PSF is both effective and durable resulting in a favorable cost/QALY gained as compared to other widely accepted healthcare interventions.

2. Direct Economic Impact of Posterior Minimally Invasive Compared to Conventional Open Fusion Procedures for Lumbar Spondylolisthesis

Randolph Gray MBBS, FRACS, Michael Fehlings MD PhD, Stephen Lewis MD FRCSC, MSc, Eric M. Massicotte MD, Y. R. Rampersaud MD FRCS
Canada

Summary: In this cohort study, the direct cost of primary, 1-2 level, MIS fusions for spondylolisthesis were 28% lower than open fusions. Acute post-operative morbidity was significantly less in the MIS group. The majority of cost benefit was due to reduced length of stay for the MIS fusion group.

Introduction: The utility of Minimally Invasive Fusion (MIS) remains controversial. Although reports of acute benefits exist, comparable controls are lacking and the impact of cost has not been assessed. The objective of this study was to compare the peri-operative morbidity and direct economic impact of one or two level primary decompression and fusions for low grade (I-II)degenerative or isthmic spondylolisthesis using a minimally invasive surgical (MIS) vs. conventional open techniques.

Methods: A retrospective cohort study was performed using prospective data from 79 consecutive patients (n= 37 [MIS -one surgeon] / n=41 [open - three surgeons]) between 2005 and 2008 in a single institution from a completely socialized health care system. All 4 surgeons had at least 5 years of experience with the fusion techniques studied. Independent review was performed. In-hospital micro-costing data (OR, nursing, imaging, labs, pharmacy and allied health cost) was utilized.

Results: The groups were comparable in age, sex, pre-operative hemoglobin (Hb), ASA, Charlson co-morbidity index, BMI and levels fused. All MIS patients had an inter-body cage(s) compared to only 14 in open group. Blood loss (206 vs. 798mls), transfusions (0 vs. 17%) and length of stay (5.9 vs. 8.6 days) were significantly ($p<0.01$) lower in the MIS group. Complications were also less in the MIS group (MIS: durotomy(1), UTI(3) / Open: durotomy (3), UTI(8), neurodeficit(1)). Average cost of an open fusion was 1.28 times greater then cost of a MIS fusion ($p=0.001$). There was a significant positive correlation between the length of stay and cost of surgery (Open $p= 0.001$, MIS $p=0.01$). Patient age, BMI or instrumentation did not have a significant influence on the cost.

Conclusion: This matched cohort study demonstrates reduced acute postoperative morbidity and a 28% reduction in direct institutional cost associated with MIS lumbar fusion compared to open.

Significance: This study refutes the common perception of higher costs associated with minimally invasive fusion.

Paper Abstracts

★ *Whitecloud Award Nominee - Clinical*
☐ *Whitecloud Award Nominee - Basic Science*

3. SWISSspine National Mandatory Registry for Lumbar Total Disc Arthroplasty: Clinical Results of 427 Patients and 497 Implants

Emin Aghayev, Thomas Zweig, Patrick Moulin, Group SwissSpine, Christoph Röder MD MPH
Switzerland

Summary: We report on clinical results of 427 patients and 497 implants out of SWISSspine registry.

Introduction: Due to reported high rates of complications in Total Disc Replacement (TDR) Swiss Federal Office of Public Health demanded a national mandatory Health Technology Assessment registry for TDR. We report on short-term clinical results in the registry.

Methods: In an observational multicenter mode data on 427 patients and 497 implants were documented between March 2005 and August 2008. Data collection was performed preoperatively, at 3-month and 1-year FU and annually thereafter. EQ-5D, NASS and co-morbidity forms were completed by the patients, and OP- and FU-forms by the surgeons. Descriptive statistical analyses and multivariate logistic regressions were performed.

Results: A significant reduction of back pain (71 to 31) and leg pain (54.7 to 20.7) preop to 1-year postop on VAS scale was documented. Quality of life (EQ-5D) improved from 0.32 to 0.73 ($p<0.001$). Postoperatively, the amount of patients that did need pain medication decreased from 97.5% to 34.4%. The complication rates for mono- and bisegmental interventions after discharge were 9.8% and 12.9% and the revision rates 3.1% and 1.4% respectively. Pharmacologically treated depression had a negative predicting influence on the outcome.

Conclusion: In a short-term perspective lumbar TDR appears as a relatively safe and efficient procedure concerning pain reduction and improvement of quality of life. Nevertheless, no prediction about the long-term goals of TDA can be made yet. The SWISSspine registry proofs to be an excellent tool for collection of observational data in a nationwide framework providing surgeons and responsible authorities with population-based evidence.

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4. Re-Operations in Lumbar Total Disc Replacement: Experience with Our First Consecutive 800 Cases

Jack Zigler MD, Andrew B. Parkinson, Richard D. Guyer MD, Scott L. Blumenthal MD, Donna D.Ohnmeiss
USA

Summary: This study reviewed re-operations encountered in 800 consecutive lumbar total disc replacement (TDR) patients in which 982 TDRs were implanted. Among the 800 patients, 46 (5.75%) underwent a total of 70 interventions, many of which were related to trial and implant procedures for spinal cord stimulation. When considering the 982 TDRs, only 18 re-operations (1.8%) were performed at the TDR level. The results of this study found that the re-operation rate for lumbar TDR was relatively low.

Introduction: As with any surgery, there will inevitably be some patients requiring revision following lumbar total disc replacement (TDR). The purpose of this study was to review the re-operations encountered in 800 consecutive patients undergoing TDR.

Methods: A database of all TDRs performed since the first case in 2000 was created from logs of FDA IDE trials and an ongoing surgery log. Re-operations were identified from adverse event records and surgery logs. A total of 982 TDRs were implanted in 800 patients (583 one-level, 165 two-level, 7 three-level, 41 single-level as part of a TDR/fusion hybrid and 4 two-level TDR as part of a hybrid). The mean length of time since the TDR surgery was 44 months. Re-operations were classified based on the level of the spine operated with respect to the index procedure and the reason for re-operation.

Results: Among the 800 patients, 46 (5.75%) underwent a total of 70 interventions. Twenty-seven of these involved the use of a spinal cord simulator and its trial, implantation, explantation, and/or revision. The reasons for index level revision procedures included: malpositioned polyethylene core (n=1), facet arthrosis (n=2), wound infection of posterior incision (n=1 hybrid patient), painful posterior instrumentation (n=1 hybrid patient), vertebral body fracture (n=1), pars fracture (n=1 at TDR level, n=1 at 2 levels above TDR level), synovial cyst (n=1), metal sensitivity (n=2), spinal cord tumor (n=1), or ongoing pain or onset of new back and/or leg pain (n=34). A description of the re-operations is presented in Table 1. The mean length of time between the index and re-operation surgery was 26.7 months, ranging from 2 days to 85 months. When considering the 982 TDRs, only 18 re-operations (1.8%) were performed at the TDR level.

Conclusion: This study found that the re-operation rate for lumbar TDR was relatively low. The revision rates compare well with the rates experienced in more commonly-performed spinal procedures.

Significance: In a large consecutive series of patients beginning, with the first TDR at a single site, the overall re-operation rate was relatively low and only 1.8% of patients underwent intervention at the TDR level. This study supports the safety of these implants.

Paper Abstracts

★ *Whitecloud Award Nominee - Clinical*
☐ *Whitecloud Award Nominee - Basic Science*

Overview of subsequent procedures

Type of re-operation	Incidence
Index level anterior approach	0.75%
Index level posterior spine surgery	0.88%
Revision at fusion levels of hybrid surgery, not the TDR level	0.12%
Surgery at non-index level:	
Adjacent segment	1.88%
Two levels away	0.38%
Index and adjacent segment	0.38%
Re-op level unknown (performed at another center)	0.12%
Spinal cord stimulation only	1.12%
I&D (posterior wound infection in a hybrid case)	0.12%
Removal of tumor on spinal cord	0.12%

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).

★ 5. Complication Rates of Three Common Spine Procedures and Rates of PE/DVT Following Spine Surgery Based on 108,419 Procedures: A Report from the Scoliosis Research Society Morbidity and Mortality Committee

Justin Smith MD PhD, Christopher I. Shaffrey MD, Charles A. Sansur MD, Kaiming G. Fu, Sigurd Berven MD, Theodore J. Choma MD, Michael J. Goytan MD, Hilali Noordeen MA BM BCh (Oxon) FRCS(Eng) MChOrth FRCS(Orth), D.R. Knapp MD, Robert A. Hart MD, Reinhard Zeller MD, FRCSC, William Donaldson, David W. Polly, Joseph H. Perra MD, Oheneba Boachie-Adjei MD
USA

Summary: We assessed complication rates of three common spine procedures, anterior cervical discectomy and fusion (ACDF), lumbar microdiscectomy (LD) and lumbar stenosis decompression (LSD) using the Scoliosis Research Society (SRS) Morbidity and Mortality (MM) database. The resulting rates are comparable to prior reports of smaller series and provide validation of the SRS MM database as a resource to study less common spine procedures and complications. In addition, we used the database to assess rates of pulmonary embolism (PE) and deep venous thrombosis (DVT).

Introduction: The SRS prospectively collects MM data from its members. We used these data to assess the rates of complications for three common spine procedures as a means of validating the database for study of less common procedures and complications. We next used the database to assess rates of PE and DVT in all cases reported over four consecutive years.

Methods: The SRS MM database was queried for cases of ACDF, LD and LSD from 2004-2007. Revision cases were excluded. Numbers and types of complications were assessed. The database was also queried for occurrence of PE and DVT in all cases from 2004-2007.

Results: For the common procedures assessment, 26910 cases were identified, including 6735 ACDFs, 9846 LDs and 10329 LSDs. The overall complication rates for ACDF, LD and LSD were 2.4%, 3.5% and 6.8%, respectively. A subset of the complication rates is shown in Table 1. Overall complication rates are comparable to previously published smaller series. A total of 108419 cases were identified from 2004-2007 for the assessment of PE/DVT. Incidences of PE, death due to PE, and DVT were higher in cases using implants (1.75, 0.42, and 1.59, respectively) compared with cases without implants (0.58, 0.17, and 0.03, respectively), likely reflecting increased procedure complexity and hospital stay. Rates of PE and DVT were calculated based on diagnosis (subset shown in Table 2).

Conclusion: The overall major complication rates for first-time ACDF, LD and LSD based on the SRS MM database are similar to those reported in recent smaller prospective series, while the minor complication rates from the SRS MM database are more comparable to those reported in prior retrospective series. Collectively, these findings support the validity of the SRS MM database as a resource to study other less common spinal disorders and complications. In addition, our data suggest that post-surgical PE and DVT, even among skilled spine surgeons, is an inherent potential complication. These data provide general benchmarks of PE and DVT rates as a basis for on-going efforts to improve safety of care.

★ 6. Radiographic and Clinical results of L5 and S1 Pedicle Subtraction Osteotomies (PSO) for the Correction of Spinal Sagittal Imbalance

Hassan Alosh BS, Ahmed S. Mohamed MD, Khaled M. Kebaish MD
USA

Summary: Sagittal plane spinal deformities can be effectively treated with an L5 and S1 osteotomies in select patients with good clinical results and low complications

Introduction: Pedicle subtraction osteotomy at L5 or S1 is rarely performed due to the difficulty in achieving distal fixation and the concern about higher complications compared to those performed at a more proximal level. It can be more effective in correcting a focal deformity at the lumbosacral junction or the sacrum.

Methods: Retrospective review of 14 consecutive patients who underwent a PSO at L5 or S1 between 2005 & 2007. Detailed radiographic measurements were done at preoperative and at final follow up. Functional outcome data were collected prospectively, including SRS-22 and Oswestry Disability Index (ODI). Values are reported as means followed by the minimum and maximum values in the range.

Results: Fourteen patients received a PSO at L5 or S1. Ten at L5 and four at S1 for Lumbosacral deformities. Diagnoses

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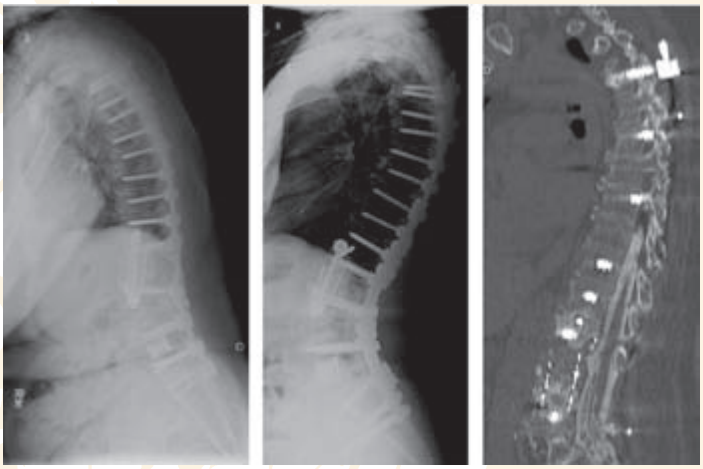
included; sacral fractures (n=4), pseudoarthrosis (n=2), congenital kyphoscoliosis (n=1), ankylosing spondylitis (n=1), Charcot's spine (n=1), and Lumbar flat back(n=1). Complications were, two superficial wound infections and one L5 radiculopathy which resolved within 6 months. There was no pseudoarthrosis or loss of fixation. Mean follow-up was 2.24 yrs (1.39, 3.15 yrs). Mean lumbar lordosis pre-operative was -28.7° (5.8, -63.6), improving to -50.3°degrees (-21.2, -73.8) at last follow-up. An overall 22.2°(8.3, 37.5) correction. At baseline, SVA was +182.9 mm (+103.9, +303.4), decreasing to +18.7 mm (-66.0, +146.9). A mean 164.2 mm (73.1, 268.4) correction of sagittal balance.

Patients also reported significant clinical improvement; ODI score decreased from an average 66.5 ±13.1 (48, 84) to 40.2±18.8 (24, 72) at last visit. The mean SRS-22 score was 2.3 (1.3, 2.9) prior to surgery, improving to 3.0 (2.2, 3.4) at last follow-up.

Conclusion: L5 and S1 PSOs are technically more difficult procedures, however they are effective in the correction of lumbosacral sagittal imbalance. Clinical and radiographic outcomes are satisfactory with comparable complications to other levels PSOs and without an icreased risk of neurologic injury or loss of fixation.

Significance: PSOs at L5 & S1 can safely be done when indicated in patients with lumbosacral sagittal imbalance with satisfactory outcome and without an increased risk of complications.

Preoperative radiograph (L) and postoperative radiograph & CT (R) of 64yo F status post L5 PSO for sacral fracture



7. The Incidence of C5 Palsy after Multilevel Cervical Decompression Procedures: A Review of 750 Consecutive Cases

Jason C. Eck DO MS, Ahmad Nassr MD, Ravi Ponnappan MD, Rami R. Zanoun, William Donaldson, James D. Kang MD
USA

Summary: We reviewed incidence of C5 palsy in a large consecutive series of multilevel cervical spine decompression procedures. Incidence of C5 nerve palsy was 6.7%. There is no significant difference in incidence of C5 palsy based on surgical procedure, although there was a trend toward high rates with laminectomy and fusion.

Introduction: Palsy of the C5 nerve is a well-known complication of cervical spine surgery with rates ranging from 0-30%. The etiology remains uncertain but has been attributed to iatrogenic injury during surgery, tethering from shifting of the spinal cord, spinal cord ischemia, and reperfusion injury.

Methods: We performed a retrospective review of 750 consecutive multilevel cervical spine decompression surgeries performed by a single spine surgeon. We included patients undergoing multilevel cervical corpectomy, corpectomy with posterior fusion, posterior laminectomy and fusion, and laminoplasty. Exclusion criteria included lack of follow-up data, spinal cord injury preventing preoperative or postoperative motor testing, or surgery not involving the C5 level.

Results: Of the 750 patients, 120 were eliminated based on the exclusion criteria. The 630 patients included in the analysis consisted of 292 females and 338 males. The mean age was 58 years (range, 19-87). The incidence of C5 nerve palsy for the entire group was 42 of 630 (6.7%). The incidence was highest for the laminectomy and fusion group (9.5%), followed by the corpectomy with posterior fusion group (8.4%), the corpectomy group (5.1%), and finally the laminoplasty group (4.8%), although these differences did not reach statistical significance.

Conclusion: Incidence of C5 nerve palsy following cervical spine decompression was 6.7%. This is consistent with previously published studies and represents the largest series of patients to date. There is no statistically significant difference in incidence of C5 palsy based on surgical procedure, although there was a trend toward high rates with laminectomy and fusion.

Significance: We have determined the incidence of C5 nerve palsy following cervical spine decompressive procedures is 6.7% with an increased risk in male patients. There was a trend towards an increased risk in patients undergoing laminectomy and fusion; however, this was not statistically significant. Patients should be counseled that 19% have residual deficits. Over 70% of these patients recover within six months, but there can be additional recovery up to two years.

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8. Perioperative Complications of rhBMP-2/ACS vs. ICBG for Posterior Cervical Arthrodesis

Charles H. Crawford MD, Leah Y. Carreon MDMSc, Mark D. McGinnis MD, Mitchell J. Campbell MD, Steven D. Glassman MD
USA

Summary: In a consecutive series of 77 patients who underwent instrumented posterior cervical fusion, a higher incidence of posterior cervical wound complications was seen in patients receiving rhBMP-2/ACS compared to ICBG. This potential risk must be weighed against the elimination of donor site complications associated with ICBG harvesting, and considered in light of ultimate clinical outcome. Additional studies are needed to clarify this issue, as well as to determine optimal dosing and carrier for usage in the posterior cervical spine.

Introduction: There is substantial use of rhBMP-2/ACS as a bone graft substitute for spine fusions outside the FDA approved indication of anterior lumbar interbody fusion. Site-specific perioperative complications that have been reported confirm that safety and efficacy should be established for specific anatomical sites and clinical indications. The purpose of this study is to determine the risk of perioperative complications using rhBMP-2/ACS for posterior cervical fusion compared to ICBG.

Methods: From July 2002 to February 2005, a consecutive series of patients who underwent instrumented posterior cervical fusion were identified. Patients received either rhBMP-2/ACS or ICBG based on the discretion of the surgeon. Patients were excluded if they had a preoperative diagnosis of trauma, tumor or infection, or if they underwent a concomitant anterior procedure. Seventy-seven patients met the inclusion criteria. Forty-one of these patients received rhBMP-2/ACS and thirty-six received ICBG. Standard demographic, surgical, and perioperative complication data were collected from the medical records.

Results: There were no significant differences in age, gender distribution, smoking status, number of surgical levels, blood loss, operative time, nor length of stay between the two groups. There were more posterior cervical wound complications requiring treatment in the rhBMP-2/ACS group (6, 14.6%) vs. the ICBG group (1, 2.8%), although this was not statistically significant (p=0.113). One patient (2.8%) in the ICBG group had a wound complication at the iliac crest donor site. Additional perioperative complications were noted in three patients (7.3%) in the ICBG group and none in the rhBMP-2/ACS group.

Conclusion: The higher incidence of posterior cervical wound complications in the rhBMP-2/ACS group, although not statistically significant, may be related to an inflammatory response to rhBMP-2. This potential risk must be weighed against the elimination of donor site complications associated with ICBG harvesting, and considered in light of ultimate clinical outcome. Additional studies are needed to clarify this issue, as well as to determine optimal dosing and carrier for usage in the posterior cervical spine.

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9. Major Complications Following Adult Spinal Deformity Surgery: Is There a High Risk Patient Profile?

Nicola Hawkinson NP, Frank J. Schwab MD, Beverly J. Kelly MS, Jean-Pierre C. Farcy MD, Gregory M. Mundis MD, Matthew E. Cunningham MD PhD, Behrooz A. Akbarnia MD, Richard Hostin md, Robert A. Hart MD, Oheneba Boachie-Adjei MD, Douglas C. Burton MD, Eric Klineberg, Christopher I. Shaffrey MD, Shay Bess MD, International Spine Study Group
USA

Summary: Perioperative complications are a major consideration in Adult Spinal Deformity. This retrospective consecutive multicenter study established patient profile of subjects with major peri-operative complication. Results revealed that patient profiles may not be 'typical' of high risk patients. Future prospective studies will use this information to develop a risk scoring system (RS3) for Adult Spinal Deformity patients.

Introduction: Perioperative complication rates for adult spinal deformity (ASD) have been reported as high as 80%. Reported risk factors include age, co-morbidities, and blood loss. While risk scores exist in other surgical disciplines, a system is lacking for ASD. The goal of the study is to identify major peri-operative complications and determine if patient profiles can be defined in the setting of ASD surgery

Methods: Retrospective, consecutive, multi-center (n=8) review of major peri-operative (<6wks post-op) complications in ASD patients (documented coronal or sagittal deformity). Major complications were identified and categorized as: pulmonary, neurological, cardiovascular, gastrointestinal, and infectious. Clinical chart reviews were conducted to obtain; ASA grade, co-morbidities, preoperative lab values, and intra/post-operative parameters. Incidence of complications and patient profiles were described.

Results: 72 patients (18M, 54F) were identified in a review of 953 consecutive ASD patients. Mean age was 54yo (18-79) with a total incidence of 99 major and 133 minor complications. Mean operative time was 491mn, mean EBL was 2440ml and mean transfusion was 3100ml RBC's. 54% were revision cases (mean 1.9 previous surgeries) and 50% were staged procedures. 44% of patients were ASA grade III (mean ASA 2.33). There was a mean co-morbidity rate of 2.5 per patient. Most common comorbidities were hypertension, depression/anxiety, coronary artery disease and hypothyroidism. The mean length of ICU stay was 3.4 days. Most common major complications included excessive (>4L) intraoperative bleeding (n=11), return to the OR for deep wound

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infections (n=11) and pulmonary embolus (n=10)

Conclusion: The inherent risk in ASD surgery may not be avoidable. An improved understanding of risk profiles in patients and procedure-related parameters is critical. Such information can assist in pre-operative risk-benefit decisions and pre-emptive approaches to reduce risk. This study reveals that patients affected by major complications in ASD surgery may not be 'typical' high risk patients. This study will form the basis for a prospective multi-center study and aid in the development of a risk scoring system for ASD (RSSS=RS3)

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10. Improvement of Neurologic Deficits Following Anterior Cervical Spine Surgery

Jacob M. Buchowski MD MS, Paul A. Anderson, K. Daniel Riew MD USA

Summary: In order to assess neurologic outcome in patients with preoperative motor and/or sensory deficits, a prospective study of 229 patients undergoing cervical arthroplasty and 194 patients undergoing ACDF was conducted. Our analysis suggests that while the majority of motor and sensory deficits improve following anterior cervical spine surgery by 6 weeks and the improvement is maintained at 2 yrs, sensory deficits appear less likely to resolve and are more likely to worsen than motor deficits.

Introduction: One of the most common questions patients have regarding neurologic deficits associated with cervical pathology is whether surgery can reverse such deficits. Yet, there are no large prospective randomized multi-center studies with minimum 2-yr FU that address this question. The purpose of this study was to determine the neurologic outcome in patients with preoperative motor and/or sensory deficits 2 yrs after surgery.

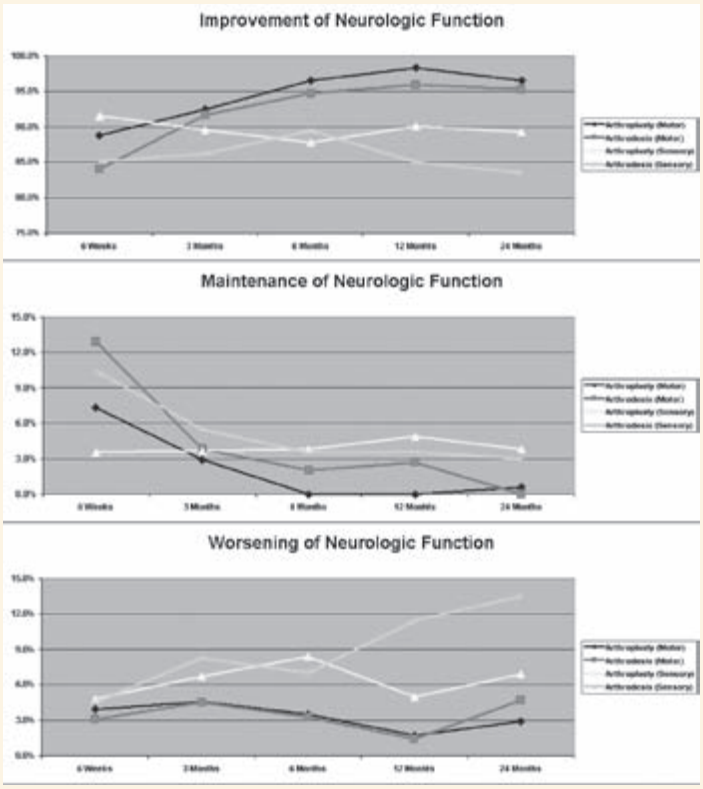
Methods: This was a post-hoc analysis of prospectively collected data from an arthroplasty FDA IDE study. All patients had single-level pathology resulting in radiculopathy and/or myelopathy. Neurologic exams were recorded preoperatively and at scheduled time points. Patients who had motor and/or sensory deficits preoperatively were identified and followed to determine if and when deficits improved.

Results: There were 229 arthroplasty and 194 fusion patients with 2-yr FU. 74.7% (171/229) arthroplasty and 76.3% (148/194) fusion patients had motor deficits preop. These mostly improved by 2 yrs: 96.5% (165/171) arthroplasty and 95.3% (141/148) fusion patients improved, 0.6% (1/171) arthroplasty and 0% (0/148) fusion patients remained unchanged, and 2.9% (5/171) arthroplasty and 4.7% (7/148) fusion patients worsened. 69.4% (159/229) arthroplasty and 68.6% (133/194) fusion patients had sensory deficits preop. By 2 yrs, 89.3% (142/159) arthroplasty and 83.5% (111/133) fusion patients improved, 3.8% (6/159) arthroplasty and 3.0% (4/133) fusion patients remained unchanged and 6.9% (11/159) arthroplasty and 13.5% (18/133) fusion patients worsened. In the majority of cases, sensory and motor improvement occurred within the first 6 wks postop. Compared to motor improvement, fewer sensory deficits improved postop in both groups and more worsened by 2 yrs ($p<0.05$). There were no differences between the two groups in either motor or sensory improvement.

Conclusion: Our data suggest that the majority of motor and sensory deficits improve by 6 wks and the improvement is maintained at 2 yrs. However, sensory deficits appear less likely to resolve and are more likely to worsen than motor deficits.

Significance: This is the first prospective study with 2-yr FU to demonstrate the extent of neurological improvement following anterior cervical spine surgery.

Neurologic outcome following anterior cervical spine surgery.



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11. Anterior Cervical Decompression and Fusion Accelerates Adjacent Segment Degeneration - Comparison with Asymptomatic Volunteers in 10-Year MRI Follow-Up Study

Morio Matsumoto MD, Eijiro Okada MD, Daisuke Ichihara, Hirokazu Fujiwara, Suketaka Momoshima MD, Yuji Nishiwaki, Akio Iwanami, Takeshi Ikegami, Takeshi Takahata, Yoshiaki Toyama, Kazuhiro Chiba MD PhD
Japan

Summary: Our comparative 10 year-follow-up MRI study of patients who underwent anterior cervical decompression and fusion and healthy volunteers revealed that the patients group had degenerative chages at the adjacent segments more frequently than at the corresponding levels in the volunteers.

Introduction: Adjacent segment degeneration after anterior cervical decompression and fusion (ACDF) can be a sequel of phisiological aging. The purpose of this study was to elucidate the incidence of adjacent segment degeneration 10 years after ACDF in comparison with asymptomatic volunteers.

Methods: 64 patients who underwent preoperative MRI and one or two-level ACDF for disc hernia or spondylosis between 1990 and 1997 were included in this study (48 males, 16 females, mean age 47.3 years). 201 asymptomatic volunteers who underwent MRI between 1993 and 1996 in our previous study were also included in this study and served as controls (113 males, 88 females, mean age; 41.1 years). The paricipants underwent MRI again in the present study. Following MR findings related to intervertebral disc degeneration were evaluated using a numerical grading system from C2-3 to C7-T1: 1) Decrease in signal intensity of disc (DSI), 2) Posterior disc protrusion (PDP), 3) Disc space narrowing (DSN), and 4) foraminal stenosis (FS). When an increase in at least one grade in any of the radiographic parameters was detected between the two time points, progression of disc degeneration was judged as present at the level of interest. The incidence of progression of degenerative MR findings at adjacent levels in ACDF group was compared with that at the corresponding levels in control group. Logistic regression analysis was employed to determine statistical significance.

Results: Progression of DSI was significantly more frequent in ACDF group than in control group only at C4-5(54.1% vs. 28.9%), while progression of PDP was significantly more frequent in the ACDF group than in the control group at all levels except for C5-6; C2-3; 20% vs. 0%, C3-4; 60% vs. 10.9%, C4-5; 69.4% vs. 29.4%, C5-6; 38.9% vs. 50.2%, C6-7; 56.8% vs. 33.8%, C7-T1; 31.6% vs. 2.5%. Progression of DSN and FS was significantly more frequent in ACDF group at C3-4 (15% vs. 1%) and at C6-7(22.6% vs. 5.5%), respectively.

Conclusion: Although both ACDF patients and control subjects demonstrated progression of disc degeneration during 10 years, ACDF patients had significantly higher incidence of progression of disc degeneration at adjacent segments than control subjects.

Significance: ACDF accelerates adjacent segment degeneration.

☐ **12. Is Laminoplasty Contraidicated Following Single Level Cervical Arthroplasty? An In-Vitro Biomechanical Study**

Jun Kikkawa MD, Bryan W. Cunningham MSc, Osamu Shirado MD, Nianbin Hu, Paul C. McAfee MD
USA

Summary: Postoperative recurrence of myelopathy following cervical arthroplasty or ACDF may occur because of inadequate decompression or adjacent-segment disease. The current study demonstrated demonstrated increased ROM and NZ in flexion/extension, lateral bending and axial rotation following posterior decompressive surgery vs. that produced by disc arthroplasty alone. The findings suggest that immobilization of cervical spine may be necessary after multilevel posterior decompressive surgery following disc arthroplasty in early post-operative term.

Introduction: This study served to define the multi-directional flexibility properties of laminoplasty and laminectomy following cervical arthroplasty, and determine if posterior decompressive surgery is contraindicated with cervical arthroplasty.

Methods: Seven cervical spines were evaluated under the following C5-C6 conditions: 1) Intact, 2) Diskectomy, 3) PCM (arthroplasty), 4) PCM+three-level laminoplasty (C3-5), 5) PCM+four-level laminoplasty (C3-6), 6) PCM+five-level laminoplasty (C3-7), 7) PCM+laminoplasty without hydroxyapatite spacers, 8) PCM+laminectomy (C3-7). Multi-directional flexibility testing utilized moments of ±2Nm for all loading modes. The centers of intervertebral rotation (COR) were calculated and operative level range of motion (ROM) and neutral zone (NZ) normalized to intact (100%).

Results: Flexion-extension indicated an increase in operative level ROM of diskectomy compared to intact and PCM($p<0.05$). With PCM, flexibility was restored near to intact ROM (92.2±36.6%) and NZ (120.8±35.0%) ($p>0.05$). Laminoplasty combined with PCM produced greater motion than PCM alone ($p>0.05$). Although there were no significant differences between three- (121.2±49.7%), four- (134.1±49.9%) and five-level (147.6±55.6%) laminoplasties, additional levels increased segmental C5-C6 motion. Laminoplasty without spacers (162.8%) and laminectomy (170.6%) combined with PCM indicated greater segmental motion ($p>0.05$)(Figure 1). Diskectomy resulted in posterior movement of COR, which was effectively restored following PCM reconstruction.

Conclusion: Multidirectional flexibility demonstrated increased ROM and NZ in all modes following posterior decompressive surgery vs. disc arthroplasty. Laminoplasty markedly reduces motion compared to laminectomy and extending laminoplasty increased overall cervical flexibility. Minimizing the extent of laminoplasty is more favorable from a biomechanical standpoint. The current findings suggest that cervical immobilization may be necessary after multilevel posterior decompressive surgery following disc arthroplasty in early post-operative term.

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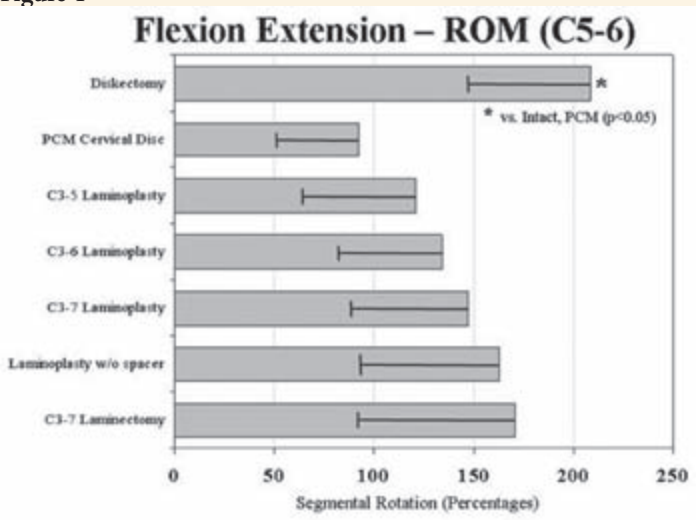
Figure 1



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13. Three and Five Year Results from a Prospective, Randomized US IDE Trial on Cervical Arthroplasty

Praveen V. Mummaneni MD, Vincent Traynelis MD, Regis Haid, Thomas Zdeblick, J. Kenneth Burkus MD
USA

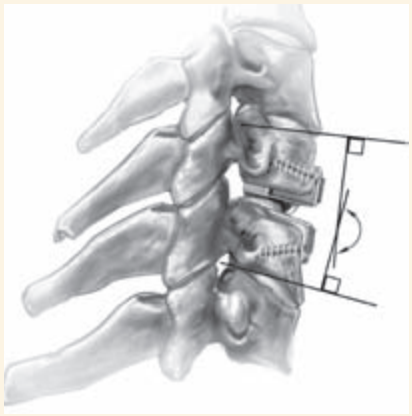
Summary: We present 3 and 5 year results from a prospective, randomized US IDE trial comparing one level cervical arthroplasty with ACDF in an initial cohort of 541 patients.

Introduction: We compare ACDF vs. arthroplasty with the PRESTIGE device in patients who have reached 3-5 years of follow up.

Methods: 541 patients with single-level cervical disc disease with radiculopathy were prospectively randomized and enrolled at 32 sites to 1 of 2 treatment groups: 276 patients underwent ACD and arthroplasty with the PRESTIGE ST cervical disc and 265 patients underwent ACDF. Of the original 541 patients, 247 have now reached 3 years of follow up and 111 have reached 5 years follow-up.

Results: The NDI and Neck Pain scores were significantly better in the arthroplasty group at 3 years (P<0.01 and P= 0.044 respectively) but were similar at 5 years (P=0.214 and P=0.895 respectively). There was no statistical difference between groups for the SF36 PCS, SF 36 MCS, or VAS Arm Pain Scores at 3 years or 5 years. At latest follow up, the PRESTIGE arthroplasty devices did maintain a mean of 7.1 degrees of motion on flexion and extension X-rays. At latest follow up, there were 7 PRESTIGE arthroplasties removed vs. 11 ACDF's removed.

Conclusion: The PRESTIGE ST Cervical Disc maintains physiologic segmental motion at up to 5 years after implantation. The arthroplasty device is associated with improved NDI and Neck Pain scores at 3 years, but these scores were not significantly different at 5 years. The PRESTIGE arthroplasty group had reduced secondary surgical procedures compared with anterior cervical discectomy and fusion.



Significance: This is the longest follow up of any US IDE cervical arthroplasty trial.

14. Outcomes of Anterior Cervical Fusion in Patients with Predominant Neck Pain, Predominant Arm Pain or Equal Neck and Arm Pain

Sarah Jernigan MD, Leah Y. Carreon MDMSc, Mitchell J. Campbell MD, James Smith MD, John R. Johnson MD, Rolando M. Puno MD, Steven D. Glassman MD
USA

Summary: In patients undergoing one to two level ACDF, improvement in all HRQOL measures from pre-op to two years was seen whether they had predominant neck, predominant arm or equal neck and arm pain. Although patients with predominant neck pain had less improvement in NDI and SF-36 PCS this did not reach statistical significance.

Introduction: The purpose of this study is to compare outcomes following anterior cervical discectomy and fusion in patients with predominant neck pain, predominant arm pain or equal neck and arm pain.

Methods: Patients who had one to two level discectomies and fusion (ACDF) with complete pre-op and two-year postop health related quality of life (HRQOL) measures, including numeric rating scales for neck and arm pain, the Neck Disability Index (NDI) and the Short Form-36 (SF-36) were identified. Patients were divided into three groups: predominant neck pain, predominant arm pain and equal neck and arm pain. Paired t-tests to compare pre-op to two-year postop HRQOL within each of the three groups and ANOVA to compare differences in the change in HRQOL among the three groups was performed.

Results: Of 166 patients identified, 83 had predominant neck pain, 33 had predominant arm pain and 50 had equal neck and arm pain. There was no statistically significant difference in the demographics or smoking status among the three groups. There was statistically significant improvement in all HRQOL measures from pre-op to two years post-op in all three groups. Patients with predominant neck pain had a statistically smaller improvement in arm pain compared to patients with predominant arm pain or

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equal arm and neck pain. Similarly, patients with predominant arm pain had a statistically smaller improvement in neck pain compared to patients with predominant arm pain or equal arm and neck pain. Although patients with predominant neck pain had smaller improvements in NDI and SF-36 PCS compared to patients with predominant arm pain or equal arm and neck pain, this did not achieve statistical significance.

Conclusion: In patients undergoing one to two level ACDF, improvement in all HRQOL measures from pre-op to two years was seen whether they had predominant neck, predominant arm or equal neck and arm pain. Although patients with predominant neck pain had less improvement in NDI and SF-36 PCS this did not reach statistical significance. Studies with larger numbers may show this difference to be significant.

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15. The Time Course of Range of Motion Loss After Cervical Laminoplasty: A Prospective Study with Minimum Two Year Follow-up

Seung Jae Hyun, Seung Chul Rhim MD PhD, Sung Woo Roh
Korea, South

Summary: This is a prospective study of 23 laminoplasty patients with a minimum 2 year follow-up. Average cervical range of motion(ROM) decreased by 10.1±9.5° (31.66%) post-operatively, but the rate of ROM reduction slowed with time. Post-laminoplasty cervical ROM decreased with time but appeared to plateau by 18 months after the procedure.

Introduction: To identify the time-dependent change in range of motion (ROM) after cervical laminoplasty. Although numerous studies have reported on the loss of flexion-extension ROM associated with laminoplasty, few have reported on the time course of this loss of motion.

Methods: Twenty-three patients who received unilateral open-door laminoplasties, including miniplate fixation over two levels, were serially evaluated at regular set intervals post-operatively. The mean follow-up period was 26.78 months (range 24-41 months). Twelve patients had OPLL and 11 patients had cervical spondylotic myelopathy. Enrolled patients were divided into two groups (OPLL and CSM) to compare the ROM between the OPLL and the spondylosis patients. We evaluated the time-dependent neck ROM changes by taking neutral, flexion, and extension radiographs pre-operatively and at 1, 3, 6, 9, 12, 18, and 24 months post-operatively. Postoperative neck and arm pain was evaluated using a numerical rating scale.

Results: The preoperative, and 1, 3, 6, 9, 12, 18, and 24 month postoperative ROM figures were 37.8±14.6°, 34.1±12.9°, 35.0±12.3°, 30.3±13.0°, 28.6±15.1°, 27.3±12.4°, 26.1±14.8°, and 25.9±13.2°, respectively, and at the most recent follow-up, ROM was 25.8±15.2°. Thus, the mean ROM decreased by 10.1±9.5° (31.66%) after surgery (p=0.002). In OPLL group, we observed a more limited cervical ROM than in CSM group (35.3% vs. 29.2%). However, the rate of ROM reduction slowed with time in both groups (p = 0.000). Postoperative axial pain did not correlate with the degree of serial cervical ROM.

Conclusion: The results suggest that the loss of cervical ROM is time-dependent and plateaus by18 months post-operatively, with no further decreases thereafter.

Significance: - This is a prospective study of 23 laminoplasty patients with a minimum 2 year follow-up.

- Average cervical ROM decreased by 10.1±9.5° (31.66%) post-operatively, but the rate of ROM reduction slowed with time.
- In OPLL group, we observed a more limited cervical ROM than in CSM group (35.3% vs. 29.2%).
- Postoperative neck pain did not correlate with the extent of serial cervical ROM.
- Post-laminoplasty cervical ROM decreased with time but appeared to plateau by 18 months after the procedure.

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16. Posterior C2 Instrumentation: Accuracy and Risks Associated with Four Techniques

Richard J. Bransford MD, Anthony Russo MD, Mark Freeborn, Quynh Nguyen, Michael J. Lee MD, Jens Chapman, Carlo Bellabarba
USA

Summary: The variety of options for C2 instrumentation allow for accurate placement.

Introduction: The variable C2 anatomy can make instrumentation challenging. The goal of this study was 1) to evaluate a series of posterior C2 screws to determine accuracy as assessed by computed tomography (CT) scan 2) assess dimensions of "safe bony windows" with CT and 3) assess the perioperative complication rate related to screw placement.

Methods: A retrospective review of a single tertiary care referral center spine database was assessed to identify all patients with C2 instrumentation between December 2002 and September 2008. Clinical data was obtained from the electronic medical record. Radiographic analysis included evaluation of CT scans to quantify the patients' bony anatomy as well as to classify the accuracy of C2 screw placement using the following definitions:

Type I - Ideal - screw threads completely within the bony cortex.

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

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

Results: 326 patients underwent posterior C2 screw fixation during this time period. Average CT measurements of pedicle height, axial width and laminar width were 8.1 mm(standard deviation 2.1 mm), 5.8 mm (1.9 mm) and 5.7 mm(1.5 mm) respectively with males having larger pedicle height (p<0.001), pedicle width (p<0.001), and laminar width (p<0.022).

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326 patients with 634 screws underwent CT analysis and chart review. 339 pedicle (P), 154 trans-articular (TA), 63 laminar (L), and 77 short pars (SP) screws were placed with 98.8%, 98.5%, 100%, and 94.6% accuracy rates (Grade I and II) respectively. 8 screws (3 P, 2 TA, 3 SP) were unacceptably (Grade III) placed. 2 patients had medially placed screws (1 P, 1 TA) in the spinal canal without neurological sequalae. 6 patients had screws encroaching on the vertebral artery foramen; one patient had a vertebral artery occlusion (P) and one had a grade I dissection (P) documented on CT angiogram.

Conclusion: The multiple techniques of posterior C2 fixation currently available allow for flexibility in determining which technique is best suited for a given patient's anatomy with high accuracy rates.

Significance: The options available for C2 instrumentation allow for accurate screw insertion with minimal risks.

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17. Cervico-Thoracic Osteotomy for Ankylosing Spondlytis: A Prospective Clinico-Radiological Analysis

Hossein S. Mehdian FRCS (Tr & Orth), Arun Ranganathan DNB (Orth), Nanjundappa S. Harshavardhana MS(Orth), Dip. SICOT, Brian J. Freeman DM FRCS (Tr & Orth)
United Kingdom

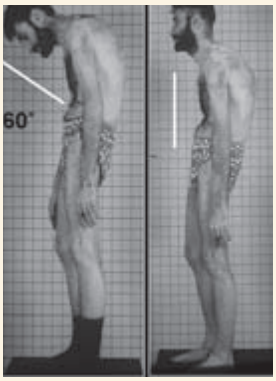
Summary: Ankylosing spondylitis (AS) results in progressive cervico-thoracic kyphosis & fixed sagittal imbalance affecting horizontal gaze & activities of daily living (ADL). Cervico-thoracic osteotomy is performed to restore horizontal gaze and normalise chin-brow vertical angle (CBVA). We report minimum 2 year follow-up results from a single centre using controlled reduction manoeuvre and discuss its safety with clinico-radiological correlation. Use of temporary malleable rods during correction reduces translation and risk of iatrogenic neurological injury.

Introduction: Loss of forward gaze and inability to lie supine in bed are most incapacitating symptoms in patients with fixed sagittal imbalance due to AS.

Methods: 11 patients (10 males & 1 female) with progressive AS operated over 13 years (1993-2006) who underwent correction of cervico-thoracic kyphosis by an extension osteotomy at C7/T1 junction and prospectively followed-up for a minimum of 2 years formed the study cohort. The mean age at surgery was 56 years (range 40-74y) and mean duration of symptoms was 2.7 years (range 1-5y). Lateral mass screws were placed from C3-C6 and thoracic pedicle screws from T2 to T5 after midline posterior exposure. Chevron osteotomy with removal of posterior elements was performed at C7-T1 junction. The reduction manoeuvre was then carried out by the senior surgeon lifting the halo, while bilateral temporary malleable rods (fixed to cervical lateral mass screws) were allowed to slide through top loading thoracic pedicle screws. These temporary malleable rods were then tightened with head in desired position and sequentially replaced with definitive rods, thereby creating a solid internal fixation. All patients wore halo vest for 12 weeks to support the instrumentation and facilitate fusion.

Results: The mean follow-up was 7.3 years (range 2.5-15y) and mean duration of surgery was 4.7 hours (range 3-6.5h). The mean blood loss was 0.35 times EBV. (range 0.18-0.65). The mean pre-op CBVA was 54 degrees (range 20-70) which reduced to 7 degrees (range 2-20) post-operatively. The mean pre-op kyphotic angle was +19.2 degrees which corrected to -34 degrees at final follow up (minus sign indicating lordosis). Restoration of normal forward gaze was achieved in all cases. There were no neurovascular injury or permanent nerve root palsy.

Pre-op & post-op clinical photographs following cervicothoracic osteotomy



Conclusion: Cervico-thoracic osteotomy for AS is hazardous. The safety is increased by use of temporary malleable rods during reduction manoeuvre and should be performed by experienced spinal deformity surgeons.

Significance: Cervico-thoracic osteotomy for AS facilitated restoration of horizontal gaze and improved quality of life in this patient series.

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18. Cervical Kyphotic Deformity Correction Using 360-Degree Reconstruction

Naresh P. Patel MD, Eric W. Nottmeier, H. Gordon Deen, Barry D. Birch MD
USA

Summary: Despite multiple studies demonstrating the feasibility of operative cervical kyphotic deformity correction, few reports detail the the amount of preoperative kyphosis, the amount of deformity correction, and maintenance of deformity correction. This study aims to determine whether adequate deformity correction could be achieved and maintained with 360-degree reconstruction.

Introduction: A paucity of literature exists concerning 360-degree approaches for the correction of cervical kyphotic sagittal deformity in which the amount of deformity correction achieved, as well as the maintenance of deformity correction, is detailed. The authors report on their experience with cervical sagittal deformity correction using 360-degree reconstruction with emphasis on degree of deformity correction and maintenance of deformity correction.

Methods: : The charts of all patients undergoing 360-degree cervical reconstruction for kyphotic sagittal plane deformity between 2000 and 2006 at Mayo Clinic Jacksonville and Mayo Clinic Scottsdale were retrospectively reviewed. Only patients with a minimum of 1-year follow up were included in this study and 41 patients fit this criteria. The clinical data was further analyzed

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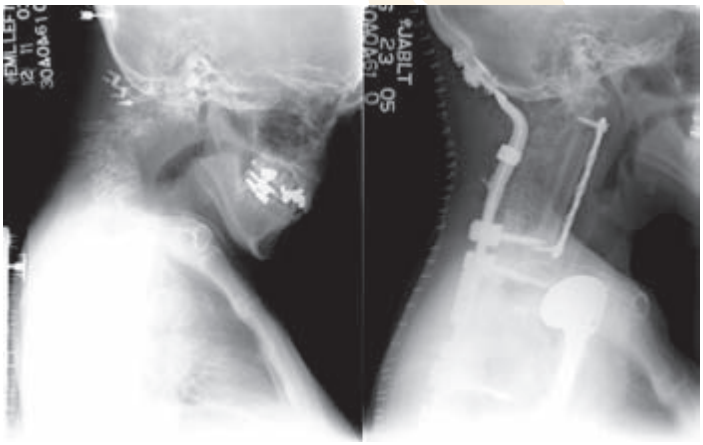
in this cohort to determine preoperative and postoperative sagittal angle, loss of correction, fusion rate, complications and clinical status at last follow-up.

Results: Average follow-up was 19 months (range 12-48 months). The mean preoperative sagittal angle was 18° of kyphosis (range 3-58°). The mean correction of sagittal angle was 22° (range 4-56°) resulting in a postoperative mean sagittal angle of 4° lordosis. There was no loss of correction across the instrumented segments in any patient. Neurologic complications included 1 case of quadriparesis and 1 case of transient C8 radiculopathy.

Conclusion: The correction of cervical kyphotic sagittal plane deformity can be accomplished safely and effectively using a 360-degree approach. The incidence of major complications in this study was low. All patients were able to be corrected to a neutral or lordotic alignment. No loss of deformity correction was seen in any patient and a 98% fusion rate was obtained.

Significance: Circumferential cervical deformity correction via 360-degree fusion appears to be safe and effective at a minimum one year follow-up.

Cervical kyphotic deformity due to severe rheumatoid arthritis before (left) and after (right) 360-degree correction.



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).

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19. Sequential-Simultaneous Posterior-Anterior-Posterior vs. Posterior Only Surgery for the Treatment of Posttraumatic Kyphosis

Meric Enercan, Ahmet Alanay, Cagatay Ozturk, Selhan Karadereliler, Ibrahim Ornek, Azmi Hamzaoglu
Turkey

Summary: Posttraumatic kyphosis (PTK) causes pain, neurological deficit, sagittal imbalance, progressive deformity, cosmetic and functional deterioration. Surgical treatment via posterior approach only is helpful especially in older population by lowering the rate of mortality and morbidity.

Introduction: The purpose of this study was to compare the clinical and radiological effectiveness of sequential-simultaneous posterior-anterior-posterior surgery and posterior only surgery in surgical reconstruction of posttraumatic deformity.

Methods: From 2001 to 2007, 21 patients (group 1) were operated by sequential-simultaneous approach and 16 patients (group 2) underwent posterior only surgery. The average age was 48 (range; 23-62) years in group 1 and 56 (22-74) years in group 2. Preoperative, immediate and last follow-up standing AP and lateral roentgenographies were evaluated to determine correction of sagittal alignment and its maintanance during follow-up including the measurements of global and local kyphosis or lordosis, pelvic incidence, sacral slope and pelvic tilt. Functional status of the patients were assessed by Oswestry score.

Results: The average follow-up was 3.2 years. For group 1, the average correction ratio in the sagittal alignment is 82%. The mean values of pelvic incidence, sacral slope and pelvic tilt changed from 440, 300 and 140 preoperatively to 530, 400 and 130 respectively at the last control. Oswestry functional scores decreased from preoperative 48 % to 11%. For group 2, the average correction ratio in the sagittal alignment is 80%. The mean values of pelvic incidence, sacral slope and pelvic tilt changed from 460, 310 and 150 preoperatively to 550, 420 and 130 respectively at the last control. Oswestry functional scores decreased from preoperative 56 % to postoperative 16%. There were neihter pseudoarthrosis nor hardware failure seen. Analysis from last follow-up X-rays showed showed solid fusion in all patients without significant loss of correction in the sagittal plane.

Conclusion: The controversy between combined surgery vs. posterior only surgery depends of classification of posttraumatic spinal deformities based on three criteria: the region involved, the neurological status, the presence of any sagittal or frontal plane deformities outsides the local kyphosis and the presence of co-morbidities to avoid anterior surgery. Surgical treatment via posterior approach only is helpful especially in older population by lowering the rate of mortality and morbidity.

Significance: -

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20. A New Technique to Prevent Proximal Junctional Kyphosis in the Surgical Treatment of Scheuermann Disease

Azmi Hamzaoglu, Cagatay Ozturk, Fatih M. Korkmaz, Omer Karatoprak, Meric Enercan, Mehmet Tezer
Turkey

Summary: The rate of proximal junctional kyphosis has been reported up to 31%. In this study, we have defined a new surgical strategy to prevent proximal junctional kyphosis in surgical treatment of Scheuermann kyphosis.

Introduction: The rate of proximal junctional kyphosis has been reported up to 31%. The mechanism is probably that initial fixation of the uppermost screw and start of correction from

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there by either cantilever or compression maneuvers exert much more stress force on interspinous and supraspinous ligaments of adjacent segment creating tension on facet joint capsule leading to subluxation of the joint. Our new approach is that fixation and start of correction one level below the uppermost screw secure the adjacent segment and prevent stress force in the segment adjacent to most proximal instrumented segment. The aim of this study is to determine whether our new surgical strategy prevents proximal junctional kyphosis or not in surgical treatment of Scheuermann kyphosis.

Methods: Between the years of 1996 and 2007, 37 adolescents with Scheuermann disease undergoing surgery were included in the study. In all patients, the upper instrumented vertebra was T2. In the group1 (13 patients), classical surgery was done. In the group 2 (24 patients), after placing pedicle screws or hooks, instead of upper most segment; locking was started from one below vertebra (T3 in our cases) and going down to distal segments. Correction was done by cantilever and segmental compression maneuvers in the main thoracic deformity as previously defined. After finishing correction, loose T2 pedicle screws or hooks were fixed to rod in situ, without applying any corrective force.

Results: The mean postoperative follow-up was 54 (24-112) months. All patients were male and the average age was 17.5 years. Four of 13 patients in group 1 showed PJK of more than 10 degrees (mean of 18 degrees) and the proximal junctional angle changed only 3 degrees in favor of kyphosis during the postoperative follow-up period in group 2.

Conclusion: We have compared the efficacy of our technique with classical correction technique in terms of prevention of PJK. Besides the traditional methods for prevention of PJK, above defined strategy will prevent the mechanical failure at the uppermost instrumented segment.

Significance: -

21. Pedicle Substraction Osteotomy (PSO) in Severe Rigid Post-Tubercular Dorsal Kyphosis

Saumyajit Basu MS(Orth),DNB(Orth),FRCSEd, Sreeramalingam Rathinavelu
India

Summary: PSO in rigid postTB dorsal kyphosis improves SRS/VAS scores & Cobb without much complication.

Introduction: This is a retrospective study of a cohort of patients with strict inclusion criteria who underwent surgical correction of healed post-tubercular dorsal kyphosis.The objective was to assess the efficacy and safety of Pedicle Subtraction Osteotomy (PSO) as a single stage surgical procedure for correcting severe, rigid post-tubercular dorsal kyphosis with or without late onset neurodeficits.

Methods: Clinical and Radiological outcomes were measured in 10 consecutive patients were followed up for a minimum of 2 years (range: 4yrs 11months to 2yrs 2months, average 3yrs 4months). Clinical outcomes were evaluated using the SRS -30 questionnaire and VAS scores of pain relief. Radiological evaluation was done by measuring the pre and postoperative Cobb angle. The complications were documented.

Results: The mean improvement of SRS-30 scores was 1.39 (range -0.61 to 1.93) with maximum improvement in patient satisfaction. The mean improvement in VAS (out of 100) was from 67.6 (preoperative) to 7.2 (postoperative). Mean preoperative Cobb angle of 64.8° (range - 42° to 102°) improved to 32.4° (range - 14° to 60°) -- an improvement of 32.4° (51.2%). Other than one patient of superficial wound infection, there was no major complication. No patient had neurological deterioration.

Conclusion: PSO is an efficient and safe single stage surgical option for correcting severe, rigid and healed post-tubercular dorsal kyphosis with or without late onset neurological deficits.

Significance: This retrospective study was done to evaluate clinical & radiological efficacy and to assess the safety of Pedicle Subtraction Osteotomy (PSO) in rigid post-tubercular dorsal kyphosis with or without neurodeficit. SRS scores and VAS scores improved in all and Cobb correction was about 50% without significant complications.

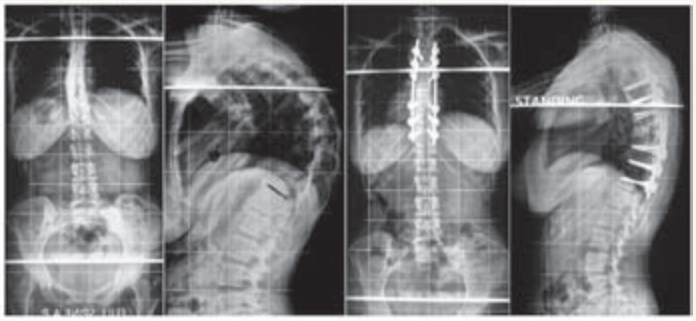

Fig: 1

Figure 1: Whole spine standing AP and Lateral X-rays before and after surgery. Showing a Cobb correction of 80° to 40°. Note that there is no balance of sagittal balance. Note also the anterior reconstruction by a cage.

22. Segmental Resection Osteotomy and dual axial rotation corrective technique for severe angular kyphosis

Zhongqiang Chen, Qiang Qi, Zhaoqing Guo doctor, Weishi Li, Yan Zeng doctor, Chuiguo Sun
China

Summary: The treatment of severe angular kyphosis is a difficult problem in spine surgery. Previous surgical technique is neither effective nor safe. We designed a new surgical technique, ie. segmental resection osteotomy, dual axial rotation correction and instrumentational fusion technique. It is an effective and safe way to treat severe angular kyphosis. The correction rate was satisfactory. It had a good long term results.

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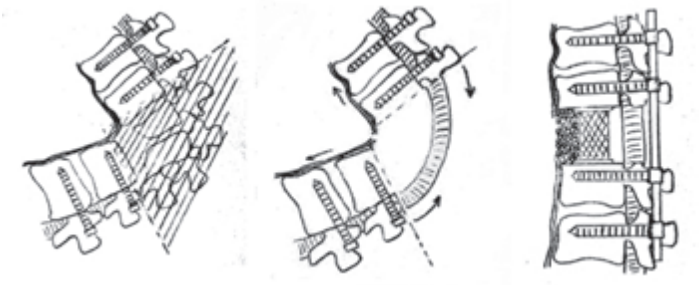
Introduction: Design a new surgical correction and fixation technique for severe angular kyphosis. Observe the feasibility, safety and effectivity of the surgery.

Methods: From May 2004 to December 2006, we treat 23 cases severe kyphosis (average Cobb angle 86.9°, range 50°-130°) with segmental resection osteotomy, section distraction, dual axial rotation correction and instrumentational fusion technique (Figure 1). Radiographic assessment for sagittal alignment of the total spine and kyphosis Cobb angle, including 9 cases of combined scoliosis Cobb angle, was performed before and immediately after operation, and at last follow-up (minimum 2 years). The Frankel Grading system for neurological function and Oswestry Disability Index (ODI) were evaluated preoperatively and at last follow-up. Patients Satisfactory Index (PSI) was also used for clinical evaluation at last follow-up.

Results: The mean surgical time was 6.7 hours. The average blood loss was 3700ml. The complications include 1 shifting of artificial vertebrae, 5 nerve root injury, 3 dural tear and 1 transitory dysfunction of lower extremity. All of these complications recovered after feasible treatment. All the patients were followed 2 years or more after surgery. The average kyphotic angle was 86.9°preoperatively, which was improved to 25.6°immediately after surgery, and got an average correction rate of 72.17%. At follow-up, the average kyphotic angle was 27.4°, and correction rate was 69.87%. The 9 cases who combined with scoliosis had an average Cobb angle of 31.2°, which decreased to 3.4°immediately after surgery, and the correction rate was 90.06%. The correction rate was kept until follow-up (83.39%). Some patients got an improved neurological function. Except for 4 cases who had no symptoms before surgery, the average ODI was 18.47 preoperatively, and 10.47 at follow-up. The average improvement of ODI was 43.31%. The PSI result showed a total satisfied rate of 91.30%.

Conclusion: Segmental resection osteotomy, dual axial rotation correction and instrumentational fusion technique is an effective and safe way to treat severe angular kyphosis. The correction rate was satisfactory. It had a good long term results.



23. Residual Kyphosis After Posterior Vertebral Column Resection For Severe Kyphoscoliosis: Its Risk Factors And Further Surgical Strategy

Qiu Yong, Zhu Ze-zhang, Qian Bang-pin, Wang Bin, Yu Yang, Zhu Feng, Sun Xu, Ma Wei-wei
China

Summary: Severe kyphoscoliosis treated with posterior vertebral column resection(PVCR) showed well short term clinical outcome. However, few studies reported the risk factors and surgical strategy of residual kyphosis after PVCR for severe kyphoscoliosis.

Introduction: To explore the risk factors of residual kyphosis after PVCR for severe kyphoscoliosis, and to present further surgical strategy.

Methods: From April 2002 to January 2006, 75 patients with severe kyphoscoliosis deformity were treated with PVCR. The pre-operative scoliosis Cobb angle was 72° (51°-130 °) and kyphosis Cobb angle was 82 °(69°-147 °). There were 7 patients with neurological deficits pre-operatively. All the patients received first-stage PVCR. 28 out of 75 patients underwent second-stage anterior strut grafting on the concave side (Group A) or anterior interbody autografting on the convex side (Group B) according to the residual kyphosis after posterior operation

Results: There were 11 cases in Group A and 17 cases in Group B.The risk factors of the residual kyphosis were as follows: hyperkyphosis in 11, continuous convex hemivertebrae in 5, hemivertebra combined with failure of vertebral body segmentation in 4, insufficient osteotomy on the concave side in 3, insufficient rib head resection in 2, and partial correction to avoid spinal cord compression in 3. The average period of follow-up was 21 months. In Group A, one patient developed pseudarthrosis and rod broken due to the tibial strut fracture, one patient with pseudarthrosis, all the other patients achieved bony fusion. One patient suffered from tibia fracture after trauma. All the patients in Group B achieved bony fusion and no implant failure was found.

Conclusion: For the patients with residual kyphosis after PVCR, additional anterior strut grafting on the concave side or anterior interbody autografting on the convex side could reduce the implant failure, correction loss and neurological complication.

24. How Much Kyphosis Correction Can Be Obtained With Posterior Vertebral Column Resection (VCR)?

Woojin Cho MD & PhD, Lawrence G. Lenke MD, Linda A. Koester BS, Brenda Sides MA, Christine Baldus RN MHS
USA

Summary: The kyphosis correction after PVCR can be estimated with two approximations.The geographic approximation(G)= (tanG * 2+1)*15°. The rough approximation(R) is about the same amount of x, if y≥40; twice of x, if y<40.

Introduction: Recently posterior VCR (PVCR) has been performed to correct severe rigid spinal deformities and was proven to be

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relatively safe and effective. However, there is no scientific reference to the correlation between the amount of correction achieved and the shortening of the vertebral column with PVCR.

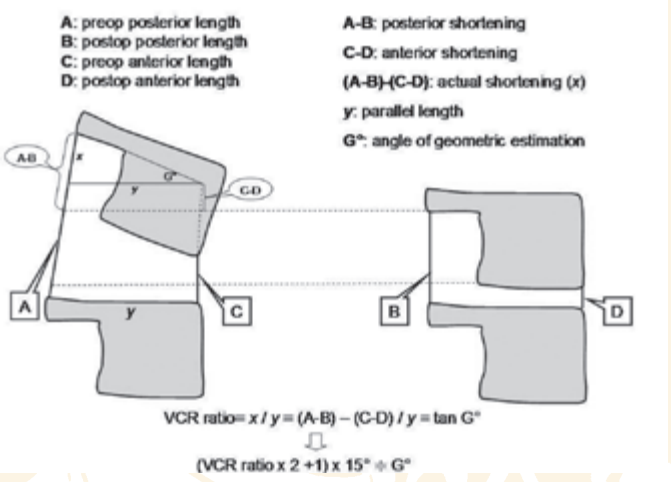
Methods: Among 88 PVCR patients treated by a single surgeon, 26 patients with primarily a kyphotic deformity and clear anatomical landmarks visible on pre and post-op x-rays were selected, and several anatomical lines and angle measurement were utilized as depicted in Fig. 1. (Left side is preop and right side is postop. The vertebra above and below are supra-adjacent and infra-adjacent vertebra respectively. The body at the level of resection was omitted.)

Two approximations were calculated. The geographic approximation(G)= (tanG * 2+1)*15°. The rough approximation(R) is about the same amount of x, if y≥40; twice of x, if y<40. The change in segmental kyphosis (the angle between one level above and below) was measured(K) and compared with the geometric(G) and the rough approximation(R).

Results: The absolute Mean ± SE for K-G and K-R was 0.99 ± 0.14°, 4.33 ± 0.55°, respectively. 99% confidence interval(CI) for mean of K-G and K-R was 0.60~1.38°, 2.79~5.88° respectively. K-G is not significantly different from 0.5° (p=0.001). K-R is also not significantly different from 3° (p=0.01). The validity of this approximation was also tested with 20 patients, which was also high(p=0.0009, 0.02;respectively). In other words, the actual kyphosis correction(K) was very close to the 2 approximations G and R and thus can be predicted by these.

Conclusion: With both approximations, the amount of kyphosis correction can be estimated precisely. If the vertebral body was small, the amount of kyphosis correction was exaggerated.

Significance: Preoperative planning can be made with the formula for the geographic approximation(G), and the intra-operative rough planning can be made with the rough approximation(R). The size of the vertebral body affects the amount of kyphosis correction with the same amount of vertebral column shortening.



25. Morbidity and Mortality in the Surgical Treatment of 605 Pediatric Patients with Isthmic or Dysplastic Spondylolisthesis: A Report from the Scoliosis Research Society Morbidity and Mortality Committee

Kaiming G. Fu MD PhD, Justin Smith MD PhD, Christopher I. Shaffrey MD, Sigurd Berven MD, Theodore J. Choma MD, Michael J. Goytan MD, Hilali Noordeen MA, BM BCh (Oxon), FRCS(Eng), MChOrth, FRCS(Orth), D. R. Knapp MD, Robert A. Hart MD, Reinhard Zeller MD FRCSC, William Donaldson, David W. Polly, Joseph H. Perra MD, Oheneba Boachie-Adjei MD
USA

Summary: Pediatric isthmic and dysplastic spondylolisthesis are relatively uncommon disorders. The large series of these cases collected by the SRS demonstrates a high rate of complications associated with their surgical treatment, consistent with prior reports of smaller series, and provides surgeons with potentially useful information for comparison of outcomes and preoperative counseling.

Introduction: Prior reports suggest high complication rates for the surgical treatment of pediatric isthmic and dysplastic spondylolisthesis, but due to their relatively low prevalence, useful estimates of complications remain limited. The SRS prospectively collects MM data from its members. We used these multi-centered data to provide benchmark complication rates.

Methods: Patients who underwent surgical treatment for isthmic or dysplastic spondylolisthesis from 2004-2007 were identified from the SRS MM database. Inclusion criteria for analysis included: age ≤21 and a primary diagnosis of isthmic or dysplastic spondylolisthesis.

Results: Of 25,432 pediatric cases reported, there were a total of 605 (2.4%) cases of pediatric dysplastic (n=62, 10%) and isthmic (n=543, 90%) spondylolisthesis, with a mean age of 15 years (range: 4-21). Approximately 50% presented with neural element compression, and less than 1% of cases were revisions. Surgical procedures included fusions in 92%, osteotomies in 39% and reductions in 38%. The overall complication rate was 11%. The most common complications included postoperative neurological deficit (n=31, 5%), dural tear (n=8, 1.3%) and wound infection (n=12, 2%). Perioperative deep venous thrombosis and pulmonary embolus were reported in 2 (0.3%) and 1 (0.2%) patients, respectively.

Conclusion: Pediatric isthmic and dysplastic spondylolisthesis are relatively uncommon disorders, representing only 2.4% of pediatric spine procedures in the present study. Even among experienced spine surgeons, surgical treatment of these spinal conditions is associated with a relatively high morbidity.

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26. Comparative Analysis of Minimally Invasive Lumbar Posterolateral Fusion with Transcutaneous Pedicle Screws vs. Conventional Approach for Degenerative Spondylolisthesis

Yoshihisa Kotani MD, Kuniyoshi Abumi MD, Manabu Ito MD, Hideki Sudo MD, Yoshihiro Hojo MD, Akio Minami
Japan

Summary: Although there have been several reports regarding minimally invasive lumbar interbody fusion, the minimally invasive posterolateral fusion has not been reported. The surgical technique we utilize obviates the need for interbody fusiion even in minimally invasive approach. The dramatical decrease of perioperative invasiveness and successful bony fusion were demonstrated in this study.

Introduction: To minimize the perioperative invasiveness and improve the quality of life, we have performed the minimally invasive lumbar posterolateral fusion (MIS-PLF) with transcutaneous pedicle screw fixation for degenerative spondylolisthesis. This study prospectively compared the clinical result of MIS-PLF with that of conventional PLF (Open-PLF) with emphasis on perioperative invasiveness and patients' quality of life.

Methods: The total of sixty-five patients received single-level PLF for lumbar degenerative spondylolisthesis. There were thirty-five cases of MIS-PLF and thirty cases of Open-PLF. The surgical technique of MIS-PLF includes 4 cm of main incision and transcutaneous pedicle screwing and rod insertion followed by posterolateral iliac bone graft. Analyzed parameters included the operation time, intra and postoperative blood loss, Oswestry-Disability Index(ODI), Roland-Morris Questionarre (RMQ), JOA score, and VAS scores of low back pain.

Results: The average follow-up period was forty-three months postoperatively (12-47). The intra and postoperative blood loss was significantly smaller in MIS-PLF group (180cc) when compared to open-PLF group (479cc). The ODI and RMQ score rapidly decreased at initial two weeks postoperatively in MIS-PLF group, which was significantly different from those in open-PLF group. The VAS score demonstrated further rapid decreases on postoperative day 3, 5, and 14, which was significantly different from those in open-PLF group. The fusion was obtained in all two groups, and no major complications were demonstrated.

Conclusion: The minimally invasive lumbar posterolateral fusion with transcutaneous pedicle screw system successfully decreased the perioperative invasiveness when compared to conventional open-PLF. The reduction of postoperative pain led to early extension of ADL, demonstrating the rapid improvement of several QOL parameters.

Significance: The minimally invasive posterior lumbar fusion does not necessarily require the interbody fusion with the presented technique. Even in the minimum access surgery, the use of interbody fusion should be carefully considered based on the degree of segmental instability and spinal alignment.

27. Outcomes of Posterolateral Spinal Fusion in Geriatric Patients

Jennifer Smail MD, Steven D. Glassman MD, Rolando M. Puno MD, John R. Johnson MD, Jennifer M. Howard MPH, Leah Y. Carreon MD MSc
USA

Summary: In a cohort of 35 patients 75 years and older who underwent one or two level posterolateral fusion, a statistically significant improvement in all of the HRQOL measures from pre-op to two-years was demonstrated, with the majority of patients achieving MCID for ODI, PCS, back and leg pain.

Introduction: Health related quality of life (HRQOL) measures after lumbar fusion is gradually becoming more widespread in the literature. Despite the increasing impact of the geriatric population, the availability of geriatric HRQOL after lumbar fusion is limited. The purpose of this study is to report on the health-related-quality of life in patients 75 years and older undergoing lumbar fusion.

Methods: From a database of prospectively collected HRQOL measures in patients undergoing lumbar fusion, 35 patients 75 years and older who had one or two level instrumented posterolateral lumbar fusion with complete pre-op and two-year post-op

HRQOL measures were identified. HRQOL measures included the Oswestry Disability Index (ODI), Short Form 36 (SF-36) Physical Component Score (PCS) and Mental Component Score (MCS), and back and leg pain numeric rating scales. Paired sample t-tests were used to compare pre-op and two-year post-op scores. The percentage of patients reaching thresholds for Minimum Clinically Important Difference (MCID) was also determined.

Results: There were 11 males and 24 females with a mean age of 78.3 years (range 75-85). Diagnoses included stenosis (57.1%), spondylolisthesis (34.3%), instability (2.9%), disc pathology (2.9%), and scoliosis (2.9%). The complication rate was 34.3% (11.4 minor, 22.9 major). There was a statistically significant improvement in all of the HRQOL measures from pre-op to two-years. Sixty percent (21 of 35) of the patients achieved MCID for ODI and PCS and leg pain, while 83% (29 of 35) achieved MCID for back pain.

Conclusion: Improvements in HRQOL after posterolateral fusion in patients 75 years and older is an achievable goal, with the majority of patients achieving MCID for ODI, PCS, back and leg pain.

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★ **28. Does Fusion Status Correlate with Patient Outcomes in Lumbar Spinal Fusion?**

Mladen Djurasovic MD, Steven D. Glassman MD, John R. Dimar MD, Mark Mugavin BS, Jennifer M. Howard MPH, Kelly R. Bratcher RN, CCRP, Leah Y. Carreon MDMSc
USA

Summary: Evaluation of validated patient reported clinical outcomes and radiographic fusion status based on two-year fine-cut CT scans showed that low-back specific outcomes measures (ODI) were better in those with a solid fusion compared to those with a non-union.

Introduction: Previous studies have shown that a solid fusion does not always produce clinical success. However, these studies did not use validated patient-reported health-related quality of life (HRQOL) measures. The purpose of this study is to examine the relationship between radiographic fusion and patient reported HRQOL measures in patients undergoing instrumented posterolateral lumbar fusion.

Methods: One hundred ninety three patients who underwent instrumented posterolateral fusion with complete pre-operative and two-year HRQOL measures and a fine-cut CT scan with reconstructions done at two years post-operatively specifically to assess fusion status were identified. HRQOL measures included the Oswestry Disability Index (ODI), the Short Form-36 (SF-36) and back and leg pain numeric rating scales. The percentage of patients reaching the minimum clinically important difference (MCID) for ODI and SF-36 were also calculated. CT scans were graded as fused or not by 3 independent reviewers. Comparisons were made in outcomes measures between the patients with solid fusions and those judged not to have a solid radiographic fusion.

Results: There were 124 females and 69 males with an average age of 63 years. Patients judged to have a solid fusion demonstrated a better ODI score at two years compared to those who were not solidly fused (p=0.023). There was a trend towards greater improvement in mean ODI score in those with a solid fusion (p=0.074). A statistically greater number of patients who had a solid fusion (111 of 171, 65%) achieved the MCID for ODI compared to those who did not achieve a solid fusion (7 of 22, 32%) (p=0.003).

Conclusion: Patients with a radiographically solid fusion demonstrated better low-back specific quality of life measures at two years compared to patients who did not have a solid fusion. Despite the relatively large sample size, the low number of non-unions limited statistical power in other variables. While radiographic fusion may not be the true measure of clinical success, this study suggests that solid arthrodesis contributes to clinical outcome and is an important goal of fusion surgery.

29. Clinical Outcomes in Worker's Compensation Patients: A Case-Control Study

Leah Y. Carreon MD MSc, Steven D. Glassman MD, Neha Kantamneni BS, Mark Mugavin BS, Mladen Djurasovic MD
USA

Summary: After controlling for covariates known to affect outcomes, producing two groups of 58 patients with similar demographics, indications for fusion and pre-operative outcome scores, patients on worker's compensation have significantly less improvement of clinical outcomes in both mean change in ODI, SF-36 PCS and back pain scores as well as the number of patients achieving substantial clinical benefit after posterolateral lumbar fusion.

Introduction: Previous studies have shown poor outcomes in worker's compensation patients after lumbar fusion. However, these studies had no comparison group of patients not on worker's compensation. The purpose of this study is to compare clinical outcomes after lumbar fusion in patients receiving worker's compensation (WC) to a case-matched control group who are not on worker's compensation (non-WC).

Methods: From 783 patients who had posterolateral fusion with complete pre-op and two-year post-op outcome measures, 60 patients who were on worker's compensation were identified. Outcome measures were the Oswestry Disability Index (ODI), Short Form 36 (SF-36), back and leg pain numeric rating scales. Propensity scoring technique was used to match these patients to a control group not on worker's compensation using gender, age, smoking status, BMI, diagnosis, number of levels fused, pre-op ODI, SF-36 PCS, SF-36 MCS, back and leg pain scores producing 58 matched pairs.

Results: There were no significant differences between the demographics and pre-operative outcome scores in the two groups. At two-years post-op, non-WC patients had a significantly greater improvement in ODI, SF-36 PCS and back pain scores compared to WC patients. The mean two year ODI, SF-36 PCS and back pain scores of WC patients were significantly lower than the non-WC patients.

11 of 58 (19%) WC patients reached the ODI minimum clinically important difference (MCID, ODI≥12.8) compared to 21 of 58 (36%) non-WC patients (p=0.061). Only 5 of 58 (9%) WC patients reached ODI substantial clinical benefit (SCB, ODI≥18.8) compared to 19 of 58 (33%) non-WC patients (p=0.002). Only 9 of 58 (16%) WC patients reached SF-36 PCS MCID (PCS≥4.9) compared to 23 of 58 (40%) non-WC patients (p=0.006). Only 7 of 58 (12%) WC patients achieved SF-36 PCS SCB (PCS≥6.2) compared to 21 of 58 (36%) non-WC patients (p=0.004).

Conclusion: After controlling for covariates known to affect outcomes after lumbar fusion, producing two groups with similar demographics and low back disabilities, patients on worker's

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compensation have significantly less improvement of clinical outcomes in both mean change in ODI, SF-36 PCS and back pain scores as well as the number of patients achieving substantial clinical benefit.

30. Post-Surgical Effects of Smoking on Patients After Circumferential ALIF

John S. Thalgott MD, Madilyne E. Fogarty BS
USA

Summary: This study compares the radiographic and clinical outcomes of smoking and non smoking patients with degenerative disc disease who were treated circumferential ALIF. Although not all differences were significant, nonsmoking patients out-performed smoking patients in every category assessed.

Introduction: Prior studies have demonstrated a number of differences between smoking (SP) and non-smoking patients (NSP). The purpose of this study is to compare the clinical and radiographic outcomes of circumferential ALIF in these populations.

Methods: Fifty DDD patients were treated at one or two consecutive levels with a circumferential ALIF procedure from L3 to S1. All operations were performed by a single spinal surgeon using the same surgical technique for each case. Evaluations were collected pre-operatively, and post-operatively at 6 weeks, 3, 6, 12, 18, and 24 months, then yearly thereafter. Data collected included; fusion status on plain radiographs, ODI, and SF-36 scores. 40 patients completed the required minimum 24 month follow-up.

Results: The average patient follow-up was 42.73 months (NSP=41.44, SP=44.87). At latest follow-up, the average SF-36 PCS score was 36.78 (NSP=40, SP=31.4, p=0.001). The average increase in PCS score was 5.73 (NSP=9.08, SP=0.133, p=0.001). The average ODI at 24 months was 42.48 (NSP=34.56, SP=55.67, p=0.073). The average decrease in ODI was 17.33 (NSP=22.52, SP=8.33, p=0.120). The average change in 1 to 10 patient reported back pain with medication was 2.16 (NSP=2.25, SP=2.00, p=0.702), and without medication was 2.74 (NSP=3.35, SP=1.64, p=0.597). Overall, fusion occurred in 48 out of 56 treated levels (NSP=30, SP=18). The average time to fusion was 12.7 months (NSP=11.6, SP=14.5, p=0.1347).

Conclusion: Although most comparisons did not result in statistical significance, the trends in this data indicate that smoking patients can expect a longer healing time, a smaller decrease in pain, and a reduced improvement on physical functioning after circumferential ALIF procedure.

Significance: Differences in post-op recovery and post operative pain relief between smoking and non-smoking patients may call for different courses of treatment for these patient populations in the future.

31. The Far Lateral, Trans-Psoas Approach to the Lumbar Spine: Preliminary Experience in 100 Consecutive Patients

Nicholas J. Wills MD, Manuel R. Pinto MD, Cate Pandiscio PA-C, Amy Hanson CCRC
USA

Summary: Retrospective review of 100 consecutive procedures done by a single surgeon.

Introduction: New procedures need to be evaluated by skilled surgeons independent of the original developer.

Methods: This was a retrospective review of 100 consecutive far lateral transpsoas approach procedures performed by one surgeon over a two year period. We compiled information on age, medical history, smoking history, BMI and complications.

Results: Average age and BMI of the patients was 55 and 30.6 respectively. 19 patients were smokers and 6 were diabetics. 88% had at least one medical comorbidity. 89% of the surgeries utilized combined anterior and posterior techniques and 11 were anterior only. 47 were multi-level and 53 were single level. Complications not related to the far lateral approach were: 2 posterior wound infections that required I&D. 2 posterior malpositioned screws. 2 patients requiring reoperation for breakage of posterior instrumentation. 1 posterior incidental durotomy. Problems associated with the far lateral approach were: 11 patients described thigh numbness which resolved in all patients except one by 3 months, 2 patients had ileus lasting longer than 3 days which required no invasive interventions. 1 patient had a psoas hematoma that required readmission and 2 units of blood for anemia but no surgical intervention. 6 patients had grade 4/5 or weaker iliopsoas ipsilateral to the approach 6 weeks after surgery. All were resolved by four months except 1 patient. 2 patients had life-threatening vascular lacerations that required immediate laparotomy and vascular repair. Neither patient had long term sequelae but did require multiple units of blood. 3 patients had new quadriceps weakness, one did not resolve by 3 months and is ongoing. During the approach in one procedure, the neurological monitoring did not alarm, but the L5 nerve root was directly in the field of the retractor and would have been transected if the surgeon had not noticed it.

Conclusion: Overall, serious or persistent complications were few. The vascular and neurological risks and iliopsoas weakness do merit patient discussion.

Significance: Contrary to previous reports, this new procedure is associated with significant problems and compliactions.

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32. Clinical and Radiological Outcomes Of Minimally Invasive Vs. Open Transforaminal Lumbar Interbody Fusion

Chan W. Peng MD, Wai Mun Yue, Seng Yew Poh, William Yeo Masters (Physiotherapy), Seang Beng Tan
Singapore

Summary: Minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) has similar clinical outcomes and fusion rates when compared to the open procedure. Its benefits over Open TLIF include less blood loss, less analgesic use, shorter hospitalisation and fewer complications.

Introduction: Open TLIF has been performed for many years with good results. MIS TLIF techniques have recently been introduced with the aim of smaller wounds and faster recovery.

Methods: From 2004 - 2006, 29 MIS TLIF were matched paired with 29 Open TLIF. Patient demographics and operative data were collected. Clinical assessment in terms of NASS, SF-36 and VAS scores were performed preoperatively, 6 month and 2 year postoperatively. Fusion rates based on Bridwell grading were assessed at 2 years.

Results: The mean age for MIS and Open procedures were 54.1 and 52.5 years respectively. There were 24 females and 5 males in both groups. Fluoroscopic time (MIS: 105.5 seconds, Open: 35.2 seconds, $p<0.05$) and operative time (MIS: 216.4 minutes, Open: 170.5 minutes, $p<0.05$) were longer in MIS cases. There was less blood loss in MIS (150ml) vs. Open (681ml) procedures ($p<0.05$). The total morphine used for MIS cases (17.4mg) was less compared to Open (35.7mg, $p<0.05$). MIS (4 days) patients have shorter hospitalisation compared to Open (6.7 days, $p<0.05$). Both MIS and Open groups showed significant improvement in back pain and lower limb symptoms (NASS and VAS scores, $p<0.05$) and Quality of Life scores (SF-36, $p<0.05$) at 6 months and 2 years but there was no significant difference between the two groups. 80% of MIS and 86.7% of Open TLIF levels achieved Grade 1 fusion ($p>0.05$).

Conclusion: MIS TLIF has similar good long term clinical outcomes and high fusion rates of OPEN TLIF with the additional benefits of less initial postoperative pain, early rehabilitation, shorter hospitalization and fewer complications.

Significance: MIS TLIF is a topic of much interest in recent years to spine surgeons. Our paper is the only one that actually compared a match-paired group who had MIS TLIF vs. OPEN TLIF done. The patients were followed-up for 2 years and we are reporting validated outcome scores and fusion outcomes.

33. Selective Nerve Root Injections In Lumbar Radiculopathy: A Prospective Clinical Outcome Study As A Minimally Invasive Alternative To Surgery. A Five Year Followup

Sudeep Jain MBBS, MS(ORTH),M.CH(ORTH), Deep Sharma, Ramesh Kumar, Aravind Jayaswal
India

Summary: To establish selective nerve root injections in lumbar radiculopathy as an effective, minimally invasive alternative in patients either unwilling or unfit for surgery.

Introduction: Recent evidence supports a neurochemical basis for pain generation. Based on these findings, epidural instillation of steroids was implicated as a treatment modality. large volumes must be injected which can dilute their potency. Thus an alternative method for delivery called selective nerve root injections. Success of injection depends on precise delivery of high concentration of drug directly to interface between herniated nucleus pulposus and ventral dura and nerve root sleeve which can only be done reliably by a fluoroscopically guided transforaminal approach with pre-injection contrast documenting flow to the target tissue.

Methods: In all 150 patients were injected with Bupivacaine and Betamethasone, 220 nerve roots were injected and 300 injections were given with a minimum followup of 5 years. We used 1 ml of betamethasone(4mg/ml) with 1 ml of 0.25% bupivacaine. All injections were performed fluoroscopically and needle placement confirmed by injecting omnipaque-240.

Results: Post injection, SLR improved in 140 out of 150, list persisted in only 25 pts while nerve tension test continued to be positive in only 15 pts. Preinjection 140 pts were severely disabled with an oswestry score between 40-60 while 10 pts were crippled with scores more then 60. Following injection, 120 out of 150 were left with only a minimum disability whereas 30 did not show much improvement. On an average, oswestry scores improved by 34% from an average of 54.1% in preinjection to 20.03% in postinjection pts. 100 pts improved with a single injection while a second injection had to be repeated after 2 wks in 10 pts. 5 pts required 3 injections for complete relief. 5 pts were improved after 2 injections but had a recurrence after 3 months for which they required a third injection. Thus out of 150 pts who were ideal candidates for surgery, 115 were able to avoid a surgery after a minimum followup period of 5 yrs.

Conclusion: It can be concluded that selective, fluoroscopically guided lumbar nerve root injections are current, state of the art form of local anaesthetic and steroid delivery to exact trigger site of pain with minimal complication. They may be diagnostic as well as therapeutic and may obviate need for a lumbar surgery.

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34. Complications with rhBMP-2 in Posterior Lumbar Fusion

Steven D. Glassman MD, Jennifer M. Howard, Mladen Djurasovic MD, Rolando M. Puno MD, John R. Johnson MD, Leah Y. Carreon MD MSc
USA

Summary (80 characters max): A modest complication rate, consistent with literature standards with ICBG, was seen in patients treated by PSF (n=1037) or TLIF (n=176) using rhBMP-2. In patients treated by TLIF using rhBMP-2, 5 patients (3%) with radiographic and clinical findings characteristic of BMP induced compression in the area of the TLIF window were identified. It will be necessary to weigh this incidence of complications against the complication rate associated with ICBG harvest and any differential benefit in obtaining a solid arthrodesis.

Introduction: Bone Morphogenetic Protein (BMP) is widely used as bone graft substitute. Complications reported in the anterior cervical spine and recent reports of postoperative radiculopathy with rhBMP-2 in transforaminal lumbar interbody spine fusion (TLIF) have raised new concerns regarding potentially unidentified risks for posterolateral fusion (PSF) and TLIF. As complications are often reported in isolation, without a clear denominator, actual rates may be difficult to determine. This study characterizes perioperative complications in a large consecutive series of PSF and TLIF cases with rhBMP-2.

Methods: We reviewed records of a consecutive series of 1037 patients who had PSF and 176 patients who had TLIF using rhBMP-2 between 2003 and 2006. Complications observed within a 3 month perioperative period were categorized as to etiology and severity. Neurologic deficits and radiculopathies were analyzed to determine the presence of a clear etiology and to identify any potential relationship to rhBMP-2 use.

Results: In the PSF cases, complications were seen in 190 of 1037 patients; 81 (8%) major and 110 (10%). Major medical complications were pulmonary (21), cardiac (9), renal (5) or other (12). Major surgical complications included deep wound infection in 22 (2%). Neurologic complications were related to screw malposition in 4 and epidural hematoma in 2 patients. New postoperative radicular symptoms were noted in 9 patients (1%). Psoas hematoma on CT scan was seen in 8 patients (1%).

In the TLIF cases, complications were seen in 44 of 176 patients (25%); 13 (7%) major and 31 (18%) minor. New postoperative neurologic complaints were noted in 13 patients (7%); 7 needed additional surgery, including 1 malpositioned screw and 1 epidural hematoma. In 4 patients (2.3 %) localized seroma around the foramen caused neural compression, requiring revision. In 1 patient, vertebral osteolysis, foraminal narrowing and radiculopathy resolved without further surgery. Six patients had persistent radiculopathy without a clear etiology on imaging studies. Wound related problems were seen in 6 patients (3.4 %).

Conclusion: A modest complication rate, consistent with literature standards with ICBG, was seen in patients treated by PSF or TLIF using rhBMP-2. In patients treated by TLIF using rhBMP-2, 5 patients (3%) with radiographic and clinical findings characteristic of BMP induced compression in the area of the TLIF window were identified. It will be necessary to weigh this incidence of complications against the complication rate associated with ICBG harvest and any differential benefit in obtaining a solid arthrodesis.

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).

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35. Complications of Posterior Lumbar Interbody Fusions Encountered with use of Bone Morphogenic Protein 2

Donald K. Matthews MD
USA

Summary: Single surgeon series of posterolateral interbody fusion (PLIF)with bone morphogenic protein 2 and PEEK (polyetheretherketone)interbody cages utilized during primary or extension/revision of adjacent level degeneration with posterolateral instrumented fusion revealed five of 22 total patients with complications leading to reoperation.

Introduction: Bone morphogenic protein 2 is pending FDA approval for interbody use in posterior lumbar fusions. Over a 2 year period (January 2007 to December 2008), BMP2 and PEEK cages were inserted into the posterior lumbar interbody and supplemented by pedicle screw and rod instrumentation, five patients had complications which lead to reoperation.

Methods: A retrospective review of patients with acquired spondylolisthesis or adjacent level degeneration was completed over the two year period from 1/1/2007 to 12/31/2008. All patients were managed by posterior lumbar interbody fusion following the same surgical technique. After laminectomy and decompression, the interbody space was prepared by subtotal discectomy and the endplates rasped to allow punctate cortical bleeding. The disc space was then treated first with BMP2 (Medtronic Infuse:1/4 of a large packet) and then local morcelized bone graft followed by Capstone PEEK Cages (Sofamor Danek) placed into the prepared interbody spaces. Attempts were made to maintain a consistent concentration of BMP2. All cases were instrumented posteriorly with pedicle screws and rods as well as prepared for posterolateral fusion with a BMP2 wrap over local autograft. Spinal monitoring was employed for each case. All wounds were closed over a hemovac drain.

Results: Five patients (2 male and 3 females, average age 57.4) out of 22 total patients (23%) treated by PLIF with BMP2 and Peek cages required a revison operation. One patient developed a pseudoarthrosis believed to be secondary to the BMP2 induced osteolysis of the adjacent endplates. Four patients had late onset radiculitis with MRI demonstrating inflammatory reactions and pseudocyst formation compromising the ventral canal and lateral

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recesses. Four of the five patients were obese. Four of the five have residual radicular pain. All 22 patients reviewed eventually fused.

Conclusion: This case series revealed problems encountered with the BMP2 utilized in posterior interbody fusions. 23% of patients had revision procedures believed to be a consequence of BMP2. All 22 patients in the series did demostrate complete union in postoperative follow-up.

Significance: The use of bone morhogenic protein 2 in the posterior interbody may compromise patient safety.

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).

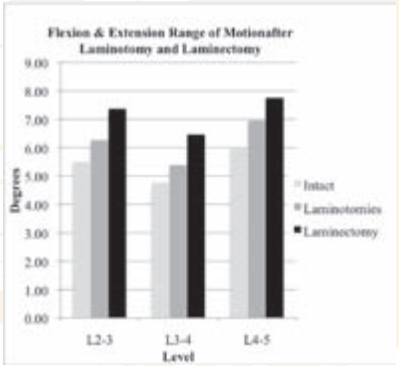
☐ **36. The Effect of Bilateral Laminotomy vs. Laminectomy on the Motion and Stiffness of the Human Lumbar Spine**

Michael J. Lee MD, Richard J. Bransford MD, Jens Chapman, Carlo Bellabarba, Amy M. Cohen MME, Richard M. Harrington MS, Randal P. Ching PhD
USA

Summary: Hyper-mobility and stiffness reduction may predispose the lumbar spine to instability. This study examines the differences in iatrogenic hyper-mobility and stiffness reduction induced by bilateral laminotomy vs. complete laminectomy in a cadaveric human model.

Introduction: A common surgical treatment of lumbar stenosis is a laminectomy with partial medial facetectomies. Excessive facet resection can result in instability of the spine. Despite efforts to maintain facet integrity, rates of post-laminectomy spondylolisthesis range from 8 to 31%. Bilateral laminotomies are effective in decompressing the spine, without resecting the spinous process, interspinous and supra-spinous ligaments. These structures act as a tension band to limit flexion and as a block to limit extension. Excessive iatrogenic hyper-mobility may be a predisposing factor to instability. We hypothesize that bilateral laminotomies induce significantly less iatrogenic hyper-mobility and less stiffness reduction than a complete laminectomy in the lumbar spine.

Methods: 6 human cadaveric lumbar spines (L1-L5) were mounted into a spine motion simulator for testing. With application of a physiologic follower pre-load, flexion-extension, lateral bending, and axial rotation moments were applied to the lumbar spine in 3 trials: 1) Trial 1: Intact lumbar spine, 2) Trial 2: After bilateral lumbar laminotomies at L2-5, 3) Trial 3: After full laminectomies at L2-5. The total and segmental lumbar spine kinematics, ROM and stiffness were measured using a Vicon motion tracking system (Vicon Motion Systems, Lake Forest, CA).



Results: In flexion-extension, bilateral laminotomies resulted in an average increase in L2-5 range of flexion-extension motion of 16.1%; full laminectomy resulted in an increase of 34.0% ($p<0.05$). Analysis per level demonstrated two-fold increase in motion with laminectomy compared to bilateral laminotomies (Fig1) ($p<0.05$ every treated level). Analysis of motion in axial rotation or lateral bending did not yield significant changes after either procedure. Stiffness was decreased by an average of 11% after the three-level-laminotomies. After three-level-laminectomy, the stiffness was reduced by 27% ($p<0.05$).

Conclusion: These data demonstrate that bilateral laminotomies induce significantly less hyper-mobility and less stiffness reduction compared to a full laminectomy.

Significance: The preservation of the central posterior osteo-ligamentous structures may provide a stabilizing effect in preventing post-decompression spondylolisthesis.

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37. Low-Density vs. High-Density Thoracic Pedicle Screw Constructs in Adolescent Idiopathic Scoliosis: Is More Better?

Joshua D. Auerbach MD, Baron S. Lonner MD, Kristin E. Kean BA
USA

Summary: Despite ample evidence to support the use of thoracic pedicle screw (TPS) constructs in the treatment of Lenke Type I curves, there remains considerable debate surrounding the optimal implant density. We hypothesized that low-density TPS constructs (<1.1screws/level) will perform similarly to high-density TPS constructs (>1.1screws/level) in Type I curves. Despite significantly higher implant costs, we identified no clinical, radiographic, perioperative, or complication-related advantages of constructs with higher TPS implant density in the treatment of Lenke Type I curves.

Introduction: Thoracic pedicle screw(TPS constructs) have improved clinical outcomes, and reduced revision surgical rates compared with hook and hybrid constructs in the treatment of AIS. Although placement of screws bilaterally at every level improves construct stiffness, the optimal implant density, or #screws/level, remains unknown in the treatment of flexible, thoracic curves.

Methods: Retrospective review of 54 consecutive primary AIS patients between 10-21 yrs of age (average age:15; 35F,19M) treated by the senior author with Lenke Type I curves between 2001-2006. Average follow up was 27 months(range:18-50). Two groups of 27 patients each were divided equally: the low-density(LD) TPS group was defined by implant density below the median number of screws/level for the entire cohort (<1.1 screws/

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level); high-density(HD) TPS group was defined by >1.1 screws/level. Paired t-tests were used to compare radiographic and clinical outcomes at baseline and at 2 years.

Results: LD and HD groups were similar at baseline with respect to age, gender, main thoracic curve magnitude, and thoracic kyphosis. The HD group had significantly higher #screws(13.2vs9.7,p<0.0001), screws/level (1.3vs1.0,p<0.0001), screws on convexity (5.0vs3.5,p=0.0007), and screws on concavity (8.2vs6.2,p<0.0001), but fewer crosslinks (1.0vs1.8,p<0.0001). There were no differences in EBL, op times, or length of stay, or apical trunk rotation(HD:6.8d; LD:7.0d,p=0.59). There were no differences in major curve correction (HD:66%; LD:64%,p=0.56), kyphosis, tilt angle, or lumbar curve correction. SRS subscores improved at 2 years within both groups, but there were no group differences in total subscores or final satisfaction(HD:4.4; LD:4.6,p=0.55). There were no differences in instrumentation-related complications(HD:3/27; LD:1/27). Total implant costs were significantly higher in the HD group($12,027vs$10,300 ,p=0.0004).

Conclusion: Despite significantly higher implant costs, we identified no clinical, radiographic, or perioperative advantages of constructs with higher TPS implant density in the treatment of Lenke Type I curves. Continued efforts should identify those cases where higher implant density is required, and conversely, where lower density constructs will suffice.

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38. Advantage of a Derotation Connector in the Correction of AIS by Simultaneous Translation on 2 Rods (ST2R). Preliminary Comparative Results

Jean-Luc Clement, Edouard Chau, Anne Geoffray, Marie-José Vallade
France

Summary: Comparison of vertebral rotation for 22 Adolescent Idiopathic Scoliosis (AIS) patients treated by Posterior Spinal Fixation and ST2R and using or not a specific connector of derotation. Significant correction of vertebral rotation was observed in the derotation connector group (DC). A normal sagittal profile was restored for all the patients. Coronal correction was similar to other screw constructs.

Introduction: Correction of 3D deformation of AIS is a real challenge. Currently, posterior spinal instrumentations allow good coronal reduction but fail to reduce vertebral rotation. Recent techniques seem to be effective for correction of vertebral rotation but detrimental to kyphosis.

Methods: Used on the apical vertebrae, the derotation connectors are preliminary locked on the concave rod in order to get a greater AP translation in the concave side than in the convex side, responsible for a rotation of the vertebrae around the convex rod. We present a comparative analysis of two consecutive cohorts of 22 AIS patients (Lenke 1-6) treated by the same surgeon by ST2R, with or without derotation connector (Derotation Connector (DC), n=11, Control Series (CS), n=11).

Radiographic parameters and CT scan vertebral rotation on the apical vertebra (Aaro's method), were measured pre and postoperatively.

Results: The average vertebral rotation was reduced by 18° preoperatively to 11° postoperatively in DC series (mean gain 7°) and by 18° to 15° in CS series (mean gain 3°) (p=0.04).

In coronal plane, the correction was similar to other pedicular screws instrumentations with a trend to a better correction for DC group (DC: 80%, CS: 72%; p = 0.048). In sagittal plane, all patients with a previous hypokyphosis (9 cases<20°) reported a normal kyphosis (range 20 to 45).

Conclusion: The use of derotation connector seems to provide a significant correction (39%) of vertebral rotation in ST2R reduction of AIS with improving the coronal correction and without worsening sagittal deformity.

Significance: A specific derotation connector used with the ST2R reduction allows to achieve a partial correction of the vertebral rotation without worsening the correction of hypokyphosis.

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39. Early Results of a Randomized, Prospective Study Comparing Thoracic Hook and Pedicle Screw Fixation for Adolescent Scoliosis

Lawrence L. Haber MD, Joshua Hughes BA, Erika D. Womack
Master of Science
USA

Summary: There were 25 patients treated with hooks and 28 with screws. All constructs were non-every level. Measured values included Lenke classification, pain scales, SRS 30 surveys, Cobb angles, kyphosis and lordosis, and rotation. Between the groups, measured differences were statistically insignificant except that screws achieved better rotational and Cobb correction of the major curve.

Introduction: To compare the results of surgical treatment of AIS using hooks vs. pedicle screws for thoracic fixation.

Methods: A computer prospectively randomized patients into two groups for thoracic fixation. Group 1 (H) received hooks and group 2 (S) received screws; both received screws for lumbar fixation. All constructs were non-every level (NEL). Only curves that bent to <40° were included. Parameters taken at preop, postop, and the most recent f/u (3-30 months) included Lenke classification, pain scales, SRS 30 surveys, Cobb angles, kyphosis and lordosis, and rotation. Paired and student t-tests were used for intra and inter-group comparisons. SRS 30 scores are out of a possible 150.

Results: H had 25 patients with a mean f/u of 15 (3-30) mos. S had 28 patients with a mean f/u of 15 (3-29). H and S both had a mean age of 14±2 yrs at DoS. Mean levels fused for both groups was 9±1. Mean intra-operative blood loss for H was 662±351 mL and for S was 848±480 mL (p=0.14). Mean operative time for H

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was 252±57 minutes and for S was 289±61 minutes (p=0.031). Patients in both groups were discharged at a mean of 4±1 days. See chart for other measured values. Comparing the groups, all preop values were comparable (p>0.05) except for the lumbar curve (LC). Postop correction of the major curve was comparable between the groups (p=0.30). At FFU, screws maintained better correction (p=0.004). Within H, p<0.05 for the change in the MC postop to FFU. S had greater rotational correction at postop and FFU, p=0.044 and 0.034. In both groups, p>0.05 for the change in pre and post op kyphosis, but p<0.05 for lordosis. Neither group had fixation failures or complications.

Conclusion: In all postop measures except MC rotation, differences between S and H were statistically insignificant. By FFU, H had lost enough correction in the MC to be statistically different.

Significance: Screw or hook fixation can be used safely and with good results as shown in this group of flexible, mostly Lenke 1 and 2 curves in NEL constructs. Screws obtain better rotational and finial Cobb correction of the MC. Screw fixation at near every level with current derotational maneuvers may offer increased advantage and will be the subject of an upcoming study.

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40. Minimally Invasive Scoliosis Surgery In AIS Patients: A Technique and Feasibility Study

Terry Amaral MD, Adam L. Wollowick MD, Laury A. Cuddihy MD, Melanie Gambassi NP, Vishal Sarwahi MD
USA

Summary: Minimally invasive surgery is technically challenging but feasible in AIS. Experience is limited to curves < 70 ° & flexible to > 50%. If needed, osteotomies can be performed. The present instrumentation is deficient for corrective maneuvers. Reasonably good correction can, however, be obtained with less blood loss & shorter hospital stay.

Introduction: With MIS becoming fairly routine, the next logical step is to assess its feasibility in AIS patients.

Methods: Five AIS patients underwent MIS surgery. Three midline skin incisions were utilized; stab incisions in the fascia were made for screw insertions. Three vertebral levels (6 screws) were instrumented per incision. Free hand pedicle screw placement technique was utilized and a mix of reduction screws and standard screws with open-ended MIS connectors were utilized. The inferior facet was osteotomized with a quarter inch osteotome and BMP with local autograft was utilized for fusion. Rod derotation, translation & DVR maneuvers were utilized. Reduction screws facilitated rod placement & curve correction.

Results: There were five female patients with a mean age of 15.2 years, mean preop COBB angle of 42.1° and mean preop kyphosis of 28.2°. The average number of levels fused was 9.8 with an average EBL of 440cc. The average operative time was 7h 50m and the average length of stay was 6.6 days. The mean VAS was 3.23. The mean postop Cobb angle was 7.3°, and the mean postop kyphosis was 26.8°.

Conclusion: This study demonstrates that it is technically feasible to treat AIS patients utilizing the MIS techniques. Possible short-term benefits include less blood loss, lower pain scores, and shorter length of hospital stay. At present, flexible curves <70° can be treated in this manner. Good correction in coronal and sagittal planes can be obtained. Pedicle screws can be placed in the standard freehand manner, thereby, decreasing the radiation exposure.

Significance: Hypothetically, minimally invasive spine surgery has significant advantages. The preservation of soft tissues can allow for faster recovery and shorter hospital stay while making the surgery less disruptive and painful. Maintaining the integrity of the midline ligaments can possibly prevent proximal junctional kyphosis. This technique can also be employed in early onset scoliosis cases to decrease the chance of spontaneous fusion. However, significant concerns persist in terms of the adequacy of fusion and use of BMP. Long-term follow-up studies are needed.

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).

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41. Minimally Invasive Pedicle Screw Instrumentation For Pediatric Spinal Deformity: Safety And Feasibility In First 30 cases

Rasesh R. Desai MD, Vivek Sharma MD, Atiq Durrani MD, Alvin H. Crawford MD
USA

Summary: Early results in 30 cases with scoliosis/kyphosis treated by minimally invasive corrective surgery using pedicle screws and rods.

Introduction: To study the feasibility of a new technique of minimally-invasive corrective surgery for scoliosis/kyphosis using pedicle screws and rods and to investigate its safety, corrective potential , complications and perioperative morbidity.

Methods: A retrospective chart review of 30 patients treated by minimally invasive percutaneous psoterior 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.

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 for scoliosis were 48.6 and 18.3 respectively.The mean preoperative and postoperative cobb angle for kyphosis were 64.7 and 36.2 respectively. Average no. of instrumented levels and screws per patient were 11 and 16

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respectively. The average duration of surgery was 4 hrs 57 minutes. The mean estimated blood loss was 261.5 ml. Only 3 patients needed blood transfusion. The mean hospital stay was 3.4 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. There were no postoperative complications.

Conclusion: To our knowledge, this is first study identifying safety and feasibility of using minimally invasive surgical techniques in treating spinal deformities in children and adolescents. Short term data suggests a trend towards decreased morbidity and feasibility of minimally invasive percutaneous pedicle screw instrumentation for scoliosis as well as kyphosis.

Significance: The first study identifying the safety and feasibility of the minimally invasive techniques for correction of pediatric spinal deformities.

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42. Pedicle Screw vs. Hybrid/Hook Instrumentation for Lenke Type 1,2 Adolescent Idiopathic Scoliosis - What Happens When Judges are Blinded to the Instrumentation?

Vincent Arlet, Jean Ouellet MD, Jeffrey Shilt MD, Francis H. Shen, Kirkham B. Wood MD, Donald P. Chan MD, John Hicks MD, Ernesto Bersusky MD, Vasantha Reddi PhD
USA

Summary: Pedicle screws vs. hybrid/hooks in the treatment of Adolescent Idiopathic Scolisis, Lenke 1&2

Introduction: The superiority of pedicle screws over hybrid/hooks in the treatment of AIS of Lenke 1&2 remains unresolved. We compared the two instrumentations with special attention to cosmesis and uninstrumented spine.

Methods: Radiographs and clinical photos of 38 cases of thoracic AIS of Lenke 1 and 2, treated with either pedicle screws or hybrid/hooks were subjectively assessed by four spine surgeons (SRS Travelling Fellows) for radiographic and operative cosmetic result, shoulder balance, trunkshift, rib hump and waist asymmetry. Instrumentation in the radiographs was blocked, with only the non-instrumented part visible. Surgeons were also asked to guess the instrumentation in the radiographs. Seventy six photographs of patients before and after surgery were assessed for cosmesis by ten non-medical judges for overall cosmetic score, shoulder balance, waist asymmetry and shoulder blade prominence. Objective assessments of radiographs and clinical photos were performed by a Spine Fellow for Cobb angle of instrumented and non-instrumented spine, global coronal and sagittal balance, number of unfused vertebrae, disc angulation, tilt of last instrumented vertebra, shoulder balance, waist asymmetry, rib prominence and percent correction. SRS-22 questionnaire was used to measure health-related quality of life in patients.

Results: Subjective assessments by surgeons and non-medical judges showed no significant difference by instrumentation (p=>0.05) for all variables. Out of the 152 guesses by surgeons of the cases with instrumentation blocked in the radiographs, they were unable to guess the instrumentation in 89% of the cases. Objective assessment of all variables and SRS-22 scores of all 5 domains showed no significant difference by instrumentation (p=>0.05).

Conclusion: In this first-ever conducted study in a blinded fashion, subjective and objective assessments and SRS-22 scoring showed no significant difference between the instrumentations used to treat AIS for Lenke 1and 2 curves.

Significance: Superiority of one instrumentation over the other could not be established in this study

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43. What Radiographic and Clinical Factors Appear Crucial for the Decision to Perform a Selective Thoracic Fusion in Lenke 1C/King II Adolescent Idiopathic Scoliosis Curves?

Lawrence G. Lenke MD, Daniel J. Sucato MD MS, Timothy R. Kuklo MD, B. Stephens Richards MD, John B. Emans MD, Keith Bridwell MD, Spinal Deformity Study Group
USA

Summary: This study highlights the importance of lumbar preoperative TL/L Cobb angle measures, as well as the AVT difference between the MT and TL/L curves as critical components to the decision of whether to perform an ST or NS fusion in Lenke 1C/King II curves. In addition, clinical parameters (i.e. lumbar scoliometer measurement) are also very important.What Radiographic and Clinical Factors Appear Crucial for the Decision to Perform a Selective Thoracic Fusion in Lenke 1C/King II Adolescent Idiopathic Scoliosis Curves?

Introduction: Lenke 1C/King II curves [structural main thoracic (MT) and nonstructural thoracolumbar/lumbar (TL/L) i.e. false double major curves] are indicated for a selective thoracic (ST) fusion. We investigated the percentage of these curves undergoing an ST fusion and analyzed the preoperative radiographic and clinical criteria present in those who underwent an ST vs a nonselective (NS) fusion of both MT and TL/L curves.

Methods: A prospective multicenter database revealed 221 patients with posteriorly treated 1C curves. An ST fusion was performed if the lowest instrumented vertebra (LIV) was L1 or cephalad. Preoperative radiographic, clinical (scoliometer), and SRS questionnaire data was analyzed.

Results: 106 (48%) of the patients had a ST fusion, while 115 (52%) had an NS fusion. There were no significant differences in approach by age or gender. Preoperative MT Cobb angles were similar for the ST group (57.1°±9.5) vs the NS group (55.3°±10.9) (p=0.183). However, the TL/L preoperative Cobb angle of the ST group (42.9°±8.4) was smaller than the NS group (47.0°±8.6) (p<0.001). In addition, the preop MT apical vertebral translation (AVT-MT) in the ST group was larger at 46.6 mm±16.8 vs 38.3

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mm±15.7 in the NS group (p<0.001). Similarly, AVT-TL/L in the ST group was smaller at 26.7 mm±9.5 vs 31.5 mm±12.4 in the NS group (p=0.001). Also, the MT:TL/L AVT ratio of the ST (1.75) group was significantly greater than the NS group (1.22; p<0.05). None of the sagittal parameters were found to be different between the 2 groups. Although preoperative thoracic scoliometer measures were not significantly different between the 2 groups (ST-7.9° vs NS-10.2°) they did reach statistical significance (p=0.003). There were no significant differences in the preoperative total SRS scores (ST-3.89 vs NS-3.83; p=0.371), or differences in the various domains (all p>0.05) between the 2 groups.

Conclusion: Surprisingly, only 48% of 1C curves were treated with an ST fusion. Preoperative criteria which were critical in the determination to perform an ST vs NS fusion included: a smaller TL/L Cobb angle, larger AVT-MT, smaller AVT-TL/L, larger MT:TL/L AVT ratio, and a smaller lumbar scoliometer measurement in the ST group. SRS total and domain scores were similar in both groups.

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44. Incidence, Distribution, and Surgical Relevance of Abnormal Pedicles in Normal and Deformed Spines: A CT Based Study of 6354 Pedicles

Adam L. Wollowick MD, John K. Czerwein MD, Beverly Thornhill MD, Terry Amaral MD, Vishal Sarwahi MD
USA

Summary: A CT based classification system of pedicle morphology was applied to patients with and without spinal defomity. Abnormal pedicles are more commonly seen in deformed spines than in normal spines. Spinal deformity also causes higher degrees of pedicle dysmorphism. Dysmorphic pedicles are more commonly found in the periapical region and are significantly more prone to screw malposition.

Introduction: Pedicle screws are commonly used in spinal defomity surgery. Pedicle screw malposition can injure vital structures and can cause significant morbidity. An understanding of vertebral morphology is critical for accurate screw placement.

Methods: 96 patients who had whole body CT scans for non-spinal pathology and 97 pediatric spinal defomity patients with pre- and post-operative CT scans were reviewed. Pedicle morphology was recorded as previously described using the CT-based classification system. Pedicle morphology was classified as: Type A: >4mm cancellous channel, Type B: 2-4 mm channel, Type C: cortical channel, and Type D: non-existant pedicle. The incidence of pedicle dysmorphism, the location within the periapical region, and the incidence of screw malposition was recorded.

Results: The incidence of pedicle dysmorphism in non-deformity subjects was 9.8% compared to 22% in pediatric deformity patients (p<.001). Of the 300 abnormal pedicles in non-deformity patients, 77% were Type B, 22% were Type C, and 1% were Type D. Of the 719 dysmoporphic pedicles in spinal deformity patients, 69% were Type B, 18% were Type C, and 13% were Type D. Dysmorphism was more common in the periapical region than in non-apical vertebrae (32.6% vs. 19.7%, p<.001). The incidence of screw malpositioning was significantly higher in dysmorphic pedicles than in normal pedicles (17% vs. 6.7%, p<.001).

Conclusion: Pediatric patients with spinal defomity have a higher incidence of abnormal pedicle morphology than non-deformity patients. The degree of pedicle dysmophism was also higher in spinal defomity patients with significantly more Type C and D pedicles than control subjects. Abnormal pedicles are more commonly found in the periapical region and are more prone to screw malpositioning.

Significance: Pedicle screw fixation is commonly used in pediatric spinal deformity surgery. Screw malpositioning can place the patient at risk for peri-operative complications. Awareness of abnormal pedicle morphology can help to reduce the incidence of surgical morbidity.

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).

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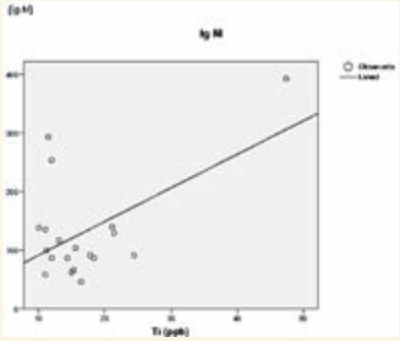
45. Serum titanium levels after instrumented spinal arthrodesis in patients with adolescent idiopathic scoliosis

Nuria Franco Ferrando MD, Teresa Bas Hermida MD PhD, Paloma Bas Hermida, Susana Soler, Luis Perez Millan, Ismael Escriba Roca, Daniel Bonete, Gerg Bordon
Spain

Summary: High serum titanium levels were found in a third of the patients with AIS after instrumented spinal arthrodesis. The risk increased with the use of double approach and when the instrumentation finished more distally. It was not related with time from surgery. These patients had higher levels of inmunoglobulines.Since the consequences of the chronic elevation of immunoglobulines are unknown and the majority of the patient population with AIS is women of reproductive age, more studies about serum titanium levels are needed.

Introduction: The use of metalic implants has increased the concern regarding the generation of metal ions and their potential local and systemic effects. These effects are currently unknown, but potential deleterious events have been suggested in the literature. Our objective is to determine serum titanium levels in patients with adolescent idiopathic scoliosis (AIS) after instrumented spinal



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arthrodesis and to identify potential causes of the metal elevation and its effects.

Methods: All subjects with AIS who underwent posterior or double titanium spinal instrumentation over a 10-year period were included. The minimum follow-up time was at least six months. Laboratory data included serum titanium levels, serum white blood cell count, ESR, CRP and immunoglobulin levels. Also radiographic parameters, SRS-22 and Oswestry score were assessed.

Results: 63 patients participate in the study. 90% were female and the follow-up time was 3.9 years. 32%(20) of the patients with titanium instrumentation had higher titanium levels (mean,16.6 ppb) than the control group (mean,<10 ppb. There was a higher risk of increased titanium levels in subjects who underwent a double approach (p=0.013) and in those in which the instrumentation ended more distally (p=0.016). Also there was a correlation between the serum titanium levels and the last level fused. The levels of immunoglobulin M and G were higher in patients with higher levels of titanium. No correlation was found between levels of titanium and time from surgery, number of levels fused or changes in SRS or Oswestry scores.

Conclusion: The increased risk of higher metal ion concentrations in patients who have undergone a double approach or in which the last level fused was more distal, could be explained by the suggested micro-movements between the implants. This could be avoided with the use of more rigid instrumentation. This study suggests that higher serum titanium levels are able to produce an inflammatory reaction. Since the consequences of the chronic elevation of immunoglobulines are unknown and the majority of the patient population with AIS is women of reproductive age, more studies about serum titanium levels are needed.

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46. Changes of Sacroiliac Joint Motion after Long Fusion: A Biomechanical Study

Honglin Teng, Chunhui Wu PhD, Amir A. Mehbod MD, Xiujun Zheng M.D, Rahul D. Chaudhari MD, Ensor E. Transfeldt MD
China

Summary: This study measured the sacroiliac joint motion after long fusion with and without iliac screws. The results suggest that long fusion without iliac screws does not significantly change SI joint motion. However, long fusion with iliac screws significantly reduced SI joint motion.

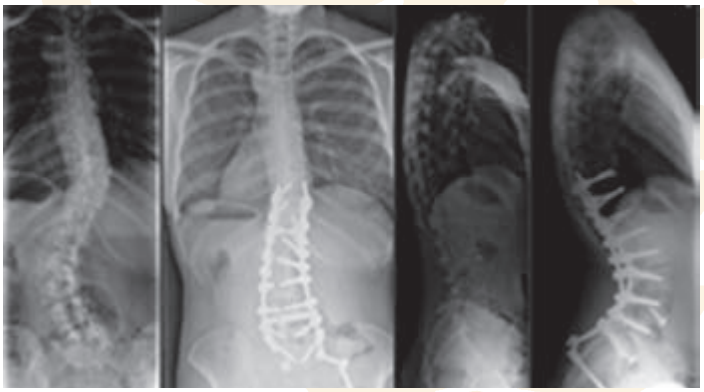
Introduction: One of the complications of long fusion is SI joint degeneration. Several studies have suggested that there is a correlation between low back pain and SI joint degeneration. Although limited clinical data and radiologic changes of the SI joint after long fusion are available, the biomechanics of the SI joint after long fusion is unknown. The purpose of this study is to determine whether long fusion affects SI joint motion.

Methods: Six fresh-frozen human cadaver spines with intact ligaments and pelvises were prepared and tested before and after long fusion. The stability of the SI joint was measured following intact, lumbosacral instrumentation (T10-S1 pedicle screws instrumentation), lumbosacral instrumentation with iliac screws. The specimen was subjected to pure bending moments (7.5Nm) in different directions (flexion and extension or FE, lateral bending or LB, and axial rotation or AT) while the iliums were fixed to the base of a hydraulic test machine. The movement of the SI joints was measured using an optical motion tracking system.

Results: On average, the intact SI joint motion was 1.4° in FE, 0.2° in LB, 0.8° in AT. The primary motion of the intact SI joint is in flexion extension. The long fusion without iliac screws had similar SI joint motion when compared to the intact condition. However, with iliac screws, the SI joint motion was significantly reduced in both FE and AT. The motion in FE and AT for the long fusion augmented with iliac screws was 0.8° and 0.4° respectively.

Conclusion: Although it has been assumed that long fusion to sacrum can be a cause of SI joint degeneration and pelvic girdle pain, the biomechanical data of this study did not confirm this assumption. The results of this study also showed that iliac screws are effective in protecting SI joint as well as S1 screws.

Significance: Long fusion itself does not increase SI joint motion. Iliac screws can significantly reduce SI joint motion and presumably reduce the risk of SI joint degeneration.



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47. Outcome and Surgical Strategies in the Treatment of Sacral Fractures Complicating Long Posterior Spinal Fusion

Ahmed S. Mohamed MD, Albert Pull ter Gunne MD, Richard L. Skolasky ScD, Khaled M. Kebaish MD, David B. Cohen MD
USA

Summary: Little work done on management and use of S2 screws for sacral fractures complicating long posterior spinal fusion.

Introduction: Little work considering the management of sacral fractures complicating long post. spinal fusion.Our aim is to assess the radiographic and clinical results.

Methods: A retrospective review of a prospectively collected database of patients who have had long post.spinal fusion between 2000 and 2007.Radiographic analysis including coronal

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curves,lumbar lordosis,thoracic kyphosis,sacral inclination,pelvic incidence,sagittal and coronal balance. Patient-centered outcomes were used to assess the clinical improvement.Values reported as means and range.

Results: Eleven patients who had sacral fractures following a posterior spinal fusion,mean current age is 62.60(47-75,SD=9.01),females (9/11=81.82%).one patient had an undisplaced fracture and was treated non operatively.The remaining 10 patients required surgical treatment.Mean duration of hospital stay was 7.30 days.90.91%(10/11) of the patients had at least one comorbidity.Mean duration of follow-up was 25.18 months(4-52,SD=15.75).All patients were treated by revision post. surgery,3 patients were treated by sacral osteotomy and all had instrumentation extended to S2 with the use of S2 sacro-pelvic screws. SVA was 16.09(-0.9-35.44,SD=13.15) and 7.82(-2.25-18.72,SD=7.05) at last follow-up.The preop pelvic incidence was 68.69(49.81-98.32,SD=16.08)and 75.15(61-89.49,SD=10.07) at last follow-up.The preop.Sacral inclination 46.97(27.62-63.92,SD=10.79)and 47.42 (30-66.22,SD=13.98)at last follow-up. SRS pre-op activity score was 2.33(SD=0.51)and 3.26(SD=0.19) post-op.SRS pre-op satisfaction score was 2.01(SD=0.95)and 3.05(SD=0.54)post-op.The intraop. neurological problem was 22.22% in form of dural tear and was repaired immediately.There was only one patient had numbness over right big toe postop. and recovered later on.

Conclusion: This retrospective case series demonstrates that among 11 patients,all benefited from S2 screw use in management of sacral fractures complicating long post.spinal fusion, along with significant clinical improvement between the pre and post-op assessment based on the SRS domain scores.

Significance: To our knowledge this study is the first to evaluate the outcome of surgical treatment and the use of S2 screws in the management of sacral fracture complicating long posterior spinal fusion

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48. Long Fusion to the Sacrum for Sagittal Imbalance -Sacral Fixation Only, Interbody Structural Graft, and Additional Iliac Screws

Kyu-Jung Cho MD, Ki-Tack Kim MD PhD, Whoan Jeang Kim, Sang-Hun Lee MD, Phd, Jae-Hoon Jung, Hyung-Suk Kim
Korea, South

Summary: The study compared three different techniques of long lumbosacral fixation in 56 adult patients with degenerative sagittal imbalance. The average number of levels fused was 7.5 segments. Sacral fixation only was not recommended for restoration of sagittal imbalance. Circumferential anterior and posterior fusion or combined sacral and iliac screw fixation was an acceptable fixation technique in long lumbosacral fusion. There were substantial complications related to instrumentation in all three groups, such as loosening of screws and pseudarthrosis.

Introduction: Long fusion to the sacrum may cause a high rate of pseudarthrosis, failure of instrumentation, and loss of correction. To prevent these complications a more stable fixation has been sought particularly in older adult patients. The study was conducted to compare three different techniques of lumbosacral fixation for degenerative sagittal imbalance.

Methods: A total of 56 patients (mean age 65) who underwent spinal corrective osteotomy were enrolled in this study with a minimum 2 year follow-up. Eighteen patients underwent posterior instrumentation with sacral screws only (Sacral group). Twenty patients underwent lumbosacral fixation and supplemental interbody structural graft (Interbody group), which was done mostly at the L4-5-S1 segments. Eighteen patients underwent additional iliac screw fixation with no interbody fusion (Iliac group). Radiographic and clinical outcomes were analyzed.

Results: The average number of levels fused was 7.5 segments, consisting of 6.3 in the sacral group, 7.9 in the interbody group, and 8.4 segments in the iliac group with no statistical difference. Lumbar lordosis was -4.5o before surgery and improved to -24.9o at the last visit in the sacral group. In the interbody group, it changed from 14.9o to -24.5o and from -4.4o to -34.8o in the iliac group. The correction of lumbar lordosis was 20.4o, 40.5o, and 30.4o in each group with a statistical difference (P<0.01). The sagittal C7 plumb was 129.9mm before surgery and corrected to 42.9mm after surgery, but changed to 90.1mm at the last follow-up in the sacral group. In the interbody group, it was corrected from 262.1mm to 116.1mm and from 119.7mm to 59.5mm in the iliac group. The restoration of sagittal imbalance was statistically different among the three groups (P<0.01). Loosening of screws and pseudarthrosis occurred more frequently in the sacral group, but the other two groups had also substantial complications.

Conclusion: Sacral fixation only is not recommended for restoration of sagittal imbalance in adult patients. Circumferential anterior and posterior fusion or combined sacral and iliac screw fixation is an acceptable fixation technique in long lumbosacral fusion. However, these techniques cannot prevent instrumentation related complications.

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49. Surgical Correction of Anterior Sagittal Imbalance by Posterior-Only Discectomy, Wedge Osteotomy of Adjacent Vertebral End Plates and Interbody Fusion. Technical Aspects, Clinical and Radiological Outcome

Jesus Burgos MD, Carlos Barrios, Eduardo Hevia MD, Pedro Domenech, Gabriel Piza, Ignacio Sanpera MD PhD, Ignacio Alvarez MD, Juan Carlos Rodriguez Olaverri MD
Spain

Summary: A new technique for treatment of anterior sagittal imbalance (SI) was prospectively evaluated with a more than 2-years follow-up period. The new surgical technique was based on posterior disc resection, wedge osteotomy of adjacent vertebral end

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plates and postero-lateral interbody fusion. A series of 29 patients with anterior SI related to failure of prior instrumentations was operated on with satisfactory clinical and radiological outcome. As other more conventional procedures, this technique was not free from major complications

Introduction: Different surgical techniques have been proposed for correction of anterior sagittal imbalance. All they have a limited ability for correction and are related to frequent complications. In this work, a new technique for treatment of SI is clinically and radiologically evaluated.

Methods: This is a study with Type IV level of evidence. A series of 29 patients (mean age 39 yr; range, 13-65) had anterior SI related to failure of prior instrumentations. The new surgical technique was based on posterior disc resection, wedge osteotomy of adjacent vertebral end plates and postero-lateral interbody fusion. Correction was applied to L5-S1 level in 12 cases, L4-L5 in 5, L3-L4 in 4, T12-L1 in 2, and at different thoracic levels in 8 patients. In all cases with correction at thoracic or thoraco-lumbar level, the fusion was extended until T2-T4 area. Mean follow-up after surgery was 2.6 yr (range, 2.1-5.3).

Results: The average blood loss was 610 cc (range, 210-2300), and the mean operative time was 33 minutes (200-520). As intraoperative complications, there were 4 dural tears, and 5 patients developed dysesthesias in one limb with complete recovering in few weeks. Two patients showed alterations during electrophysiological monitoring. Screws were removed, potentials partially recovered, and no sequels were developed. In the immediate postoperative period, 3 deep wound infections were detected and required a new cleaning surgical procedure. Non-fusion at the site of correction was found in 4 patients along follow-up. Outcome was satisfactory in these 4 cases after revision surgery for BMP-2 application. Preoperative sagittal imbalance was 13.3 cm (12-32), and 3.3 (0-6) in the last follow-up. Lumbar lordosis improved from an average of -7 (preO) degrees to -35 (postO). At correction level, SI angle changed from +11 degrees (preO) to -12 (postO).

Conclusion: Surgical correction of anterior SI throughout the intervertebral disc provided good clinical and radiological outcome. This technique required high surgical skills because it was not free from major complications.

Significance: A new attractive method to surgical correction of anterior SI based on posterior-only approach throughout the disc space was prospectively evaluated.

50. Male vs. Female Adult Deformity Surgery: Is There A Difference In Complications and Outcomes?

Geoffrey A. Cronen MD, Lukas P. Zebala MD, Lawrence G. Lenke MD, Daniel S. Mulconrey MD, Peter S. Rose MD, Joshua D. Auerbach MD, Brenda Sides MA, Keith Bridwell MD
USA

Summary: A retrospective, matched, comparative analysis of 62 adult male and female deformity patients revealed that male patients present with larger curves but achieve similar postoperative radiographic and functional outcomes despite greater operative time and blood loss. A trend for higher perioperative complications and need for revision surgery occurred in adult males.

Introduction: Research has shown that gender affects surgical outcomes in adolescent idiopathic scoliosis. The study purpose was to assess genders role on outcomes in adult spinal deformity.

Methods: Consecutive case series of 62 adult deformity patients with minimum 5 level fusion at a minimum 2-year follow-up (F/U). 32 males were matched (age, curve type, surgical approach, instrumentation) to 30 females (2 males without matches). Radiographic and functional outcomes were compared at preop and F/U. Complications were listed as recommended by Glassman et al (Spine 2007).

Results: Male and female patients had similar average age (29.4 vs 32.2 years, p=0.07). Males had larger preop main curve Cobb (65.3 vs 55.5°, p=0.03), T2-T5 Cobb (11.6 vs 4.8°, p=0.01) and C7 plumb (0 vs -17.9 mm, p=0.02) than females. Males had more postop T2-T5 kyphosis (13.2° vs 8.1°, p=0.01) and C7 plumb kyphosis at F/U, but other radiographic measures were similar. Males had longer surgical times (468 vs 411 min, p=0.04) and greater intraoperative blood loss (1198 vs 928 ml, p=0.03). Males had greater preop ODI (45.6 vs 21.6, p=0.01) than females. Males had significant ODI improvement at F/U (26.1, p=0.04) but not females (16.6, p=0.38). Male preop SRS total score (62.8) was similar to female (63.0, p=0.97) and both males (74.1, p=0.04) and females (76.7, p=0.01) had improvement at F/U. 10 males (17 complications, 13 major) and 3 females (3 complications, 1 major) had postoperative complications (p=0.09). 4 males and 0 females (p=0.13) had revision surgery during F/U.

Conclusion: Male adult deformity patients had greater initial curve magnitude than females, but achieved similar deformity correction. Males had longer surgical times and greater blood loss than females. A trend for greater perioperative complication and revision surgery occurred in males. SRS total score improved significantly in both groups, but surprisingly ODI improved only in males at F/U.

Significance: Adult deformity males achieve similar radiographic outcomes after surgery as females but with greater operative time and blood loss. Adult males may have more complications and need for revision surgery than females. At F/U, both groups had improved SRS total scores, but surprisingly ODI improved significantly only in males.

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51. The Effect of Operative Position during Posterior Spinal Fusion for AIS: Does it Influence Sagittal and Axial Alignment of the Thoracic Spine?

Jahangir Asghar MD, Patrick J. Cahill MD, Amer Samdani MD, M. Darryl Antonacci MD, David H. Clements MD, Randal R. Betz MD USA

Summary: A retrosepctive review of varying positions of chest roll for patients with AIS was performed. We found the placement of the chest roll influences thoracic sagittal plane. Furthermore, due to the complex planar coupling of the spine, the axial plane was concurrently affected

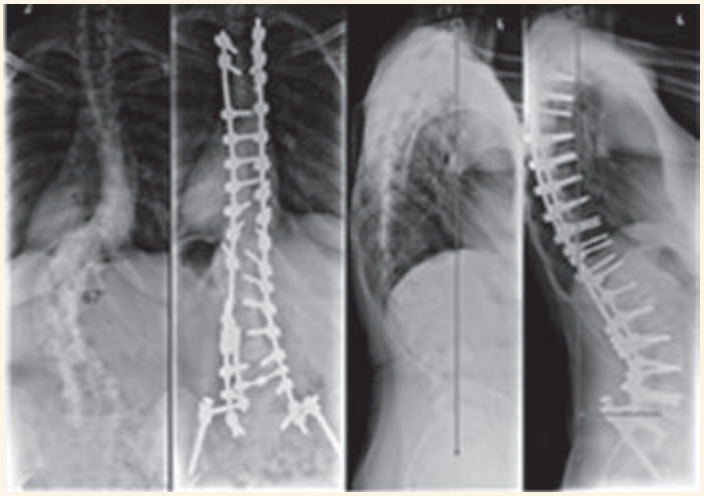
Introduction: Correction of all 3 planes during PSF for AIS remains a challenge. This study was to examine the effects of the position of the chest roll on thoracic kyphosis and its influence on axial alignment of the thoracic spine.

Methods: An IRB approved retrospective review of 25 consecutive patients with Lenke 1, 2, 3 and 4 AIS curves positioned prone on the Jackson spinal table. The inclusion criteria consisted of patients with pre-positioning standing lateral radiographs. Plus, lateral radiographs of the patient positioned prone on the Jackson table. One with the chest roll positioned approximately 2 cm below sternal notch (ST). A second lateral radiograph with the chest roll postioned proximal to the level of the xiphoid process (Xi). Axial measurements with a scoliometer and the rib hump index on radiograph were recorded. A statistical analysis using SPSS software was performed to measure for significant differences between the groups.

Results: The mean coronal deformity on standing AP radiograph was 58 degrees with the median apex of the deformity at T9. The mean erect standing thoracic kyphosis measurements were 9.2 degrees. The Scoliometer reading on the Adam's forward bend was 21.2 degrees. In the prone, position the mean thoracic kyphosis for the sternal notch chest pad was 4.9 degrees (range: -3 degrees to +17 degrees) and the mean kyphosis for the xiphoid positioned chest roll was 13.8 degrees (range: +6 degrees to +24 degrees, P=0.0093). The mean scoliometer reading between the two groups (Xi-16.5, St-12.2, P=0.021). This was further exhibited by the significant difference in the rib index. (Xi-1.74, St- 1.41, P=0.039).

Conclusion: The Xiphoid placed chest roll as compared to the standard sternal position resulted in a statistically significant increase in the amount of thoracic kyphosis averaging 9 degrees. However, there was also an associated with increase in the thoracic deformity with the altering of the position of the chest roll clinically with a scoliometer and by the rib hump index on radiograph.

Significance: When positioning a patient on the Jackson spine table, the placement of the chest roll influences thoracic sagittal plane. Due to the complex planar coupling of the spine, the axial plane is concurrently affected.



52. Which is a better ALIF graft at the base of a long fusion to the sacrum in patients over age 60: Titanium Mesh Cage vs Patellar Allograft?

Brian A. O'Shaughnessy MD, Frank L. Acosta MD, Patrick A. Sugrue MD, Jamal McClendon, Tyler Koski MD, Stephen L. Ondra MD USA

Summary: We studied 35 patients over age 60 who underwent 72 ALIFs at the caudal segments of a long (>6 level) posterior fusion to the sacrum in adult deformity. We compared the clinical and radiographic outcomes between patients that had ALIFs with titanium mesh cages (TMCs) to those in whom patellar allograft (PA) was used. We found that PAs were more likely to be judged a "definite fusion" and resulted in significantly less graft settling.

Introduction: ALIF is commonly performed at caudal segments of long posterior fusions to the sacrum. In patients over age 60, we hypothesized that PAs would result in equally high fusion rates as TMCs and perhaps less settling.

Methods: Patients over 60 who had a long (>6 levels) posterior fusion to the sacrum between 2002-2005 were studied. A matched cohort analysis was performed comparing ALIFs with TMCs to PAs. ALIFs were performed through a mini-open approach. In addition to either a TMC or PA, 4-mg of rhBMP-2 was used at each level. Minimum f/u for all patients was 2 years.

Results: 35 patients (9M/26F), mean age of 69.7±5.5 years, had a total of 72 ALIFs performed (41 TMC/28 PA). Mean f/u 4.7±0.9 years. The TMC cohort had 18 patients and 37 ALIFs (2.1±0.8 levels/pt). The PA cohort had 17 patients and 35 ALIFs (2.1±1.2 levels/pt). Mean number of posterior fusion levels were similar (TMC=11.6±5.2 vs PA=9.5±4.2). Final improvement in lumbar lordosis (TMC=8.41° vs PA=10.6°) and sagittal vertical axis (SVA) (TMC=25.2 mm vs PA=31.9 mm) were also similar. There was no statistical difference in loss of lumbar lordosis prior to solid fusion (TMC=4.75° vs PA=2.26°, P=0.452). A greater number of

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ALIFs in the PA group were "definitely fused" (TMC=54.1% vs PA=91.4%, P=0.005); a similar number were "definitely fused" or "probably fused" (TMC=94.6% vs PA=100.0%) according to Bridwell's fusion assessment. There was no case of PA graft resorption. There was a greater prevalence of graft settling in the TMC population (TMC=51.4% vs PA=17.1%, P=0.003). The amount of graft settling was also greater in the TMC group (TMC=5.35±1.8 mm vs PA=2.51±1.2 mm, P=0.012).

Conclusion: Both TMCs and PAs are viable ALIF grafts at the caudal segments of a long fusion to the sacrum in patients over age 60. PAs, however, are more easily judged to be fused and result in significantly less graft subsidence than TMCs.

Significance: An ALIF graft with a modulus of elasticity closer to that of native bone, such as a PA, may be a better option in the aging spine than TMCs. Additionally, the ease of fusion assessment and revision makes PA an attractive structural graft option for ALIF.

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53. The impact of reciprocal regional alignment changes distant from the site of spinal osteotomies affects post-operative spinal balance

Virginie Lafage PhD, Frank J. Schwab MD, Oheneba Boachie-Adjei MD, Jean-Pierre C. Farcy MD, Alexis P. Shelokov MD, Richard Hostin md, Robert A. Hart MD, Behrooz A. Akbarnia MD, Michael F. O'Brien MD, Douglas C. Burton MD, Christopher I. Shaffrey MD, International Spine Study Group
USA

Summary: Large vertebral resections are more frequently utilized in the setting of sagittal malalignment. If the effect of such a resection on regional alignment can be predicted, its impacts on distant unfused levels still need to be understood as they relate to the final post-operative alignment. Data from this study suggests that a lumbar and thoracic resection/osteotomy will impact the unfused reciprocal levels and respectively increase the thoracic and lumbar regional curvature of the unfused segments.

Introduction: Treatment of complex spinal deformity in adult patients requires an understanding of the effect of regional changes on global balance. While the regional impact of an osteotomy can be planned, the impact on distant segments of the spine remains poorly understood. The objective of this study is to analyze reciprocal regional corrective changes in the unfused segments of the spine away from the site of osteotomies as it relates to the final radiographic outcome.

Methods: This is a consecutive, multicenter retrospect review of 134 consecutive adult patients (24M, 110F, mean age= 54 +/- 12 yo). 29 subjects underwent thoracic resection procedures ("Thoracic group"), and 105 underwent lumbar resection procedures ("Lumbar group"). Resection levels ranges from T2 to L4 (Table). Radiographic analysis included pre and postoperative assessment of Thoracic Kyphosis, Lumbar Lordosis, SVA, Pelvic tilt, Pelvic incidence. Paired independent t-test analysis (SPSS) was computed to evaluate the changes in radiographic parameters

Results: In "Thoracic group", preop thoracic Kyphosis of 58° was corrected to 38° (p<0.001) and localized correction measured to 11°. For the unfused lumbar segment (12 patients), spontaneous Lordosis changed from 70° to 62° (p<0.05). Preop SVA improved from 2.4cm to -1cm (p=0.006) and pelvic tilt improved from 19deg pre-op to 13deg (p<0.001)

In "Lumbar group", the average correction at the osteotomy was 23°. Lumbar Lordosis increased from 20° to 49° (p<0.001). For the unfused thoracic segment (34 patients), Kyphosis increased from 22° to 35 post op (p=0.002). Pre op SVA improved from 14cm to 4cm post-op (p<0.001) and pelvic tilt improved from 33° to 25° (p<0.001).

Conclusion: In an attempt to correct spinal imbalance several parameters play important roles in pre-operative planning. If reciprocal changes related to regional deformity correction can be anticipated, then better post-operative alignment can be achieved. Furthermore, limiting resection to the site of maximum deformity may addresses the regional malalignment and result in reciprocal and spontaneous changes in unfused segments leading to improved restoration of overall spinal balance. This may eliminate the need to perform longer fusions of the spine.

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54. Changes in Coronal and Sagittal Plane Alignment Following Minimally-Invasive Direct Lateral Interbody Fusion for the Treatment of Adult Degenerative Lumbar Disease

Frank L. Acosta MD, John C. Liu MD, Nicholas Slimack, David Moller MD, Stephen L. Ondra MD, Richard G. Fessler MD PhD, Tyler Koski MD
USA

Summary: We reviewed the changes in spinal alignment of 36 adult patients with degenerative disease of the lumbar spine treated with the percutaneous direct lateral interbody fusion (DLIF) technique. Although DLIF resulted in significant improvements in segmental, regional, and global coronal plane spinal alignment, its effect on the sagittal plane was limited to an increase in the segmental sagittal Cobb angle, while regional lumbar lordosis and global sagittal alignment were not significantly improved.

Introduction: The lateral transpsoas approach for lumbar interbody fusion is a minimal-access technique that has been used by some to treat lumbar degenerative conditions. No study; however, has analyzed its effect on segmental, regional, and global coronal and sagittal alignment in patients with degenerative lumbar disease.

Methods: Review of the radiographic records of 36 patients with lumbar degenerative disease treated via direct lateral interbody fusion (DLIF). 35 patients had supplemental posterior fixation to maintain correction. Pre- and postoperative standing AP and lateral lumbar radiographs were taken of all patients for measurement of

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segmental and regional coronal and sagittal Cobb angles. Standing AP and lateral 36-inch films were also obtained in 23 patients for measurement of global coronal (center sacral vertebral line) and sagittal (C7 plumb line) balance.

Results: Mean preoperative coronal segmental Cobb was 4.5 degrees and 1.5 degrees postoperatively ($p<0.0001$). Mean pre- and post-operative regional lumbar coronal Cobb was 7.6 and 3.6 degrees, respectively ($p=0.0001$). In 8 patients with degenerative scoliosis, mean pre- and postoperative regional lumbar coronal Cobb was 21.4 and 9.7 degrees, respectively ($p=0.0004$). Mean preoperative global coronal alignment was 19.1mm and postoperatively was 12.5 mm ($p<0.05$). In the sagittal plane, mean segmental Cobb angle measured -5.3 degrees preoperatively and -8.2 degrees postoperatively ($p<0.0001$). Mean pre- and postoperative regional lumbar lordosis was 42.1 and 46.2 degrees, respectively ($p>0.05$). Mean global sagittal alignment was 41.5mm pre- and 42.4mm postoperatively ($p=0.7$).

Conclusion: DLIF significantly improves segmental, regional, and global coronal plane alignment in patients with degenerative lumbar disease. Although DLIF increases the segmental sagittal Cobb angle at the level of instrumentation, it does not improve regional lumbar lordosis or global sagittal alignment.

Significance: DLIF significantly improves segmental, regional, and global coronal plane alignment and therefore seems to be a valuable surgical tool for the minimally-invasive correction of coronal plane deformities in patients with lumbar degenerative disease. However, DLIF does not improve regional or global sagittal alignment.

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55. Pre-Operative Pelvic Parameters Must be Considered to Achieve Adequate Sagittal Balance after Lumbar Osteotomy

Frank J. Schwab MD, Virginie Lafage PhD, Christopher I. Shaffrey MD, Jean-Pierre C. Farcy MD, Oheneba Boachie-Adjei MD, Alexis P. Shelokov MD, Richard Hostin MD, Robert A. Hart MD, Behrooz A. Akbarnia MD, Michael F. O'Brien MD, Douglas C. Burton MD, International Spine Study Group
USA

Summary: PSO procedure is now commonly used for realignment of patients with marked sagittal mal-alignment. It is also commonly accepted that patients with different sagittal deformities will require different surgical procedures. This study focuses on patients with large pre-operative imbalance and aims to identify the key parameters that lead to successful post-operative alignments based on pre-operative sagittal spino-pelvic parameters. This study demonstrated that patients with large pre-operative pelvic tilt required a larger PSO resection of reach an acceptable post-operative alignment

Introduction: Lumbar osteotomies are increasingly applied in the setting of adult sagittal spinal deformity and may be effective in obtaining appropriate spino-pelvic re-alignment. Additionally, it has been established that correction of global sagittal spinal balance improves self reported clinical outcomes. The study aims to investigate the impact of pre-operative radiographic spino-pelvic parameters on post-operative sagittal vertical axis offset (SVA) with the hypothesis that patients with a larger pelvic tilt (PT) will require larger wedge resections

Methods: This is a multicenter consecutive retrospective review of 105 patients (mean age 54yo, 22M, 83F) who underwent lumbar PSO procedures for correction of major sagittal mal-alignment (mean pre SVA=14.3cm). Pre- and post-op free standing full length sagittal xrays were analyzed for regional curves (LL, TK), pelvic parameters (PI, PT) and global balance (SVA). Only patients with a pre-op SVA ranging from 10 to 20cm and with a post-op SVA less than 5cm were retained. The group was subdivided by pre-op pelvic tilt (low/high, cutoff =35°). Independent t-test analysis was used to determine differences in local/regional correction required to achieve the desired SVA correction

Results: A total of 14 patients were identified in the low_PT group and 16 in the high_PT group. There were no statistical differences in pre-op SVA, thoracic kyphosis (TK) and post-op SVA. The low_PT group had a significant lower lumbar lordosis (12° vs 31°, $p=0.002$) and a lower PT (23° vs 41°, $p<0.001$). Analysis of the surgical intervention demonstrated that high_PT group required a larger osteotomy resection (resp. 29° and 20°, $p<0.001$) and a larger regional change of lumbar lordosis (resp. +41° and+26°, $p<0.001$) to achieve an acceptable post-op SVA (<5cm).

Conclusion: It has been accepted that improvements in surgical outcomes in patients with sagittal malalignment relates to global and pelvic radiographic parameters. An understanding of spino-pelvic alignment may help the surgeon during complex re-alignment procedures. This study demonstrates that in the presence of increased pelvic retroversion (high PT), a larger angular lumbar osteotomy and regional correction is required to obtain a satisfactory post-operative SVA offset.

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56. Posterior-Only Multilevel Modified Vertebral Column Resection for Extremely Severe Pott's Kyphotic Deformity with a Konstam's Angle Beyond 90°

Yonggang Zhang MD, Yan Wang MD, Xuesong Zhang MD, Zheng Wang MD, KeYa Mao, Guoquan Zheng, Gang Li MD, Kirkham B. Wood MD
China

Summary: An extremely severe Pott's kyphotic deformity can not be corrected perfectly by many conventional techniques, such as the traditional two-stage technique, single-stage anterior-posterior vertebral body resection, Smith-Petersen osteotomy, pedicle subtraction osteotomy or even vertebral column resection (including posterior vertebral column resection). MVCR enables adequate correction.

Introduction: The present study aimed to report the technique and results of posterior-only multilevel modified vertebral column

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resection for more aggressive correction in extremely severe Pott's kyphosis with the Konstam's angle beyond 90°, and to evaluate the efficacy and safety of this technique.

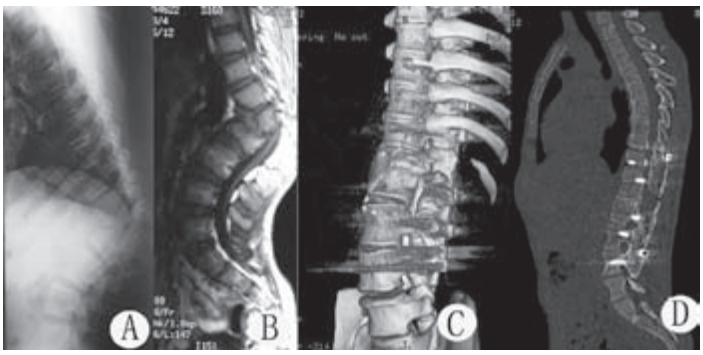
Methods: A total of 9 patients (6 males, 3 females) in our institution with extremely severe Pott's kyphosis who underwent single stage posterior-only multilevel modified vertebral column resection were retrospectively reviewed. The follow-up averaged 30.6 months (range, 21 to 50 months). The candidates for multilevel modified vertebral column resection were the patients who had a remarkable sharp, angular kyphosis in the lower thoracic or upper lumbar spine with a Konstam's angle beyond 90°. The Konstam's angle of the vertebral resection segment was measured on lateral X-ray view, fusion situation was evaluated at each follow up by analyzing the CT 3-dimensional reconstruction images. External appearance, complications were documented.

Results: An average of 2.5 vertebrae was removed in each case (range 2-4 vertebrae). A mean of 7 vertebrae were instrumented (range, 6-11 vertebrae). The mean duration of surgery was 285 minutes (range, 246-400 minutes), the average intraoperative blood loss was 2933 ml (range, 2000-6000 ml). The mean preoperative kyphus was 100.3°(range, 90°-132°). The mean kyphosis in the immediate postoperative period was 15.9°(range, 4°-30°) with an average postoperative kyphus correction of 84.4°(range, 63°-126°). Fusion of the resection site was confirmed on radiographs in all patients at the minimum 12 months follow-up. No pseudoarthosis was found. No loosening or breakage of pedicle screws occured.

Conclusion: A single stage posterior-only multilevel modified vertebral column resection is an effective way to correct extremely severe Pott's kyphosis with Konstam's angle beyond 90°.

Significance: This technique can satisfactorily correct the extremely severe Pott's kyphosis with a sagittal Konstam's angle beyond 90°.

A,B: preoperative X-ray and MRI; C,D: postoperative CT scan



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57. Does Appearance Influence Outcome in Adult Scoliosis?

Steven D. Glassman MD, Leah Y. Carreon MD MSc, Justin Smith, Frank Schwab, Se-Il Suk MD, PhD, William C. Horton MD, Keith Bridwell MD
USA

Summary: Prior studies of adult scoliosis patients indicated that appearance is an important factor in their decision to undergo scoliosis surgery. Our results show that change in appearance appears to make a relatively minor contribution to HRQOL after surgical correction of adult spinal deformity. Concern regarding appearance should be regarded with caution as a primary indication for surgery in adult scoliosis patients.

Introduction: Appearance is recognized as a pivotal issue in the management of adolescent idiopathic scoliosis, whereas pain and disability are considered the primary drivers for adult deformity surgery. However, a recent study showed that appearance was an important consideration in surgical decision making for adult scoliosis as well. The purpose of this study is to determine whether appearance, or change in appearance, significantly affect HRQOL after adult scoliosis surgery.

Methods: Prospectively collected data from 188 adult scoliosis patients (88% females, mean age = 49.7 years) enrolled in a prospective multi-center database for adult spinal deformity were reviewed. SRS-22, SF-12, and ODI were assessed on the basis of net mean change from baseline to two years post-treatment. At baseline, associations between the SRS-22 Appearance score and responses to the Appearance questions (Questions 4, 6, 10, 14 and 19) was evaluated. Associations between baseline SRS-22 Appearance scores, SF-12 PCS, ODI and radiographic parameters were also analyzed. At two years, associations between change in SRS-22 Appearance score and change in HRQOL, two-year SRS Satisfaction score and radiographic parameters were evaluated.

Results: At baseline, all SRS-22 Appearance questions except "appearance in clothes" correlated well with the overall domain score. There was a small degree of correlation between SRS Appearance and SF-12 PCS (0.344), ODI (-0.346), sagittal balance (-0.232) and curve magnitude (-0.215). There was no correlation between coronal balance and curve type. At two years post-op, there was a low correlation between change in SRS-22 Appearance and change in SF-12 PCS (0.265) and change in ODI (0.269). Change in curve magnitude correlated with change in SRS-22 Appearance (0.242), but the correlation was small.

Conclusion: While prior studies of adult scoliosis patients have indicated that appearance is an important factor in their decision to undergo scoliosis surgery, change in appearance appears to make a relatively minor contribution to their post-surgical HRQOL outcomes. Concern regarding appearance should be regarded with caution as a primary indication for surgery in adult scoliosis patients.

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58. Predicting Ideal Spinopelivc Balance in Adult Deformity

Chris J. Neal MD, Jamal McClendon, Frank L. Acosta MD, Tyler Koski MD, Stephen L. Ondra MD
USA

Summary: Restoring spinopelvic balance may play an important role in the surgical outcome of adult deformity patients

Introduction: Spinopelvic balance describes the relationship between the pelvis and the spine. Developing a formula to describe this relationship can allow its application to adult deformity surgery.

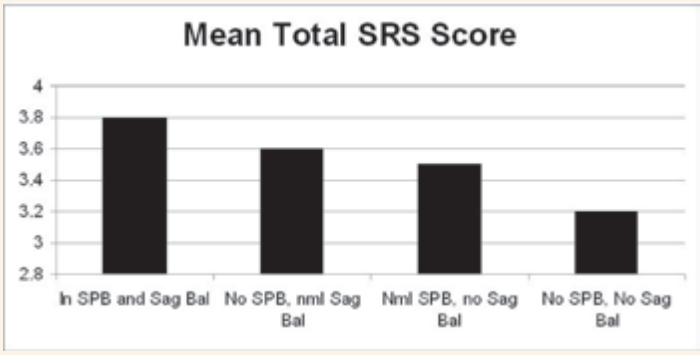
Methods: Using the literature for normal values, a mathematical relationship between the spine and pelvis was derived for 2 age groups, adults (18-60) and geriatric (>60), by dividing the pelvic incidence (PI) by the sum of the main thoracic kyphosis (TK) and lumbar lordosis (LL). This relationship is termed the spinopelvic constant (r). An equation was then constructed: PI=r(LL+TK). A retrospective review was performed using post-operative patients in our spinal deformity database. The difference between the predicted, as determined by the formula, and the measured sum of LL+TK was then calculated to determine the degree of spinopelvic imbalance.

Results: The spinopelvic constant in adult (-2.57) and geriatric population (-5.45) was calculated. The formula was applied to 41 adult deformity patients (13 adults, 28 geriatric). There were significant differences in outcome measures across the spinopelvic balance groups at the .05 level; being 0 to 10° of predicted resulted in the best outcomes. Sagittal and spinopelvic balance were then compared. A patient was in sagittal balance if they were +/-50mm from neutral and in spinopelvic balance if they were +/- 10° of predicted. Four categories were compared: 1) those in sagittal and spinopelvic balance (n=17), 2) those in sagittal but not spinopelvic balance (n=11), 3)those in spinopelvic but not sagittal balance (n=5), and 4)those in neither sagittal nor spinopelvic balance (n=8). There were significant differences in outcome measures across the sagittal/spinopelvic balance groups at the .05 level. From this analysis, patients that are in both sagittal and spinopelvic balance have better outcomes than those who are in neither. However, the results between those that are either in sagittal or spinopelvic balance, but not the other, are roughly equivocal.

Conclusion: Restoring spinopelvic balance in adult deformity patients may be important in determining surgical outcomes independent of sagittal balance.

Significance: Restoration of spinopelvic balance may improve outcomes in adult deformity patients.

Comparing the mean Total SRS Score to sagittal and spinal pelvic balance shows the best outcomes in patients in both sagittal and spinal pelvic balance, the worse outcomes in patients in neither sagittal or spinal pelvic balance and equivocal results in patients wither either sagittal or spinal pelvic balance. SPB=Spinopelvic balance SB=Sagittal Balance



59. Can Minimally Invasive Lateral Interbody Fusion Replace Open Interbody Approach in Combined Surgery for Complex Adult Spine Deformity?

Gregory M. Mundis MD, Behrooz A. Akbarnia MD, Richard Manos MD, Vikas Varma MD, Ramin Bagheri
USA

Summary: Lateral Interbody fusion is a promising and safe minimally invasive procedure when interbody fusion is required for surgical treatment of adult spinal deformity.

Introduction: The role of minimally invasive spine surgery (MISS) in adult deformity is yet to be defined. The purpose of this study is to report radiographic and clinical results of a series of adult deformity patients treated with lateral interbody fusion (LIF) as an alternative to traditional open anterior approach.

Methods: A retrospective review was performed of patients with adult deformity who underwent MISS interbody fusion via lateral approach and posterior spinal fusion (PSF). Clinical and radiographic data was collected peri-operatively, at 6 months and final follow up. Data analyzed with paired t-tests.

Results: 23 patients with average (avg) age 58 years(24-84), 21 female, 2 male and avg 3.2 comorbidites. Primary diagnosis: idiopathic (11), degenerative (11) and sagittal imbalance (1). Avg number of LIF and PSF was 2.9 (1-5) and 8.8(3-15) levels respectively. Avg blood loss for LIF was 117 cc and 1267 cc for PSF ($p<0.05$). Avg coronal curve was 41°(20-92) pre-surgery (PS) and 20°(4-40) at 1 year (1Y) ($p<0.05$). Lordosis (T12-S1) improved from 37° to 47°($p<0.05$). L4 tilt improved from 21° to 10° ($p<0.05$). VAS, SRS-22 and ODI improved from 7, 2.5 and 61 PS to 3, 3.5 and 34 respectively at 1Y($p<0.05$). 9 patients had a major complication (39%) including one death. Only 1 (4.3%) was directly related to LIF (end-plate fracture requiring revision of cage).

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Conclusion: LIF is a promising MISS technology that is as effective to achieve anterior interbody fusion and deformity correction as the traditional open anterior approach. Similarly, LIF avoids the reported complications associated with an open approach. Although only 1 complication resulted directly from LIF, the need for posterior augmentation remains a significant source of peri-operative morbidity.

Significance: LIF is a safe and effective treatment in patients with complex adult spinal deformity.

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60. Failure and Success of Spinal Surgery in Patients with Parkinson's Disease - A Critical Case Series Review in Light of Sagittal Balance

Heiko Koller Dr, Juliane Zenner, Axel Hempfing, Stephen Ondra MD, Tyler Koski MD, Frank L. Acosta MD, Luis Ferraris, Oliver Meier MD
Germany

Summary: Treatment of spinal disorders in Parkinson's disease (PD) patients is troublesome due to biomechanical challenges that this neuromuscular disease with a global sagittal imbalance imposed on poor bone quality. We investigated a large series of spinal surgery in PD: 18 of 23 patients had multi-level surgery, addressing sequelae of previous surgeries in 44% of patients; 5 had short segment surgeries (<3-level). Satisfaction was high, but postural dysfunction, postoperative worsening of muscular fatigue and brittle bone caused complications and revision surgeries. Detailed radiographic analysis stress that the presence or the reconstruction of sagittal balance is imperative for successful treatment.

Introduction: There are few data concerning biomechanical challenges spine surgeons face if treating patients w/ Parkinson's disease (PPD). We recognized PPD suffering spinal deformity aggravated by burden of PD stress the principles of sagittal balance if treated surgically indicating further investigation.

Methods: Retrospective series of 23 PPD treated surgically. ASA score was Ø2.3. Outcome analysis included review of med records focusing on failure characteristics, complications & radiographic analysis of balance parameters.

Results: 15 fem., 8 male PPD w/ age Ø66.3years at index surg, 67.9y at follow-up of Ø14.5months; mid- to long-term (MLT) data available in 17 pat (73.9%). 10 pat (43.5%) presented w/ failed previous surg. 18 pat (78.3%) underwent multilevel surgery. 16 pat (69.6%) had fusion to S1-S2-Ilium. Med. complications occured in 7 pat (30.4%), surgical in 12 pat (52.2%). Adjacent segment fractures occurred in 3 of 17 pat (17.6%) w/ MLT-data. Lumbar lordosis L1-S1 was 38.8°, 46.0° and 45.3°. C7-sagittal plumb-line was 12.2cm (8-57), 6.9cm and 7.6cm, resp. 3 of 17 pat (17.6%) had proximal junctional kyphosis (PJK >10°). 5 pat of 20 pat (25%) w/MTL-data had a positive C7 off-set of >10cm, indicating revision in 4 cases (80%). 6 of 18 (33.3%) had any early perioperative or late revision after index surgery. Fusion was achieved in 10 of 17 pat (58.8%) with MLT-data. Number of patients satisfied/very satisfied was 15 of 17 (88.2%).

Conclusion: The surgical history of PPD treated for spinal disorder and the reasons indicating redo surgery for recalcitrant sagittal imbalance in our sample highlight the mainstays of surgery in PPD: If spinal surgery is indicated, reconstruction of spino-pelvic balance w/ focus on lumbar lordosis & global sagittal alignment is mandatory. If short segment surgery is scheduled in PPD w/ sagittal decompensated imbalance, failure of instrumentation, fusion & decompression is likely.

Significance: Treatment of spinal disorders in PPD is troublesome due to biomechanical challenges imposed by postural dysfunction due to neuromusc. disorder and sagittal imbalance. Besides focus on local disease, decision making in PPD has to address primarily concerns of global imbalance, frequently indicating fusion into the thoracic spine to succeed.

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61. An Algorithm for Treating Adult Thoracic Major Spinal Deformity is Helpful in Guiding Surgical Treatment

Frank J. Schwab MD, Virginie Lafage PhD, Keith Bridwell MD, Steven D. Glassman MD, Christopher I. Shaffrey MD, Jean-Pierre C. Farcy MD
USA

Summary: For thoracic major spinal deformity, a clinically helpful treatment algorithm is offered

Introduction: Adult spinal deformity treatment approaches vary due to a lack of treatment algorithms. A Classification of Adult Spinal Deformity ("Classification") has been established but validation of treatment has been limited. The purpose of this study is to evaluate outcomes following surgery for thoracic major deformity based upon a consensus algorithm developed by the Spinal Deformity Study Group.

Methods: Multi-center analysis of consecutive adult patients. Type I,II ,III curves (thoracic only/major) treated surgically included: 164 patients 1yr, 98 with 2yr follow up (radiographs, health related quality of life (HRQOL) data and operative details). The consensus treatment algorithm calls for fusion 2 levels above and below the end vertebrae of the thoracic curve, 50% correction of the coronal Cobb angle and apical derotation (2 grades by Nash-Moe). Statistical comparison of outcomes (reaching minimal clinically important difference, MCID) was made between groups dependant upon adherence with algorithm guidelines.

Results: 119 patients (76%) had fusion levels per algorithm. Only 38% reached MCID threshold for ODI, 41% for SRS activity at one year (31%, 49% respectively two year). Patients treated per algorithm were significantly more likely to reach MCID thresholds at one and two years post-op (p=0.02-0.03). At two years patients treated per algorithm were more likely to also reach SRS appearance MCID (p=0.03). By coronal Cobb, 37% of patients

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reached 50% or more correction (per algorithm), and those were more likely to reach MCID for SRS appearance (p=0.002 year one, p=0.04 year two). Correction of axial rotation of 2 grades was noted in 26%, and was not correlated with reaching any MCID thresholds.

Conclusion: Adult thoracic major spinal deformity treatment has had little guidance from outcomes. Combining Classification and treatment algorithm (2 levels above and below coronal end levels of a curve, 50% Cobb reduction) showed adherence to guidelines lead to significantly improved outcome.

Significance: The Classification of adult spinal deformity can be combined with a treatment algorithm. In the setting of thoracic major curves the algorithm effectively guides ideal treatment for best outcome based upon HRQOL measures.

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62. Translational vs. Derotational Correction of Adult Scoliosis: A Comparison of Clinical and Radiographic Outcomes

Dennis Crandall MD, Jan Revella RN
USA

Summary: Computer modeling has shown decreased stress and improved deformity correction with translation techniques compared to derotation. Clinical and radiographic outcomes of 126 consecutive nonrandomized adult scoliosis patients were corrected by one of these techniques and followed 46months. Translational correction was superior to derotation 70% vs. 47%(P<0.01), with the biggest improvements seen in thoracolumbar and lumbar curves and in degenerative scoliosis. Complications, Oswestry, and VAS scores were not statistically different between groups.

Introduction: Computer finite element analysis has shown decreased stress and improved deformity correction with segmental translational forces vs. rod derotation. This study compares clinical and radiographic outcomes in adult scoliosis patients corrected using these two techniques. This is also the largest series of adult scoliosis corrected by low-stress translation ever reported.

Methods: A prospective nonrandomized study of 126 consecutive adult scoliosis patients age61(19-88yrs) underwent posterior instrumented correction by one surgeon, followed 46mo(24-84mo); the first 17 by rod derotation/in situ rod bending, the next 109 by low-stress translation by slowly pulling the spine to a contoured rod via pivoting reduction posts attached to screws, simultaneously correcting both coronal and sagittal deformity. Anterior surgery: 15/17 derotation, 57/109 translation patients. Osteotomies: Derotation- 2, Translation- 4. Clinical and radiographic results(curves, sagittal T5-12, T10-L2, T12-S1, balance, pelvic incidence) were analyzed by curve type.

Results: Translation group curves of 42°(range10-87°) corrected 70% to 13°(0-48°) was better (P<0.01) than derotation group curves of 55°(25-84°) corrected 47% to 30°(10-59°). Translation group idiopathic scoliosis of 57°(26-87°) corrected 69% to 18°(4-48°) compared to 49% derotation group correction (thoracic curves 65%vs51%, thoracolumbar 76%vs44%, lumbar 76%vs67% , double major 60%vs34%). Translation vs derotation group correction for degenerative scoliosis was 72%vs 49%,. Derotation group complications included 3 nonunions(17%), 2 screw loosening, 1 broken rod, 1 infection. Translation group had 10 nonunions(9%), 5 infections, 10 adjacent fractures, 1 screw pullout, 1 broken rod. Oswestry preop 45(4-84) improved to 27(0-70); VAS preop 6.2(1-10) improved to 2.7 (0-8), not statistically different between groups at 2 years and later.

Conclusion: This study showed better deformity correction of by translation than rod derotation for all types adult scoliosis, without increased complications. Thoracolumbar, lumbar, and degenerative scoliosis benefited most.

Significance: Translation appears superior to rod derotation in correcting adult scoliosis.

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63. Proximal Junctional Kyphosis Following Adult Scoliosis Surgery Results from a Mismatch between Lumbar Lordosis and Sacral Slope

Sergio A. Mendoza-Lattes MD, Zachary Ries BSc, Yubo Gao PhD, Stuart Weinstein MD
USA

Summary: Predictors of PJK following surgery for adult scoliosis include older age, a thoracic kyphosis that remains greater in magnitude relative to the lumbar lordosis, and where the C7-P is transferred to the sacral endplate at the expense of an increased pelvic tilt.

Introduction: Proximal Junctional Kyphosis (PJK) develops in 39% of adults following surgery for spinal deformity, and is defined as: 1) Proximal junction sagittal Cobb angle ≥ 10 and 2) Proximal junction sagittal Cobb angle ≥10 greater than the pre-operative measurement. The pathogenesis, risk factors and methods to prevent this complication are still unclear.

Methods: Retrospective prognostic study; 55 consecutive patients subject to surgery for adult spinal deformity (age= 59.3±10.1years); 19/55 (35%) developed PJK. Follow-up: 25.2±15.7months. Clinical outcomes: SF-36, ODI and VAS. Radiographic parameters of sagittal alignment were measured at pre-operative, early post-operative (6 weeks), and final follow-up. Sagittal alignment was measured by the ratio C7-P/SFD (sacral-femoral distance). Confounding variables: Age, BMI, levels fused and inter-body cages.

Results: Patients that developed PJK (group-II) were significantly older than those that did not develop this complication (group-I) (group-I vs. II: 63.8±8.6 vs. 59.3±10.1; p=0.01). Both groups presented with comparable sagittal imbalance, sacral slope (SS) and lumbar lordosis (LL) before surgery. The average |LL|-TK was significantly smaller in Group II patients (6.6±23.2 vs. -6.6±14.2; p=0.012).

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At 6-weeks, Group-II had better restoration of sagittal balance when compared to Group-I (C7-P/SFD: 1.43±2.1 vs. 0.17±1.3; p=0.04), but continued to have a larger TK than LL (|LL|-TK: 6.2±13.1 vs. -5.2±9.6; p=0.004). The SS was better restored in Group I patients (Group-I: from 31.2±15.9 to 35.7±8.0; Group-II: from 29.3±8.2 to 30.4±8.5; p=0.05). At final follow-up, the C7-P of Group II patients had returned to its pre-operative position (C7-P/SFD=1.09±1.4) at expense of the development of PJK.

Pre-operative clinical outcomes were comparable between groups. The SF-36 and VAS improved similarly with surgery except for ODI (23.6±16.4 vs. 41.7±20.4, p=0.03).

Conclusion: PJK developed in older patients, where the TK remained greater in magnitude relative to the LL, and where the C7-P is transferred to the sacral endplate at the expense of an increased pelvic tilt.

Significance: PJK can be prevented by obtaining a LL that is greater in magnitude than the TK, and must incorporate restoration of the Pelvic Tilt.

64. Scoliosis Research Society Morbidity and Mortality of Adult Scoliosis

Charles A. Sansur MD, Jeffrey D. Coe MD, Justin Smith MD, PhD, Christopher I. Shaffrey MD
USA

Summary: To determine the incidence of complications in the surgical treatment of adult scoliosis, and to assess the risk factors leading to complications, 4980 adult scoliosis patients from the Scoliosis Research Society (SRS) database were retrospectively reviewed. Overall complication rate was 10.5%. Complications were significantly higher in revision cases, osteotomies, and combined anterior/posterior approaches.

Introduction: This is a large retrospective review for the treatment of degenerative and idiopathic adult scoliosis (AS) from the SRS Morbidity and Mortality index. This database was reviewed to obtain an updated assessment of complication incidence, and to determine if the rate of complications depends on various clinical parameters.

Methods: The SRS Morbidity and Mortality database was queried to identify cases of AS from 2004-2007. Complications were identified and analyzed based on patient age, type of scoliosis, use of osteotomy, revision surgery status, and surgical approach. Age was stratified into <= 60 and >60. Surgical approach was stratified into: anterior only, posterior only, anterior and posterior, and unspecified.

Results: 4980 cases of AS were submitted from 2004-2007. There were a total of 521 complications (10.5%). The most common complications were dural tear 142 (2.9%), superficial wound infection 46 (0.9%), deep wound infection 73 (1.5%), implant complication 80 (1.6%), acute neurologic deficits 49 (1.0%), delayed neurologic deficits 41 (0.5%), epidural hematoma 12 (0.2%), wound hematoma 22 (0.4%), pulmonary Embolus 12 (0.2%), pulmonary complication 31 (0.5%), deep venous thrombosis 9 (0.2%). There were 17 deaths making the mortality rate (0.3%). Age and scoliosis type did not result influence the complication rate (P=0.32, 0.20). Patients who underwent osteotomies, who were having revision surgery, and who were undergoing anterior and posterior surgery had significantly higher rates of complication (P=0.0006, 0.006, 0.03).

Conclusion: The rate of complications for treatment of AS is 10.5%. Complication rate is significantly higher in patients undergoing osteotomies, revision procedures, and combined anterior/posterior approaches. Complication rate is not influenced by age or scoliosis type.

Significance: This report of complications for adult scoliosis is based on the laregst known sample of patients undergoing surgery using modern surgical techniques. It reviews the factors that significantly influence the rate of complications and may be useful for spine surgeons while they contemplate performing surgery on adults with scoliosis.

65. Late-Developing Infection Following Posterior Instrumented Surgery for Adolescent Idiopathic Scoliosis

Mario Di Silvestre, Georgios Bakaloudis, Francesco Lolli
Italy

Summary: A retrospective clinical and radiographic review of patients with adolescent idiopathic scoliosis who were surgically revisioned due to a late-developing post-operative infection.

Introduction: Few reports focus on late-developing infection following posterior instrumented fusion. However, the decision whether or not to remove or retain implants remains unclear.

Methods: From a total of 540 patients who underwent posterior-only fusion from 1993 through 2005, fifteen (2,77%) were surgically revisioned due to a late-developing post-operative infection. The implant alloy used was a stainless-steel instrumentation in 11 patients (4,56% of 241/540), and in 4 patients in titanium (1,33% of 299/540). Comparing the two groups, there was a statistically significant difference on the incidence of late developing infection (p<0.0001). There were 6 males and 9 females, average age at initial surgery 15,8 years (range,12-18), with infection occurred at a mean 70 months (15-195) after the index procedure.

Results: The clinical signs of infection included mild back pain, spontaneous sinus drainage, and a fluctuance mass. Complete removal of instrumentation was performed in 9 patients. In six patients an attempt to save/replace the previous instrumentation was performed. A complete removal of the instrumentation had to be performed 11,6 months later (3-24) for the persistence or recurrence of infection. All healed uneventfully at a minimum 2

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years follow up (25-70). Intra-operative cultures were obtained in all 15 patients, being positive in 13 (S. Epidermidis in 5, S.Aureus in 3, Propionibacterium Acnes in 1, Serratia Marcescens in 1, Propionibacterium Acnes+ S.Epidermidis in 1, S.Aureus+S. Epidermidis in 1, coagulase-negative Staphylococci in 1).

Conclusion: According to our experience, late-developing postoperative infection in adolescent idiopathic scoliosis surgery should be treated only by means of a complete removal of the implant, continuous drain and short-term adequate antibiotic therapy. To our findings, this entity is sustained by a polimicrobic flora, always necessitating an antibiogram-based post-operative antibiotic treatment. Our results suggest that titanium alloy spinal instrumentations are less subject to late post-operative infection, when compared to stainless-steel one.

66. Beneficial Influence of Titanium Mesh Cage on Infection Healing and Spinal Reconstruction in Hematogenous Septic Spondylitis

Panagiotis Korovessis PhD, Thomas Repantis
Greece

Summary: This large series reports on single-stage instrumented open and minimally invasive surgery for septic spondylitis. The use of titanium mesh cage on the site of infection has a beneficial influence on the eradication of infection. Supplementary posterior minimal invasive pedicle screw fixation eliminates posterior soft tissue injury and preserves blood supply, reduces surgical time, blood loss, and surgical complications.

Introduction: There is a controversy concerning the optimal treatment for pyogenic spondylitis regarding approach, instrumentation and staging.This series investigates if the use of titanium mesh cage on the site of infection could be beneficial for successful outcome of the operative treatment for pyogenic spondylitis.

Methods: Twenty-four patients aged 57 ± 16 years suffering from persistent or complicated septic spondylitis were treated by a total of 25 single stage combined surgeries (first: anterior debridement/ partial vertebrectomy plus mesh cage filled with autologous bone graft; second: pedicle screw fixation with open and minimal invasive techniques). The indications for surgery included neurologic compromise, significant vertebral body destruction with kyphosis associated with segmental instability, failure of medical treatment, and/or epidural/ paravertebral abscess formation. Needle biopsy was performed in all patients before surgery. Patients were evaluated before and after surgery in terms of pain and neurologic level, sagittal segmental spinal balance, radiologic fusion and recovery.

Results: All but 1 tetraplegic patient, who died because of massive clot lung embolism 2 months after surgery, were followed for 56 months (range, 31-116 months) The VAS score improved from 6.5 before surgery to 1.8 after surgery. The segmental kyphotic deformity was corrected at an average of 6°, without cage settling. An insignificant loss of kyphosis correction of an average 0.6° was measured in the thoracolumbar junction only. Blood loss, surgical time, and surgical complications were significant less in the patients who operated with minimal invasive technique. Patients with incomplete neurologic impairment improved after surgery. Physical function (SF-36) averaged 72 1 year after surgery. All operated patients had resolution of infection. There was neither migration of mesh cage nor posterior instrumentation failure at the last follow-up observation.

Conclusion: A radical debridement of spinal infection and anterior insertion of titanium cage, filled with autogenous bone graft, secured with pedicle screw instrumentation should have had a beneficial influence on the eradication of infection, segmental and global spinal reconstruction and fusion.

67. TLIF Revision for Failed Posterolateral Spinal Fusion

Mohammad El-Sharkawi MD
Egypt

Summary: Revision of failed posterolateral fusion by TLIF seems to consistently yield excellent clinical and radiological outcome.

Introduction: Posterolateral fusion is commonly used for managing many degenerative spinal problems. Reported pseudarthrosis rate varies between 5 - 40 percent. Several approaches have been used for revision, including regrafting, ALIF, PLIF, and TLIF. The aim of this work is to compare between revising posterolateral fusion by regrafting and by TLIF using autogenous iliac bone graft.

Methods: Forty-three patients with symptomatic pseudarthrosis after previous posterolateral fusion were revised using TLIF technique and were prospectively evaluated and followed for a minimum of 2 years (Range: 2-5.6ys). The clinical and radiological outcomes were recorded and compared to a historical group of 21 patients treated earlier with refreshing the same fusion bed and regrafting. Only autgenous iliac grafts were used in all cases. VAS and Oswestry Disability Index (ODI) were used to judge for the clinical improvement. Radiographs were obtained at 2, 6, 12 and 24 months.

Results: The difference in operative time amount of blood loss was statistically insignificant between the 2 groups. The TLIF group showed significantly better clinical outcome as reflected by the improvement in the VAS score and the ODI. The fusion rate in TLIF group was also significantly higher than the posterolateral fusion group (42/43 vs 8/21). Ten patients who failed regrafting were later successfully re-revised by TLIF. Complications included 2 dural tears in the TLIF group, one superficial infection in the posterolateral group and 2 temporary graft donor site discomfort.

Conclusion: The success of TLIF for revising pseudarthrosis after posterolateral fusion might be attributed to the fact of placing the graft in a wide fresh (non-fibrosed) bed under compression. The approach is relatively easy because it avoids any fibrosis from

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previous surgery. The reported morbidity of this approach is less than ALIF and its use is therefore encouraged.

68. Complications In 575 XLIF Surgeries

W. B. Rodgers MD, Curtis Cox MD, Edward Gerber
USA

Summary: A single-site, single surgeon series of 575 patients who underwent the XLIF procedure for a variety of indications is reviewed.

Introduction: The XLIF procedure allows for minimally invasive placement of a large anterior graft, disk height and alignment restoration, and indirect decompression.

Methods: Our single-site consecutive series of 575 XLIF outcomes were reviewed. Surgical and postoperative complications were documented.

Results: 575 cases included patients aged 22-89 years (average 66 years). Diagnoses included stenosis (50%), spondylolisthesis (15%), DDD (12%), HNP (10%), post-laminectomy instability (6%), and scoliosis (7%). 77% had one or more pre-existing comorbidities, including diabetes, CAD, COPD, smoking, and chronic steroid use. 40% had prior lumbar surgery. 284 (49%) were obese or morbidly obese. 713 levels were treated: 81% single-level; 59% at L4-5. All but 5 included supplemental instrumentation. Hospital stay averaged 1.20 days. 40 complications were reported: (6.9% complication rate): 2 wound (hernia and subcutaneous hematoma); 7 GI (6 ileus, 1 gastric volvulus); 2 renal (1 urinary retention, 1 peritoneal catheter occlusion); 5 respiratory (3 pneumonia, 1 pulmonary embolism, 1 re-intubation); 6 cardiac (5 atrial fibrillations, 1 MI at 6 wks post-op); 4 neural (3 quad weakness, 1 anterior tibialis weakness); 7 vertebral body fractures (1 endplate fracture, 1 osteophyte fracture requiring reoperation, 1 subsidence requiring reoperation, 4 compression fractures at an adjacent level requiring vertebroplasty); 1 iatrogenic HNP (requiring laminectomy at 4 wks); 1 hnp at an adjacent level (requiring discectomy), and 5 hardware failures (3 cage fractures on insertion, 1 fractured rod at 6 months, 1 fractured screw at 1 year). Reoperation rate was 25/575 (4.3%) (4 vertebroplasty, 5 axiaLIF, 6 XLIF, 4 PLIF, 1 ALIF, 2 laminectomy, 1 hardware revision, 1 hematoma drainage). 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.

Significance: Our results show that XLIF is a safe and effective minimally invasive treatment option for many thoracolumbar spinal conditions.

69. Longer Surgical Times May Increase Your Complication Rate

Suken A. Shah MD, Peter O. Newton MD, Baron S. Lonner MD, Randal R. Betz MD, Tracey Bastrom MA, Michelle C. Marks PT, MA, Harms Study Group
USA

Summary: The duration of surgery was examined as a risk factor for complications in a multicenter, prospectively enrolled database of adolescent idiopathic scoliosis patients with greater than 2 year follow up. In a cohort of 289 patients, 28 patients with a surgical time greater than 420 minutes experienced a complication rate of 32.1%, a rate 3.5 times higher than patients with a surgical time of less than 420 minutes.

Introduction: Major spinal deformity surgery is stressful on the patient due to prone positioning, blood loss, fluid shifts, anesthetic effects and autonomic deregulation. Longer duration of surgery may lead to adverse outcomes as the patient's reserves are exhausted. The purpose of this study was to examine duration of surgery as a variable on the incidence of complications.

Methods: From a multicenter, prospectively enrolled database, patients who underwent surgery for AIS with greater than 2 year follow up were reviewed for surgical time and complications. A secondary review of all cases was performed to ensure completeness and accuracy of complications. Using a histogram analysis of surgical time, long duration of surgery was defined as > 420 minutes and cases were grouped (I - greater than 420 min and II - less than 420 min) and analyzed.

Results: Patients in Group I (28/289) experienced 9 complications: wound infections/dehiscence (4), implant-related (3), neurologic (1) and excessive blood loss (1) for a rate of 32.1%. Patients in Group II (261/289) had 24 complications for a rate of 9.2%. This difference in complication rate related to surgical time was significant (Chi Square p=0.002). There was no significant difference in the preoperative demographics of the groups with regard to curve magnitude or co-morbidities.

Conclusion: Surgical duration of greater than 420 minutes resulted in an increased complication rate of 32.1%, a rate 3.5 times higher than cases less than 420 minutes (9.2%). The most frequent complications were wound issues, implant-related problems, neurologic events/alerts and excessive blood loss. Although complex procedures may have long operative times and an increased complication rate in and of themselves, this data may be useful in counseling the patient/family and perhaps in staging procedures when appropriate.

Significance: In this otherwise healthy population of AIS patients, duration of surgery > 420 minutes was seen to adversely affect outcomes.

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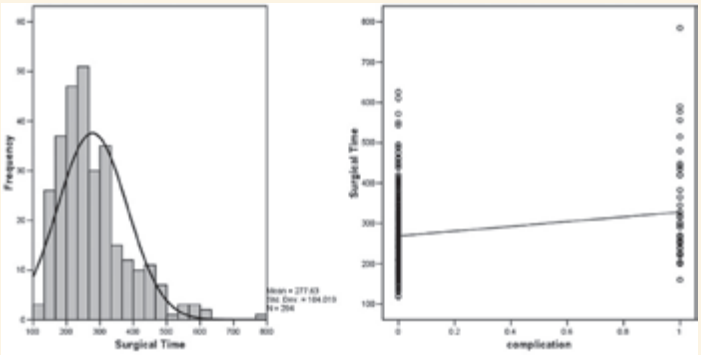
Histogram illustrates distribution of surgical time for 289 cases. Scatterplot shows a correlation of complications with increasing surgical time.



★ 70. Higher Risk of Dural Tears and Recurrent Herniation with Lumbar Micro-Endoscopic Discectomy

Marco G. Teli MD, Alessio Lovi, Marco Brayda-Bruno, Antonino Zagra, Andrea Corriero
Italy

Summary: In a single-blinded randomised prospective study, micro-endoscopic discectomy (MED) was tested against standard open and microscopic aided discectomy for surgery of lumbar disc herniation. While clinical results at two years do not differ significantly, MED showed a significantly higher rate of recurrence and dural tears compared to standard techniques.

Introduction: Previous studies on the efficacy and safety of micro-endoscopic (MED) lumbar discectomy have reported similar results to those of open (OD) and micro-discectomy (MD). Given the higher costs and surgeon learning curve implied in the technique of MED, aim of this study was to investigate the hypothesis of better clinical outcome with MED compared to the more traditional techniques.

Methods: Inclusion criteria: diagnosis of lumbar disc herniation (LDH) made by spine specialists in patients aged 18 to 65 years. Exclusion criteria: spinal stenosis, tumours, previous spine surgery, deformity, current infection and rheumatic disease. The following instruments were applied pre-operatively and at 3, 6, 12 and 24 months of follow-up: Oswestry Disability Index (ODI) 2.0, back and leg Visual Analogue Scale (VAS) and Short Form-36 (SF36). Patients enrolled were single-blinded randomised to receive OD MD or MED. A previous retrospective pilot study indicated 80 patients per treatment arm would be necessary to test the hypothesis of a different clinical outcome. Surgeons were fully trained in the three techniques with a minimum 4 years experience in practising each.

Results: 240 patients were included and 212 completed the 24 months follow-up period (91%). Results follow.

VAS back: no significant difference among techniques throughout follow-up.

VAS leg: no significant difference among techniques throughout follow-up.

ODI: no significant difference among techniques throughout follow-up.

SF3: no significant difference among techniques throughout follow-up.

Complications:

Significantly higher incidence of dural tears with MED.

Significantly higher incidence of recurrent herniations with MED throughout follow-up.

Average surgical time was significantly longer with MED compared to OD (shortest) and MD.

Conclusion: MED in the hands of surgeons with sufficient training failed to show better VAS, disease-specific and quality of life scores compared to more traditional techniques of lumbar discectomy. On the other hand, complications were significantly higher. Based on this outcome, the authors support the use of open or microscopic discectomy as standard techniques in clinical practice.

71. Early Failure of Metal-on-Metal Artificial Discs Due to Metal Hypersensitivity: The Diagnostic and Treatment Approach in 4 Collected Cases

Richard D. Guyer MD, Jessica Shellock, David Hanscom, Robert Urban, Reginald Knight, Peter McCombe, Josh Jacobs, David Bradford MD
USA

Summary: This study describes the diagnosis and treatment of four patients from three centers with presumptive metal hypersensitivity following lumbar or cervical total disc replacement using a metal-on-metal device. In all cases, the implants were removed and fusion performed. Although the incidence is low, surgeons should be aware of this problem.

Introduction: Systemic metal ions produced have not been associated with adverse clinical sequelae following arthroplasty surgery, although there have been reports of local soft-tissue reactions leading to early prosthetic failure. Histological evaluation in these cases suggested a cell-mediated hypersensitivity reaction. Metal-on-metal bearings have emerged in total disc replacement (TDR) prostheses, but to our knowledge, this complication has not been reported. The purpose of this study is to report the diagnostic and treatment approach undertaken in patients with failed spinal arthroplasty due to presumptive metal hypersensitivity.

Methods: This report is on four patients, from three centers, who underwent TDR using a metal-on-metal implant and later presented with symptoms that were determined to be due to metal hypersensitivity. Details of their symptoms, diagnostic work up, treatment and outcomes were compiled.

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Results: All patients initially had good surgical outcome, followed by onset and worsening of axial pain and/or radicular symptoms (Table 1). In two patients (cases 2 and 4), an auditable squeaking and/or grinding sound was produced by the prosthesis during motion. Intra-operatively, in all lumbar cases, a thick, yellowish, avascular soft tissue mass was found causing an epidural mass effect on the thecal sac. In the cervical case, there was a grey-tinged soft tissue response around the implant suggestive of metallosis. Laboratory analysis confirmed metal hypersensitivity. Three patients had a good outcome after the explant and revision surgery. Case 3 continues to have mild renal dysfunction and bilateral foot drop from nerve root compression by the mass.

Conclusion: To our knowledge, this is the first report of presumptive metal hypersensitivity causing subsequent failure of metal-on-metal lumbar and cervical disc arthroplasties. This phenomenon has been recognized with metal bearings in hip arthroplasty, with a reported prevalence of 1%. Our findings from the prostheses in this report suggest that a similar prevalence could exist in metal-on-metal TDR.

Significance: This study describes the occurrence and treatment of a reaction to metal-on-metal TDRs.

Description of the 4 cases

Case	Gender	Age	Level	Time to symptoms	Time to explant	Procedure with explant
1	Male	41	L5-1	10 mo	16 mo	360 fusion
2	Female	56	L4-5	12 mo	23 mo	360 fusion
3	Male	45	L5-1	18 mo	37 mo	Anterior interbody fusion
4	Female	45	C5-6	5 mo	14 mo	Anterior cervical fusion

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).

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72. Reduction in Spinal Surgery Wound Infection Rates by Minimally Invasive Technique

Richard G. Fessler MD PhD, John O'Toole MD, Kurt Eichholz MD
USA

Summary: This large series of MIS operations reveals an incidence of postoperative infection that is demonstrably less than that published in the literature for traditional open spinal surgery, particularly for instrumented cases.

Introduction: Reported rates of wound infection after traditional open spinal surgery range from 0.9% to greater than 15%. These infections can be difficult to treat and augment the utilization of health care resources significantly. The techniques used in minimally invasive spine (MIS) surgery confer many benefits, but the incidence of postoperative wound infections when using these approaches has not been specifically studied in the literature.

Methods: We analyzed a prospectively collected database of MIS operations performed over a 6.5 year period, and the total incidence of postoperative wound infection as well as the rates of infection for the different types of procedures performed were calculated

Results: 1338 MIS operations were performed on. Mean follow-up was 11.7 months. The cohort demonstrated 2 postoperative infections for a 0.2% overall infection rate. One of the infections occurred after a lumbar microendoscopic decompression of stenosis (MEDS) and the other after minimally invasive transforaminal lumbar interbody fusion (MI TLIF). Both patients were successfully treated with antibiotic therapy without re-operation. The procedure-specific infection rates were 0.7% for MEDS, 0.7% for MI TLIF, and .1% for all other procedures.

Conclusion: This large series of MIS operations reveals an incidence of postoperative infection that is demonstrably less than that published in the literature for traditional open spinal surgery, particularly for instrumented cases. It is our hypothesis that this reduced incidence stems from 1) reduced exposure of deep tissues during MIS surgery, 2) the barrier to skin contact provided by tubular retractors, and 3) reduced postoperative dead space after MIS surgery.

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73. Vertebral Bone Mineral Density Changes Following Kyphoplasty for Osteoporotic Fresh Vertebral Body Fractures

Panagiotis Korovessis PhD, Thomas Repantis
Greece

Summary: This prospective controlled cohort study of 27 adult osteoporotic patients who underwent kyphoplasty, studied the changes of vertebral bone mineral density (BMD) at the kyphoplasty and at the adjacent levels over a minimum two-year period. Kyphoplasty increased preoperative BMD and strength in the augmented vertebra, while only in the case of multilevel kyphoplasty, the preoperative BMD and strength of the adjacent non-augmented vertebra immediately above kyphoplasty was decreased.

Introduction: Osteoporotic compression fractures can be effectively treated with methylmethacrylate vertebral augmentation, but the effect of augmentation on the BMD changes in the augmented and adjacent non-augmented vertebrae has not yet been identified.

Methods: Twenty-seven consecutive patients (9 men, 18 women) with an average age 73+9 years underwent one, two or three-level percutaneous kyphoplasty for painful fresh osteoporotic compression vertebral fractures at the thoracolumbar spine. All patients were examined with AP and lateral standing whole spine roentgenograms preoperatively and postoperatively. Lateral DEXA at the upper and lower endplates of the augmented and at the adjacent vertebrae (one level above and one below kyphoplasty) was performed, preoperatively, three and six moths, one and two years postoperatively. The endplates were selected for BMD measurements to avoid artifacts provided by centrally placed cement.

Results: A total of 48 vertebral bodies were augmented. Thirteen patients received one level and the remaining 14 two or three-level

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kyphoplasty. No significant changes in the saggital plane balance, Gardner kyphotic angle and posterior vertebral body height were observed pre-, to postoperatively. The anterior vertebral body height ratio increased significantly (ANOVA, P=0.008), without subsequent loss of correction. BMD increased significantly in the lower endplate of the augmented vertebra (ANOVA, P=0.05). In the multi-level augmentation, the BMD of the upper endplate in the adjacent level above kyphoplasty decreased statistically significantly (ANOVA, P=0.05). In the two-year-follow up there were 5(18%) new fractures above the augmented vertebra, all occurred in patients who received two and three-level kyphoplasties.

Conclusion: Kyphoplasty increased preoperative BMD and strength in the augmented vertebra, while only contiguous kyphoplasty in two & three vertebrae decreased the preoperative BMD and strength of the adjacent non-augmented vertebra immediately above kyphoplasty within a period of two years. These changes in vertebral bone strength may offer an at least theoretical explanation for the pathogenesis of new fractures in adjacent vertebra following multilevel kyphoplasty.

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74. Secondary Prevention of Osteoporotic Compression Fractures after Cement Augmentation: Comparative Results of Treatment with Alendronate, Risedronate and Calcium Carbonate

Jin-Young Kim, Sang-Phil Yoon, Ankur Nanda, Dong-Eun Shin MD, Hak Sun Kim
Korea, South

Summary: We studied 199 patients who were operated for kyphoplasty or vertebroplasty and were then either treated by risedronate, alendronate or calcium carbonate to counter osteoporosis. The patients were divided into 4 groups according to the type of treatment given. A control group was formed which was not given any treatment. The groups did not show any significant difference in symptomatic as well as morphogenic re-fracture rates suggesting that the common anti-osteoporotic agents do not provide sufficient protection against re-fractures.

Introduction: Various studies have reported variable rates of re-fractures in patients treated by vertebroplasty or kyphoplasty for osteoporotic vertebral compression fractures. But the treatment strategy to prevent these secondary fractures is still unclear. The purpose of our study was to evaluate the difference in re-fracture rate of patients who had been operated for vertebroplasty or kyphoplasty and were later treated either by alendronate sodium, risedronate sodium or calcium carbonate.

Methods: A total of 292 patients with osteoporotic compression fractures were operated for either vertebroplasty or kyphoplasty from December 2001 to October 2007. 199 patients who met the inclusion criteria were included in the study. They were divided into 4 groups according to the anti-osteoporotic medication given: Group I (n=71) - no treatment, Group II (n=64) - risedronate sodium, Group III (n=42) - alendronate sodium and Group IV (n=22) - calcium carbonate. The groups were compared in terms of age, body mass index (BMI), bone mineral density (BMD), symptomatic re-fracture rate and morphogenic (radiological) re-fracture rates.

Results: The average follow-up period was 18.2 months. The symptomatic re-fracture rate for Group I, II, III and IV was 8.5% (n=6), 6.3% (n=4), 7.1% (n=3) and 9.1% (n=2), respectively. There was no statistically significant difference between them (p=0.32). The morphogenic re-fracture rate for Group I, II, III and IV was a little higher at 22.5% (1n=6), 18.8% (n=12), 19.1% (n=8) and 22.8% (n=5), respectively. Again there was no statistically significant difference between the groups (p=0.43). The groups were comparable in terms of other parameters.

Conclusion: There was no significant difference between the groups in terms of both morphogenic and symptomatic re-fracture rates. Hence, all the anti-osteoporotic medications used in the study were found to have a low protective effect on the patients.

Significance: The patients who were not given any treatment and those on common anti-osteoporotic agents did not show any difference in the re-fracture rate. Hence, it suggests that these agents do not provide sufficient protective effect and so it may be better to consider other treatment options like teriparatide in cases of severe osteoporosis.

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75. Pulmonary Cement Embolism After Multilevel Percutaneous Vertebroplasty

Cagatay Ozturk, Ahmet Alanay, Selhan Karadereliler, Mursel Debre, Neslihan Aksu, Azmi Hamzaoglu
Turkey

Summary: Extravasation of cement, a common event associated with vertebroplasty, may lead to cement emboli in the lungs. 598 percutaneous vertebroplasties were performed in 148 patients (106 women and 42 men) in our institution. Pulmonary cement embolism was detected on chest radiographs and confirmed with chest computed tomography (CT) in 11 patients treated with multilevel percutaneous vertebroplasty for osteoporotic fracture. Single stage procedure was performed in all 11 patients. The frequency of pulmonary cement embolism was 7.4%.

Introduction: The reported incidence of pulmonary cement embolism in vertebroplasty is 4.6%. The aim of this study was to determine the frequency of pulmonary cement embolism after multilevel (more than 3 levels) PV in our institution.

Methods: Between 2002-2007, 598 percutaneous vertebroplasties were performed in 148 patients (106 women and 42 men) in our institution. Except 16 patients in whom multilevel vertebroplasty was performed in two stage (2 or 3 day interval), all procedures were performed in single stage. If the patient have an excessive

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osteoporosis (t score <3.0), prophylactic vertebroplasty should be done in order to prevent further neighboring vertebral fractures. Postprocedural chest radiographs were obtained for all patients and assessed for the presence of pulmonary cement emboli.

Results: The minimum follow-up period was 2 years. The mean age of the patients was 77 years. 52% of the procedures were done in thoracic region and the rest in lumbar region. Pulmonary cement embolism was detected on chest radiographs and confirmed with chest computed tomography (CT) in 11 patients treated with multilevel percutaneous vertebroplasty for osteoporotic fracture. Single stage procedure was performed in all 11 patients. Five of these 11 patients developed mild dyspnea and chest discomfort 1-5 hours (mean 2.5 hours) after the procedure. The remaining 6 patients with pulmonary cement emboli detected by chest radiographs were asymptomatic. The frequency of pulmonary cement embolism was 7.4%.

Conclusion: The incidence of pulmonary embolism caused by cement in multilevel VP (7.4%) is higher than general occurence rate reported in literature (4.6%). To avoid this complication, the cement should be injected with caution and under fluoroscopic control during the pasty polymerization phase. There were no pulmonary embolism in patients in whom multiple level VP were done in two different session. So, in our opinion, vertebroplasty more than 3 levels should be done in two different sessions.

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76. Preventive Vertebroplasty in Osteoporotic Patients - Early Outcomes and Subsequent Vertebral Fractures

Peter Diel, Paul F. Heini MD
Switzerland

Summary: Preventive reinforcement of adjacent vertebra in selected patients is efficient and safe.

Introduction: Vertebroplasty (VP) is a cost-efficient alternative to kyphoplasty. It is considered inferior in safety and vertebral body (VB) height restoration. We assessed the safety and efficiency of VP in alleviating pain, improving quality of life, reconstituting alignment and refracture rates.

Methods: 226 VPs in 203 patients were performed from 04/2007 - 03/2008. 364 (32%) VBs were fractured, 773 levels (68%) were cemented.

Analysed were demographics, treatment details, pain alleviation, quality of life (QoL) improvement (NASS and EQ-5D), complications and subsequent fractures. Wilcoxon rank-sum (continuous variables)and Chi-square test (proportions) were used. The significance level $p<0.05$.

Results: There were 77.8% females. Median age of both sexes was 78 years. On average there were 1.8 vertebral bodies (VB) fractured and 5 VBs treated. Pain decreased from 56.7 preop to 41.4 pts six months postop. ($p<0.0001$). QoL on EQ-5D (-0.6 to 1) improved from preop 0.32 pts to 0.58 pts six months postop ($p<0.0001$). The preop Beck-Index (ant/post height) improved from a mean of 0.64 to 0.8 after six months ($p<0.0001$). There were cement leakages in 33% of the fractured VBs and in 0.78% of the prophylactically cemented VBs without radiculopathy. Total intraoperative complications were seen in 4.4% (9 cases), 8 cases with hypotension and one cement embolism. The reference group 1 with a maximum one prophylactically cemented level had refracture and reoperation rates of 18% at 2 months. The group 4 with multilevel augmentation above and below the fractured levels had 12% new fractures and 9% reoperations. Group 2 with prophylactic augmentation of the adjacent levels only had rates of 16% and 13%, respectively. Group 3 with multilevel augmentation either above OR below the fractured levels had 23% new fracture or reoperation rates.

Conclusion: Vertebroplasty is a safe and efficient treatment for osteoporotic vertebral fractures regarding pain relief and improvement of ADL and QoL. A partial VB height restoration can be achieved. Preventive augmentation can reduce the risk of subsequent vertebral fractures.

Significance: The results show an important gain in life quality and a significantly reduced rate of new vertebral fractues

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77. Is the Intraoperative H-Reflex a Viable Substitute for Transcranial Electric Motor Evoked Potential (tceMEP) Monitoring in Detecting Emerging Spinal Cord iInjury During Scoliosis Surgery?

Daniel M. Schwartz PhD, Vidya M. Bhalodia MS, Anthony K. Sestokas PhD, John M. Flynn MD, Suken A. Shah MD, Peter G. Gabos MD, J. A. Bowe MD, John P. Dormans MD
USA

Summary: Recent reports have touted the intraoperative H-reflex as a viable option to tceMEP monitoring in spinal cord injury detection. We compared efficacy of H-reflex, tceMEP and SSEP monitoring in 92 consecutive patients undergoing scoliosis correction. Results demonstrated a low sensitivity for the H-reflex compared to tceMEP monitoring. H-reflex value was also highly limited by the inability to record a baseline response in a large percentage of non-idiopathic scoliosis patients again compared to tceMEPs. Results do not substantiate the claims.

Introduction: The intraoperative H-reflex has been advocated as a viable alternative to monitoring tceMEPs during scoliosis surgery. The neurophysiological basis for this claim is that H-reflex amplitude suppression reflects alterations in descending spinal cord influences on alpha motor neuron excitability and should thus correlate highly with tceMEP changes. This study compared the efficacy of H-reflex monitoring to tceMEPs and SSEPs in detecting emerging spinal cord injury during scoliosis surgery.

Methods: tceMEP, SSEP and H-reflex monitoring was attempted in 92 pediatric patients (X age=12.9 yrs) undergoing corrective

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scoliosis surgery. Type of scoliosis was idiopathic in 47, congenital in 23 and neuromuscular in 22 patients.

Results: Table 1 summarizes the percent success rate for recording a reliable intraoperative baseline for each monitoring modality according to type of scoliosis. Baseline H-reflexes were unobtainable in a large segment of non-idiopathic patients, particularly when compared to tceMEPs. 22 patients showed significant neuromonitoring changes. H-reflex loss was noted in 6/79. The H-response failed to improve with intervention in 5/6, none of whom awoke with neurologic deficit. Conversely, tceMEP alerts occurred in 18 patients. In 17 of these, amplitudes returned to baseline following intervention, and none awoke with a deficit. The remaining patient showed sustained unilateral tceMEP loss, without H-reflex or SSEP changes, and emerged with post-operative hemiparesis. The only SSEP change which also was coincident with a tceMEP alert was in a neuromuscular child in whom H-reflexes were unobtainable.

Conclusion: This study does not support the H-reflex as a viable substitute for tceMEP monitoring during scoliosis surgery. The low sensitivity is essentially the same as for SSEPs, and significantly less than tceMEPs for detecting emerging spinal cord injury. The value of H-reflex monitoring is limited further by the large percentage of non-idiopathic scoliosis patients for whom a baseline response is unobtainable.

Significance: H-reflex monitoring is not recommended for routine use during scoliosis surgery and should not be considered a viable alternative to tceMEPs.

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78. Major Intraoperative Neurologic Monitoring Deficits in Consecutive Pediatric and Adult Spinal Deformity Patients at One Institution

Jonathan R. Kamerlink MD, Thomas J. Errico MD, Shaun Xavier MD, Ashish Patel MD, Amar Patel, Alexa Cohen, Mark A. Rieger MD, Joseph W. Dryer MD, David Feldman MD, Baron S. Lonner MD, Aleksandar Beric MD, Frank J. Schwab MD
USA

Summary: This is an analysis of consecutive operative spinal deformity cases at one institution to determine predictive factors for intra-operative neurological monitoring changes (NMC). Primary neuromuscular scoliosis and revision sagittal plane deformities had the greatest risk for NMC's during surgery.

Introduction: Spinal deformity correction is a demanding realignment of the spine in which neurological monitoring can be used to reduce the risk of neurological deficits related to surgery. The purpose of this study was to assess the pre-op neurological risk in a consecutive series of spinal deformity patients undergoing correction surgery at one institution.

Methods: This is a retrospective consecutive review of deformity surgical cases at our institution in 2007. Patients were grouped according to diagnosis: Neuromuscular (NM) scoliosis, Sagittal plane deformity, and Scoliosis. There were 301 cases performed (154 pediatric and 126 adult), 281 cases were monitorable. Intra-operative neurological status was measured with a combination of somatosensory evoked potentials (SSEPs) and/or motor evoked potentials (MEPs).

Results: Comparing each diagnositic criteria and primary vs. revision status, primary NM scoliosis cases had the highest incidence of NMC's (11%). In patients with primarily sagittal plane deformity, NMC's were increased in the setting of larger kyphosis (58° vs. 42°, $p<0.05$), larger operative change in lumbar lordosis (16.4° vs. 3.9°, $p<0.05$), and increased blood loss (2.5L vs. 1.6L, $p<0.05$). Sagittal plane deformity cases had the second highest incidence of NMC's (10.87%). In scoliosis patients, significant increases in NMC's were found with larger pre-operative thoracolumbar/lumbar curves (50.4° vs. 31.5°, $p<0.05$) and larger blood loss (1.95L vs. 989mL, $p<0.05$). However, revision surgery did not appear to significantly affect NMC's in this group ($p<0.05$). Of the 13 NMC's patients, 3 patients had persistent neurological deficit detected by post-operative neurological examination; one patient had a resolving foot drop, one patient had motor paraplegia that improved to walker assisted ambulation, and one patient had a partial foot drop that completely resolved.

Conclusion: Primary neuromuscular scoliosis and revision sagittal plane deformities appear to carry greatest risk for NMC's during surgical intervention. Most observed NMC's did not predict a permanent neurological deficit.

Significance: This study may aid surgeons and patients to better assess neurological risks related to spinal deformity surgery.

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79. Validation Trials of a DNA-Based Prognostic Test (AIS-PT) Designed to Predict Curve Progression in Adolescent Idiopathic Scoliosis Patients

Kenneth Ward, Marc V. Singleton MS, Therese Berry BS, Lesa M. Nelson BS, James W. Ogilvie MD
USA

Summary: The adolescent idiopathic scoliosis prognostic test (AIS-PT) can identify mild AIS patients with a very low risk of progression to a severe spinal curve.

Introduction: We developed a DNA Prognostic Test (AIS-PT) using a panel of 53 DNA markers associated with curve progression and logistic regression. The goal of this study was to validate the negative predictive value of AIS-PT in the intended use population.

Methods: Two separate retrospective trials were conducted. The first trial included 379 skeletally mature subjects (306 females and 73 males) who had mild AIS (<25° primary curve) initially documented prior to the age of 13. The cohort was selected to mirror referrals form a school screening program so that 80-85% had a curve that remained mild or improved, 10-12% progressed

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to moderate scoliosis, and 2-4% required fusion. Patients for the second trial (341 females and 61 males) were selected to mirror the cohort of new patients presenting to a referral center (60-65% had a curve that remained mild or improved, 20-25% progressed to moderate scoliosis, and 10-15% required fusion). Ratios for this second study were determined using patient acuity data from 20 representative spine centers. Progression to a severe curve was defined as progression to a >40° curve in an individual still growing or progression to a >50 ° curve in an adult. AIS-PT scores were calculated (blinded to the clinical data) through Taqman genotyping of all subjects the 53 DNA markers and the prognostic algorithm

Results: Both trials confirm the sensitivity and specificity of the AIS-PT (see table below). The negative predictive value in Caucasian females was 100% in the "screening" population and 99% in the "high acuity" population. As expected, a smaller percentage of patients were scored as "low risk" in the high acuity trial.

Conclusion: The DNA-based AIS-PT offers outstanding negative predictive value in the intended use population. AIS-PT offers prognostic information not presently

Significance: AIS prognostic test could reduce inefficiencies in the management of mild scoliosis patients allowing cost savings and reduced x-ray exposure for many patients.

Table I: Sensitivity/Specificity and Negative Predictive Value in an intended use population: Female Caucasian data (95% confidence limits shown in parentheses)

	Sensitivity AISPT Score-40 cut-off	Specificity AISPT Score-180 cut-off	Subjects Scored as Low Risk	Negative Predictive Value AISPT Score<40 cut-off
Research Data (n=2192)	85% (84-85%)	99% (99-100%)	NA	NA
Clinical Trail 1 (n=277)	100% (74-100%)	99% (99-99%)	64%	100% (99-100%)
Clinical Trial 2 (n=281)	93% (82-98%)	98% (97-99%)	54%	99% (98-100%)

80. Diagnostic Efficacy of CT Guided Percutaneous Biopsy in Spinal Lesions

Uday M. Pawar D'orthDNB orth, Vishal Kundnani MS,F.A.S.S.I,, Abhay Nene
India

Summary: Lesions in the spine & para-spinal area are difficult to target with high false negative results leading to increased number of failing empirical trials and open/surgical biopsy procedure's .Studies evaluating the efficacy of CT guided percutaneous biopsy in spinal lesions are limited

Introduction: 1.To determine the efficacy CT-guided biopsies in spinal lesions in regards to Predicitive value, Diagnostic Yield, Accuracy and Safety

2.To emphasise the technique & importance of fine resolution CT guided percutaneous biopsy for spinal lesions

Methods: Between 2003-2007, 282 procedures performed in 266 patients with spinal lesions of various nature ,without definitive diagnostic clinico-radiological features ,(Spondylodiscitis -136, collapsed vertebrae-61,lytic vertebrae-14,sclerotic lesion-18,MRI abnormal signal-37) subjected to CT guided percutaneous biopsy, performed under local anaesthesia on a day care basis, were studied prospectively in this study. Biopsy specimens were sent for histolopathological ,cytological analysis & Bacteriologic studies with needful culture /sensitivity studies performed when indicated clinico radiologically.

An independent observer blinded for objective of study analyzed the results for Diagnostic Yield (Ability to generate tissue sample adequate for pathologic examination) and Accuracy (Ability to generate correct diagnosis in positive cases) confirmed later during definitive treatment / surgery.

Stastitical analysis was done to evaluate the diagnostic predicitive value.

Results: The time taken for biopsy, including the pre-biopsy CT examination time, varied from 21 min to 60 min (median 35 min).In 241 patients representative tissue good enough for histopathological evaluation was obtained(227 single session ,12 patients 2 session, 2 patients three session), while 25 patients had inconclusive results (diagnostic yield of 88.41%) because of scanty tissue / non-representative tissue. None of the patients had any major complication (Pneumothorax / Haemothorax, Neurological injury) during the procedure and subsequently at 6 month follow up. The overall diagnostic yield and accuracy rate for spinal lesions were 88.41% and 95.74%. positive predicitive value of diagnostic procedure was >95 %

Conclusion: Percutaneous biopsy method used in conjunction with CT guidance has excellent potential to result in preoperative diagnosis of spinal lesions with great safety and precision thus avoiding unnecessary surgery for doubtful diagnosis

81. A Prospective Double Blind, Randomised, Placebo Controlled Study to Assess and Compare the Analgesic and Anxiolytic Effects of Pregabalin and Tramadol in Patients Undergoing Lumbar Laminectomy

Pradeep Koramutla MD DA
India

Summary: This decade has been designated, the decade of pain control and research by the United State Congress. While there have been significant advancements in options for pain assessment and therapy, effective post operative pain management remains a frequent dilemma for both patients and clinicians.Although opioids are an important component of postoperative pain management, they are associated with side effects . Effective pain management

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improves patient satisfaction, decreases hospital stay and shortens recovery of the post surgical patients. Alfa-2-delta (α2-δ) subunit calcium channel ligands, gabapentine and pregabalin are two mechanistically different types of analgesics that have demonstrated efficacy after a variety of surgical procedures . Pregabalin has greater analgesic efficacy in rodent models of neuropathic pain and exhibits linear pharmacokinetics across the therapeutic dose range with low intersubject variability. The hypothesis of this prospective double blind, randomized placebo controlled trial is to compare and assess the analgesic and anxiolytic efficacy of Pregabalin and Tramadol in patients undergoing lumbar laminectomy.

Introduction: Prevention and treatment of postoperative pain continues to be a major challenge in postoperative care. Opioid analgesics, with their well-known side-effects, continue to represent a cornerstone in postoperative pain control. Anticonvulsant medications are established treatments for neuropathic pain. Pregabalin (S-[+]-3-isobutylgaba) a structural analogue of gamma amino butyric acid has been used for treatment of various neuropathic pains and also as an adjunctive therapy for adults with partial onset seizures.

Methods: Study group included 75 patients between 20-60 yrs belonging to ASA-I and II, The patients were randomly allocated into 3 groups of 25 each. Placebo group received placebo capsule, Tramadol group received 100mg capsule while the pregabalin group received 150mg capsule orally 1hr before the anesthetic induction.

Results: Pregabalin showed statistically significant analgesic effect compared to placebo but was found to be less compared to tramadol. The need for rescue analgesia was least in tramadol patients followed by pregabalin and maximum in control group. Pregabalin showed statistically significant anxiolytic effects compared to placebo and this was associated with less sedation in comparison to tramadol .Pregabalin had less number of postoperative complications of nausea, vomiting and drowsiness in comparison to tramadol.

Conclusion: The results of this study support, the wider clinical use of pregabalin in the post surgical setting for pain relief as it is well tolerated, and usually with transient adverse effects

Significance: Prevention and treatment of postoperative pain and complications such as nausea and vomiting, continues to be a major challenge in postoperative care and plays an important role in the early mobilization and well-being of the surgical patient. Opioid analgesics, with their well-known side-effects, continues to represent a cornerstone in postoperative pain control, and testing new analgesics as well as combinations of analgesics in order to reduce the need for opioids, is a key area in acute pain research .hence pregabalin is a novel newer drug which can be used in post surgical settings

82. Economic Outcomes in a Worker's Compensation Cohort after Single-Level Lumbar Disc Arthroplasty vs. Anterior Lumbar Interbody Fusion

Matthew F. Gornet MD, David W. Polly, John H. Peloza MD, J. Kenneth Burkus MD
USA

Summary: Back injuries among workers are a major source of lost wages and productivity. Workers' compensation patients who can be treated with lumbar disc arthroplasty instead of fusion may experience less disability and return to work sooner, with fewer restrictions, resulting in significant productivity gains.

Introduction: Estimated back pain costs in the US exceed $100B/year, 2/3 related to lost wages and productivity. For selected patients, lumbar disc arthroplasty (LDA) is an alternative to fusion that returns patients to work more quickly and may provide improved socioeconomic outcomes.

Methods: A retrospective review of 24 workers' compensation (WC) patients with persistent low back pain secondary to single-level degenerative disc disease, having final settlement documentation for their claim and outcomes to 24months post-op. Patients were treated with LDA with a Maverick Disc (n=16) or anterior lumbar interbody fusion (ALIF) with rhBMP-2 and threaded titanium cages (n=8) (both Medtronic, Memphis, TN). WC documents included employment status, injury claim, disability status and final settlement, pre-injury and disability wage information, medical payments, and settlement terms. True direct costs were obtained from the hospital. Work status was analyzed (Kaplan-Meier) by a patient's date of release to return to work (RRTW) as well as actual return-to-work (RTW) date; work restrictions were noted. A socioeconomic impact model to estimate differences in lost productivity will be presented.

Results: Facility costs to 2 years post-op were not significantly different (p=0.081). LDA patients were RRTW a median 96 days before ALIF patients (p=0.005); work restrictions were imposed on 88% of ALIF vs. 31% of LDA patients. At 2 years, only 3/8 (38%) ALIF patients were working, vs. 13/16 (81%) LDA patients (p=0.037). ALIF patients were compensated for a median 109 TTD weeks vs. 67 for LDA (p=0.024). Permanent disability payments were $80K higher for ALIF patients (p=0.05). Total disability paid was $121K higher for ALIF than for LDA (p=0.035), while median total medical charges awarded were similar (p=0.976) for LDA ($76K) and ALIF ($79K). Based on our model, the gain in productivity might exceed $150K/patient for LDA vs. ALIF.

Conclusion: LDA patients spent fewer days on TTD, returned to work sooner with fewer restrictions, had earlier settlement of claims, and received lower overall disability awards. Productivity loss for work-related back injuries may be reduced significantly when arthroplasty is an option vs. fusion.

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).

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83. Two-Level vs. One-Level Prospective, Randomized, FDA Cervical Arthroplasty Clinical Trial

Jeffrey A. Goldstein MD, Rick Delamarter, Jack Zigler MD, Richard Balderston, Jeffrey M. Spivak
USA

Summary: Compare results of 2-level & 1-level ProDisc®-L FDA studies.

Introduction: In the 2-level clinical trial, significant differences were seen between ProDisc®-L total disc replacement (TDR) and circumferential fusion. Is multiple level as successful as single level surgery in these two treatments?

Methods: A total of 237 2-level patients at 16 sites were compared to 236 1-level patients at 17 sites. Evaluations occurred pre-operatively, post-operatively at 6 weeks, 3, 6, 12, 18, & 24 months, and included Oswestry Disability Index (ODI), SF-36, Visual Analog Scales (VAS) for pain/satisfaction, neurological examination, and radiographic evaluation.

Results: At 24 months, 90.0% of 2-L ProDisc®-L patients reported improvement in ODI from pre-operative levels compared to 91.8% of 1-L ProDisc®-L patients; 73.3% of 2-L ProDisc®-L and 77.2% of 1-L ProDisc®-L patients met the ≥15 point ODI improvement criteria. In the Fusion group, 86.7% of 2-L Fusion patients reported improvement in ODI from pre-operative levels compared to 84.5% of 1-L Fusion patients; 55.9% of 2-L Fusion and 64.8% of 1-L Fusion patients met the ≥15 point ODI improvement criteria. In 2-L patients, overall neurological success of the ProDisc®-L group was statistically superior to the Fusion group (PD-L: 89.2%; Fusion: 77.9%; p = 0.0260), similar to 1-L patients where ProDisc®-L was also statistically superior to the Fusion group (PD-L: 91.2%, Fusion: 81.4%; p = 0.0341). 2-L ProDisc®-L patients recorded SF-36 scores significantly higher than 2-L Fusion patients at all follow-up points; SF-36 scores of both 1-L groups were not significantly different. At 24 months, VAS pain scores showed significant improvement from baseline (p < 0.0001) in both 2-L groups; the ProDisc®-L group showed significantly higher pain reduction than the Fusion group (p = 0.0466). In 1-L patients, VAS pain scores were not statistically significant between the two groups. Radiographic range of motion was maintained within normal range in over 90% of all ProDisc®-L patients.

Conclusion: At 24 months, TDR patients present overall improvement comparable to fusion patients. Similar clinical outcomes are being experienced by ProDisc®-L patients, regardless of number of levels treated.

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).

84. SwissSpine: Governmentally Mandated HTA-Registry for Total Disc Arthroplasty. Methodology and Results of 825 Cervical Disc Prostheses in 719 Patients

Emin Aghayev, Thomas Zweig, Patrick Moulin, Group SwissSpine, Christoph Röder MD MPH
Switzerland

Summary: We report on data of 719 patients and 825 cervical disc implants from SwissSpine HTA registry.

Introduction: The Swiss health insurance demanded a HTA-registry to reimburse total disc replacements (TDR) due to reported high complication rates. Following this regulation, SwissSpine as a nationwide mandatory TDR-register, had recorded data from March 2005 to June 2008.

Methods: Assessment preoperative, 3month postoperative, 1 and 2years postoperative and continuing in observational multicenter-mode. Patients: 825 cervical implants / 719 patients documented. There were 56.5% of females. Mean-age was 46.7years. Average-number of follow-ups was 2.2/patient, mean followup-time 8months. 2266 EQ-5D (708 preop, 1558 follow-up), 2167 COSS (698 preop, 1469 follow-up) forms and 556 co-morbidity questionnaires were analyzed. Frequency statistics, multivariate regressions analysis were performed.

Results: A significant reduction of neck pain (VAS preop 59.4 to 24.1 at two years followup; p<0.0001) and arm pain (VAS preop 65.3 to 18.9 at two years followup; p<0.0001), increasing quality of life, reduced analgesic medication, re-established cervical lordosis and better ROM. A clinically relevant pain reduction of >20 points was most probable in patients with preoperative pain levels >40 points on VAS. Distribution of co-morbidities showed that 15.2% of the patients suffered from depression and 11.1% were under treatment. Depression had significant influence on postop neck (p=0.0051), arm pain relief (p=0.0005) and improvement of life quality (p=0.001). Five complications and 20 revisions were reported during mono- and bisegmental TDR recorded.

Conclusion: Cervical TDR is efficient for pain reduction and improvement of quality of life, re-establishment of mobility and alignment of the cervical spine. Clinically relevant pain alleviation is more probable if preoperative pain levels are > 40 points of VAS.

85. Intermediate Results of Lumbar Disc Replacement: Clinical and Radiological Analysis with Minimum Two Year Followup

Chan W. Peng MD, Wai Mun Yue, William Yeo Masters (Physiotherapy), Seang Beng Tan
Singapore

Summary: Prestige-LP cervical disc replacement (ADR) shows significant improvement in clinical outcomes with restoration of segmental lordosis at 2 years. It preserves segmental motion, hence potentially reducing the risk of adjacent level degeneration.

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Introduction: Motion preservation with ADR can potentially reduce adjacent segment degeneration. This study reviews the results of Prestige-LP cervical disc replacement.

Methods: From 2005-2006, 40 patients with 59 Prestige-LP ADR were analysed prospectively. Cervical range of motion (ROM), Visual Analogue (VAS) scores for neck/leg pain, Short Form-36 (SF-36), Modified American Academy of Orthopaedic Surgeons (AAOS) Cervical Spine Instrument scores for neck pain/disability and neurogenic symptoms, Japanese Orthopaedic Association (JOA) score for myelopathy and dynamic radiographs were evaluated.

Results: There were 21 females and 19 males. Mean age was 43.9 yr. Mean followup was 2.9 yr. 62% had single level ADR mainly for C56 level (52%). 56% had radiculopathy and 44% had myelopathy. 54% of the neural compression was due to a herniated disc, 42% spondylosis and 3% both. There was significant improvement in the AAOS score for neck disability and neurogenic symptoms and VAS scores for neck and limb pain ($p<0.05$)at 6 mth and 2 yr. There was significant improvement in all aspects of the SF-36 scores except general health compared to preop ($p<0.05$) at 6 mth and 2 yr. The mean JOA score for myelopathy improved significantly from 14.7 preop to 15.7 at 6 mth and 15.6 at 2 yr ($p<0.05$). There was no significant difference in the clinical cervical ROM at 6 mth and 2 yr compared to preop($p>0.05$). Based on static radiographs, segmental alignment was preserved (8, 14 and 13 degrees lordotic at preop, 6 mth and 2 yr postop respectively). On dynamic radiographs, there was significant segmental motion of 11.1 degrees at 6 mth and 13.9 degrees at 2yr ($p<0.05$). No neurological deterioration, dislocation, subsidence or any other complication occurred in all 40 patients.

Conclusion: Prestige-LP ADR can be inserted safely with low morbidity and is associated with significant improvement in clinical outcomes at 2 years. It restores segmental lordosis with preservation of segmental motion even at 2 years followup, thus potentially reducing the risk of adjacent level degeneration.

Significance: This study reports on the clinical and radiological outcomes of Prestige-LP ADR which is a relatively new implant with a minimum of 2 year followup.

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86. Clinical Outcomes after Cervical Disc Arthroplasty for Axial Neck Pain vs. Radiculopathy/Myelopathy

Matthew F. Gornet MD, Brett A. Taylor, John H. Peloza MD, Rudolf Bertagnoli
USA

Summary: Patients with predominant axial neck pain may achieve improvements comparable to patients with radiculopathy/myelopathy after cervical disc arthroplasty (CDA).

Introduction: Evidence from 3 large prospective, randomized multicenter trials confirms that cervical disc arthroplasty is at least as safe and effective as anterior cervical discectomy and fusion for selected patients with symptomatic cervical disc disease with radiculopathy and/or myelopathy. Less evident, however, is the efficacy of CDA for patients with predominant axial neck pain.

Methods: This monocentric study reports prospective collected clinical outcomes up to 2 years after surgery for 69 patients with cervical degenerative disease. Patients unresponsive to nonoperative measures participating in a randomized IDE clinical trial were treated with CDA. Patients were divided into 2 groups on the basis of their primary diagnosis: predominant axial neck pain (AX) or radiculopathy/myelopathy (RM). Patients were operated at a single level from C3-C7 with a cervical artificial disc prosthesis. Outcome measures including Neck Disability Index (NDI), numerical pain scores for neck pain and arm pain, and return to work were collected preoperatively and at 1.5, 3, 6, 12, and 24 months.

Results: Patients in the AX (n=31) and RM (n=38) groups were statistically similar with respect to gender, age, weight, smoking status, baseline disability and pain measures, surgical level, operative time, blood loss, hospital stay, and medications usage. Both groups had statistically significant improvement from baseline to 1 year and 2 years for NDI, neck pain and arm pain. AX patients improved a mean 41.7/39.0 pts in NDI vs.32.9/30.9 pts in RM patients at 1 ($p=0.105$) and 2 ($p=0.156$) years post-op. Differences in neck pain and arm pain improvement were not statistically significant. AX patients and RM patients had similar maintenance or improvement in neurological status. Return to work times were comparable for both groups.

Conclusion: Patients with predominant intractable axial neck pain from degenerative disc disease may achieve equivalent outcomes to radiculopathy/myelopathy patients up to 2 years after surgery.

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87. In-Vivo Kinematics of the Intervertebral Disc Allograft Transplantation

Stephen Ka Lok Lam, Dike Ruan PhD, Yu Ding PhD, William Lu, Keith D. Luk
China

Summary: Kinematics of the intervertebral disc allograft transplantation was investigated.

Introduction: In a recent clinical trial of the Intervertebral disc (IVD) allograft transplantation, Ruan et al.(2007) observed remodelling of the allograft and concluded that the transplanted allograft disc can preserve motion and stability of the spinal segment. It is hypothesized that remodelling of the allograft implant can restore the kinematics of the functional spinal unit. This study aims at studying the in-vivo kinematics of the patients that underwent IVD allograft transplantation in the clinical study.

Methods: Five patients, average age 47 years, with cervical disc herniation underwent transplantation of fresh-frozen composite disc allografts after disc excision as described in Ruan et al.(2007).

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Dynamic active flexion-extension radiographs were taken 2 months after surgery, and every 3 months thereafter to a minimum follow-up of 5 years. Measurement of the Center of Rotation (COR) was analyzed using an image analysis program developed in MATLAB as described in Penning et al.(2005). The position of the COR between full flexion/extension was calculated and reported as a pair of coordinates offset from the posterior superior corner of the lower vertebral body. The COR coordinates were normalized as values based on the length and height of the lower vertebral body. The results were compared to the data found in the literature.

Results: The COR positions are presented in Fig1.

Studies of the position of the COR following the operation showed that the COR position have initially deviated to the very posterior position in the early stages following surgery. However, at the final follow up all patients showed that the COR position have been restored close to the normal position.

Conclusion: Changes in the position of the COR were observed at different stages following the transplantation as opposed to the results of some of the artificial disc implants studies in which the position of the COR had deviated from the physiological position of a normal disc permanently. These changes in the position of the COR may suggest that the remodelling of the allograft may play a part in restoring the natural kinematics of the spine.

Study of the allograft implantation demonstrated that the kinematics of the spinal segment may be restored in the long term.

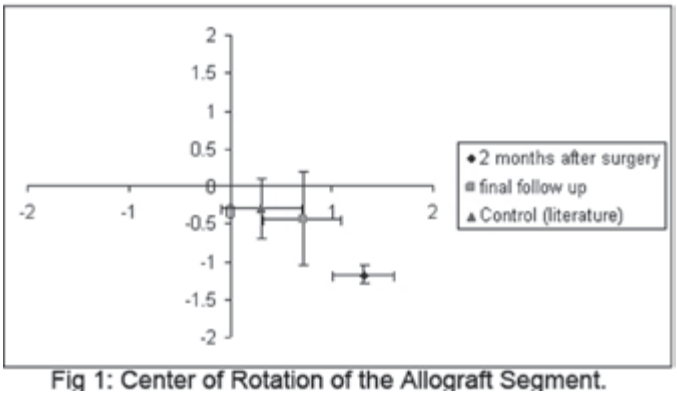

Fig 1: Center of Rotation of the Allograft Segment.

88. Incidence of Recurrent Disc Herniation in Patients Treated with Lumbar Discsctomy and Application of Fendstrom Type Disc Spacer; One Year Follow-Up

Jorge E. Isaza MD, Steve A. Guillory PA-C, Steven A. Rundell, Felipe Ramirez MD
USA

Summary: This was a retrospective study reviewing treat of patients with lumbar disc herniations who had a discectomy and application of a disc spacer.

Introduction: While short term success rates for lumbar discectomy have been reported at above 90%, long term success has been more inconsistent. One of the described complications associated with lumbar discectomy include recurrent herniation. The current study hypothesized that implantation of a spherical intradiscal spacer subsequent to discectomy would prevent recurrent herniation by reducing intradiscal hydraulic pressure by carrying the compressive load.A retrospective review of 91 patients who had a discectomy with implantation of a spherical intradiscal spacer was performed.

Methods: A chart review was conducted on 91 patients who had lumbar discectomy with application of the disc spacer. Indications for surgery included a lateral disc herniation with leg pain. Basic demographics were collected. Minimum follow-up was one year. After chart reviews were done, 41 patients were found that met inclusion criteria.

Results: The most common level operated on was L5-S1 at 46.3% (n=19), while L4-5 accounted for 36.6% (n=15). 61% of patients were male (n=25). Of the 41 surgeries, 17.1% (n=7) were revision hemilaminectomies. Post-operatively, 43.9% (n=18) of patients required a repeat MRI. Of the 18 repeat MRI's, six (14.6%) documented recurrent disc herniations. Of the six patients who developed a symptomatic recurrent disc herniation, four had a revision hemilaminectomy and two had a fusion.

Conclusion: At present, the data collected does not reflect a significant reduction in recurrent herniation with implantation of a spherical intradiscal implant when compared to historical data. We hypothesized that an intradiscal spherical spacer would reduce intradiscal pressure by carrying the compressive load, and therefore act to prevent extrusion of disc material through the annulus. Results from the current study suggest that this is not necessarily the case. Further examination is needed to determine whether the intradiscal spacer was able to maintain disc height.

Significance: The information gathered from this study will hopefully provide more insight and allow us to better address this common condition.

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).

89. Retrospective Measurement Study on the Placement Accuracy of Lumbar Arthroplasty and its Correlation with Patient Outcome Scores

Madilyne E. Fogarty BS, John S. Thalgott MD
USA

Summary: McAffee et al showed correlation between accurate placement of the Charité implant and desirable clinical results. The purpose of this study is to examine placement accuracy of Charité total disc in a single surgeon's patient population and compare patient outcome scores across classifications of placement accuracy. 50.0% of the Charité discs measured in this study were placed

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'ideally'. There were no significant differences in patient outcomes between patients with ideally placed discs vs. those with suboptimal placed discs.

Introduction: McAffee et al showed correlation between accurate placement of the Charité implant and desirable clinical results. The purpose of this study is to retrospectively examine placement accuracy of Charité total disc arthroplasty devices in a single surgeon's patient population and compare patient outcome scores across classifications of placement accuracy.

Methods: 22 patients with a single Charité implant from L3-S1 returned for CT imaging post-operatively (minimum of 6 months, range: 6-24 months). The images were used in conjunction with measurement software (BrainLAB AG, Munich, Germany) to measure placement accuracy of the Charité implant in the right-left, and anterior-posterior translation planes. Placement accuracy was classified as 'IDEAL' (<3mm deviation in either plane), 'SUBOPTIMAL' (3-5mm deviation in either plane) or 'POOR' (>5mm deviation in any plane). Patient SF-36, VAS, and ODI outcome scores were collected a minimum of 1 year after surgery (1.0-3.2 years) and compared between placement classification groups.

Results: The average absolute translation was 3.651+1.44mm (Right-Left Translation: 2.01+1.352mm, Anterior-Posterior Translation: 2.368+1.726 mm. Placement of 11 artificial discs were classified as 'IDEAL', 11 were 'SUBOPTIMAL', and 0 were 'POOR'. Average patient outcome scores between placement groups were as follows: Oswestry- Ideal: 47.45+20.10, Suboptimal: 44.16+18.93, p=0.697. SF-Physical component summary- Ideal: 35.73+8.53, Suboptimal: 34.30+7.26, p=0.684. VAS back- Ideal: 5.50+2.20, Suboptimal: 5.40+2.40, p=0.922.

Conclusion: According to McAfee's classification, 50.0% of the Charité discs measured in this study were placed 'ideally' by a single surgeon with several years of anterior lumbar experience. There were no significant differences in patient outcomes between patients with ideally placed discs vs. those with suboptimal placed discs.

Significance: Patient outcomes after Charite disc implantation may not be dependent on device accuracy of less than 3mm in the Left-Right or Anterior posterior plane.

90. Revision Following Lumbar Total Disc Replacement: Analysis of Reoperations in the U.S. IDE Study of Lumbar Arthroplasty

Sam Saidy MD, Paul C. McAfee MD, Fred H. Geisler MD PhD, Sandy Moore, John Regan MD, Richard Guyer MD, Scott Blumenthal MD, Ira L. Fedder, Justin P. Tortolani MD, Bryan W. Cunningham MSc
USA

Summary: In the IDE Study of the CHARITÉ Artificial Disc, there were 27 reoperations in 347 patients (7.8%) receiving TDR and 10 reoperations in 99 patients (10.1%) receiving lumbar fusion. Five of the 15 CHARITÉ prostheses requiring removal were successfully revised to another CHARITÉ prosthesis. Lumbar TDR with the CHARITÉ Artificial Disc did not "burn any bridges" during primary insertion. At two years or more follow-up, 93.7% (325/347) of patients receiving TDR had a successfully functioning prosthesis.

Introduction: This study served to analyze the incidence and reasons for reoperation in patients enrolled in the prospective randomized IDE study of the CHARITÉ™ Artificial Disc.

Methods: 446 patients were enrolled in one of three study arms: 1) 71 TDR training cases received the CHARITÉ. 2) 205 patients in the treatment group (TDR), and 3) 99 in the control group (ALIF threaded fusion cages and autograft). The first 71 cases receiving TDR in the continued access phase were also included. Clinical and radiographic data were collected pre- and at regular intervals postoperatively. A detailed analysis was performed of clinical charts, operative notes, and adverse events for all patients requiring reoperation following their index surgery.

Results: Of 347 TDR patients, 27 (7.8%) required reoperation. Of 99 patients with lumbar fusion, 10 (10.1%) required reoperation. 13 patients with TDR (3.7%) and 8 patients with lumbar fusion (8.1%) required supplemental fixation. 15 TDR patients underwent a repeated anterior retroperitoneal approach with prosthesis removal and five of these were revised to another CHARITÉ. One BAK cage migrated laterally and required removal. The mean time to removal was 177 days (range= 2 days-38 mos). The most common complaints necessitating reoperation were persistent pain; pseudoradicular symptoms; lower extremity cramping; and mechanical back pain. 19 patients had posterior exploratory laminectomies and pedicle screw instrumentation performed as a salvage procedure. Three of the 99 (3.0%) fusion patients had iatrogenic neurological signs and 4 of 347 TDR patients (1.2 %) had transient neurological signs following the primary surgery; all 7 of which resolved following posterior nerve root decompression.

Conclusion: Lumbar TDR with the CHARITÉ Artificial Disc did not "burn any bridges" during primary insertion with one third being revisable to a new motion preserving prosthesis and two thirds being successfully converted to anterior interbody fusion

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or posterior pedicle screw arthrodesis, the original alternative procedure. At two years or more follow-up, 93.7% (325/347) of patients receiving TDR with the CHARITÉ Artificial Disc had a successfully functioning prosthesis with a mean of 7.4 degrees of flexion/extension mobility.

91. Selective Treatment of the Thoracic Curve by VEPTR in the Growing Spine: What Happens to the Lumbar Curve?

Amer F. Samdani MD, John Birknes, Reed C. Williams, Norman Ramirez MD, John M. Flynn MD, Randal R. Betz MD
USA

Summary: Correction of the lumbar curve after selective thoracic fusion is well established for AIS. No studies have examined the response of the lumbar curve after growing system instrumentation of the thoracic curve. We identified 14 patients with two-year follow-up whose thoracic curves were treated with VEPTR. The thoracic curves corrected from 62±16 to 39±15 degrees, for a 40% correction. The lumbar curves responded by correcting from 38±17 to 20±10 degrees, for a 49% correction. These results suggest that the growing spine may accommodate selective instrumentation of a thoracic curve through compensatory correction of the lumbar curve.

Introduction: Selective thoracic fusion for AIS relies on spontaneous correction of the lumbar curve. It remains unknown whether or not these principles apply with growing systems. The purpose of this study was to examine the response of the lumbar curve after treatment of the thoracic curve.

Methods: We retrospectively identified 14 patients with two-year follow up who had undergone unilateral VEPTR placement with caudal instrumentation between T11-L2. Pre-op and two-year radiographs were analyzed for: thoracic and lumbar Cobb angles, coronal/sagittal balance, lumbar rotation/apical translation, and Lenke modifier. Paired t-test was used to compare preoperative and two-year data.

Results: The mean age at surgery was 5.2 years with a mean follow-up of 3.3 years. Diagnoses included congenital (10), infantile (3), and neurofibromatosis (1). The thoracic curves improved from 62±16 to 39±15 degrees (p<.001), for a correction of 40%. The lumbar curves improved from 38±17 to 20±10 degrees (p<.001), for a correction of 49%. Overall coronal balance improved from 3.0±1.8 cm to 1.5±1.4 cm (p=.001). No differences were seen in sagittal balance, rotation, or apical translation.

Conclusion: In the growing child, selective instrumentation of the thoracic curve with VEPTR may result in a compensatory decrease of the lumbar curve. This may spare lumbar motion segments when definitive fusion is performed.

Significance: Selective treatment of the thoracic curve in the growing spine may result in a compensatory decrease in the lumbar curve. This may spare motion segments when definitive fusion is undertaken.

92. Dual Growing Rod Instrumentation with Pedicle Screw Foundation at a Single Institution: Assessment of Outcomes and Complications

Lukas P. Zebala MD, Timothy R. Kuklo MD, Lawrence G. Lenke MD, Scott J. Luhmann MD, Joshua D. Auerbach MD, Keith Bridwell MD
USA

Summary: Growing rod instrumentation (3.5 or 4.5 mm rods) with mainly pedicle screw anchors is effective at controlling early onset scoliosis. Growing rods with pedicle screw anchors allowed an average 6.9 cm of spinal growth at follow-up. Pedicle screw revision for minor loosening was only 9% and there were no catastrophic pedicle screw failures. Broken rods were common (59%) but did not compromise outcome and were easily revised.

Introduction: Early onset scoliosis (EOS) is often refractory to nonoperative treatment and frequently requires growing rod (GR) techniques. The study purpose was to report GR outcomes with pedicle screw fixation (PS) at one institution.

Methods: Consecutive case series of 16 patients (6M, 10F) with minimum 2-year follow-up (F/U) treated with GR for progressive scoliosis (6 idiopathic, 8 syndromic and 2 congenital). Average age at initial surgery was 4.9±1.8 years. All patients had dual rod (3.5 or 4.5 mm) submuscular GR with mainly PS anchors. 4 patients had anterior spinal fusion prior to GR. Average F/U was 3.5±1.5 years.

Results: There were 6.1±3 lengthenings/pt (total surgeries 8.0±3) at an interval of 7.7±2.3 months. 9 patients had an unexpected return to the OR with 66% having multiple returns (range, 1-3). Main curve Cobb improved from 73.°±16.9 to 46.8°±14.9 (p<0.001) after GR and 43.8±17.5° (p<0.001) at last F/U. Coronal and sagittal balance, T2-T12, T5-T12 and T12-S1 Cobb angles were not statistically different at F/U. T1-S1 length increased from 26.2±4.3 cm to 29.9±4.2 cm (p=0.04) after initial GR insertion and 32.9±3.9 cm (p<0.001; total 6.9±2.0) after last F/U, and average growth was 1.2±0.4 cm/year. T1-T12 length increased from 15.5±3.0 cm to 17.8±2.7 cm (p=0.05) after initial GR insertion and 20.2±3.9 cm (p=0.002) after last F/U. 10 patients had broken rods with 70% having multiple occurrences of broken rods. 127 PS were implanted with only 12 (9%) PS revisions for loosening (no catastrophic failures) during F/U. 3 infections (1 superficial, 1 deep, 1 superficial at ICBG site) occurred during F/U. 2 patients had definitive fusion during F/U.

Conclusion: GR with PS is effective in controlling coronal (37% main curve correction) and sagittal deformity. GR provided an average spinal elongation of 3.7 cm and an average of 3.2 cm of spinal growth at last F/U. Broken rods are common (59%) but did not compromise outcome and were easily revised. PS appear safe and effective (9% needing revision) as anchors without catastrophic failure.

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Significance: GR with PS anchors is effective at controlling scoliosis and allows for spinal growth. PS complications were minimal. Broken rods are common and families should be advised of this occurrence.

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93. The Utility of VEPTR in the Older Child (> 10 Years) with Complex Spine and Chest Deformity

Amer F. Samdani MD, Tricia St. Hilaire BS, John Emans MD, John T. Smith MD, Kit Song MD MHA, Robert M. Campbell MD, Randal R. Betz MD
USA

Summary: VEPTR is mainly used to treat chest and spine deformity in young children. However, select older children with complex spinal deformity may also benefit from VEPTR placement when VCR is deemed too risky. We reviewed 10 patients in whom VEPTR was placed after age 10 who had 2 year f/u data. Cobb angle, T1 tilt, thoracic cage parameters, and coronal balance all improved, with no reported neurological complications.

Introduction: VEPTR is designed to treat chest and spine deformity in young children. However, older children with complex spinal deformity may also benefit from placement of a VEPTR when VCR is deemed neurologically too risky. The purpose of this paper is to report the results of children over 10 years of age with complex spinal deformities who were treated with VEPTR.

Methods: From a database of 214 patients treated in an FDA IDE study of VEPTR, 10 patients were identified who underwent surgery after age 10 and had a minimum of two year f/u. Patients were followed for an average of 39.6 months. Diagnoses included congenital scoliosis with or without fused ribs (n=6), hypoplastic thorax (n=3), and myelomeningocele (n=1). Patient charts were reviewed for clinical and radiographic data.

Results: Four of ten patients had previously undergone a limited spine fusion. The mean age at initial VEPTR surgery was 12.4 years. Immediate Cobb angle correction averaged 26.2%. At two year follow-up, Cobb angle correction averaged 18.6%. Excluding those that were previously fused, correction at 2 years averaged 32%. The average absolute T1 tilt angle demonstrated modest improvement from avg. 17 to avg. 14 degrees. Coronal balance showed an average improvement of 3.8cm. Thoracic height, hemithoracic height, and width all improved (Table 1). One patient (10%) experienced two device related complications, one rib fracture, and one hook migration. No neurologic complications were seen in any patients. Patients underwent an average of 5 lengthenings. Replacement of the device due to growth was required in two patients. Four patients have since undergone definitive spinal fusion.

Conclusion: This study demonstrated the safety and utility of VEPTR in carefully selected older patients (> 10 years) with complex spine and chest wall deformities. VEPTR results in modest curve improvement (32% in previously unfused patients), continued growth of thoracic spine height (1.5cm), stabilization of hemithoracic height and width, and improved head shift. Based on our review, VEPTR may be a viable option for these children when VCR is deemed too risky.

Significance: VEPTR can be implanted in older children with complex spine deformity and results in a modest radiographic and clinical improvement.

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94. A New Surgical Strategy for the Treatment of Early-Onset Idiopathic Scoliosis

Cagatay Ozturk, Meric Enercan, Mehmet Tezer, Mehmet Aydogan, Mirza Biscevic, Azmi Hamzaoglu
Turkey

Summary: The continuation of anterior growth in the apical and adjacent segments of the deformity and not controlling the rotation in the apical segments are two major problems that the dual growing rod techniques with only proximal and distal fixation points have. Our new treatment strategy provides that the screws in apical and intermediate vertebra controlled the curve, prevent progression, maintain rotational stability and allows continuation of trunk growth.

Introduction: The continuation of anterior growth in the apical segments of the deformity and not controlling the rotation in the apical segments are two major problems that the dual growing rod techniques with only proximal and distal fixation points have. To overcome these problems; we have presented a new surgical strategy allowing spinal growth and lung development and controlling the apical rotation for the surgical treatment of early-onset idiopathic scoliosis.

Methods: Between the years of 2007 and 2008, 6 children (2 males, 4 females; with a mean age of 5 years, ranging from 2-8 years) with progressive scoliosis (average 61 degrees) were included in the study. In the initial surgery; polyaxial pedicle screws were placed to the strategic vertebra (apical, end, intermediate and transitional zone vertebrae) after skin and subcutaneous tissue dissection without subperiosteal muscle dissection on midline. Then, rods were placed in situ after achieving correction with the help of intraoperative halofemoral traction. The most proximal and most distal screws were fixed and the rest of the screws were left with nonlocked tap-screws. The lengthening re-operations were performed every 6 months. The coronal plane correction ratio, truncal heigth increase and complications were documented.

Results: Initial curve correction went from 61 degrees (38-88) to and average of 22 degrees (4-40) and maintained at 24 degrees (4-36) at minimum one year follow-up. Two lengthening operations were done in 3 patients and one in 3 patients. The average coronal plane correction was 60% and average truncal heigth increase was 12%. In the sagittal plane; decrease of thoracic kyphosis was not seen. No patient had significant changes in the spinal cord monitoring.

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Conclusion: Our new treatment strategy provides that the screws in apical and intermediate vertebra controlled the curve, prevent progression, maintain rotational stability and allows continuation of trunk growth. This strategy can also provide that there is no need to develop special instrument designs and production and one can safely perform the treatment with classical instrumentation systems present in the market.

Significance: -

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95. Infantile Idiopathic Scoliosis; Variations in Preferred Treatment Options

Pooria Salari, Daniel D. Oliveira MD, Behrooz A. Akbarnia MD, Paul Sponseller MD, Gregory M. Mundis MD, Study Group Growing Spine
USA

Summary: In order to evaluate variations of preferred treatment options for infantile idiopathic scoliosis (IIS), case scenarios were created using clinical and radiographic data of eleven patients. Surgeons were asked to select their preferred treatment option. Surgical treatment was recommended 83% of the time. Distraction based growing rod (GR) was the most commonly used technique. There was a considerable variation in level and type of anchors in GR as well as number and levels of apical fusion in Shilla (Growth directed GR).

Introduction: There is a paucity of data on definitive treatment of early onset scoliosis (EOS). The purpose of this study is to evaluate the variation of preferred treatment options specifically for infantile idiopathic scoliosis among a contemporary group of specialized surgeons.

Methods: Eleven patients with IIS with mean curve size of 87.5° (72° -109°) were included. Mean age was 51 months (20-84). A case scenario was created for each patient including the initial clinical photo and radiographs (AP and lateral). A power point presentation of all information on eleven cases and a response sheet were sent to forty surgeons. Participants were asked to select the treatment option they would prefer for each patient.

Results: 17 surgeons participated in the study. Mean curve size for patients treated non-operatively and operatively was 76° (72°-90°) and 81° (72°-109°) respectively. Surgery was recommended in 83% of cases and all options involved off-label use of currently available pediatric implants. Non-operative treatment was chosen in 17%. GR was the most commonly used technique (57%). Shilla and VEPTR were recommended 15% and 7% respectively. In GR group, a single rod was suggested in 14% and 4.5mm rods were used in 50%. There was a notable variation in type and level of anchors in the GR group. In VEPTR group, 85% used Spine to Rib anchors. In SHILLA: 83% of selected foundations were between T2-T4 and L2-L5, there was a considerable variation between number and levels of apical fusion. 87% of all non-operative treatments were casting. The greatest agreement among surgeons polled was seen in a 6 y.o. with no kyphosis, and the greatest variation was in a 2+6 y.o. child with almost the same curve size and flexibility, but with thoracolumbar kyphosis of 35 degrees.

Conclusion: Significant variations exist in recommended treatment options for EOS. Non-operative treatment continues to be recommended even in children with large size curves. All surgical treatments involved off-label use of pediatric spine implants. Long-term outcome based data is needed to elucidate which treatment option best serves this variable group of patients.

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).

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96. Vertebral Column Resection for Severe Pediatric Deformity: Deformity Correction, Trunk Height and Pulmonary Function Results

Daniel J. Sucato MD MS, Anna M. McClung RN
USA

Summary: A single surgeon series of vertebral column resections for severe pediatric spine deformity demonstrated overall coronal plane correction of 60%, average thoracic height gain of 6.3cm and significant improvement in pulmonary function without permanent neurologic deficit.

Introduction: Patients with progressive early onset scoliosis often present with severe spine deformity and severe restrictive pulmonary disease following prior surgeries. Vertebral column resection (VCR) has been shown to be an effective procedure to obtain significant correction of the spine but carries potentially significant neurologic risk. There are no studies analyzing deformity correction, thoracic height measurements and pulmonary function following VCR.

Methods: A consecutive series of prospective patients from 2001 to 2007 who had a VCR by a single surgeon for severe spine deformity was analyzed. Review of medical and operative records to determine demographic, intraop- and postop details and complications. PFTs were reviewed preop and at final followup.

Results: There were 12 pts, average age at VCR of 13.3 years. Diagnosis was congenital deformity in 6, syndromic 2, tuberculosis 2, idiopathic 1, and thoracogenic in 1. Primary deformity was kyphoscoliosis (6), kyphosis (3), and scoliosis (4). 7 (58.3%) had previous surgery. All-posterior approach was used in 9. There were 4 single level, 7 double and 1 triple VCR. Operative time was 639.7 min (300-861) and blood loss was1785.8mls (550-4000). Preoperative curve magnitude was 118.3° (70-160°), postop correction 51.8% (21.9% to 80%), final correction of 60.5% (24.7% to 81.4%). Preop thoracic height was 12.0cm (7.2 to 15.0cm), postop was 18.4 cm (14.4 to 24.6 cm), and was maintained at final followup- 18.3 cm (14.4 cm to 21.3 cm). Intraoperative neuromonitoring (IONM) deviated from baseline in 6: 3 during resection and 3 during correction. One had a transient monoplegia that completely resolved and the remaining patients

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were normal. Preop PFTs were: FVC % pred 47.2 %, FEV1 % pred 47.4% At final follow-up PFTs improved to 60.5% for FVC %-pred and 61.5% FEV1 %-pred. (P<0.05)

Conclusion: Vertebral column resection is a powerful procedure to correct the most severe pediatric spinal deformities with significant improvement in the coronal and sagittal planes, marked improvement in both thoracic height and critically low preop PFTs. No permanent neurologic deficits were seen, however, good baseline IONM was critical to avoid this complication.

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97. The Effect of Tethered Cord Release on Scoliosis in Tight Filum Terminale

Andrew Jea MD, Joshua J. Chern MD PhD, Robert C. Dauser MD, William E. Whitehead MD, Daniel J. Curry MD, Thomas G. Luerssen
USA

Summary: The association between neuromuscular scoliosis and tethered spinal cord has been well-documented, and most of these studies were based on patients with myelomeningocele. There have not been studies examining the effects of spinal cord untethering on scoliosis in children with tight filum terminale.

Introduction: The association between neuromuscular scoliosis and tethered spinal cord has been well-documented, and most of these studies were based on patients with myelomeningocele. There have not been studies examining the effects of spinal cord untethering on scoliosis in children with tight filum terminale.

Methods: 45 pediatric patients with tight filum terminale who had undergone untethering were retrospectively reviewed to understand the effects of untethering on scoliosis progression

Results: 26 girls and 19 boys underwent tethered cord release at a mean age of 4.5 years. 14 of 45 (31%) patients presented with scoliosis. 5 patients had thoracic scoliosis, 7 had thoracolumbar scoliosis, and 2 had lumbar scoliosis. After untethering surgery (mean follow-up of 28 months), 7 curves progressed > 10 degrees (5 patients eventually underwent surgical fusion). 2 patients had curves that improved, and 5 stabilized. In the group of 31 patients without scoliosis on presentation, 2 patients developed de novo scoliosis > 10 degrees during the follow-up period. Therefore, at the end of follow-up period, 36 of 45 patients (80%) had stable or improved spinal alignment, while 9 of 45 patients (20%) progressed. In the multivariate analysis, patients who presented with a Cobb angle greater than 35 degrees were most likely to progress (p=0.002, OR=21). There was no operative morbidity or mortality associated with scoliosis surgery.

Conclusion: A significant number of children with tight filum terminale were found to have scoliosis in agreement with the literature. Tethered cord release may not stabilize scoliosis in a substantial number of these patients. Most patients with progressive curves needed scoliosis correction and spinal fusion.

Significance: A significant number of children with tight filum terminale were found to have scoliosis in agreement with the literature. Tethered cord release may not stabilize scoliosis in a substantial number of these patients. Most patients with progressive curves needed scoliosis correction and spinal fusion.

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98. Reliability Testing of the Shriners Pediatric Instrument for Neuromuscular Scoliosis (SPINS): A Quality of Life Questionnaire for Children with Spinal Cord Injury

Louis N. Hunter PT MS, Fred Molitor PhD, Mary Jane Mulcahey PhD, Randal R. Betz MD, Lawrence C. Vogel, Craig McDonald MD
USA

Summary: Shriners Hospitals for Children has published on the development, comprehensibility, and scoring of the multi-dimensional Shriners Pediatric Instrument for Neuromuscular Scoliosis (SPINS) questionnaire for administration to children and adolescents with spine deformity. Before using the tool to measure health-related quality of life outcomes on children and adolescents with SCI and neuromuscular scoliosis, the reliability of the instrument was tested.

Introduction: The SPINS is a 92-item questionnaire that assesses function, satisfaction, and importance for the domains of sitting balance, activities of daily living (ADLs)/self-care, bowel/bladder management, mobility, and sports/recreation/leisure. It also assesses the domains: pain, cosmesis, skin integrity, thoracic-lumbar-sacral orthosis (TLSO) effectiveness, and surgery. There is a parent version for children less than 10 years old as well as a child/adolescent version for children 11-18 years old. The purpose of this study was to report the test-retest reliability of the SPINS.

Methods: A convenience population of 45 children with SCI completed the SPINS as part of a multi-center study examining its validity and reliability. Of those 45 subjects, 15 children (ages 5-17 years old) completed the SPINS twice. The theoretical range of scores for each domain is 0-100 with higher scores representing better quality of life and outcomes. Both Pearson correlation and Lin's concordance coefficients were calculated, with the former more commonly reported but the latter representing a superior statistic to assess reliability.

Results: SPINS demonstrated excellent reliability (> 0.90 for both Pearson and Lin's) with assessing function for bowel/bladder management and mobility; and acceptable reliability (> 0.80 for Lin's) for sitting balance, self-care, sports/recreation/leisure, and skin integrity. When these same coefficients were calculated using weighted values for satisfaction and importance, excellent reliability was found with self-care only (0.95); Lin's concordance coefficients for sitting balance, bowel/bladder management, mobility, and sports/recreation/leisure ranged from 0.67 to 0.77. Excellent reliability was also found for cosmesis (0.90), and acceptable reliability was found for skin integrity (0.81). Pain domain yielded unacceptable reliability (0.64).

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Conclusion: With the exception of assessing pain, the SPINS has been shown to be comprehensible and demonstrates acceptable to excellent reliability. With further psychometric testing, the SPINS will serve as an outcomes instrument that can measure the health-related quality of life of children with SCI with neuromuscular scoliosis.

Support: Shriners Hospitals for Children Grant #9155.

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99. Surgical Correction and Fusion Using Posterior-Only Pedicle Screw Construct for Neuropathic Scoliosis in Patients with Cerebral Palsy - A Three Year Follow-Up Study

Hitesh N. Modi MS, Seung-Woo Suh MD PhD, Jae-Hyuk Yang MD, Jae-Young Hong MD
Korea, South

Summary: Although there have been many reports in literature supporting the use of pedicle screw-only constructs for the correction of AIS, similar studies have not been reported in patients with CP.

Introduction: Objective of this study was to determine the effectiveness and amount of correction using posterior-only pedicle screw construct.

Methods: We retrospectively evaluated outcomes of 52 neuropathic scoliosis patients (28 male and 24 females) with cerebral palsy over minimum two years of follow-up. All patients underwent pedicle screw fixation without any anterior procedure for the correction. Pelvic fixation was done in ten patients who had pelvis obliquity more than 15 degree. All coronal and sagittal parameters were noted postoperatively and at final follow-up. Patient's functional outcome was measured using modified Rancho Los Amigos Hospital system criteria. Complications were recorded from record sheets and any change in the ambulatory status was also recorded.

Results: Mean age was 22 years at the time of operation and average follow-up was 36.1 months. Cobb's angle was improved to 62.9% ($p<0.0001$) from 76.8 degree to 30.1 degree postoperatively and 31.5 degree at final follow-up. This correction of scoliosis (41% ~ 92%) was found to be statistically significant ($p<0.0001$). Overall correction in pelvic obliquity was 56.2% from 9.2 degree preoperatively to 4.0 degree postoperatively which was 43.1% at final follow-up to 5.2 degree. 21 patients (42%) improved their functional ability by grade one with two patients by grade two. After the operation parent or caretakers of patients exhibited better sitting balance and nursing care. There were 32% complications in the series major being pulmonary. There were two perioperative deaths and one patient developed neurological deficit due to screw impingement in canal which was resolved after removal.

Conclusion: We reported satisfactory coronal and sagittal correction with posterior-only pedicle screw fixation without higher complication rate in CP patients. Further long-term study is recommended to evaluate the success of pedicle screw in this population.

Significance: This is probably the first study in CP patients who were treated with posterior-only pedicle screw fixation with follow-up of three years.

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100. Incidence of Spinal Injuries and Their Surgical Treatment in Children and Adolescents: a population based study from 1997 to 2006 in Finland

Ville T. Puisto MD, Sakari Kääriäinen, Antti Impinen Msc, Timo J. Parkkila PhD, Erkki Vartiainen, Tuomas Jalanko Medical Student, Mikko P. Pakarinen MD PhD, Ilkka Helenius MD PhD
Finland

Summary: The annual incidence of pediatric spinal fractures averaged 66 per million in this population based epidemiological study. Most commonly affected area in children below eight years was cervical spine, while in older children most fractures occurred in lumbar and thoracic spine. One-third of the injuries required surgical intervention.

Introduction: Epidemiological data on spinal injuries and their treatment in children is sparse, and only few population based data exist on the subject. Aims of the current study were: to define incidences of children's spinal fractures and spinal cord injuries and to evaluate the need for surgical interventions in a population based epidemiological study in Finnish children and adolescents.

Methods: All spinal fractures and spinal cord injuries in children under 18 years of age treated in hospital between 1997-2006 in Finland were included. The data on injuries, hospitalizations, and surgical treatment were collected from the National Hospital Discharge Register which includes all in-patient treatment periods. Fatal spinal injuries were derived from the Official Cause-of-Death Statistics of Finland.

Results: The overall incidence of spinal fractures remained rather stable during the follow-up period, averaging 66 per million children and representing 2.3% of all pediatric fractures. The proportions of cervical, thoracic, and lumbar spine injuries altered with age. In younger children (<8 years of age), cervical spine was most often affected, and cervical spine dislocation was the most common injury. In the older children, lumbar (42%) and thoracic spine injuries (33%) were more common than cervical. Annual incidence of pediatric spinal cord injuries was 4.3 per million children and 1.9 if prehospital fatalities were excluded. Cervical spinal cord injury with or without cervical spine fractures accounted for 80% of the fatalities. One-third of the spinal injuries required surgical treatment. Most common procedures were posterior lumbar spine stabilization, anterior cervical spine decompression and stabilization, and posterior thoracic spine stabilization.

Conclusion: Pediatric spine and spinal cord injuries are rare. Prevention of spinal cord injuries is part of the overall prevention of severe accidents

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Significance: In contrast to previous literature, the most commonly affected area in pediatric spinal injuries was lumbar spine. One-third of the injuries require surgical intervention.

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101. Isolated Alar Ligament Disruption in Children: Cause of Persistent Torticollis and Neck Pain After Injury

Michelle S. Caird MD, Frances Farley, Kelly Vanderhave MD, Martin K. Gelbke MD, Robert N. Hensinger MD
USA

Summary: We describe three children who developed painful torticollis following cervical injury. They were found to have an isolated alar ligament disruption. This problem should be included in the differential diagnosis of persistent neck pain and torticollis after neck injury. Imaging shows asymmetry in the dens-C1 lateral mass space with edema acutely and fat replacement chronically. Non-operative immobilization leads to good results when this is an isolated injury.

Introduction: In upper cervical trauma, frequently the odontoid is fractured and the alar ligaments remain intact. We describe isolated alar ligament disruption, previously undescribed in children in the English literature

Methods: We reviewed medical records and imaging of patients with this injury. Data collected included patient age, mechanism of injury, presenting symptoms, treatment method, time to healing, and final neck range of motion.

Results: Three patients were identified. Patient 1 (17 year-old girl) was a pedestrian struck by a motor vehicle who sustained a painful neck injury and a femur fracture. Plain films of the cervical spine were normal. CT demonstrated widening of the left dens-C1 lateral mass space, and MRI showed hyperintensity left of the dens indicating edema and ligamentous injury. She was treated with halo immobilization for 12 weeks with no complications and has returned to activities. Final neck motion was full and painless.

Patient 2 (15 year-old girl) was involved in a motor vehicle accident (MVA) and sustained a painful neck injury and a femur fracture. CT and MRI were similar to Patient 1. She was treated with halo immobilization for 12 weeks and returned to full activities with stable flexion/extension lateral plain films at 6 months.

Patient 3 (five year-old girl)was a restrained front seat passenger in a MVA with torticollis and a cranial nerve IV injury. Plain X-rays and CT scan showed no fractures, malalignment, or instability. MRI obtained 4 months after injury showed increased right dens-C1 lateral mass space and increased fat signal. She was treated with valium, a hard collar for 2 months, and physical therapy for 1 year. Torticollis resolved and final neck motion was full and painless.

Conclusion: Isolated alar ligament disruption is a cause of persistent neck pain and torticollis after neck injury. Imaging shows asymmetry in the dens-C1 lateral mass space with edema acutely and fat replacement chronically. Non-operative immobilization leads to good results when this is an isolated injury.

Significance: As MRI studies of the upper cervical spine become more easily obtainable and the images improve, this injury may be detected more frequently.

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102. Dens Fractures in Patients over 65 Years of Age: Anterior Screw Fixation of the Dens vs. Posterior Fixation of C1-C2

Jan Stulik, Petr Sebesta, Jan Kryl, Tomas Vyskocil
Czech Republic

Summary: The aim of this study is a retrospective evaluation of dens fractures in patients over 65 years of age treated with anterior screw fiaxation of the dens or posterior atlantoaxial fixation and fusion.

Introduction: The aim of this study is a retrospective evaluation of dens fractures in patients over 65 years of age treated with anterior screw fiaxation of the dens or posterior atlantoaxial fixation and fusion.

Methods: We treated surgically 28 patients 65 years old and older with dens fractures. The group consisted of 13 men and 15 women with a mean age of 77.4 years (range, 65-90 years). According to the type of treatment, anterior screw fixation or posterior C1-C2 fixation, the whole cohort was divided into 2 groups that were subdivided into two age groups of patients 65-74 years old and 75 years old and older. Final retrospective evaluation of the patients was carried out at the interval of 12 to 78 months after the primary surgery (mean 31.3 months).

Results: Comparison of the two age groups showed a statistically significant difference in the mortality, with 0 % in the younger group and 40 % in the older group. In total, mortality within 6 weeks after the injury accounted for 28.6 %. Comparison of surgical techniques revealed 21.4% mortality after anterior screw fixation of the dens and 35.7% mortality after posterior instrumented fusion. The difference was statistically insignificant. Of the 20 surviving patients, 11 were treated with anterior screw fixation and 9 with posterior instrumented fusion. In the two groups there was only one case of nonunion of the dens (9.1 %) and one fibrous callus in the region of C1-C2 fusion and the fracture line in the dens (11.1 %). The difference was again insignificant.

Conclusion: Active surgical treatment conduces considerably to the improvement of the quality of life of elderly patients after dens fractures. Mortality is influenced by the patients age rather than by the surgical technique used. Elderly patients with a neurological deficit mostly die of associated diseases regardless of the method of treatment.

Significance: See "Results"

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☐ **103. A Biomechanical Comparison of Two Constructs in a C5 Burst Fracture Model: Pedicle Screw-Rod vs. Lateral Mass Screw-Rod and Anterior Plating**

James P. Sieradzki MD, Jason Savage MD, Hyung-Soon Park PhD, Li-Qun Zhang PhD, Eugene Lautenschlager PhD, Eldin Karaikovic
Assistant Professor of Orthopaedic Surgery
USA

Summary: An in vitro biomechanical study comparing two stabilization constructs in a C5 burst fracture model. Biomechanical stability obtained from a pedicle screw-rod construct is equal to that of a circumferential one using lateral mass screw-rods and anterior plating.

Introduction: Multiple instrumentation techniques exist for the surgical stabilization of unstable cervical spine injuries, and proper fixation for these injuries is debatable. To the best of our knowledge, there are no biomechanical studies comparing the stability of a posterior pedicle screw-rod construct alone with that of a circumferential one using lateral mass screw-rods with anterior plating.

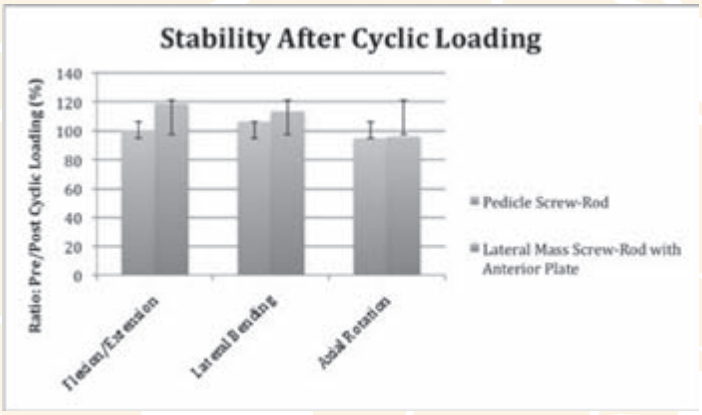
Methods: Eight human cadaveric cervical spines were divided into two groups. Group 1 received pedicle screws at C4 and C6 after removal of the C5-6 disc and C5 partial corpectomy to simulate a burst fracture. Group 2 received lateral mass screws at C4 and C6 and a dynamic anterior plate with placement of an acrylic spacer after corpectomy. Specimens were nondestructively tested. Angular motion was recorded under controlled loadings during flexion and extension, lateral bending, and axial rotation.

Results: No significant differences were seen in the initial biomechanical stability between the posterior and circumferential constructs. This was true in flexion/extension (p=0.46), lateral bending (p= 0.73), and axial rotation (p= 0.64). There were also no differences after 200 cycles of fatigue testing in flexion/extension (p=0.43), lateral bending (p=0.87), and axial rotation (p=0.63).

Conclusion: We found no significant differences in initial stability and after cyclic loading of 200 cycles between a pedicle screw-rod construct and a circumferential one using lateral mass screws and an anterior plate in a cervical spine burst fracture model.

Significance: In a C5 burst fracture model, a cervical pedicle screw-rod construct offers equivalent stability to that of a circumferential one using lateral mass screw-rods and an anterior plate. Cervical pedicle screw insertion carries inherent risks, but may be warranted in certain clinical situations where increased stability is necessary and a concomitant anterior approach is undesirable.

Stability after cyclic loading: the decrease in stability is shown by the average ratios of the ROMs pre/post cyclic loading for all four loading directions (flexion/extension, lateral bending, and axial rotation). Error bars represent one standard deviation.



104. Lumbosacral Dissociation Injuries in High Energy Blast Injuries

Ronald A. Lehman MD, Melvin D. Helgeson MD, Romney C. Andersen MD, Carlo Bellabarba, Michael Frisch
USA

Summary: We have seen an increased incidence of lumbopelvic dissociations in patients sustaining high energy, combat-related traumatic injuries. While the treatment of this complex injury has varied, patients at high perioperative risk have been adequately treated with percutaneous sacroiliac screw fixation in our series.

Introduction: Lumbosacral dissociation (LSD) injuries are defined by an anatomic separation of the pelvis from the spinal column usually as a result of high-energy trauma. In the last five years, a relative increase in these injuries has been seen in young, healthy combat casualties subjected to high-energy blast trauma and helicopter crashes.

Methods: We reviewed the inpatient/outpatient medical records and radiographs for all patients treated at our institution with combat-related lumbosacral dissociations. Included were all patients with radiographic evidence of a zone III sacral fracture, with associated lumbar fractures indicating loss of the iliolumbar ligamentous complex integrity.

Results: Twenty-three (23) patients met our inclusion criteria and had at least 1 yr follow-up. In 15 patients, the sacral fracture could be classified as a H or U type zone II fracture, while in the remaining 9 patients the sacral fracture was severely comminuted and unable to classify. Six patients sustained open sacral fractures. Patients were treated as follows: no fixation - 9, sacroiliac screw fixation - 8, posterior spinal fusion - 5, sacral plate - 1. One patient treated non-operatively with a severely comminuted LSD died three weeks later due to other associated injuries and was not included in the study. At a mean follow-up of 1.71 years (range

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1 to 4.5 years), 11 (48%) still reported residual pain and mean visual analog score at latest follow-up averaged 1.7 (range 0 to 7). There was no difference in VAS between different treatment modalities. Two open injuries treated initially with repeated debridements returned after final closure for residual infection. One patient treated with L4 to ilium posterior spinal fusion with instrumentation required hardware removal for presumed infection.

Conclusion: In our case series, operative stabilization promoted healing and earlier mobilization, but is not without significant perioperative risk. Nonoperative management should be considered in patients whose comorbidities prevent safe stabilization before the early consolidation phase of healing.

Significance: In multitrauma patients with lumbopelvic dissociations, percutaneous operative stabilization with SI screws appears to be a reasonable alternative to spinal fusion.

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105. Complications of High Thoracic Spinal Fractures

Pedro M. Fernandes, Nuno Batista, Jacinto Monteiro
Portugal

Summary: The authors proposed to evaluate the frequency and type of complications associated with unstable thoracic spinal fractures.

Introduction: Thoracic spinal fractures occur whenever forces exceed the strength and stability of the spinal column. The vast majority of spine fractures occur as a result of motor vehicle accidents, falls, sports and acts of violence. Although spinal cord injury represents the most serious long-term morbidity, this type of fracture is usually associated with serious chest injuries and other multisystemic complications even after surgical management

Methods: The clinical and imaging report of patients with unstable high thoracic fractures surgical managed between 1999 and 2006 were evaluated. Patients with thoracolumbar fractures were excluded. In this period of time, 46 patients were surgical managed. Mean age was 36,4 y (16-89). 72% had hemothorax; 14% rib fractures; 11% abdominal trauma; 11% associated spinal fractures; 9% pneumothorax; and 9% other injuries. 33% had neurologic deficit. All patients underwent long posterior stabilization procedures above and below the thoracic kyphosis apex. Surgery was done on an average of 5 days (1-15) after initial trauma.

Results: All patients need to be admitted in an intensive care unit; mean time 15 days (1-70).

71% had complications reported during hospital stay. 24% urinary tract infections; 19% respiratory infections; 14% pressure sores; 14% long periods of assisted breathing; 5% sepsis; 5% operative wound infection. 63% of fatal or near fatal complications occurred within the first 14 days. 62% of all complications occurred in patients surgical managed more than 72 hours after admission.

Conclusion: The chest decreases the mobility of the thoracic spine increasing its resistance in compression, so fractures are usually associated with high-energy injuries and multisystemic damage. Therefore as was to be expected complication rates are considerable higher in this patients. Our neurologic injury rate was higher than the one mentioned in the literature probably because 57% of our patients underwent car accidents. Although not statistical significant a trend was noticed between late surgery (>72hours) and increased rate of complications.

Significance: Level IV - case series

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106. Ten Years Follow Up of Thoracoscopically Assisted Treatment of Thoracolumbar Fractures

Heinrich Boehm MD, Ahmed M. Shawky MD
Germany

Summary: Thoracoscopically assisted spine surgery is one of the recently introduced minimal invasive procedures in spine surgery. The early results of such technique were thoroughly studied but not the long-term ones.

Introduction: Although there are many studies that show good outcomes regarding the follow up of thoracoscopically treated patients with fractured spine, there are no single available study concerned with the long-term follow up of such patients (after reviewing Medline, Pubmed, and Ovid).

Methods: Between May 1994 and August 1998 forty four patients with spinal fractures were operated upon in our hospital using thoracoscopically-assisted technique. Out of those, thirty patients were available for late follow up. Clinical and radiological outcomes of these patients were evaluated after a mean follow up period of 11.57 years (range 10-13 years). Those patients underwent posterior stabilization plus anterior thoracoscopically assisted decompression and fusion. Of these 30 patients 15 were operated in lateral decubitus position and 15 in prone position. The ODI (Oswestry Disability Index) was used for subjective clinical evaluation, combined with clinical examination evaluating range of motion, local tenderness, scars condition, and neurological status. Plain x-ray in two views (anteroposterior and lateral) was used for the radiological evaluation.

Results: Fusion rate was 100%. The ODI ranged from zero to 18 with a mean of 4.66. With the exception of one patient, there were no restrictions of range of motion. All patients showed no local tenderness and excellent scar condition. The neurological status was not changed compared with that 2 years after surgery. Although patients operated in prone position showed better initial correction and less loss in correction in follow up, but the difference was statistically insignificant. There is no statistically significant difference between cases operated in lateral position and those operated in prone position as regarding ODI, and fusion rate.

Conclusion: The use of thoracoscopy in cases of spinal fractures showed a good long term results regarding both clinical and radiological evaluation in either lateral or prone position. In

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comparison to open thoracotomy, our results were better in form of better fusion rate and less incidence of long-term complications.

Significance: To our knowledge, this is the first study with a minimum of 10 years follow up of thoracoscopically treated patients with fractured spine.

107. Low Lumbar Burst Fractures: A Unique Fracture Mechanism Sustained in Our Current Overseas Conflicts

Ronald A. Lehman MD, Tobin Eckel, Melvin D. Helgeson MD, Patrick B. Cooper MD, Ryan Sieg, Carlo Bellabarba
USA

Summary: Low lumbar burst fractures have an increased incidence and are more common than thoracolumbar burst fractures in the casualties returning from Iraq and Afghanistan.

Introduction: The most common location for burst fractures occurs at the thoracolumbar junction, where the stiff thoracic spine meets the more flexible lumbar spine. With our current military conflicts in Iraq and Afghanistan, we have seen a disproportionate number of low lumbar burst fractures (caudad to L2). We set out to report our institutional experience with these relatively uncommon injuries.

Methods: We performed a retrospective review of medical records and radiographs for all patients treated at our institution with combat-related injuries and thoracolumbar fractures. All patients who had sustained a burst fracture from T12 to L5 and had at least 1 year clinical follow-up were included.

Results: Thirty-two (32) patients sustained thoracolumbar burst fractures, and of these, 20 patients (62.5%) had low lumbar (L3-L5) burst fractures and 13 patients (40.6%) had upper lumbar (T12-L2) burst fractures. Additionally, 7 patients sustained multiple burst fractures (with upper and lower fractures). The locations of the 39 fractures were as follows: T12-0, L1-9, L2-5, L3-8, L4-7, L5-10. Of lower lumbar fractures, 56.3% had a major neurologic injury, with two being complete. Similarly, in the upper lumbar group, 67% sustained a major neurologic injury, again, with two being complete injuries. Twenty-two patients (10 upper, 12 lower) underwent surgical intervention, complicated by infection in 18.2%. At the most recent follow-up, all but one patient who had presented to us with a neurologic deficit still had evidence of a persistent deficit.

Conclusion: While previously thought to be uncommon, low lumbar burst fractures actually have an increased incidence within our military population. This is likely multifactorial, but a potential cause is the distinctive rigidity offered by our current body armor which transfers force into the lower lumbar spine.

Significance: An increased awareness of this fracture pattern is warranted by all surgeons as it presents unique clinical challenges in its treatment. Although the incidence is increased in the military population, all surgeons must be aware of the injury pattern.

108. Thromboprophylaxis in Spinal Trauma: State of the Art with Analysis of Questionnaire Response

Avraam Ploumis MD PhD, Ravi Ponnappan MD, John Sarbello, Marcel Dvorak MD FRCSC, Michael Fehlings MD PhD, Eli Baron MD, Neel Anand MD, David O. Okonwko MD, Alpesh Patel MD, Alexander R. Vaccaro MD PhD
Greece

Summary: A survey on thromboprophylaxis in spinal surgery and trauma was conducted among surgeons of Spinal Trauma Study Group. The recommended mode (none, mechanical, chemical), time of initiation, duration, and possible complications of thromboprophylaxis were analysed and followed by consensus-based recommendations. Spinal trauma with SCI affecting mobility generally necessitated chemical prophylaxis for at least 6 weeks.

Introduction: Neurosurgeons and Orthopaedic surgeons from the Spinal Trauma Study Group were surveyed in an attempt to understand current practices in the perioperative administration of thromboprophylaxis in spinal surgery.

Methods: Forty-seven spine surgeons were provided with a 34-question survey pertaining to deep vein thrombosis (DVT) prophylaxis in spine surgical patients. There was 100% response to the survey.

Results: Institutional protocols for DVT prophylaxis existed for 42 (89%) of the respondents; however, only 27 (57%) indicated that these protocols included SCI patients. Preoperatively, no prophylaxis or mechanical prophylactic measures for SCI and non-SCI spinal fracture patients were routinely used by 36 (77%) and 40(85%) respondents, respectively. Postoperatively, pharmacologic prophylaxis was prescribed by 42(91%) and 28(62%) surgeons for SCI and non-SCI spinal fracture patients, respectively. There was a statistically significant tendency to use more intensive prophylactic measures for patients with SCI (x^2 10.86, $p<0.01$) as well as a statistically significant longer duration of proposed thromboprophylaxis (x^2 24.62, $p<0.001$). Postoperative pharmacologic thromboprophylaxis for elective anterior thoracolumbar spine surgery was reported by 23(51%) of the respondents while only 18(40%) utilized pharmacological prophylaxis in elective posterior thoracolumbar spine cases Spine complications from low-molecular weight heparin (LMWH) were reported by 22(47%) surgeons including fatal pulmonary embolism by 19(40%) surgeons.

Conclusion: No more than mechanical prophylaxis was recommended preoperatively for non-SCI patients or postoperatively for elective cervical spine cases. Chemical prophylaxis was commonly utilized postoperatively in patients with SCI and in patients with elective anterior thoracolumbar surgery.

Significance: A basis for a consensus protocol on thromboprophylaxis in spinal trauma was attempted.

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109. Total Spondylectomy of C2: A New Surgical Technique

Jan Stulik, Petr Sebesta, Jan Kryl, Tomas Vyskocil
Czech Republic

Summary: Progress in the surgical technique and an intensive development of instrumentation for stabilization of the spine allow applying ever more aggressive surgical techniques. Complete resection of the entire mobile segment offers new possibilities in the treatment of primary spinal malignancy.

Introduction: According to the available sources, no case of total spondylectomy of C2 with preservation of roots, preservation of vertebral arteries and a short fixation without occipitocervical fusion has been so far described in the literature.

Methods: A total spondylectomy of C2 with preservation of roots, preservation of vertebral arteries and a short fixation without occipitocervical fusion has been performed in 3 patients.

Results: Similarly as other authors, also we could not avoid serious complications that substantially prolonged the period of hospitalization. In spite of this, the short-term results are very satisfactory and all 3 patients are satisfied.

Conclusion: Total spondylectomy of C2 with preservation of vertebral arteries and roots stabilized only by a short fixation is an extreme surgical procedure suitable only for exceptional cases of young patients with a good bone quality. With regard to potential complications it is of vital importance to consider carefully such operation and consult the proposed therapy with the patient.

110. Posterior Transpedicular Corpectomy and Reconstruction of the Axis Vertebra for Metastatic Tumor: Report of Three Cases and Review of the Literature

Vincent Y. Wang MD PhD, Christopher P. Ames, Vedat Deviren, Frank Vrionis

Summary: Management of metastatic disease is a significant challenge in modern cervical spinal surgery. Recent evidence suggests that surgical decompression with radiation improves functional outcome in patients compares with radiation alone. In the thoracic spine, a posterolateral approach with transpedicular resection and reconstruction has become a mainstay of surgical therapy for thoracic metastatic disease. We report three cases in which a similar posterior transpedicular technique, adapted for the cervical spine, was used for intra-lesional resection of metastatic tumors of the axis vertebra and describe our technique.

Introduction: Management of metastatic disease is a significant challenge in modern spinal surgery. Recent data suggest that surgical decompression in addition to radiation therapy improves functional recovery compared with radiation therapy alone. In the thoracic spine, surgical techniques for decompression and reconstruction has been shifted significantly from a two stages anterior resection and reconstruction with supplemental posterior fixation to a single stage transpedicular resection and reconstruction through a posterolateral approach. In the cervical spine, such single stage posterior approach with radical resection and circumferncial reconstruction is difficult due to anatomical constraints. We report three cases in which a similar posterior transpedicular technique, adapted for the cervical spine, was used for intra-lesional resection of metastatic tumors of the axis vertebra and describe our technique.

Methods: Our study is a retrospective review of three cases performed in two tertiary spine tumor referral centers. All patients presented with metastatic disease involving the C2 vertebral body with cord compression and C1-C2 instability.

Results: All three patients underwent transpedicular corpectomy for tumor resection and reconstruction of the axis vertebra without any complications. At their six months follow-up, two patients remained neurological intact and one patient had died from his systemic disease. There were no instrumentation failure at six month follow-up.

Conclusion: Our report demonstrates that tumors of the axis can be successfully resected from a transpedicular approach and the important load bearing transfer function of the area can be successfully reconstructed from an all posterior approach.

Significance: This is a description of a surgical technique that allows surgical resection of a tumor and reconstruction of the axis vertebra through a single stage posterolateral approach. This approach is an alternative to the trans-oral approach for resection and reconstruction of the axis vertebra and may avoid some of the morbidity associated with the trans-oral approach and spares the patient a second stage surgery.

111. Relation Between Health-Related Quality of Life Score And Survival in The Patients With Spinal Metastases -A Prospective Analysis-

Takayuki Yamashita MD, Krzysztof B. Siemionow, Thomas E. Mroz, Vinod K. Podichetty MD, Isador H. Lieberman MD MBA FRCSC
USA

Summary: SF-36 health survey can be used as prognostic factors for spinal metastases.

Introduction: Prognostic factors in the patients with spinal metastases were previously reported, however, the relation between health-related quality of life score and survival has not been reported. The purpose of this study was to determine the relation between health-related quality of life score and survival in the patients with spinal metastases.

Methods: All patients newly diagnosed with spinal metastases within 2 years of diagnosis of cancer, whether symptomatic or not were recruited. Survival was defined as the time interval from enrollment until death or the latest follow-up. At enrollment the SF-36 health survey was administered and documented for each patient. The data was analyzed between 2 groups using a student's t-test.

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Results: Eight-seven (87) patients (Males 46, Females 41) were investigated in this study. The mean age at enrollment was 61 years old (range: 35-84). The primary cancer types were breast (23), multiple myeloma (18), lung (17), kidney (11), prostate (10), thyroid (2), and others (6). Sixty (60) patients were survived more than 6 months (long survival group) and 27 patients died within 6 months (short survival group). Of SF-36 health domains, there were significant differences between the 2 groups in relation to physical functioning (long survival 44.0 vs short survival 20.7; P<0.001), role limitations-physical (long survival 25.4 vs short survival 8.3; P=0.012), bodily pain (long survival 43.2 vs short survival 26.8; P=0.001), vitality (long survival 43.4 vs short survival 28.7; P=0.002), role limitations-emotional (long survival 53.3 vs short survival 33.3; P=0.044), and mental health (long survival 71.6 vs short survival 56.7; P=0.001).

Conclusion: Of the SF-36 health survey domains, physical functioning, role limitations-physical, bodily pain, vitality, role limitations-emotional, and mental health, all revealed statistically significant better scores in the long survival group. These domains can be used as prognostic factors in the patients with spinal metastases.

Significance: The accurate prediction of prognosis will enable treating physicians to choose the most appropriate treatment, and provide cancer patients with a better quality of life.

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112. Percutaneous transsacral screw fixation and sacroplasty for treatment of pathologic sacral fractures

Peter S. Rose MD, S. A. Sems MD, Ahmad Nassr MD, Mark A. Pichelmann MD, Paul M. Huddleston MD, Michael J. Yaszemski MD, PhD, Mark B. Dekutoski MD
USA

Summary: We report a technique and outcomes of percutaneous transsacral screw fixation and sacroplasty for the treatment of present and impending pathologic sacral fractures.

Introduction: Pathologic sacral fractures following radiotherapy and/or tumor resection pose a challenging clinical problem. Most patients are managed adequately with protected weight bearing and analgesic medications. However, there are no established methods to prevent completion of impending pathologic sacral fractures or to guide treatment of fractures which fail to respond to conservative management. We report our initial experience with a new technique of percutaneous transsacral screw fixation combined with sacroplasty for management of these fractures.

Methods: A retrospective review identified 6 patients treated with transsacral screws for fixation of present (n=2) or impending (n=4) pathologic fractures of the sacrum. Additional polymethylmethacrylate sacroplasty was performed in 4.

Results: Malignancies treated included myeloma/plasmacytoma (n=2), chordoma (n=1), and metastatic carcinoma (n=3).

Screw placement was performed percutaneously using biplanar fluoroscopy. There were no perioperative complications attributable to screw placement; post-operative CT scans confirmed extraforaminal screw placement in all patients. Four patients had additional L5/S1 instrumentation placed openly as a part of their tumor resections.

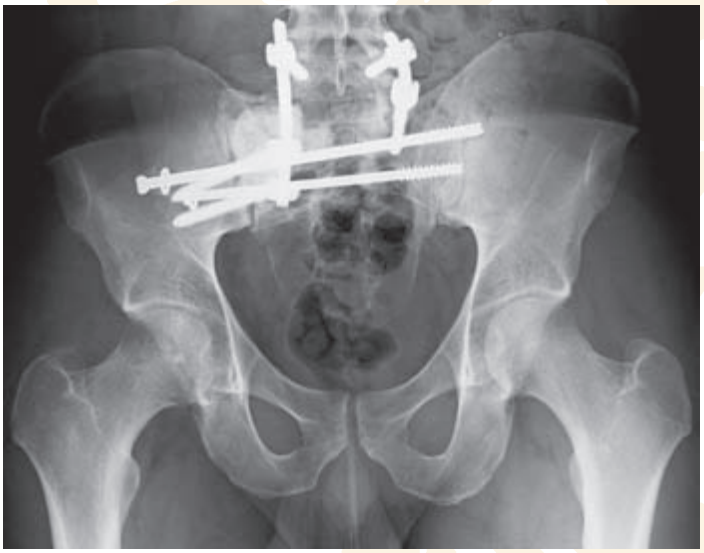
One patient with metastatic carcinoma was lost to follow-up. Median follow-up on remaining patients was 14 months. No patients have completed any impending pathologic fractures or progressed any pre-existing fractures, and no implant migration or failure has been observed.

Two patients require no narcotic pain medications; two others have decreased narcotic requirements; one patient (in hospice for widespread disease progression) has had an increase in total narcotic requirements.

Conclusion: In this initial series, percutaneous transsacral screw fixation and sacroplasty of impending and present pathologic fractures appears safe and effective. Results were durable to a median 14 month follow-up in this palliatively treated population.

Significance: The technique described provides safe and effective stabilization of impending and present pathologic sacral fractures.

15 month follow-up image for patient treated for impending pathologic fracture following radiation for plasmacytoma



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113. Balloon Kyphoplasty as an Adjunct to Stabilization in the treatment of Metastatic Spinal Disease

James Langdon MRCS, Sam Heaton, Jason Bernard MD FRCS(Orth), Sean Molloy FRCS (Orth)
United Kingdom

Summary: This paper presents a series of patients with spinal metastases causing cord compression, in whom balloon kyphoplasty was used as an adjunct to posterior decompression and fixation to provide pain relief and anterior column support.

Introduction: Spinal decompression with posterior stabilization and radiotherapy allows most patients with cord compression due to spinal metastases to remain ambulant and continent, but it does not provide pain relief and spinal stability. This can be achieved in these patients with adjunctive cement augmentation.

Methods: Retrospective follow-up of 11 patients with spinal metastases treated with decompression, posterior fixation, and balloon kyphoplasty.

Results: Eleven patients (5 male, 6 female, mean age 66.5 years) with spinal metastases causing cord compression were treated with decompression, posterior fixation and balloon kyphoplasty. Post-operatively all patients reported excellent relief of back pain (mean VAS 0.5/10). At the last follow-up (mean 6.2 months, range 4 - 12) 10 patients remain ambulant, continent and pain free. One patient with pre-operative urinary incontinence remained incontinent of urine. Seven of the 11 patients have subsequently died.

Conclusion: The use of cement augmentation as an adjunct to decompression, posterior stabilization, and radiotherapy not only allows patients to remain ambulant and continent but also provides immediate pain relief and lasting anterior column support.

Significance: The use of balloon kyphoplasty with a posterior decompression and stabilization is a simple technique that provides effective pain relief and anterior column support. Further work is needed to evaluate the use of cement augmentation to stabilize spinal metastases.

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114. Posterolateral Approach for Thoracic Corpectomy with Circumferential Decompression and Instrumented Fusion Using Expandable Cages: A Prospective Case Series of 15 Consecutive Patients

Patrick C. Hsieh MD, Ziya Gokaslan MD, John C. Liu MD
USA

Summary: Posterolateral transpedicular and costotransversectomy approaches were first described as treatment options for thoracic herniated discs. However, they can be used for corpectomy to achieve circumferential spinal canal decompression with stabilization of the spine in a single posterior-only procedure without the morbidities associated with transthoracic or lateral extracavitary approaches.

Introduction: Posterolateral transpedicular and costotransversectomy approaches were first described as treatment options for thoracic herniated discs. Although they provide smaller surgical corridors, circumferential decompression of the spinal canal with corpectomy can be achieved in a single stage. In addition, reconstitution of vertebral column stability can be achieved with expandable cages despite the smaller working corridor.

Methods: Fifteen consecutive patients that underwent a single-stage posterolateral corpectomy with circumferential decompression and stabilization for thoracic tumor, infection, or fracture in our prospective surgical database were analyzed for the study.

Results: The mean age of patients in this study was 52.3 years old and their mean follow-up was 13.2 months. The surgical indication in this group included 10 tumors, 3 infections, and 2 fractures, and all 15 patients presented with myelopathy or spinal cord injury. The region of corpectomy was high thoracic (T1-T4) in 7 patients, 5 mid thoracic (T5-T10), and 3 thoracolumbar (T10-L2). Mean estimated blood loss associated with these procedures was 1250cc and the average length of hospitalization was 6.2 days following surgery. Neurological improvement by >1 grade motor scale was achieved in 80% of the patients. Our 30-day peri-operative complications included 2 wound infections and 1 symptomatic pleural effusion. There were no neurological or vascular complications in this series.

Conclusion: Posterolateral transpedicular and costotransversectomy approaches can achieve effective circumferential spinal decompression for spine tumors, infections, and fractures in the thoracolumbar spine. They are particularly useful in 47% of the cases in this series with spinal cord compression in high thoracic region (T1-T4) where transthoracic and lateral extracavitary approaches are difficult and not practical. Despite the smaller surgical corridor, vertebral column reconstruction can be achieved with expandable cages following corpectomy without increased risk for neurological complications.

Significance: Posterolateral transpedicular and costotransversectomy approaches are safe and effective to achieve circumferential decompression and stabilization of the spine without increased morbidity.

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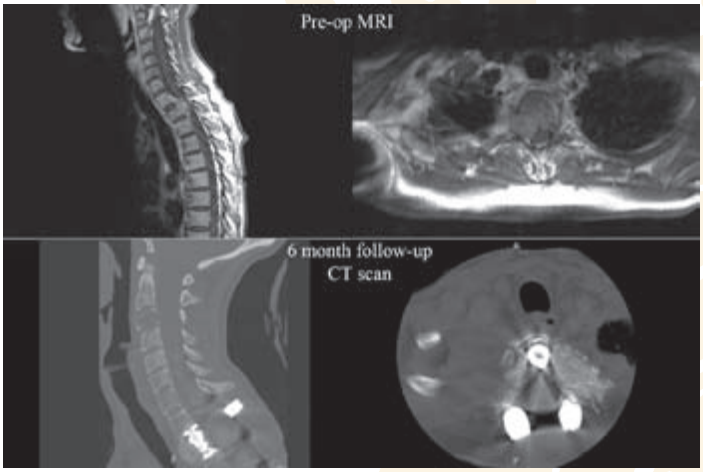

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115. A Novel Muscle Sparing High Thoracotomy Approach for Upper Thoracic Spine Resection and Reconstruction

Rex Marco MD, Wu Zhuge MD
USA

Summary: A muscle sparing high thoracotomy approach for treatment of ventral upper thoracic spine lesions

Introduction: Many tumors, infections and deformities involving the ventral upper thoracic vertebra require surgical intervention. Most existing approaches to the area require transection of muscles of the shoulder girdle, which can impair postoperative shoulder function.

Methods: A muscle sparing high thoracotomy approach was developed. The patient was placed in a lateral decubitus position. A posterior midline incision was made and a second incision made perpendicular to the midline incision was used to gain further exposure. The trapezius, rhomboids, and levator muscles were split in the midline raphae and then elevated off the chest wall. The paraspinous muscles were mobilized to expose the underlying ribs. A high thoracotomy was made through rib(s) corresponding to the ventral lesion. The vertebral lesion along with any surrounding soft tissue mass was then removed and spinal column reconstruction and instrumentation was performed.

Results: This approach was used for the treatment of five patients with upper thoracic tumors. One patient had stage 4 lung carcinoma with invasion of T5 and T6; two patients had upper thoracic spinal cord compression from malignant fibrous histiocytoma and associated large soft tissue mass; one patient had a metastatic T6 lesion from an unknown primary; and one patient had a Pancoast tumor. Simultaneous or staged resection of the tumors, spinal reconstruction and instrumented fusion were achieved in all the patients. All the patients had full shoulder range of motion post operatively.

Conclusion: This approach provides excellent exposure of the ventral upper thoracic spine without transection of muscles of the shoulder girdle. It has advantages of direct visualization for easier removal of large anterior soft tissue masses, allows for simultaneous reconstruction and instrumentation of the anterior and posterior spine, and maintenance of full shoulder functions. This approach is especially useful for patients with primary malignant bone tumors requiring en bloc excision, metastatic tumors with large soft tissue masses, and Stage IV lung cancer with direct vertebral body invasion.

Significance: This approach spared the muscles of shoulder girdle with maintenance of full range of motion of the shoulder posteoperatively.

116. Effect of Surgical Staging on Patient Outcomes, Resource Utilization, and Institutional Costs in Oncologic Sacral Resections with Spinopelvic Reconstruction

Peter S. Rose MD, Michael J. Brown MD, Daryl J. Kor MD, Timothy B. Curry MD, PhD, Matthew A. Warner, Eduardo S. Rodrigues MD, Mark B. Dekutoski MD, Steven H. Rose MD
USA

Summary: An analysis of 25 oncologic sacral resections with spinopelvic reconstruction demonstrates that patients undergoing staged procedures have less morbidity, reduced resource utilization, and lower total hospital costs compared to single stage procedures. This is the first study to analyze and document this effect.

Introduction: Oncologic sacropelvic and sacrospinal resections generally require anterior and posterior approaches for wide resection and reconstruction of malignant tumors. These extensive surgical procedures may be performed in a single session or a staged fashion. We investigated the impact of surgical staging on patient outcomes, resource utilization, and institutional costs in oncologic sacral resections requiring spinopelvic reconstruction.

Methods: A single center retrospective comparative study identified 25 potentially cases from 2000-2008. Institutional practice patterns and outside regulations (ACGME duty hour regulations) led to a tendency to stage these procedures into two surgeries in the later part of the series (n=8).

Results: Surgical staging was associated with significant increases in ICU free days at day 28 (21.3 vs 16.2, p=0.03), ventilator free days at day 28 (27.3 vs 21.2, p<0.01) and reduced morbidity (50 vs 100%, p<0.01). Staged patients required fewer post-operative transfusions (median 0 vs 1.4 liters, p=0.03) and less after-hours transfusions (1.4 vs 3.2 liters, p=0.02). Intraoperative anesthesia team "hand-offs" were significantly fewer with surgical staging as were total hospital costs ($168,000 vs $263,000).

Surgical staging did not change total operative time or in hospital mortality. A trend towards greater hospital free days and improved 6 month mortality were observed.

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Conclusion: Staging of oncologic sacral resections requiring spinopelvic stabilization is associated with improved clinical outcomes, reduced resource utilization, and reduced institutional costs. This is the first study to analyze and document this effect.

Significance: Oncologic sacral resections are very resource intensive procedures. Additionally, current external regulations limit the ability to perform extensive surgeries in a single session. These data demonstrate that staging such procedures conserves resources and positively impacts patient outcomes.

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117. Circumferential Spinal Reconstruction Using False Pedicles after Total en bloc Spondylectomy: A Biomechanical in vitro Study

John Seaburg MD, Michael Liebschner PhD, Rex Marco MD
USA

Summary: False pedicle constructs were more rigid than posterior instrumentation.

Introduction: Total en bloc spondylectomy (TES) is becoming the standard of care for spinal tumor removal. To our knowledge, false pedicles have not been studied biomechanically or clinically. Our hypothesis was that the addition of false pedicles will provide a more rigid construct after TES.

Methods: We developed a 7 level synthetic spine analog to provide more readily reproducible results (Fig. 1). The model was validated against prior published data of cadaveric samples.

The testing apparatus consisted of a pulley system for pure oscillating bending moments and a follower load system for physiological axial loading. The spinal segments were cycled 10 times to ±5 Nm flexion/extension. We tested 5 axial loading cases ranging from 75 N to 975 N. Afterwards, the segment was tested in bi-lateral bending and torsion.

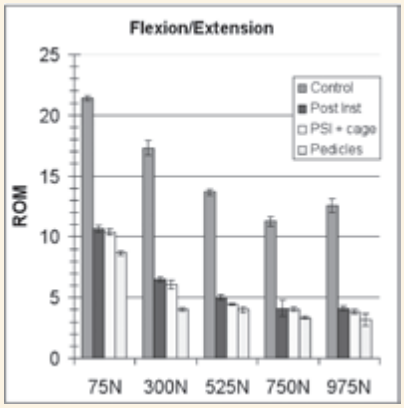
Two-way ANOVA tests (implant configuration and preload level) were applied to the primary kinematic measures: ROM of flexion/extension, bilateral bending, and torsion. To test for individual significance, pair wise post-hoc tests were performed.

Results: Flexion/Extension. Our control data closely correlated with our previously reported data on cadaveric spines. At physiologic loads, 750N and 975N, the addition of false pedicles made our construct significantly more rigid, compared to posterior instrumentation with and w/o a cage.

Bilateral Bending. When bilateral bending data were analyzed together, the false pedicle construct provided significantly more rigidity than the other two constructs ($p<0.001$). Whereas, the posterior instrumentation with and w/o cage were similar ($p=0.532$).

Torsion. At physiologic load level (750N and 975N) the false pedicle construct was significantly more rigid than either of the alternate constructs. Interestingly, the false pedicle construct was less influence by axial pre-load than either of the other constructs.

Conclusion: Spinal reconstruction after TES is difficult and a definitive standard has not been reached for the best method. The false pedicle constructs significantly increased rigidity as compared to the posterior instrumentation constructs. Together, this supports the hypothesis that false pedicles provide more rigidity than the commonly used posterior instrumentation constructs.



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118. Grade II Sponylolisthesis Treated by XLIF

W. B. Rodgers MD, Curtis Cox MD, Edward Gerber
USA

Summary: 50 patients with grade II spondylolisthesis underwent an XLIF procedure. Results are presented.

Introduction: The XLIF approach is a less disruptive alternative to anterior column reconstruction allowing for large graft placement, disk height and alignment restoration, and indirect decompression. A review of Grade-II slips treated by XLIF is reported.

Methods: The XLIF approach is a less disruptive alternative to anterior column reconstruction allowing for large graft placement, disk height and alignment restoration, and indirect decompression. A review of Grade-II slips treated by XLIF is reported.

Results: Ages ranged from 25-87yrs (ave 65.4 yrs). Comorbidities included smoking (34%), diabetes (22%), CAD (56%), and COPD (8%), Obesity (44%) and prior surgeries (18%). 41 procedures were single-level (39 at L4-5, 2 at L3-4), 8 were two-level (all at L3-5), and 1 was three-level (at L2-5); the XLIF approach was successfully accessible in all cases. All cases included supplemental fixation. Hospital stay averaged 1.1 days. Complications included 1 pulmonary embolism requiring anticoagulation, 1 atrial fibrillation, and1 late-term hardware failure (screw fracture at 1 year). Postoperative thigh discomfort was routine and slight thigh numbness rare, resolving completely within 4-6wks in all cases. No significant hip flexor weakness was noted beyond 6 weeks. VAS pain scores improved from 8.7 at pre-op to 2.4 at 3 months, 2.0 at 6 months, and 1.7 at 12 months. Disk height improved from an average of 5.1mm at pre-op to 10.38mm post-op, and was maintained at 9.2mm at 12 months. Slip improved from 10.9mm at pre-op to 3.0mm post-op, and was maintained at 3.1 mm at 12 months. Lenke fusion scores averaged 2.0 at 3 months, 1.3 at 6 months, and 1.1 at 12 months.

Conclusion: Grade-II spondylolisthesis is a challenging application to treat minimally invasively, but access, alignment, and fusion

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are shown to be achievable using the XLIF approach, without the concomitant morbidity seen in traditional open fusion.

Significance: Successful outcomes were achieved with the XLIF procedure in our series of grade II spondylolisthesis patients.

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119. Reduction of High Grade Adolescent Isthmic Spondylolisthesis Using a Three-State Shortening Procedure

Hossein S. Mehdian FRCS (Tr & Orth), Arun Ranganathan DNB (Orth), Nanjundappa S. Harshavardhana MS(Orth), Dip. SICOT, Brian J. Freeman DM, FRCS (Tr & Orth)
United Kingdom

Summary: Conventional reduction techniques do not address important anatomical restraints on the L5 and S1 nerve roots during reduction manoeuvre of high-grade adolescent isthmic spondylolisthesis. The senior author has published a safe novel technique in Spine 30(19), E579-84. We report clinico-radiological results of a case series of 7 patients treated by this innovative single operative session three stage surgery which facilitated anatomical reduction, restoration of sagittal balance with a minimum follow-up of 2 years in management of such challenging deformities.

Introduction: The optimal management of severe adolescent isthmic spondylolisthesis (Meyerding Gr ≥3) is controversial. Anatomical reduction is desired to restore normal biomechanics and sagittal balance.

Methods: 8 patients (4M & 4F) operated over 7 years (2000-06) for high-grade spondylolisthesis formed the study cohort. The slip was Meyerding Gr III(3), IV(4) & spondyloptosis(1) respectively. The mean duration of symptoms (back/leg pain) was 13.7 months (r 6-24 mo) and the mean age at surgery was 15 years (r 12.3-17.3 yrs). We measured slip angle (SA), percentage of slip (%S), sacral slope (SS) and sagittal vertical axis (SVA) and correlated them with Oswestry disability index (ODI) & Visual analog scale (VAS) pain score as outcome mesures. All underwent a single operative session 3 procedure surgery which included:-

1) Extensive posterior decompression of L5 and S1 nerve roots with sacral dome osteotomy.

2) Anterior L5/S1 discectomy by trans-peritoneal approach

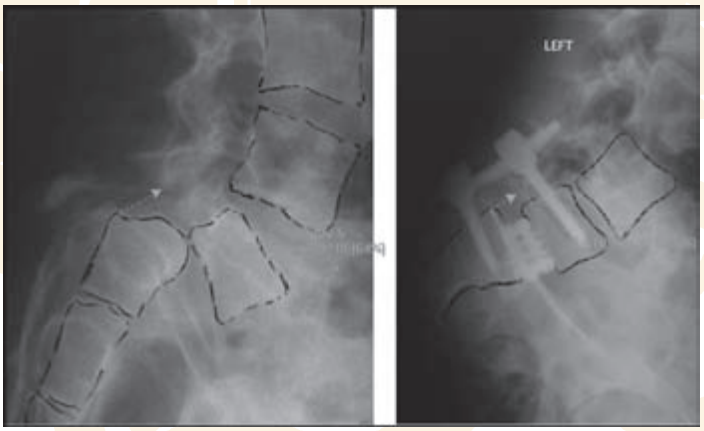
3) Reduction of spondylolisthesis & instrumented posterior lumbar interbody fusion (PLIF) using interbody cages.

Results: Anatomical reduction was obtained in all but 1 case of spondyloptosis which reduced to Gr II. The mean operative time was 6.5 hours (r 5-8 hrs) with a mean blood loss of 0.45 times estimated blood volume (EBV) (r 0.28-0.80). The mean follow-up was 4.5 years (r 2-7 yrs). The mean pre-op L5 SA & SS were 30 (r 21-43) & 16 (r 8-28) which reduced to 2 (r 0-7) & 38 (r 25-43) respectively post-operatively. The mean posterior shit of SVA was 38 mm (r 14-55mm). The mean change in ODI was 46% (pre-op 56% to post-op 10%) and VAS improved from 8 to 1 post-operatively. One patient with Gr IV listhesis had transient L5 paresis that recovered fully by 3 months. There was no pseudoarthrosis or loss of reduction at final f/u.

Conclusion: The technique is safe, permits anatomical reduction with minimal column shortening (as compared to spondylectomy) and restores normal biomechanics at lumbo-sacral junction.

Significance: The 3 stage procedure facilitated immediate anatomical reduction, circumferential fusion and stabilisation of high grade spondylolisthesis without any neurological deficit with excellent outcome in this study cohort.

Near anatomical reduction of Gr IV spondylolisthesis (Slip angle 42 reduced to 2)



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120. Single Level Lumbar Fusion for Grade I and II Spondylolisthesis Correction Using the AXIALIF Rod System

W. B. Rodgers MD, Curtis Cox MD, Edward Gerber
USA

Summary: 67 patients were treated with the AxiaLIF procedure for grade I or II spondylolisthesis. Results are presented.

Introduction: Spondylolisthesis correction has been conventionally addressed by lumbar fusion of the slipped segment. The applicability of MIS techniques to this diagnosis is expanding. MIS transsacral fusion (AxiaLIF) offers the opportunity to address spondylolisthesis correction and spare the facet joint and surrounding ligamentous tissues to the spinal column, thus providing superior stability to the slipped segment. In addition, the directional vector of placement of the intervertebral device facilitates reduction of the listhetic segment. Herein, we report our early results using this approach. To our knowledge, this represents the first report of the use of this technique in spondylolisthesis.

Methods: Sixty-seven patients (28 M,39 F, age 53.8 yrs, BMI 31.6) were treated with AxiaLIF fusion at L5-S1 for either a Grade I (n=54) or Grade II (n=13) spondylolisthesis. The VAS scores, disc heights, and improvement in slip and complications are presented.

Results: VAS improved by 76% over the first six months; disk height increased 3.7 mm from preop to postop (although there

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was some settling (1.3 mm) by 6 months); listhesis was halved and this reduction was maintained over time. There were no infections, neural or visceral injuries, or hardware failures. One patient had mild gapping of his coccygeal incision that was treated with local dressings and resolved, and one patient had a graft herniation requiring laminotomy.

Conclusion: Using proper care, a transsacral MIS approach using the AxiaLIF fixation system at L5-S1 for a Grade I or Grade II spondylolisthesis provides a readily reproducible and safe alternative to traditional open procedures. This approach provides adequate reduction of a Grade I or II spondylolisthesis due to the added contribution in biomechanical stability of the intact surrounding ligamentous tissue. Meticulous attention to operative technique is required but the early results demonstrate excellent clinical outcomes with minimal morbidity.

Significance: Our results are promising and support the use of the AxiaLIF procedure as a viable minimally invasive option for the treatment of spondylolisthesis at the L5-S1 level.

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121. Mini Open PLIF with Minimal Invasive Pedicle Screw Insertion

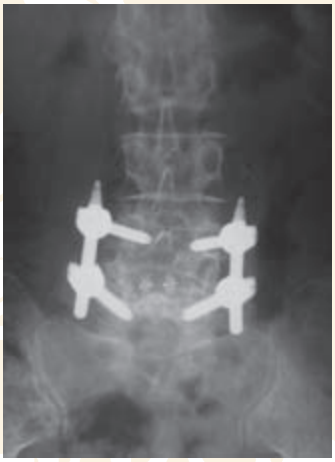
Tetsuo Ohwada, Shozo Suzuki, Kimihiko Onoue, Tomoya Yamashita
Japan

Summary: Seventy-three cases of degenerative lumbar diseases were treated by ordinal PLIF operation, combined with minimal invasive pedicle screw system. Clinical results were discussed and utility of this method was evaluated.

Introduction: We applied ordinal PLIF method with minimum skin incision combined with recent advanced minimal invasive pedicle screw system.

Methods: Since Nov. 2006, seventy-three cases of degenerative lumbar diseases had been operated by means of PLIF with MIS screw insertion. There were 24 males and 49 females, with the average age of 65.0 years.

Diagnosis were degenerative spondylolisthesis in 61 cases, LCS in five, MOB in four, isthmic spondylolisthesis in two, and disc herniation in one. PLIF was performed in single segment in 61 cases, and two segments in 12. First, PLIF operation was performed with midline incision. In single segmental PLIF, only one segment was exposed with 5cm incision. Decompression and fusion were performed in a direct visualization, with Brantigan I/F cage and local bone autograft, and MIS pedicle screw instruments were inserted fluoroscopically.



Results: Operation time on single PLIF averaged 146.5 minutes. Estimated blood loss averaged 162 ml.

Peri-operative complication occurred in 11 cases (15%). Neurological deterioration due to hematoma occurred in 5 cases, and surgical intervention was needed in two. Screw malposition was identified in 5 cases, and two cases with medial malposition required re-insertion. Superficial wound infection occurred in one.

Clinical results were evaluated in 54 cases, which were followed more than one year. Excellent clinical outcome was achieved in 29 cases (53.7%), good in 15 (27.8%), fair in 8, and poor in two. The average follow up period was 18.6 months.

One case with poor result complained of radicular symptom after hematoma, and the other case complained of upper nerve root irritation due to adjacent segment degeneration.

As a fusion results, union was confirmed in 52 cases (96.3%).

Conclusion: This PLIF method focused on direct visualization of the neural elements, which may avoid neurological complication. Pedicle screw insertion was carried out in MIS manner, which preserve back muscles from dissection and postoperative backache. More than 80 % of the cases had satisfactory results.

Significance: PLIF operation can be carried out with in small skin incision, without dissecting back muscles. MIS pedicle screw insertion is also useful in this method.

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122. Extreme Lateral Interbody Fusion (XLIF) for the treatment of Degenerative Spondylolisthesis

Luiz Pimenta MD PhD, Juliano Lhamby, Etevaldo Coutinho, Leonardo Oliveira BSc
Brazil

Summary: Satisfactory clinical outcomes for the treatment of degenerative spondylolisthesis have been reported, but its optimal surgical treatment still remains unclear.

Introduction: The purpose of this paper is to present the extreme lateral interbody fusion (XLIF) minimally invasive for the treatment of degenerative spondylolisthesis, to stabilize, and improve the sagittal balance, foramen height and indirect decompression.

Methods: 27 patients, 9 males and 18 females, mean age 62.2 (39-85 years) up to two year follow up with a diagnosis of degenerative spondylolisthesis at L3-L4 or L4-L5. Lateral, A-P, and flexion-extension X-rays, neurological examination, and clinical outcome assessment using Oswestry and VAS scores were performed at the preoperative, 1, 6 week, 3, 6, 12 and 24 months postoperative intervals. The extreme lateral approach was done through the retroperitoneal space and through psoas muscle avoiding neurological and vascular lesions. A discectomy was done and the

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end-plate cleaned, a cage settled with graft and the ALL and PLL were preserved, adding more stability, thus the ligamentotaxis. In 16 patients the cage was left stand alone and 11 used pedicle screws for posterior supplementation.

Results: The procedures were performed without complication in an average 121 minutes and with less than 50cc blood loss. VAS pain scores improved from the average 8.84 at pre-op to 3.2 at 2 years, standard deviation 1.75 and 1.16 respectively. Oswestry scores improved from an average 58.44 at pre-op to 20.75 at 2 years with standard deviation of 12.79 and 9.32 respectively. In the two groups, stand alone or supplemented with pedicle screws, occurred fusion, with no difference of consolidation time.

Conclusion: Using the XLIF technique we were able to treat the deformity, improving pain, providing stabilization and fusion, with a quicker and better postoperative period.

Significance: The XLIF technique has shown to be a safe and reproducible technique to treat spondylolisthesis deformity thought a minimally invasive way.

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123. Anatomic Mapping of Lumbar Nerve Roots Using a Direct Lateral Transpsoas Approach to the Spine

Kelley Banagan, Kornelis Poelstra MD PhD, Steven Ludwig, Daniel Gelb MD
USA

Summary: A cadaveric approach to evaluate structures at risk during a direct lateral transpsoas was performed.

Introduction: The direct lateral transpsoas approach is a novel technique that has been described for anterior lumbar interbody fusion. The purpose of this study was to identify the structures at risk during the direct lateral transpsoas approach to the spine and to minimize the risk of intra-operative nerve injury.

Methods: Sixteen dissections were performed on fresh frozen male cadavers. Eight were performed to localize the proximal lumbar nerve roots, ilioinguinal, and genitofemoral nerves, their relationship to the psoas muscle and disc space. Four simulated the direct lateral transpsoas approach with a K-wire placed into the mid-disc space under fluoroscopy. Sequential dilators were placed in the final four, the disc space evacuated and an interbody device placed. Dissections were performed to identify potential nervous structure damage.

Results: In the initial dissections, perforating branches of the lumbar nerve roots were identified in the anterior, middle and posterior third of the psoas muscle. The sympathetic chain was identified in the anterior third of the psoas over the disc spaces of L1-L4. The distance from the middle of the anterior longitudinal ligament at the level of the disc to the sympathetic chain averaged 9.25mm. The nerve roots and the genitofemoral nerve were placed at risk in all dissections in which the approach was recreated. Damage secondary to K-wire placement was found in 25% of cases at L3/L4 and L4/L5; in one,the L4 nerve root was pierced, in another the genitofemoral nerve was pierced. The K-wire was posterior to the nerve roots in 25% of cases at L3/L4, and in 50% of cases at L4/L5. The lumbar plexus was placed under tension due to sequential dilator placement. Hip flexion/extension did not affect these results.

Conclusion: On the basis of the dissections, the lumbar nerve roots are at greater risk during the direct lateral transpsoas approach than was previously reported. Even in the anterior third of the psoas muscle the nerves appear vulnerable to injury.

Significance: To avoid damage to the lumbar nerve roots the direct lateral transpsoas approach should be performed with free running EMG neuromonitoring, or dissection through the psoas should be done with direct visualization.

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124. Local Application of Low-dose Depo-Medrol is Effective in Reducing Immediate Postoperative Back-pain- A Prospective Randomized Case-control Study in 59 Patients with Single Level Lumbar Disc Herniation

Kook Jin Chung
Korea, South

Summary: Patients with disc herniation, 28 in control(C) and 29 in steroid group(S). After discectomy, Depo-Medrol soaked Gel-foam was applied over affected root in only S group. Postoperatively, patients were asked to evaluate backache using VAS.

There was no statistical difference on preopertive index. Difference was significant ($p<0.0001$) regarding postoperative VAS during first month and then it became insignificant.

Introduction: Perioperative use of corticosteroids and bupivacaine has been reported as effective analgesia and decease opioid or analgesic usage without complications. Literature described local or systematic uses of various steroids in lumbar disc patients. However uses of these methods in high-doses predispose the risk of postoperative infections. In addition the studies describing the success of local steroid application after surgery use control group that had received application of collagen foam or fat graft soaked in saline. We present prospective, randomized case-control study of local application of low-dose Depo-Medrol (Methylprednisolone) on the affected nerve root postoperatively. We have compared our results with control group who did not receive local application of Depo-Medrol or saline postoperatively.

Methods: 57 patients with L4-5 or L5-S1 single level disc herniation with unilateral leg pain were selected for the study. Study was divided in two groups. 28 patients were in control group and 29 were in steroid group. Discectomy was done after flavotomy in all patients. In steroid group low-dose 40 mg Depo-Medrol soaked Gel-foam was applied over the affected nerve root after discectomy while in control group neither saline nor plain Gel-foam applied to affected nerve root. Postoperatively, patients'

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were asked to evaluate their back pain using VAS score which was compared statistically using un-paired t-test.

Results: There was no statistical difference between steroid and control groups regarding age, duration of symptoms, level of involvement, follow-up and preoperative VAS score. However the difference was significant (p<0.0001) regarding postoperative VAS score during first month and then it became insignificant. There was no infection or any other complications noted in the study.

Conclusion: Results indicate that local application of low-dose Depo-Medrol is helpful in reducing immediate postoperative back pain after discectomy.

Significance: We can say that local application of low dose Depo-Medrol reduces immediate postoperative back pain and leg pain effectively without any risk of infection.

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125. Reduction of Mean Arterial Pressure During Surgical Exposure Safely Reduces Operative Blood Loss and Transfusion Requirements

Kushagra Verma MS, David Vecchione BA, Laura E. Dean BA, Joshua D. Auerbach MD, Baron S. Lonner MD
USA

Summary: Spinal fusion surgery for Adolescent Idiopathic Scoliosis (AIS) has been associated with significant blood loss and transfusion requirements. Reduction of Mean Arterial Pressure during surgical exposure is controversial. However, proper management of blood pressure safely reduces operative blood loss and transfusion requirements in patients with AIS.

Introduction: Reduction of mean arterial pressure (MAP) during surgery to control operative blood loss has been debated in terms of efficacy and potential for neurologic complications. The purpose of this study was to analyze the management of MAP for its impact on blood loss, transfusion requirements, and complication rates.

Methods: We reviewed medical records from 340 adolescent idiopathic scoliosis (AIS) patients treated with spinal fusion by a single surgeon from 2000-2007. Variables assessed included: age, gender, body mass index (BMI), associated comorbidities, pre-operative hematocrit, radiographic measurements, perioperative data, and complications. MAP was estimated from the anesthesia flow sheet during both surgical exposure (SE-MAP) and the entire surgery (Avg-MAP). Surgical exposure was defined as the time from incision to the point of instrumentation. Patients were also stratified into groups by SE-MAP (Group 1: <66; Group 2: 66-75; Group 3: >76) and analyzed with a t-test for relative blood losses. Blood loss was also analyzed with a multivariate regression analyses (statistical significance p<0.05).

Results: Mean blood loss was 920±777 ml for posterior spinal fusion (PSF, n=183), 319±168 ml anterior spinal fusion (ASF, n=127), and 1190±755 for combined procedures (n=30). Regression analysis identified the MAP during surgical exposure to be a predictor of blood loss (p <0.05). This was true for patients undergoing ASF or PSF. There were no neurologic complications.

Conclusion: Proper management of blood pressure during surgical exposure safely reduces operative blood loss and transfusion requirements in the AIS patient. MAP below 65 during surgical exposure is well tolerated and did not lead to any neurologic complications.

Significance: Reduction of MAP during surgical exposure reduces blood loss and transfusion requirements. Allogenic transfusions can lead to adverse outcomes and is a common concern for families considering spinal fusion surgery.

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126. Differences in Male and Female Spino-Pelvic Alignment in Asymptomatic Young Adults - A Three-Dimensional Analysis Using Upright Low-Dose Digital Biplanar X-Rays

Michiel Janssen, Xavier Drevelle, Ludovic Humbert, Wafa Skalli PhD, René M. Castelein MD PhD
Netherlands

Summary: This is the first accurate 3D analysis of differences in the spinopelvic alignment including sagittal vertebral inclination of each vertebra between the sexes. It is demonstrated that the spine as a whole, as well as individual vertebrae in certain regions are more backwardly inclined in females than in males. This suggests that the female thoracic spine is a rotationally less stable construct than the male spine, shedding new light on the well known predominance of girls with idiopathic scoliosis.

Introduction: Given the fact that some spinal disorders, such as idiopathic scoliosis but also Scheuermann's disease have sex-related prevalence rates, it is surprising that only a few studies have analyzed differences in the normal spino-pelvic alignment between the sexes. Moreover, no study has ever analyzed the differences in sagittal spinopelvic alignment and sagittal inclination of each individual vertebra between the sexes with an accurate 3D reconstruction technique. This is the primary goal.

Additionally, in this age of instrumented spinal fusion and an emphasis on restoration of sagittal spinal balance, it is of great importance to have a set of reference values of normal spinal alignment in men and women.

Methods: Simultaneous biplanar radiographs from head to feet in a freestanding upright position were obtained of 30 asymptomatic women (mean age of 26 yrs, range 20-42) and 30 asymptomatic men (mean age of 27 yrs, range 21-49) using the EOS imaging device (Biospace Med, Paris). Subsequently, a 3D reconstruction of the bony shape of the spine, sacrum and pelvis was made by two observers using accurate reconstruction software. Independent samples t-tests were used to analyze differences in the spinal and pelvic parameters between the genders.

Results: Age and BMI was equally distributed between the sexes. The female spine was significantly more dorsally inclined (11°

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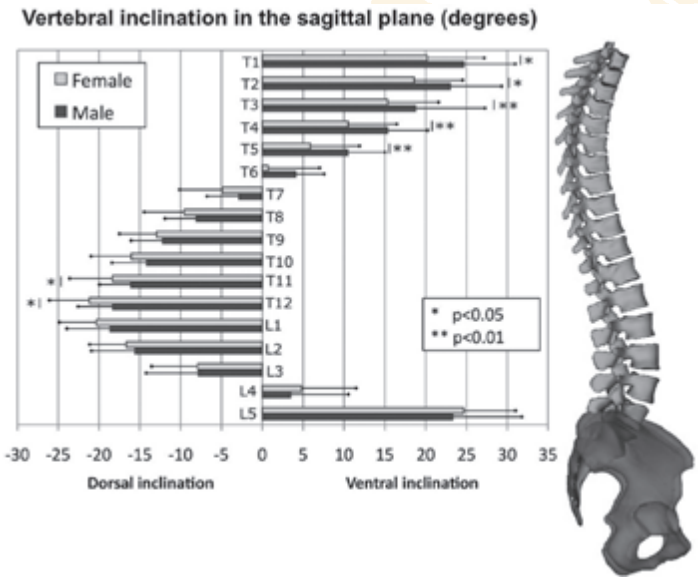
vs 8°; P<0.01). High thoracic and thoracolumbar vertebrae were significantly more dorsally inclined in women (Figure). The inter and intra observer reliability were both excellent.

Conclusion: An important biomechanical consequence of our results is that the female spinel is more subjected to dorsally directed shear loads (DDSLs). DDSLs make spinal segments less rotationally stable as was shown by Kouwenhoven et al. in a previous biomechanical studie (Spine 2007). This signifies that certain areas may be less rotationally stable already in the normal female population, and may explain why progressive idiopathic scoliosis (under certain still undetermined circumstances during growth) occurs more in girls than in boys.

Significance: This study sheds new light on the well known predominance of girls with idiopathic scoliosis and the etiology of idiopathic scoliosis in general.

Mean vertebral inclination in the sagittal plane (and SDs) of T1-L5 in men (n=30) and women (n=30). All measurements are in degrees. Upper thoracic and thoracolumbar vertebrae are significantly more dorsally inclined in women.



127. Outcomes Of Minimally Invasive Surgery (MIS) Compared To Open Fusion For Spondylolisthesis

Y. R. Rampersaud MD FRCS, Mladen Djurasovic MD, Leah Y. Carreon MD MSc, Oma D. Persaud MSc, Paul A. Anderson, Steven D. Glassman MD
Canada

Summary: One level MIS fusion resulted in improved one-year outcomes (ODI, SF-36) compared to open fusion for low-grade isthmic or degenerative spondylolisthesis.

Introduction: The primary objective of this study was to compare patient reported outcomes (PRO) following MIS or Open fusion for spondylolisthesis.

Methods: A retrospective cohort study of prospectively collected data was performed. One level instrumented fusions for low grade (I-II) spondylolisthesis from 3 centers, using either a posterior MIS (2 centers: TLIF-n=59) or Open technique (2 centers: TLIF-n=43 / posterolateral-n=87), with a minimum of 1 year follow-up and baseline patient reported outcomes (PROs) were compared. The primary clinical outcome measure was change in ODI at 1 year. The secondary measures were pain scores and SF-36 PCS/MCS.

Results: As shown in table 1, both groups demonstarted significant clinical improvement, however, there were greater improvements in the MIS compared to Open group in ODI and PCS at 1 and 2 years. Using ODI as the dependent variable, linear regression demonstrated that MIS, revision status and baseline PRO were significant factors at one year and MIS and baseline PRO at 2 years. Age, sex, BMI, co-morbidity, type of spondylolisthesis (degenerative or isthmic) and complications did not affect ODI. Significantly more patients (p<0.05) reached the minimum clinically important difference in the MIS group at 6m for back (81 vs 62%) / leg (88 vs 65%) pain; at 1year for leg pain (83 vs 60%), ODI (72 vs 52%) and PCS(78 vs 59%); and 2years for ODI (82 vs 64%) and PCS (85 vs 59%). Significantly more patients (p<0.05) reached the substantial clinical benefit in the MIS group at 6m for back (75 vs 49%) / leg (84 vs 56%) pain, and PCS (66 vs 46%); at 1year for leg pain (73% vs 42%), ODI (62 vs 42%) and PCS (76 vs 54%); and 2year for ODI (68 vs 47%) and PCS (82 vs 55%).

Conclusion: In this multicentered cohort study, the MIS technique independently demonstrated superior outcomes at 1 and 2 years postoperatively compared to open fusion for spondylolishtesis.

Significance: Based on the results of this study, MIS fusion for spondylolisthesis, should be considered a viable surgical management option. Further follow-up with increased patient numbers and participating centers are required to further validate the generalizability of these findings.

128. Restoration of Lumbar Lordosis: A Comparative Study of Four Commonly-Used Surgical Techniques

John R. Dimar MD, Steven D. Glassman MD, Venu Vemuri MD, Justin Esterberg MD, Jennifer M. Howard MPH, Leah Y. Carreon MD MSc
USA

Summary: Four surgical techniques evaluated in a single center review of age and sex matched patients who had a single-level instrumented decompression and fusion between L4 and S1 showed that posterolateral fusion produces a greater loss of lordosis compared to translumbar interbody interbody fusion (TLIF), anteroposterior fusion with posterior instrumentation, and anterior interbody fusion with LT Cages. Maintenance of lordosis and anterior and posterior disc space height is significantly better with anterior interbody fusion with LT cages.

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Introduction: One of the major sequelae of lumbar fusion is acceleration of adjacent level degeneration with the resultant decrease in lumbar lordosis and an increase in positive sagittal balance which is poorly tolerated. Great effort has been directed towards the development of surgical techniques that preserve or improve lumbar lordosis. This study evaluates the effectiveness of four common fusion techniques in restoring lordosis after lumbar fusion.

Methods: This is a single center, retrospective review of age and sex matched patients that underwent a single-level instrumented decompression and fusion between L4 and S1. Four techniques were evaluated: instrumented posterolateral fusion (PLSF), translumbar interbody fusion (TLIF), anteroposterior fusion with posterior instrumentation (2n1), and anterior interbody fusion with LT Cages. Radiographs were measured preop, immediately post-op and a minimum of 6 months postop by three spine surgeons on two separate occasions. Parameters measured included anterior and posterior disc space height, lumbar lordosis from L3 to S1 and surgical level lordosis using a digital protractor. Statistical analysis was done using ANOVA.

Results: There was no significant difference in age, sex or smoking history among the four groups. All pre-op parameters were similar among the four groups. Lumbar lordosis at final follow-up showed no difference between the 2n1, TLIF & LT groups while the PLSF group showed a significant loss of lordosis (-10.0°, p<0.001). Immediately postop and on follow-up, the LT cage group had a significantly greater amount of lordosis compared to the other groups. The LT cages also showed maintenance of anterior and posterior disc space height postop when compared to the 2n1, TLIF, and PLSF groups. At final follow-up the greatest increase in the anterior and posterior disc space height was in the LT cage group (Table 1). Inter- and intra-rater reliability coefficients are summarized in Table 2.

Conclusion: PLSF produces a greater loss of lordosis compared, to 2n1, TLIF, and LT Cages. Maintenance of lordosis and anterior and posterior disc space height is significantly better with AIBF with LT cages compared to PLSF, 2n1, and TLIF.

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Table 1. Summary of Radiographic Parameters

MEASURE	ALIF	PSF	TLIF	LT	p-value
L3-S1 Lordosis					
Pre-operative	52.2	49.2	48.4	44.3	0.203
Immediate Post-operative	44.1	43	41.4	40.6	0.825
Follow-up	44.5	39.6	45	41.8	0.124
Post-operative Change from Pre-op	-8.1	-6.2	-7	-3.6	0.754
Follow-up Change from Pre-op	-7.7	**-10**	-3.3	-2.4	**0.001**
Surgical Level Lordosis					
Pre-operative	17.6	17	15.8	20.4	0.095
Immediate Post-operative	19.2	16.6	15.5	**25**	**0.004**
Follow-up	18.1	15.5	15.4	**21.3**	**0**
Post-operative Change from Pre-op	1.6	-0.4	-0.3	4.6	0.237
Follow-up Change from Pre-op	0.4	-1.5	-0.2	0.9	0.355
Anterior Disc Height					
Pre-operative	8.6	7.8	7.8	9.4	0.268
Immediate Post-operative	13	9	10.8	**17.5**	**0**
Follow-up	12.5	8.5	10.6	**17.5**	**0**
Post-operative Change from Pre-op	4.4	1.1	3	**8.1**	**0**
Follow-up Change from Pre-op	3.7	-0.2	1.3	**3.8**	**0**
Posterior Disc Height					
Pre-operative	3.3	3.8	3.8	3.3	0.292
Immediate Post-operative	5	3.6	5.1	**7.1**	**0**
Follow-up	4.7	3.5	4.6	**7**	**0**
Post-operative Change from Pre-op	3.9	0.5	2.7	**8.1**	**0**
Follow-up Change from Pre-op	1.4	-0.4	0.8	**3.8**	**0**

Table 2. Inter- and Intra-rater Reliability

	Inter-rater ICC	Intra-rater reliability		
		A	B	C
L3-S1 Lordosis				
Pre-operative	**0.891**	**0.663**	**0.736**	**0.647**
Immediate Post-operative	**0.175**	0.192	0.094	**0.541**
Follow-up	**0.795**	0.227	0.191	**0.386**
Surgical Level Lordosis				
Pre-operative	**0.654**	**0.849**	**0.88**	**0.911**
Immediate Post-operative	**0.631**	-0.067	-0.148	**0.905**
Follow-up	**0.536**	**0.317**	**0.268**	0.196
Anterior Disc Height				
Pre-operative	**0.64**	**0.628**	**-0.031**	-0.167
Immediate Post-operative	**0.637**	-0.133	-0.029	**0.565**
Follow-up	**0.614**	**0.317**	**0.272**	**0.3**
Posterior Disc Height				
Pre-operative	**0.48**	**0.552**	**-0.167**	**0.38**
Immediate Post-operative	**0.627**	**0.374**	-0.027	**0.567**
Follow-up	**0.243**	**0.277**	**0.276**	**0.36**

129. Evaluative Comparison of Patient Based vs. Physician Based Outcome in Posterior Lumbar Fusion

Thomas Zweig, Emin Aghayev, Markus Melloh, Rolf Sobottke, Max Aebi, Christoph Röder MD MPH
Switzerland

Summary: Data of Spine Tango (>14k ops) were used comparing phys. vs pat. based outcome

Introduction: PLIF is one of the frequently performed procedures. High percentages of good and excellent results are indicated by physicians. On the other hand isolated patient-based outcomes are reported.Little is known about correlation of these two assessment types.We aimed at their comparison.

Methods: The analysis included 567 patients from the intl. registry "Spine Tango". 453 patients with degenerative disease and PLF had preop. and postop. VAS separately indicating back- and leg-pain, surgery and follow up data. Mean age was 57y; female/male ratio was 52% to 48%. Remaining 114 patients with the same diagnoses and treatment had additional preop. and postop. Oswestry disability indices (ODI). McNab criteria "excellent, good, fair and poor" were compared to ODI, VAS back- and leg pain and to the patients answer describing the outcome of the operation: "helped a lot"- "helped"-"helped only little"-"didn't help"-"made things worse". Then we used the concept of minimum clinically important difference(MCID).

Results: In the "excellent"-group ODI-improvement was detected

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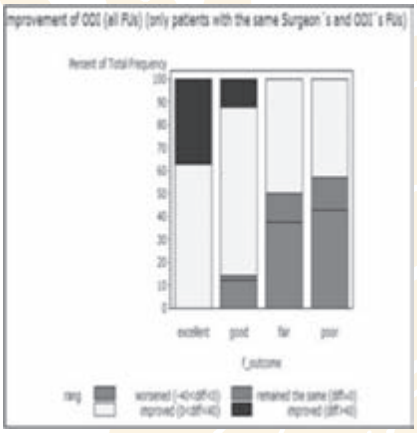

for all patients, the proposed MCID was reached in 90% for ODI. According to this model 85.2% of patients reached MCID for VAS leg pain and 54.1% for VAS back pain. All patient said that the treatment helped or helped a lot In the good-group 86% (MCID: 51.7%) of patients improved regarding ODI, 81% (MCID: 65,7%) regarding back and 93% (MCID: 89.4%) regarding leg pain. 99% of patients said that the treatment helped a lot, helped or helped only little. In the fair-group 65% (MCID: 40%) of patients had improved ODIs. Even in this group 88% of patients perceived the treatment as helping a lot, helping or helping only little. Moreover in the poor-group had 60% (MCID: 40%) of patients improved ODIs, 55% alleviated back pain. Spearman correlation coefficients were: 0.42, 0.18, 0.27,0.53.

Conclusion: The analysis of patient and physician-based outcomes showed correlation with the highest correlation coefficient for patient's verbal statement. With this study we can state that there is strong evidence that physicians evaluation of outcome is very good corresponding with the patients' perception of success or failure of the analyzed procedure.

Significance: Findings have high significance level.

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130. A Survey of Bone Grafting Options Selected by Surgeons for Combined Anterior and Posterior Procedures

John R. Dimar MD, Steven D. Glassman MD, J. Kenneth Burkus MD, Timothy R. Kuklo MD, Scott Boden MD, Sigurd Berven MD
USA

Summary: There is limited guidance for the surgeon in the choice of bone graft material. This study presents a survey of spine surgeons preferences of grafting material for various clinical scenarios in healthy hosts & hosts with co-morbidities. The results demonstrate highly variable graft selection among the surgeons demonstrating the need for further studies to delineate improved evidence based graft usage.

Introduction: The use of bone graft materials in the treatment of spinal disease is variable due to the limited data available on the efficacy the various bone graft materials in achieving a solid radiographic fusion & improved clinical outcomes. Factors other than clinical evidence may also influence the choice of which material a surgeon chooses. The purpose of this study is to appraise what factors influence a surgeon's selection of bone graft materials in anterior & posterior fusions (360°).

Methods: An independent survey was done on an online surgeon website and at spine society meetings that asked practicing spine surgeons to select their preferred graft substitutes from a list of 10 commonly used materials. The surgeon participants were given 2 clinical scenarios; either healthy hosts or those with significant co-morbidities including diabetes, smoking, steroid use and osteoporosis. Specific factors that predicted the surgeon's choice of bone graft material were identified using multiple regression analysis.

Results: There were 516 respondents with 389 surveys completed for the healthy host scenario & 385 surveys for the host with co-morbidities. Demonstrated variability in the bone graft material in the interbody space was 45 combinations in the healthy host vs. 48 in the co-morbidity host & 46 vs. 54 in the posterolateral healthy & co-morbidity hosts respectively. ICBG was the preferred grafting material for the interbody space in 21.1% of the healthy hosts & 14.3% of those with co-morbidities while surgeons chose ICBG + Local Bone 13.5% in the healthy host & co-morbidity hosts for the posterolateral fusion. With an IBF & PLF some form of Autograft+ extenders was used in 54.4% & 32.4% respectively in the healthy hosts while rhBMP + extenders was used in 42.8% & 37.5% of the co-morbidity hosts. Factors that were independent predictors of graft selection: older surgeons use less rhBMP, US surgeons use more, industry appeared to have minimal impact on graft material (Table 1).

Conclusion: A surgeon's choice of bone graft material is highly variable & the lack of consistency in the treatment of a 360° fusion demonstrates the need for additional studies to clarify which bone materials are effective.

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131. Prospective, Non-Randomized, Multi-Center Clinical Evaluation of Extreme Lateral Interbody Fusion (XLIF) in the Treatment of Adult Scoliosis

W. B. Rodgers MD, Antoine G. Tohmeh MD, Jonathan A. Hyde MD, Kaveh Khajavi MD, Mark D. Peterson MD, Vedat Deviren, Dzung Dinh, Kade T. Huntsman MD, Leonel A. Hunt MD, James R. Malcolm MD, William D. Smith MD, Sangwook Yoon MD, Ildemaro J. Volcan MD
USA

Summary: Clinical outcomes of XLIF in the treatment of patients with adult scoliosis from a prospective, nonrandomized, multi-center IRB approved study. Results to date have shown that patients demonstrate and maintain significant clinical improvement.

Introduction: Surgical intervention in adult scoliosis patients has traditionally been by large open anterior and/or posterior procedures, which can be accompanied by unacceptable morbidity and risk to the patient. Minimizing patient morbidity, especially in

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high risk elderly patients with preexisting comorbidities, is critical to rapid recovery of these patients. Minimally invasive treatment of adult scoliosis can be achieved with the XLIF approach.

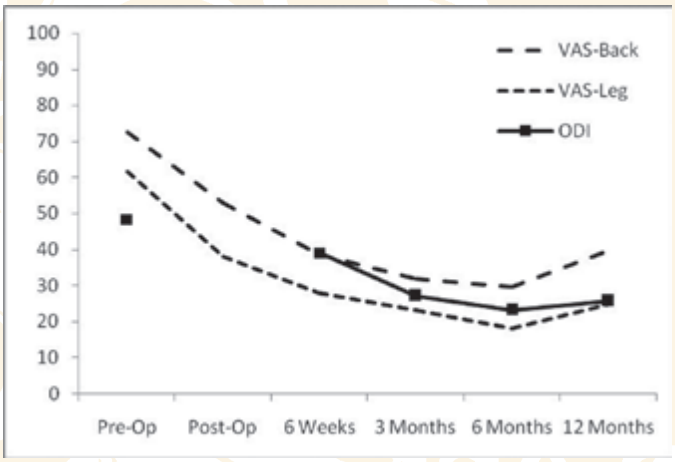
Methods: A prospective, nonrandomized, multicenter evaluation of XLIF in adult scoliosis is ongoing at 17 sites across the US. Clinical (VAS, ODI, SF-36, SRS-22) and radiographic (sagittal & coronal cobb, balance, disc height/subsidence, fusion) data is collected prospectively at the pre-op, surgery, post-op, 6-week, 3-month, 6-month, 12-month and 24-month visits for patients older than 45 years of age with XLIF procedures performed from T8 to L5, with and without instrumentation, who have at least 10° of preoperative coronal curvature.

Results: Seventy-nine patients(mean age:68.33 years, range:45-87 years) underwent XLIF procedures at levels from T12 to S1(mean:2.97 levels/pt, range:1-6 levels) where 74.3% were fixed posteriorly, 17.6% were standalone, and 8.2% used other fixation. Operative time and EBL averaged 55.2 min and less than 50 mL, respectively, per level treated. Mean length of stay was 3.38 days(median:2) overall, with means of 2.65 days(median:1) for non-staged procedures(88%) and 8.88 days(median:8) for staged procedures(12%). Mean VAS for the back and legs improved from preoperative scores of 7.24 and 6.16 to 2.95 and 1.79 and 6 months and 3.97 and 2.48. Mean preoperative ODI improved 48.4% to 23.2% at 6 months and 25.7% at 12 months.

Conclusion: Midterm results from a well designed clinical study highlight the feasibility, safety, and effectiveness of XLIF in this patient population. Longer-term outcomes and maintenance of radiographic correction is forthcoming.

Significance: This is the first prospective, multicenter evaluation of a minimally invasive lateral approach in the treatment of adult scoliosis. Clinical improvement is significant and well-maintained over time. XLIF allows for less invasive surgical treatment of patients who may have been previously considered too high risk for surgery.

VAS-Back, VAS-Leg, and ODI improvement over time in adult scoliosis patients



132. A New Low Profile Sacro-Pelvic Fixation Using S2 Alar Iliac (S2AI) Screws in Adult Deformity Fusion to the Sacrum: A Prospective Study with Minimum Two-Year Follow-Up

Khaled M. Kebaish MD, Albert Pull ter Gunne MD, Ahmed S. Mohamed MD, Ryan Zimmerman, Phebe S. Ko B.S., Richard L. Skolasky ScD, Joseph R. O'Brien MD, MPH, Paul Sponseller MD USA

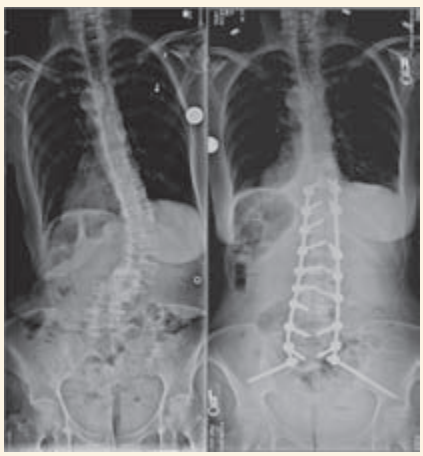
Summary: A prospective study to evaluate a new low profile technique for sacropelvic fixation shows satisfactory results

Introduction: Adult deformity patients undergoing long fusion to the sacrum often require fixation into the ilium. There are many techniques currently available, some are technically difficult & require complex connectors that may affect the construct stability

Methods: We prospectively reviewed 52 consecutive adults undergoing long fusion to the Sacrum using (S2AI) Screws. The technique uses a starting point in the S2 Ala, directed toward the anterior inferior iliac spine, allowing an in-line anchor without additional dissection. Functional outcome, radiographic data and complications were collected. 46 patients completed 2 yrs follow-up, mean 2.5 yrs.

Results: The mean age was 59.8 yrs (±13.0, 23.8-80.8). 76.9 % female, 45 patients had multiple co-morbidities. Mean radiographic changes were (pre-/post): thoracic kyphosis 7.4°(34.2/41.3), lumbar lordosis 13.0°(34.3/47.3), thoracic curve 10.9°(22.3/15.1), lumbar curve 15.1°(30.4/15.3), pelvic obliquity 1.6 (±5.1, -5.5-19.1). At 2 yrs, 92% of the patients showed radiographic fusion at L4-S1. 2 patients had 3 (S2I) screws fracture, neither required revision. Re-operation was performed on 5 patients: improper screw placement (1), pseudoarthrosis proximal to L4 (2), junctional stenosis (1), residual deformity (1). Overall complication rate was 40.4 % (7.7 % minor, 34.6 % major). Complications specific to S2-iliac fixation: screw breakage 2, screw misplacement 1. There was stastically significant improvement in all SRS 22 domains; (pre-/post): pain 1.1 (2.17/3.22), self image 1.1 (2.12/3.19), activity 0.8 (2.39/3.16), mental 1.2 (1.89-3.07), and satisfaction 0.9 (1.91/2.84). The ODI showed a mean decrease 13.4 (40.16/26.79), the SF-12 improvement (physical 12.3, mental 2.2). The VAS showed 5 patients with right SI-joint area pain (mean 4.8), 4 patients had left side pain (mean 5.5).

Pre & post-operative radiographs using S2AI sacopelvic fixation in a 64 yo female with degenerative scoliosis



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There was one superficial and one deep wound infections.

Conclusion: S2 Alar Iliac (S2AI) fixation is an easy, safe & effective method to achieve sacropelvic fixation. Complications related to the technique are rare and the revision rate is low

Significance: We are introducing a new technique for sacro-pelvic fixation that has the potential to simplify fusion to the sacrum, lower complications & improve outcome in spinal deformity surgery

☐ **133. What is the Mechanical Effect of CP Titanium vs. PEEK Rods on the Spinal Implants and the Operative and Adjacent Levels after TLIF?**

Timothy R. Kuklo MD, Joseph L. Turner MS, David Paller
USA

Summary: More rigid instrumentation with CP Ti rods resulted in increased screw strain (bone-screw interface forces) and less interbody device compression (stress shielding), as compared to PEEK rods. Furthermore, there was a trend for increased motion with the more rigid instrumentation (Ti) at the caudal segment, and a trend toward decreased caudal intradiscal pressure, as compared the cage only state. These trends suggest that segments instrumented with PEEK more closely mimicked intact physiological loading in the subadjacent level which may reduce the likelihood of adjacent level disease.

Introduction: To evaluate the effect of rod material (6.35mm PEEK vs. 5.5mm commercially pure titanium) on bone screw and interbody device strain, maximum translation, and adjacent segment disc pressure.

Methods: 12 fresh frozen lumbar cadaver motion segments were instrumented with either 5.5 mm CP Ti rods or 6.35 mm oval PEEK rods (n=6 each) and four multi-axial bone screws and an interbody device. The inferior left bone screws were instrumented with three (axial, shear, and bending) strain gauges, and compression and shear strain gauges were affixed to the interbody devices. Compression (to 700 N) and flexion (to 6 Nm) testing was performed on each segment using custom pure moment fixtures in an Instron servohydraulic test frame [Spenciner et al., Spine J 2006]. Normalized flexion translations (presented as a % of intact values) and normalized caudal level disc pressure measurements (% of cage only state) were also recorded.

Results: Screw strain data was found to be higher in both flexion (up to 4 Nm) and compression (for the test duration) for Ti compared to PEEK. Conversely, interbody device strain was higher for PEEK constructs in both tests. Translation data demonstrated no significant difference between PEEK and Ti constructs at the operative (p=0.132) and adjacent cephalad (p=0.326) levels. Caudal adjacent segment translation showed a statistical trend toward decreased motion with PEEK (p=0.065). Caudal level disc pressure measurements of Ti vs. PEEK were approaching a significant decrease (p=0.055) from the cage only state in compression. No significant difference was observed for pressure in flexion for Ti vs. PEEK (p=0.818).

Conclusion: More rigid instrumentation with CP Ti rods resulted in increased screw strain (bone-screw interface forces) and less interbody device compression (stress shielding), as compared to PEEK rods. Furthermore, there was a trend for increased motion with the more rigid instrumentation (Ti) at the caudal segment, and a trend toward decreased caudal intradiscal pressure, as compared the cage only state. These trends suggest that segments instrumented with PEEK more closely mimicked intact physiological loading in the subadjacent level which may reduce the likelihood of adjacent level disease.

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134. The Role of Vertebra Vector in Characterization and Quantification of Vertebral Position and Orientation in the Horizontal Plane

Tamás Illés MD DSc, Jean Dubousset, Szabolcs Somoskeoy MD
Hungary

Summary: A new concept of vertebra vector and its role in characterization and quantification of scoliotic curves is presented in this study, based on 3D reconstructed images generated by a new sophisticated ultra low-dose 2D/3D radiological system approved for clinical routine diagnostics. A vertebra vector characterizes the position, 3D orientation and size of a vertebra at the same time, providing means for direct quantitative analysis in the Horizontal plane and a new definition of optimal surgical correction.

Introduction: Apart from CT 3D that is rarely used in adolescent scoliosis diagnostics due to high radiation dose, the ability to visualize and analyze scoliotic deformities in 3D was not available in clinical practice. Recently a new 2D/3D digital imaging system based on Nobel prize winning ultra low-dose radiation and precise 3D reconstruction brought a breakthrough in that, providing a unique Horizontal plane view of the 3D spine. After our 1 year of clinical work in 3D spine imaging with this system, moving forward to quantify scoliotic deformities in Horizontal plane required a new approach that is based on our new concept of vertebra vector.

Methods: Pre- and postop EOS examinations, followed by semi-automatic 3D reconstruction of the spine were carried out in a representative case of a 16 years old girl with a right convex thoracic idiopathic adolescent scoliosis, treated according to Cotrel-Dubousset technique using multi-anchors and rods. Position of vector points for apical and end-vertebrae were determined manually based on existing vertebral landmarks. Vector coordinates A, B and vector angle α in the Horizontal plane were obtained after normalization based on built-in 3D calibration of EOS. Numerical

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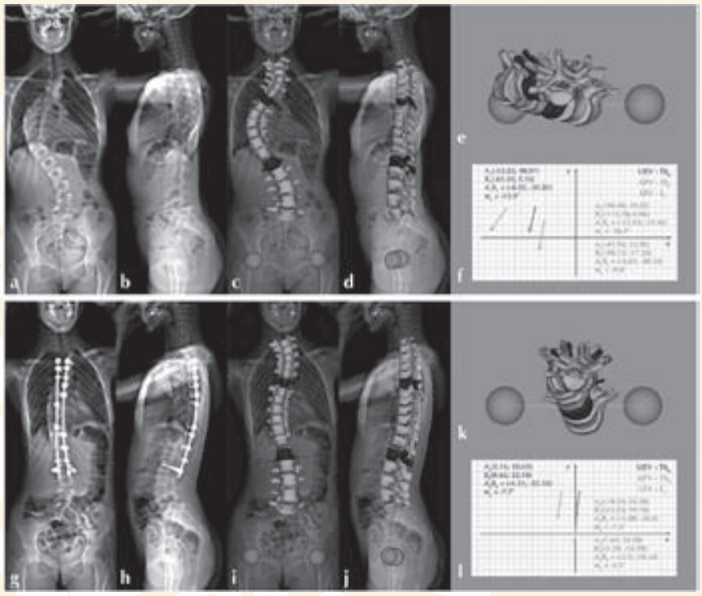
values were calculated in a coordinate system consisting of the interacetabular line and the sagittal median axis using standard vector algebra.

Results: Pre- and postop values for Cobb angle, kyphosis, lordosis and axial rotation of apical vertebra, and vertebra vector parameters of apical, upper and lower end-vertebrae are shown in Table 1. Pre- and postop EOS 2D/3D images, 3D reconstructions and vertebra vector projections in Horizontal plane are shown in Figure 1.

Conclusion: Beyond the essential 3D imaging of spinal geometry in scoliosis by EOS, visualization of vertebra vectors and comparison of their numerical values before and after surgery provides means for direct quantitative analysis in the Horizontal plane and a new definition of optimal surgical correction.

Significance: The ability to routinely visualize spinal deformities in 3D highlights the need for quantification of positional and rotational changes of vertebrae defining the scoliotic curve, especially in Horizontal plane. Our new concept of vertebra vector provides the basis for this approach.



☐ **135. Multi-Directional Flexibility Properties and Abrasion Assessment of an In Situ Cured Polyurethane for Nucleoplasty Reconstruction. An In-Vitro Human Cadaveric Model**

Bryan W. Cunningham MSc, Nianbin Hu, Jun Kikkawa MD, James Klunk BS, Jeffrey D. Gordon MS Mech Eng., Paul C. McAfee MD USA

Summary: The current study was designed to evaluate the multi-directional flexibility and biodurability of an in situ curable polyurethane nucleus pulposus replacement following implantation in a cadaveric spine model. Based on the biomechanical and analysis conducted in the current investigation, it can be concluded that multidirectional flexibility properties (pre- and post-fatigue), intervertebral disc heights and implant location are maintained. There was no evidence of device migration and the current study provides a biomechanical basis for ongoing clinical investigations.

Introduction: The in-vitro current study served to evaluate the multi-directional flexibility and biodurability of an in situ curable polyurethane nucleus pulposus replacement.

Methods: Eight lumbosacral spines were biomechanically evaluated under the following L4-L5 conditions: 1) Intact, 2) Unilateral facetectomy and nucleotomy; 3) Polyurethane device (NuDisc) pre-fatigue and 4) Polyurethane post-fatigue. Flexibility testing included moments of ±10Nm for axial rotation, flexion-extension, lateral bending and 40,000 cycles (±2.5Nm) fatigue loading. Range of motion (ROM) and neutral zone (NZ) were normalized to the intact (100%). The center of intervertebral rotation (COR), intradiscal pressures (psi), intervertebral disc height (mm) changes and extent of polyurethane area (mm2) filling were quantified.

Results: Flexibility testing demonstrated no significant changes in the operative or adjacent level motions for any loading modality - axial rotation, flexion-extension or lateral bending - for the four treatment conditions pre- or post fatigue ($p>0.05$) (Figure 1). Intradiscal pressures at the adjacent levels indicated marked decreases in flexion following nucleotomy, which were restored following implantations ($p>0.05$). No significant differences were observed for the operative or adjacent level COR's when comparing the intact spine or nucleoplasty reconstructions. Intervertebral disc height changes were intact condition (100%), nucleotomy (94.5±11.2%), nucleoplasty pre-fatigue (96.2±13.7%) and post-fatigue (90.45±15.79%) ($p=0.456$). The nucleoplasty effectively reconstructed 83.79±11.98% of the nucleotomy area with no evidence of disc fragment or polyurethane device extravasation.

Conclusion: The current study evaluated the biomechanical properties of the in situ curable polyurethane nucleus pulposus (NuDisc) replacement. Based on the biomechanical and analysis conducted in the current investigation, it can be concluded that multidirectional flexibility properties, intervertebral disc heights and implant location observed in the acute post-operative period are maintained. There was no evidence of device migration and the current study provides a biomechanical basis for the use of this device and serves to augment ongoing clinical investigations.

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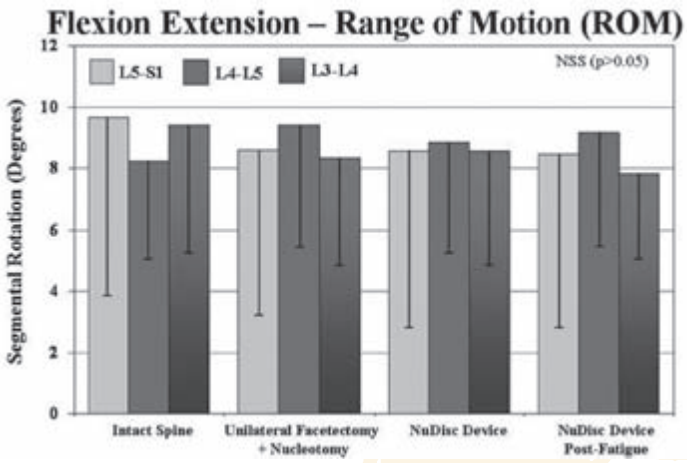
Figure 1



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136. Are There Preoperative Parameters Which Correlate to Worse Preoperative SRS Scores That Surgeons Can Strategize to Correct to Maximize Outcome?

Daniel J. Sucato MD MS, Leah Y. Carreon MD MSc, James O. Sanders MD, Mohammad Diab MD, Peter Sturm MD, Study Group Spinal Deformity
USA

Summary: From a large multi-center database of AIS patients, predictors of worse SRS scores preoperatively were determined. A larger BMI and female gender were the most significant predictors of worse domain scores and coronal imbalance and a large main curve correlated to worse appearance domain scores and total SRS scores. Surgeons should identify these factors preoperatively and focus their attention to improve these parameters, when possible, to achieve optimal results with surgical treatment of AIS.

Introduction: Previous studies have not demonstrated a correlation between postoperative coronal plane Cobb measurement correction and SRS functional outcomes for adolescent idiopathic scoliosis (AIS). It can be hypothesized that specific radiographic or clinical characteristics are associated with worse preoperative SRS scores and if these parameters can be identified, surgical or other treatment strategies to correct them will improve outcomes.

Methods: A large prospective database of preoperative AIS surgical patients was reviewed. Stepwise linear regression analysis was used to determine patient characteristic that were predictive of baseline SRS Domain (pain, activity, appearance, satisfaction, mental health) scores and SRS Total scores.

Results: There were 1006 females and 209 males with an average age of 14.2 ± 2.0 years and a maximum curve measurement of 53.9 ± 18.7°. The main scoliometer reading was 14.2° ± 7.1°, coronal balance was 17.6mm ± 13.7mm, and sagittal balance was -17.7mm ± 33.4mm. The mean domain scores were 4.1 ± 0.7 for Pain, 4.1 ± 0.5 for Activity, 3.3 ± 0.6 for Appearance, 3.9 ± 0.7 for Mental and 3.8 ± 0.5 for SRS Total score. The results of the linear regression analyses are summarized in Table 1. A greater BMI and female gender were the most significant predictors of worse SRS domain scores. Ethnicity is also a predictor of worse SRS Pain, Appearance and Total scores; older age a predictor of worse SRS Pain, Mental and Total scores; prior bracing a predictor for worse SRS Pain and Activity; and trunk shift a predictor of worse appearance. ($p<0.05$) The coronal Cobb angle was predictive of worse SRS Appearance score and total Score. ($p<0.05$)

Conclusion: There are important preoperative parameters which influence SRS scores in patients with AIS. Strategies to improve BMI preoperatively, while focusing surgical attention to improving trunk shift and maximize Cobb measurements should improve postoperative functional scores. A better understanding of the gender, age and ethnicity- associated worse preoperative SRS scores is necessary to improve patient results.

137. Distal Fusion Levels in Thoracolumbar and Lumbar Adolescent Idiopathic Scoliosis: L3 or L4 ?

Se-Il Suk MD PhD, Jin-Hyok Kim MD PhD, Sung-Soo Kim MD, Dong-Ju Lim MD, Chang-Won Jeong MD
Korea, South

Summary: In the correction of Thoracolumbar/Lumbar Adolescent Idiopathic Scoliosis with segmental pedicle screw Instrumentation. the curve can be fused to L3, not L4, saving one distal motion segment when the preoperative L3 rotation is less than Nash-Moe grade II and translation is across the Center Sacral Vertical Line in bending radiographs. If not, fusion has to be extended to L4.

Introduction: This study is to define the proper distal fusion levels in Thoracolumbar/Lumbar(TL/L) Adolescent Idiopathic Scoliosis(AIS) using pedicle screw Instrumentation(PSI).

Methods: Seventy-eight TL/L AIS patients who were treated by PSI with a minimum follow-up 2 years (range: 2-15.8) were retrospectively analyzed for scoliosis correction, lower instrumented vertebral tilt (LIVT) and spinal balance. The patients were divided according to the distal fusion in to two groups ; the L3 group (fusion to L3, n=66) and the L4 group (fusion to L4, n=12). The L3 group was subdivided into 2 groups by bending radiographs; L3-A group (n=39) was L3 rotation less than grade II and translation across the central sacral vertical line (CSVL), and L3-B group (n=27) was rotation more than grade II or translation not across the CSVL. In all L4 groups, L3 rotation was more than grade II or translation not across the CSVL. An unsatisfactory result was defined as an LIVT of more than 10° or a coronal translation of more than 15 mm.

Results: In the L3-A group, the major curve was corrected from 53°±5.4° to 10°±3.4°(80.9%), LIVT from 21.0°±7.5° to 3.3°±2.9°

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and coronal balance from 14±8mm to 5±4mm. In L3-B group, the major curve was corrected from 54°±8.0° to 20°±7.5°(63.5%), LIVT from 23.0°±7.3° to 11.0°±5.3° and coronal balance from 18±11mm to 12±9mm. In the L4 group, the major curve was corrected from 56°±6.1° to 11°±7.6°(79.5%), LIVT from 29.0°±8.0° to 5.5°±5.8° and coronal balance from 16±12mm to 9±4mm. Unsatisfactory results were obtained in 3 patients (7.6%) in L3-A group, 18 (66.6%) in L3-B group and 1 (8.3%) in L4 group, with the worst result in L3-B group.

Conclusion: In the correction of TL/L AIS with segmental pedicle screw fixation, the curve can be fused to L3 with a satisfactory result when L3 rotation is less than Nash-Moe grade II and translation across the CSVL in bending radiographs. If not, fusion has to be extended to L4.

Significance: The selection of distal fusion level remains controversial in TL/L AIS using PSI. The curve can be fused to L3 with a satisfactory result when L3 rotation is less than Nash-Moe grade II and across the CSVL in bending radiographs.

138. Cost Analysis of Adolescent Idiopathic Scoliosis Correction Surgery in 125 Consecutive Cases

Jonathan R. Kamerlink MD, Martin Quirno MD, Joshua D. Auerbach MD, Andrew H. Milby BS, Laura E. Dean BA, Joseph W. Dryer MD, Thomas J. Errico MD, Baron S. Lonner MD
USA

Summary: This is a categorical analysis of surgical and hospital cost, charge, and reimbursement incurred during the surgical treatment of adolescent idiopathic scoliosis (AIS). The individual components of surgery that predict higher cost and charge to hospitals were evaluated.

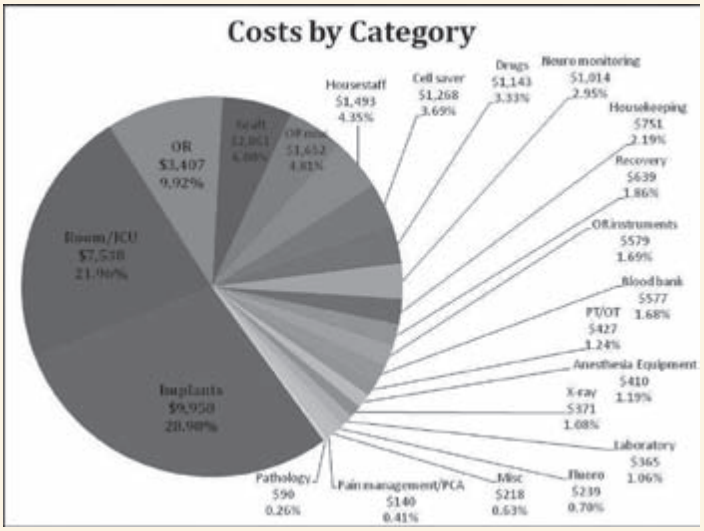
Introduction: Although achieving clinical success is the main goal in the surgical treatment of AIS, it is becoming increasingly important to do so in a cost-effective manner. This study sets out to determine the costs, charges, and reimbursements associated with hospitalization for AIS correction surgery at one institution.

Methods: We performed a retrospective reviewed of 16,536 individual costs and charges including overall reimbursements on 125 consecutive patients who underwent surgical treatment for AIS by 3 different surgeons between 2006-2007 at a single institution. Pertinent demographic, surgical, and radiographic data were recorded for each patient.

Results: Mean age was 15.2 with a mean BMI of 21.8. Females (88) outnumbered males (37) on a 2:1 ratio. The mean measured main thoracic curve was 50°, proximal curve 29°, and thoracolumbar curve 41°. Independently significant increases for total cost were found with number of pedicle screws placed, total levels fused ($1567), and the type of surgical approach ($9,600) (R2 =0.35, p<0.03). Independently significant increases for reimbursement were found with the number of pedicle screws placed and the type of surgical approach ($9,431)(R2 =0.12, p<0.02). The hospital was reimbursed 53% of total charges and 120% of total costs. Reimbursement correlated highest with charge (r=.45, p<0.001). Concerning rehospitalizations, the hospital was reimbursed 65% of charges and 93% of costs. Cost by Lenke curve type: Type 1 = $29,955; Type 2:$31,414; Type 3:$31,975; Type 4: $60,754; Type 5:$32,652; Type 6:$33,416.

Conclusion: Implants accounted for the highest percentage of total cost (29%) followed by ICU and inpatient room cost (22%), and OR (9.9%). The type of surgical approach, screws placed, and number of levels fused were identified as significant independent predictors of higher total cost.

Significance: An accurate analysis of surgical and hospital cost, charge, and reimbursement for NMS is of paramount importance to ensure future equitable allocation of financial resources in this patient population and to provide opportunities for cost containment.



139. Outcomes of Vertebral Body Stapling in Juvenile and Adolescent Idiopathic Scoliosis: A Two Year Radiographic and Clinical Follow-up

Timothy S. Oswald MD, Lindsay M. Andras MD, Erin M. Meehan BS
USA

Summary: A retrospective review of radiographic and clinical follow up at 2 years of vertebral body stapling in idiopathic scoliosis patients.

Introduction: Vertebral body stapling (VBS) has been described as an alternative treatment for juvenile and adolescent idiopathic scoliosis. In the surgical management of scoliosis, VBS offers the theoretical advantage of motion preservation. This study reports the efficacy of vertebral body stapling in patients with greater than two year follow up.

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Methods: Nineteen patients (15 females and 4 males) with idiopathic scoliosis underwent vertebral body stapling without fusion. Patients were premenarchal and Risser 0 or 1 at the time of stapling. Pre and postoperative curve magnitudes were measured. Patients were followed for a minimum of two years postoperatively. Improvement was defined as a decrease in curve magnitude of 10 degrees or more. Progression was defined as an increase of 10 degrees or more.

Results: Seventy-nine percent of patients achieved either improvement or stability of their curve. Of the 19 patients, four (21%) had improvement, eleven (58%) were stabilized, and four (21%) had progression of their curve. Of the four patients that progressed, 3 required spinal fusion for definitive treatment. Ten of 19 had reached skeletal maturity (Risser V) at the time of their last postoperative radiograph. There were no long term complications including migration or failure.

Conclusion: Vertebral body stapling appears to be a safe and effective technique to prevent curve progression in patients with juvenile and adolescent idiopathic scoliosis.

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).

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140. Computed Tomography Evaluation of Axial Vertebral Derotation in Endoscopic Anterior Instrmentation for Scoliosis

James A. Cordell-Smith FRCS, Clayton Adam, Maree T. Izatt B Phty, Robert Labrom, Geoff Askin FRACS
United Kingdom

Summary: The aims of this study were to measure preoperative and postoperative axial vertebral rotational deformity at the curve apex in endoscopically-treated anterior instrumented scoliosis surgery patients using CT, and assess the relevance of these findings to clinically-measured chest wall rib hump deformity correction.

Introduction: Open instrumented anterior spinal fusion for adolescent idiopathic scoliosis (AIS) is a proven technique for vertebral derotation. With the evolution of thoracoscopic approaches, further clinical benefits are possible including reduced pulmonary morbidity and postoperative pain, and improved cosmesis. However, quantitative data on radiological improvement of vertebral rotation using this method is lacking.

Methods: Between November 2002 and August 2005, 20 AIS patients with right-sided thoracic major curves underwent endoscopic single-rod anterior fusion. Preoperative and two-year postoperative CT was performed in accordance with ethical committee approval. Pre and post-surgical axial vertebral rotation was measured at the curve apex. Rib hump deformity correction and change in Cobb angle was correlated to CT findings. Correlation between apical vertebral rotation measured on CT and rib hump measured using a scoliometer was assessed with linear regression.

Results: The mean angle of correction achieved in axial vertebral body derotation at the apical vertebra as measured by CT was 7.9° (median preoperative angle 17.3°, postoperative angle 10.3°). This equated to a 43% improvement. The pre and postoperative clinical measurements i.e. rib hump deformity correction, correlated significantly with CT measurements using regression analysis ($p=0.03$) and the mean improvement in rib hump deformity was 55% (median preoperative 15.0°, median postoperative 7.0°). 95% confidence intervals for intraobserver and interobserver validity were within the ranges ±4.5° to ±6.4°.

Conclusion: We believe this is the first quantitative CT study to confirm endoscopic anterior instrumented fusion for AIS substantially improves axial vertebral body rotational deformity at the apex of the curve. The margin of correction of 43% compares very favourably with historically published figures of 24% for patients with posterior all-hook-rod constructs. CT measurements correlated significantly to the clinical outcome of rib hump deformity correction.

Significance: Endoscopic anterior instrumentation surgery for thoracic adolescent idiopathic curves substantially improves vertebral rotational deformity and this correlates significantly to correction of rib hump chest wall deformity.

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141. Clinical and Radiographic Predictors of Coronal Balance at Two-Years after Surgery for Adolescent Idiopathic Scoliosis with Lenke Type I Curves

John Sarwark MD, B. Stephens Richards MD, Daniel J. Sucato MD MS, Lawrence G. Lenke MD, James O. Sanders MD, John B. Emans MD, Stefan Parent MD, PhD, Daniel Schwartz MD, David Roberts MD, Jason Savage MD, Study Group Spinal Deformity
USA

Summary: Multiple regression analysis was performed on a prospective cohort of 361 patients with adolescent idiopathic scoliosis (AIS) and Lenke type I curves to determine predictors of coronal balance after surgical correction. The lumbar modifier was the only significant predictor of coronal balance at two-year follow-up.

Introduction: Restoration of coronal balance is a goal of corrective surgery for scoliosis. Predictors of coronal balance after surgery have not been clearly defined.

Methods: A multicenter, prospective database of patients with AIS was analyzed. We included patients with Lenke type I curves undergoing primary surgery, who had two-year radiographic data for coronal balance, measured as the distance from the lowest instrumented vertebrae (LIV) to the central-sacral vertebral line (CSVL). Pre-op clinical (age, height, weight, apical thoracic rotation, trunk shift, shoulder height), radiographic (coronal balance, apical vertebral translation, Cobb angle, sagittal balance, lumbar modifier), and SRS scores were evaluated. Linear regression was performed for each variable. Those significant at $p<0.20$ were

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entered into a multiple regression model to determine predictors of coronal balance at two-year follow-up. Subgroup analysis by lumbar modifier was performed.

Results: A total of 361 patients were included. Lumbar modifier was the only significant predictor of coronal balance at two-year follow-up. This accounted for only 2-3% of the variance in mean LIV-CSVL distance (p=0.003). Lumbar A curves had significantly better coronal balance compared to B and C curves together (p=0.008), or C curves alone (p<0.05). Satisfactory coronal balance, defined as LIV-CSVL distance <10 mm, was achieved more frequently for lumbar A curves than for B or C curves. None of the other variables were significant in the model. When stratified by lumbar modifier, there were distinct trends for most frequent LIV. However, differences in coronal balance within each group based on LIV were not statistically significant.

Conclusion: The lumbar modifier was predictive of coronal balance at two-year follow-up. Lumbar A curves had better coronal balance, and were more likely to achieve satisfactory coronal balance than B or C curves. None of the other clinical and radiographic parameters examined were predictive of coronal balance at follow-up.

Significance: This is the first study examining predictors of coronal balance at long-term follow-up after surgical correction for scoliosis.

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142. Adolescent Idiopathic Scoliosis Patients Treated with Pedicle Screw Constructs: Do the Favorable Two Year SRS-30 Outcomes Hold Up at Five Year Follow-up?

Charles H. Crawford MD, Lawrence G. Lenke MD, Woojin Cho MD PhD, Ronald A. Lehman MD, Kathryn A. Keeler MD, Timothy R. Kuklo MD, Brian A. O'Shaughnessy MD, Michael S. Chang MD, Josh D. Auerbach, Brenda Sides MA, Christine Baldus RN MHS, Keith Bridwell MD
USA

Summary: In AIS patients treated with posterior pedicle screw constructs, radiographic parameters and SRS-30 outcomes were stable between the 2-year and 5-year follow-up period, except for a significant decline in the mental health domain. The significant improvements in self-image and function from preoperative to 2-years post-operative were maintained at 5-year follow-up. Patient satisfaction remained high.

Introduction: Studies have shown improvements in SRS outcomes from preop to 2yr postop in patients undergoing surgery for adolescent idiopathic scoliosis (AIS). The first report on 5yr SRS-24 outcomes in AIS showed increased pain subscores between 2yr and 5yr in a multi-center group of 49 AIS patients, 76% of whom underwent anterior procedures. (Upasani et al, Spine 2008) 5yr SRS-30 outcomes in AIS patients have not been reported. We hypothesized that posterior pedicle screw constructs (PPSC) would provide stable outcomes between 2yr and 5yr postop.

Methods: 56 AIS pts from a single center treated with PPSC were analyzed for changes in SRS-30 questionnaires between 2yr and 5yr follow-up. Additionally, detailed radiographic measurements were obtained and correlated with changes in SRS-30 outcomes.

Results: (Table 1) The avg age at surgery was 14+9. Female:male was 44:12. An avg 10.2 levels were instrumented with an avg of 17.2 pedicle screws. The most frequent curve type was Lenke type 1A (30.4%), followed by type 2A (12.5%). 39% of patients had a thoracoplasty procedure. Avg major Cobb measured 61° preop with correction to 22° at 5yr (66% correction). There were no significant radiographic or SRS outcome changes between 2yr and 5yr, except for a decrease in the mental health subscore (4.28 vs 4.08,p=0.02). There was an insignificant trend towards more pain (4.28 vs 4.13,p=0.18) including 7 patients who had pain attributable to a recent injury (n=5) or a new job (n=2). Excluding these 7 patients there was no change in the 2yr to 5yr pain (4.32 vs 4.30,p=0.85), while the decline in mental health remained significant (4.34 vs 4.10,p=0.02). Significant improvements in self-image and function from preop to 2yr were maintained at 5yr. Changes in mental health and pain were not significantly correlated with any demographic or radiographic variables.

Conclusion: At 5yrs, the 2yr improvements in SRS subscores for function and self-image remained stable, although there was a decline in mental health in this young adult population. Contrary to a previous report of primarily anterior procedures, pain levels were not increased between 2yrs and 5yrs in patients treated with PPSC.

Significance: This is the first report on 5yr SRS-30 outcomes in AIS patients.

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143. Comparison of Three Surgical Treatments for Degenerative Lumbar Scoliosis with Symptomatic Spinal Stenosis

Kathy M. Blanke RN, Linda A. Koester BS, Lawrence G. Lenke MD, Ronald A. Lehman MD, Melvin D. Helgeson MD, Dennis Crandall MD, Jan Revella RN, Keith Bridwell MD, Christine Baldus RN MHS
USA

Summary: Degenerative lumbar scoliosis (DLS) with spinal stenosis (SS) is a very common problem for which older patients are seeking treatment when it interferes with their lifestyle. Our study shows that in properly selected patients, surgery for DLS with SS does provide successful clinical and radiographic outcomes and can benefit the aging population.

Introduction: The purpose of our study was to compare 3 different surgical treatments of increasing magnitude for previously untreated degenerative lumbar scoliosis (DLS) with spinal stenosis (SS) with respect to radiographic and clinical outcomes.

Methods: A detailed analysis of 36 DLS patients surgically treated from 1994-2004 was performed. Inclusion criteria: age >50, lumbar scoliosis 10-30°, operative SS, ≥1 level of rotatory

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subluxation, 1-3 level decompression, lumbar fusion only, and minimum 2-year radiographic and clinical follow-up. Patients were divided into 3 groups: 1. decompression alone (n=9; 4M/5F; avg age 71.2); 2. decompression/short fusion (1-2 level) (n=22; 11M/11F; avg age 69.7); and 3. decompression/long fusion (≥3 levels) (n=5; 2M/3F; avg age 69.8).

Results: Average levels decompressed for groups 1, 2 and 3 were 2.1, 1.9 and 3 respectively. Average fusion levels for group 2 were 1.6 and 3 for group 3. Mean coronal Cobb angles were 17.1°, 18.1° and 22.8° preop and 21.4°, 16.0° and 17.4° postop; mean sagittal T12-S1 angles were -49.2°, -42.0° and -44.6° preop and -48.1°, -38.5° and -40.0° postop for groups 1, 2 and 3 respectively. There were no significant overall or intragroup pre/postop radiographic changes ($p>0.05$). As expected, blood loss and OR time was statistically lower in group 1 vs groups 2 and 3 ($p<0.05$). Average ODI scores for Groups 1, 2, and 3 were 34.7, 39.2 and 58 preop and 21, 32.4 and 30 postop. There was significant improvement in each pre/postop group and in overall ODI scores (preop 42/postop 30, $p=0.002$) at final follow-up. Complications: Group 1: 1 wound drainage without infection, 1 patient with recurrent SS. Group 2: 1 wound infection requiring I & D, 1 DVT, 2 with recurrent SS. Group 3: No complications.

Conclusion: Patients with DLS (10-30°) and SS can be managed by 1 of 3 treatments presented. As evidenced by the improvement in ODI scores and minimal complications, our study found each of the treatments is a viable option to provide successful clinical and radiographic outcomes for DLS with SS.

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144. Posterior Vertebral Column Resection in Severe Congenital Kyphosis, Scoliosis and Kyphoscoliosis

Selhan Karadereliler, Cagatay Ozturk, Ahmet Alanay, Neslihan Aksu, Omer Karatoprak, Azmi Hamzaoglu
Turkey

Summary: In severe congenital scoliosis; translation of vertebral column is necessary to restore trunk balance and correct the deformity. Vertebral column resection is the only procedure that will provide translation of vertebral column. Between 1996-2007; 44 patients (7 kyphosis, 12 scoliosis and 25 kyphoscoliosis) were treated by PVCR procedure. Vertebral column resection is an effective technique in the surgical treatment of severe deformities since it is a spinal column shortening procedure and it allows to do correction in same session.

Introduction: We have presented the surgical strategy, correction rates and complications of PVCR in patients with severe congenital kyphosis, scoliosis and kyphoscoliosis with or without intraspinal abnormalities.

Methods: Between 1996-2007; 44 patients (7 kyphosis, 12 scoliosis and 25 kyphoscoliosis) were treated by PVCR. There were 35 female and 9 male patients with an age range from 2 to 28 years. The preoperative MRI showed the intraspinal pathologies as; 7 with tethered cord, 1 with re-tethering, 11 with diastematomyelia with tethered cord, 3 with syringomyelia and Arnold-Chiari malformation type I and 2 with isolated Arnold-Chiari malformation type I (total 24 of 44 patients). Surgery includes pedicle screw placement, neurosurgical procedure if necessary and correction with osteotomy either in same or a separate session depending on the anesthesia time. Neurosurgical porcedures for neural axis abnormalities were done simultaneously with corrective surgery in 16 patients. In the remaining 8 patients, neurosurgical procedure was done only with posterior instrumentation and thereafter corrective surgery including osteotomy was performed in another session due to long anesthesia time. PVCR was performed in one area in 41 patients and in 2 different area in 3 patients.

Results: The minimum follow-up was 2 years, average of 8 years. There were 24 one level, 13 two-level and 7 three-level resections. The average correction was 79% in coronal plane decompensation and 72% in sagittal plane decompensation. The mean correction in coronal plane deformity was 61%.

Conclusion: PVCR together with the surgery of intraspinal pathologies either in same session or in a separate session after placing pedicle screws prevent iatrogenic neural injuries, provides well correction of the deformity and prevent patient from the risks of multiple surgeries. Since it is a technically demanding procedure with possible risks for major complications, it should be performed by highly experienced surgical team.

Significance: Vertebral column resection is an effective technique in the surgical treatment of severe kyphosis/scoliosis/kyphoscoliosis.

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145. An Innovative Biomechanical Technique to Reduce Adjacent Caudal Level Motion in Scoliosis Surgery

Atiq Durrani MD, Viral V. Jain MD, Rasesh Desai MD, Aditya M. Muzumdar MS, Brandon Bucklen Bioengineering, Mark Moldavsky BS, Aditya Ingalhalikar MS, Saif Khalil PhD
USA

Summary: The current study addresses the problem of adjacent level motion/degeneration caused by rigid fixation systems used to treat scoliosis, which are especially prevalent at the distal end of the fusion construct. A biomechanical transition using posterior dynamic stabilization (PDS) is created in the caudal segment adjacent to the rigid fixation in order to sequentially increase the range-of-motion (ROM) in a non-traumatic manner to the patient, and is justified in an in-vivo biomechanical model.

Introduction: Deformity correction involves a combination of fusion with posterior pedicle screw and rod instrumentation. However, rigid instrumentation is associated with junctional kyphosis and possibly adjacent segment degeneration. We hypothesize a hybrid system of proximal rigid instrumentation attached to a distal dynamic component will allow adequate deformity correction and stabilization with reduced adjacent level pressures.

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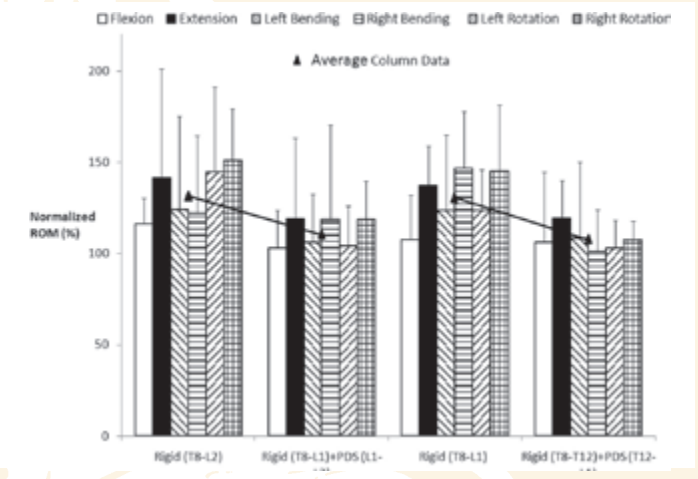
Methods: A six degree-of-freedom, spine simulator, was used to test seven cadaveric spines in displacement controlled (inducing ± 4 Nm for an intact specimen) loading in flexion-extension, lateral bending, and axial rotation. Subsequent to intact testing, the following surgical constructs were used 1.) R: rigid instrumentation with rods from T8-L2; 2.) RP: hybrid instrumentation with rods from T8-L1 and PDS from L1-L2; 3.) R2: rigid instrumentation with rods from T8-L1; 4.) RP2: hybrid instrumentation with rods from T8-T12 and PDS from T12-L1. Disc ROM and pressure data was collected for each level, and statistical analysis was performed (two-tailed, paired t-tests, type I error, α=0.05).

Results: Rigid fixations R/R2 significantly reduced ROM at levels which incorporated screw and titanium rod constructs when compared to the intact spine, as expected ($p<0.05$). The adjacent level distal to the rigid fixation system showed an increased ROM (L2-L3 for R, L1-L2 for R2) when compared to the intact spine, but was not captured statistically (n=7) in both R and R2 (Figure 1). The dynamic segment ROM (L1-L2 for RP, T12-L1 for RP2) was higher when compared to the corresponding rigid construct, and lower when compared to the intact specimen, illustrating the effectiveness of a PDS "buffering". This was confirmed statistically in flexion and left rotation for RP, and left bending for RP2, but existed as a trend in nearly all loading modes. Similarly, PDS interdiscal pressures (RP) were less than rigid pressures (R) in flexion. The adjacent level, caudal to the dynamically stabilized motion segment, also had a reduced ROM as compared to the corresponding rigid constructs levels (trend-lines Figure 1).

Conclusion: PDS with rigid fixation offers the biomechanical advantage of a gradual transition from the otherwise abrupt disparity in ROM.

Figure 1. Adjacent Caudal Level ROM.



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).

146. Blood Metal Ion Levels Following Implantation of an All-Metal Lumbar Intervertebral Disc Replacement

Jonathan R. Stieber MD, Thomas J. Errico MD, Thomas W. Bauer, Camden Whitaker MD, George Miz MD, Rick Sasso MD
USA

Summary: Blood metal ion levels in patients treated with an all-metal lumbar total disc replacement

Introduction: Metal-on-metal articulations have been used in hip and spine prostheses to maximize wear characteristics and minimize wear debris. The systemic affects of metal ions released from these implants warrant investigation. This is a prospective study to evaluate the levels of metal ions in the blood following implantation of the all-metal lumbar intervertebral disc replacement.

Methods: Forty patients treated with the Intervertebral Disc were investigated. Whole blood specimens were obtained pre-operatively, and at 6 and 12 months post-operatively. Analysis of chromium ions was conducted using Graphite Furnace Atomic Absorption Spectroscopy. Cobalt and molybdenum ions were measured using Inductively Coupled Plasma with Mass Spectrometry.

Results: Of 40 patients enrolled in the study, six-month data was available for 31 patients and twelve-month data for 34 patients. One patient had a measurable elevation of cobalt ions at both six and twelve months (2.2 µg/L and 2.9 µg/L). A second patient had an elevated cobalt ion level at the twelve months (3.2 µg/L). The mean cobalt ion level was unchanged at six months and increased to 1.1 µg/L at twelve months (P=0.33 and P=0.15, respectively).

One patient had a measured elevation in chromium ion concentration (5.2 µg/L) at six months. No patient had an elevated chromium level at twelve months. The mean chromium ion concentration was unchanged (1.1 µg/L (P=NS)) at six months and decreased to 1.0 µg/L (P=NS) at twelve months. The mean molybdenum level was unchanged at six months (1.4 µ/L, P=NS) and decreased at twelve months (1.2 µg/L, P=0.015).

Conclusion: The one-year mean whole blood cobalt and chromium levels measured following implantation of the Intervertebral Disc were unchanged with no significant elevation of metal ion levels detected.

Significance: Longer term blood levels will still be of interest, but the results of our study suggest that most patients do not have elevated cobalt, chromium or molybdenum ion levels at either six or twelve months after total disc arthroplasty with the lumbar intervertebral disc replacement.

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).

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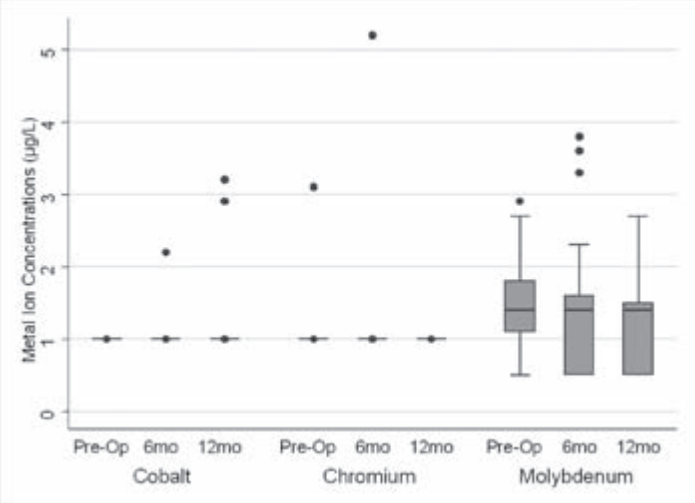


147. Device Displacement Following Cervical Total Disc Arthroplasty: Analysis of Probable Causes

Pierce D. Nunley MD, Ajay Jawahar MD, Eubulus J. Kerr MD, David A. Cavanaugh MD
USA

Summary: Device complications rate after cervical TDR can be higher than expected. A pre-operative bone density study and careful anthropometry of the cervical spine should determine proper patient selection and supero-inferior angulation between the device end-plates should approach zero degrees in neutral position to avoid vector forces causing anterior displacement of the inferior plate especially with repeated flexion and extension movements at the index levels.

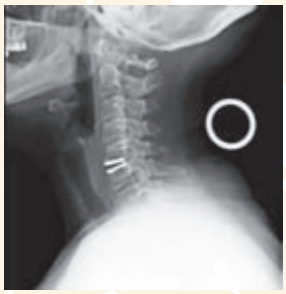
Introduction: Currently a spectrum of artificial discs is being implanted in the United States as part of investigational device exemption trials for cervical degenerative disc disease. Displacement of the implanted device is considered a rare but definite complication of cervical total disc arthroplasty but the incidence, timing and possible causative factors for this complication have not been identified.

Methods: In the past 36 months, the authors have implanted 55 artificial cervical discs of three different designs as a part of investigational device exemption FDA trials for one and two-level degenerative disc disease. Five patients (9.0%) experienced displacement of the implanted device during the follow-up. Two underwent re-operation and removal of the implants.The demographic, clinical and pre-operative radiological data of these patients was analyzed in retrospect to identify predisposing factors possibly contributing to the complication.

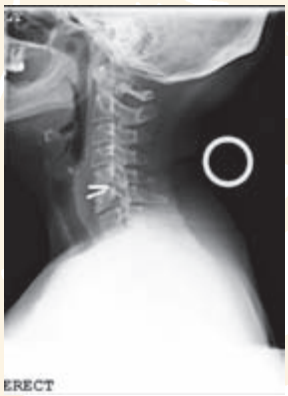
Results: All five patients were females in the 5th decade of life. Three patients had bone density in the osteopenic range (T-score < - 1.5) and were smokers (one pack per day). The device migration was detected between 6 weeks to 18 months.Only one patient (20%) developed recurrence of symptoms and signs. All patients experienced anterior displacement of the implant. Retrospective radiological anthropometry of the cervical spines revealed that the antero-posterior diameter of the vertebral bodies at the index level was less than the smallest foot-print of the available implant. Analysis of the immediate post-operative images for all patients in retrospect revealed "fish-mouth" appearance of the device even in neutral lateral images. The average angulation between the planes of superior and inferior implant plates was 16.5 degrees in neutral neck position.

Conclusion: Device complications rate after cervical TDR can be higher than expected with current patient selection criteria. Stricter patient selection criteria and intra-operative fluroscopic anthropometry should be recommended to minimize the complication rates for this otherwise safe and effective procedure.

immediate post-op lateral image showing angulation



3-month post operative neutral lateral image with device dislocation



Significance: The present series emphasizes stricter patient selection criteria and intra-operative fluroscopic anthropometry for cervical disc arthroplasty.

148. Comparison of Outcomes in Mono Segmental Lumbar Total Disc Replacement Regarding Preoperative Nucleus Pulposus Status (Herniated/Non Herniated) and Sciatica - Analysis of 358 Patients from an Observational Multi Center Study, SWISSspine

Thomas Zweig, Emin Aghayev, Rolf Sobottke, Max Aebi, Christoph Röder MD MPH
Switzerland

Summary: Herniated NP with radiculopathy was considered a contraind. for lumbar TDR. Our analysis revealed no differences regarding pain alleviation and QoL improvement in patients with these diagnoses preop.

Introduction: To date, herniated nucleus pulposus (NP) with radiculopathy and central or lateral recess stenosis are considered as contraindications for lumbar disc arthroplasty. In the present study we used data from a unique mandatory spine register, SWISSspine to investigate associations between preoperative status of NP herniated/non herniated with presence/absence of sciatica and clinical outcome.

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Methods: Between 3/2005 and 8/2008, 358 monosegmental lumbar total disc arthroplasties were documented. The data collected in a prospective observational multicenter study, included peri-operative data and clinical outcomes based on NASS, EuroQol and VAS. The patients were divided into 4 groups: group I-128 patients with herniated NP with sciatica, group II-48 patients with herniated NP without sciatica, group III-74 patients without herniated NP but with sciatica and group IV-108 patients without herniated NP and no sciatica (classic indication). The groups were pair wise compared regarding 1-year postoperative VAS, EuroQol and NASS scores using ANOVA-test with Boferroni-Holm adjustment (α=0.05)

Results: The 4 groups had similar demographic characteristics. Statistical analyses showed no significant outcome differences between the classic and the other indications. For example a outcomes for group IV: NASS back pain pre-post: 72.0/31.7 EQ-5D pre-post: 0.32/0.69.

Conclusion: Our analysis revealed no differences between patients with herniated NP combined with neural compression and patients with stenosis of recesses regarding pain alleviation and QoL improvement. The findings suggest that these diagnoses may not have to be considered as absolute contraindications for TDR anymore. The results of this multicenter observational study however, need to be verified in a more controlled or experimental study design.

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149. Surgical Treatment of Primary Spinal Tumors in the Conus Medullaris

Sung-Uk Kuh MD PhD, In-Ho Han, Young-Min Kwon MD, Dong-Kyu Chin, Keun Su Kim MD PhD, Yong-Eun Cho, Byung-Ho Jin
Korea, South

Summary: The surgical outcome of conus medullaris tumor mainly depends on preoperative neurological condition and histopathological type. The surgical treatment of conus medullaris tumor needs understanding the anatomical and functional characteristics of conus medullaris tumor for better outcome.

Introduction: The intramedullary spinal tumors mainly occur in the cervicothoracic or thoracic region and rarely in conus medullaris, occupying approximately 10% of IMSTs. Specific intramedullary lesions of conus medullaris, including tumor and infection, have been reported in case reports. Even though conus medullaris tumors have different characteristics compared to IMSTs located at other site, but there has been no analysis on primary tumors in conus medullaris.

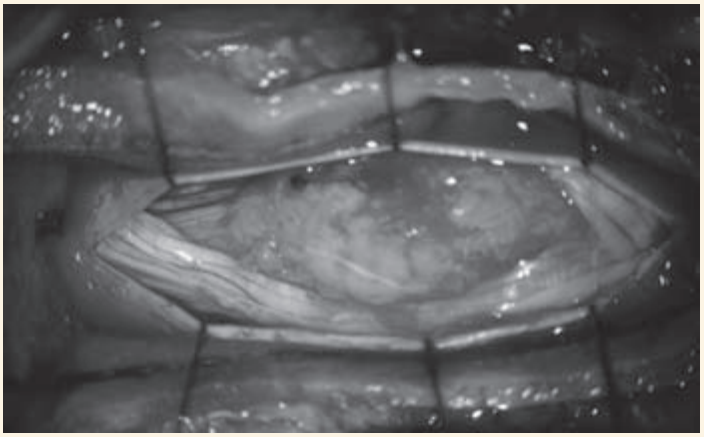
The objective of this study was to analyze the characteristics of clinical manifestation, radiological findings, treatment methods, hisopathologic types and outcomes of conus medullaris tumor.

Methods: We retrospectively reviewed 26 patients who underwent surgery for conus medullaris tumor from August 1986 to July 2007. We analyzed clinical manifestation, preoperative MRI findings, extent of surgical resection, histopathologic type, adjuvant therapy, and outcomes.

Results: There were ependymoma (13), hemangioblastoma (3), lipoma (3), astrocytoma (3), primitive neuroectodermal tumor (PNET) (2), mature teratoma (1), and capillary hemangioma (1) on histopathologic type. Leg pain was most common and seen in 80.8% of patients. Pain or sensory change in the saddle area was seen in 50% of patients and 2 patient had severe pain in the perineum and genitalia. Gross total or complete tumor resection was performed in 80.8% of patients. On surgical outcome, modified JOA score worsened in 26.9% of patients, improved in 34.6%, and remained stable in 38.5%. The mean VAS score was improved from 5.4 to 1.8 among 21 patients who had lower back pain and leg pain.

Conclusion: The surgical outcome of conus medullaris tumor mainly depends on preoperative neurological condition and pathological type. The surgical treatment of conus medullaris tumor needs understanding the anatomical and functional characteristics of conus meudllaris tumor may need for better outcome.

Significance: The objective of this study was to evaluate the characteristics and surgical outcome of the conus medullaris tumors.



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150. A Prospective Analysis of Prognostic Factors in Patients With Spinal Metastases - Use of The Revised Tokuhashi Score -

Takayuki Yamashita MD, Krzysztof B. Siemionow, Thomas E. Mroz, Vinod K. Podichetty MD, Isador H. Lieberman MD MBA FRCSC
USA

Summary: The revised Tokuhashi score was very useful regardless of the treatment pathway.

Introduction: The revised Tokuhashi score has been widely adopted in various studies to evaluate indications for surgery and predict outcome in patients with metastases to the spinal column, however, a review of the literature revealed no studies investigating

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the utility of the score on a prospective basis. The purpose of this study was to define the utility of the revised Tokuhashi score in relation to predicting survival in patients with spinal metastases.

Methods: All patients newly diagnosed with spinal metastases within 2 years of diagnosis of cancer, whether symptomatic or not were recruited. Minimum 1 year follow up was required. The relation between the revised Tokuhashi score and survival were analyzed using the Cox proportional hazard model and Spearman's rank correlation coefficient.

Results: From December 2006 to October 2008, of the 170 patients who were asked to participate, 149 (88%) agreed. During the study period, a total of 85 patients were analyzed including 44 patients who died within 1 year. The mean age was 60.3 years (range; 35-84) and the median survival was 354 days. On multivariate analysis, lower performance status (KPS 50-70%) and unresectable organ metastases were significantly associated with poor survival, with hazard ratios of 2.89 and 4.28, respectively. In primary cancer type, lung and kidney cancer were also significantly associated with poor survival, with hazard ratios of 3.98 and 2.55, respectively. The revised Tokuhashi score groups were significantly correlated with the survival groups (α=0.511, P<0.001). In 66 (78%) of 85 patients, actual survival matched the predicted survival.

Conclusion: Lower score on performance status, the existence of organ metastases, and primary cancer of the lung and the kidney were significantly associated with poor survival. The revised Tokuhashi score was found to be very useful to predict survival regardless of the treatment pathway. In most patients, actual survival matched their predicted survival, however, modification of the score groupings may provide more accurate prediction of survival.

Significance: The accurate prediction of prognosis will enable treating physicians to choose the most appropriate treatment, and provide cancer patients with a better quality of life.

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The Scoliosis Research Society gratefully acknowledges Nuvasive for their support of the delegate bags.

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Mladen Djurasovic MD, Steven D. Glassman MD, Kelly R. Bratcher RN CCRP, Neha Kantamneni BS, Rolando M. Puno MD, John R. Johnson MD, Leah Y. Carreon MD MSc
USA

202. Conservative Treatment of Thoracolumbar Burst Fractures: A Long-Term Follow-Up Results
Fuad O. Oken , Ozgur A. Yildirim, Murat Gulcek, Vuslat S. Unal, Ahmet Ucaner
Turkey

203. Lamina Screws as a Salvage Technique at C7: CT and Biomechanical Analysis using Cadaveric Vertebrae
Mario J. Cardoso MD DC, Anton Dmitriev MD PhD(c), Melvin D. Helgeson MD, Frederick Stephens, Ronald A. Lehman MD, Patrick B. Cooper MD, Michael Rosner
USA

204. Complications in Surgical Treatment of Lumbar Spinal Stenosis (LSS) and Their Predictors: Analysis of 2579 SpineTango Patients
Emin Aghayev, Rolf Sobottke, Thomas Zweig, Peer Eysel, Karl-Stefan Delank Senior Consultant, Christoph Röder MD MPH
Switzerland

205. Osteogenic Differentiation of Adipose-Derived Stromal Sells Cultured on a Novel Three-Dimensional Porous Poly(caprolactone malate) Hydroxyapatite (PPCLM/HA) Composite Scaffold
Qing Zeng MD, Yuqin Wan, Gary Balian PhD, Francis H. Shen
USA

206. Computed Tomography Angiography for Anterior Lumbar Spine Access Surgery: High Radiation Exposure and Low Clinical Relevance
Michaela Gstöttner MD, Bernhard Glodny MD, Martin Thaler, Christian M. Bach Univ. Doz.
Austria

208. Vertebral Distraction during ACDF Causes Postoperative Neck Pain
Dong Ah Shin MD
Korea, South

209. Validation of Surgeon Perception of Navigated Pedicle Screw Position: A Cadaveric Study
Edward Rainier G. Santos MD, Jonathan N. Sembrano MD, Charles Gerald T. Ledonio MD, Carlos Castro MD, Walter H. Truong MD, David W. Polly
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212. Safety and Complication Profile of Percutaneous Lumbosacral Interbody Fusion
Neel Anand MD, Eli Baron MD, Rebecca Rosemann MS PA-C, Scott Kitchel MD, Vikas V. Patel MA MD, Roger Hartl
USA

213. Impact of Stress Shielding on Interbody Bone Volume after Lumbosacral Fusion with Supplemental Instrumentation Using Oval-Shaped PEEK Rods vs. Titanium Rods
Matthew F. Gornet MD, Brett A. Taylor, Timothy R. Kuklo MD, Russ P. Nockels MD, Todd H. Lanman
USA

214. The Effect of Posterior Spinal Releases on Axial Correction Torque: A Cadaver Study
Patrick Bosch MD, Shakeel Durrani MD
USA

215. Occipitocervical Fusion with Rigid Internal Fixation in Patients Two to Six Years Old: Minimum Six Month Follow Up Data with CT Scans in 11 Patients
Matthew J. Geck MD, Dana Hawthorne BS MPAS, Anthony Rinella, Jason E. Lowenstein MD, Juan A. Uribe, Mario Gonzalez, Timothy George MD, Steven Mardjetko
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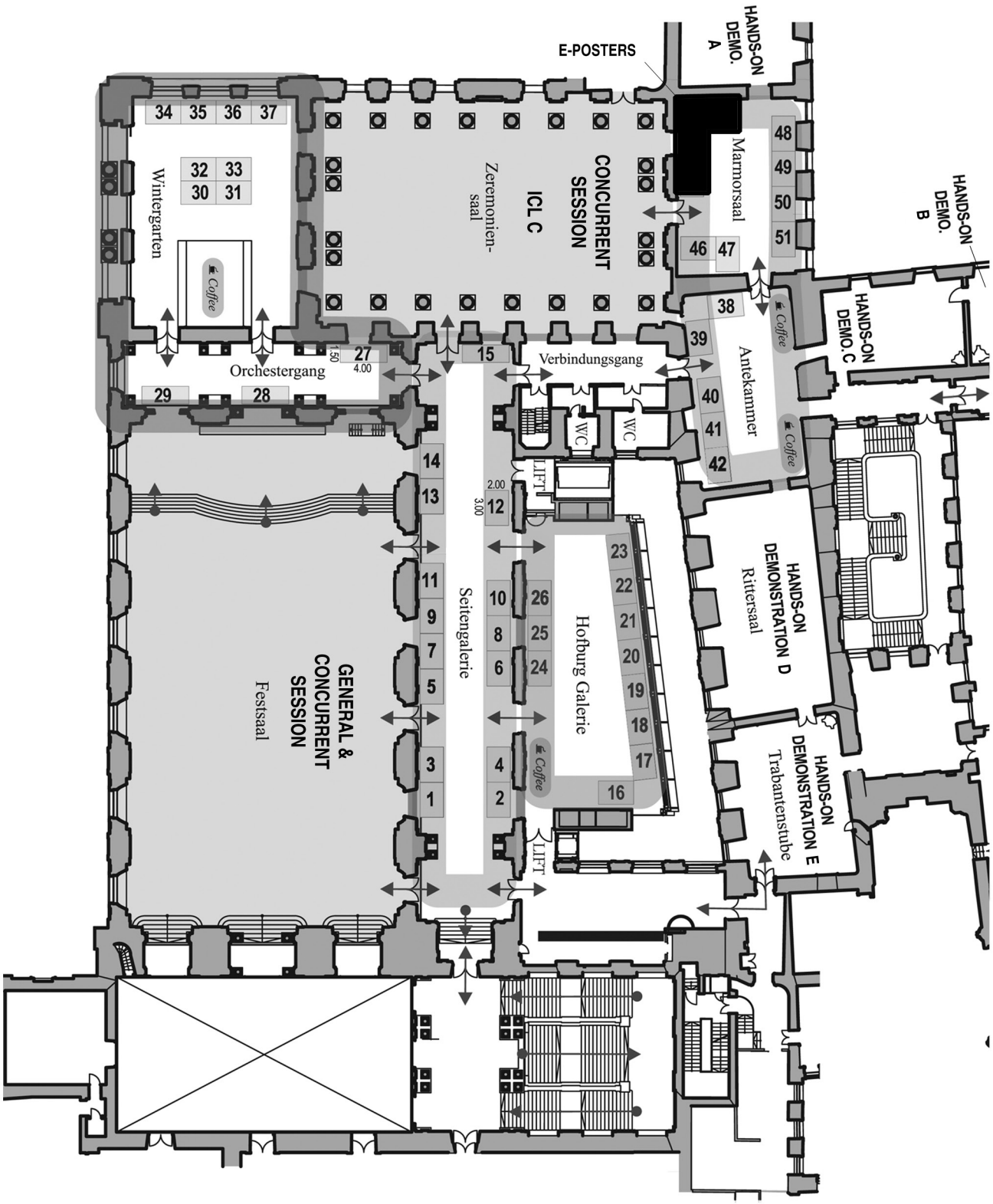
Exhibit Hall Floorplan



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Fax: +49-7461-966-1772
www.ackermannmedical.de

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USA
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Fax: 1-760-431-1624
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Staffordshire ST5 5NL
UNITED KINGDOM
Tel: +44-1782-338-580
Fax: +44-1782-338-599
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Biocomposites is a privately held pioneering developer, manufacturer and distributor of synthetic, tissue regeneration products. The company has developed a broad range of products that addresses the clinical and economic needs of medical specialties in orthopaedics and dentistry. Research, manufacturing, marketing and international sales are directed from the company's headquarters in Keele, UK. Sales companies are also based in Wilmington, NC and Shanghai. Biocomposites unrivalled knowledge of calcium technologies has led to the development of geneX. A unique, fully resorbable bone graft material with a controlled, reproducible, negative surface charge. This stimulates the gene expression of proteins which directs the adhesion and proliferation of bone forming cells for rapid osteogenesis and bone formation. geneX is the only stand alone material other than BMPs to achieve posterolateral fusion in the New Zealand White rabbit "Boden" model.

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USA
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BrainLAB
Kapellenstrasse 12
Feldkirchen 85322
GERMANY
Tel: +49-89-991568-0
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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, a Johnson & Johnson Company
325 Paramount Drive
Raynham, MA 02767
USA
Tel: 1-508-828-2820
Fax: 1-508-828-3027
www.depuyspine.com

Booth 2/4

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

Exhibitors

DiFUSION Technologies, Inc.
300 West Sixth St.
Suite 1050
Austin, TX 78701
USA
Tel: 1-281-923-9029
www.difusiontech.com

BOOTH 16

DiFUSION Technologies, located in Austin, Texas, is a medical device company that develops silver-based antimicrobial solutions for the orthopaedic spinal market to reduce Surgical Site Infections (SSIs) in spinal surgery. DiFUSION's CleanFUZE™ PEEK spinal interbody cage will be capable of mitigating 650 types of bacteria, including MRSA, up to four weeks postoperatively, thereby drastically reducing hospital-acquired infections or SSIs. Once the CleanFUZE™ interbody cage is implanted into the spinal disc space during spinal surgery, silver ions exchange with naturally occurring sodium ions in the bloodstream and diffuse antimicrobial silver ions for a period of four weeks. DiFUSION's solution will not only improve infection ratios, it will also save the patient from additional surgery, weeks of IV antibiotics and in, some cases, life long exposure to oral suppressive antibiotics, amputation and even death; benefits that will impact surgeons, patients, hospitals and insurance carriers

Doctors Research Group
574 Heritage Road
Suite 202
Southbury, CT 06488
USA
Tel: 1-203-262-9335
Fax: 1-203-262-9340

BOOTH 37

Kryptonite bone matrix is a non-toxic, osteoconductive, structural scaffold, with bone-like properties composed of naturally occurring fatty acids and calcium carbonate. Kryptonite matrix is extremely adhesive, cohesive and minimally exothermic. Kryptonite matrix achieves a strong adhesive bond through both bony interdigitation and chemical adhesion, providing a strong interface at both macro and micro levels. The unique mechanical properties of Kryptonite matrix make it an ideal product for bone void filling applications.

Future Spine Technologies
6th Floor
52-54 Gracechurch Street
London EC3 VOEH
UNITED KINGDOM
Tel: +90-532-6577921
Fax: +90-312-221-0265
www.futurespine.com

BOOTH 33

Future Spine has been working in the field of spinal surgery and neurosurgery since 2007. Our company is located in London, in the United Kingdom. Our products are:

- Anterior Cervical Peek Cages
- Posterior Cervical Fixation System
- A.P.Thoraco Lumbar Stabilization System
- HA Coated Polyaxial Screw
- Pediatric System

Globus Medical, Inc.
2560 General Armistead Avenue
Audubon, PA 19403
USA
Tel: 1-610-415-9000
Fax: 1-610-415-9144
www.globusmedical.com

BOOTH 23

Globus Medical, Inc. is one of the ten largest spinal implant manufacturers in the world, with more than $120 million in annualized revenues. Based outside Philadelphia, Pennsylvania the privately held company has a single-minded focus on advancing spinal surgery. Globus Medical has a full portfolio of spinal fusion products, burgeoning initiatives in biomaterials development and minimally invasive approaches, and is among the world leaders in the development of motion sparing technology. Additional information can be accessed at www.globusmedical.com.

Gore & Associates
PO Box 2400
Flagstaff, AZ 86003-2400
USA
Tel: 1-928-779-2771
www.goremedical.com

BOOTH 36

Gore Medical Products Division has provided creative therapeutic solutions to complex medical problems for three decades. During that time, more than 25 million innovative Gore Medical Devices have been implanted, saving and improving the quality of lives worldwide. The extensive Gore Medical family of products includes devices for orthopaedic, spine, and neuro surgeries.

Exhibitors

Joimax GmbH
Booth 39
An der RaumFabrik 33a
Amalienbadstrasse 36
76227 Karlsruhe
GERMANY
Tel: +49-0-721-25514-0
Fax: +49-0-721-25514-920
www.joimax.com

joimax® - helping to treat patients – is a leading company in the field of structure preserving methods, with particular focus on endoscopic spinal surgery. As a young and innovative organization within the medical devices industry, joimax® dedicates itself to combined-surgical technologies ("joined minimal access technologies"). joimax® is the only company offering a complete user-friendly and sophisticated system for the new generation of endoscopic spinal surgery. Our innovative solutions aim at diseases concerning the spinal canal, and enable surgical treatment through minimal accesses, as provided by Mother Nature. With this gentle method, we stand for developments in "soft surgery." With the TESSYS® method – the Transforaminal Endoscopic Surgical System – more than 12,000 surgeries have already been conducted worldwide, to the complete satisfaction of patients and the performing surgeons.

K2M, Inc.
Booth 9/11
751 Miller Drive, SE
Suite F1
Leesburg, VA 20175
USA
Tel : 1-703-777-3155
Fax : 1-703-777-4338
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.

Medicrea International
Booth 47
24 Porte du Grand Lyon
Neyron 01700
FRANCE
Tel: +33-0-472-0187-87
Fax: +33-0-472-0187-88
www.medicrea.com

MEDICREA is a fully-dedicated spinal implant manufacturer focused on introducing reliable and innovative technologies to the global marketplace. With over 18 years of experience, MEDICREA has patented and developed a full range of fusion and non fusion spinal implants in collaboration with worldwide respected and experienced spine surgeons. The result is real advancement for surgeons and patients alike, as demonstrated by MEDICREA products among which: PASS® LP an ultra-low profile polyaxial system offering a unique correction of vertebral rotation in spinal deformity C-JAWS® cervical compressive staple that reduces ACDF operative time by 90% compared to a plate IMPIX® TLIF and IMPIX® ALIFD innovative lumbar interbody devices and its last innovation in motion preservation technology with … GRANVIA® a shock absorbing ceramic on ceramic cervical disc prosthesis.

Medtronic Spinal & Biologics
Booth 5/7
2600 Sofamore Danek Drive
Memphis, TN 38132
USA
Tel: 1-901-399-2220
Fax: 1-901-399-2012
www.medtronic.com

Medtronic is the world's leading medical technology company, providing lifelong solutions for people with chronic disease. Every five seconds, a person's life is saved or improved by a Medtronic therapy. The global leader in spinal technology, we are committed to providing service, support, and innovative products that will revolutionize the future of spine care. Please visit our booth during IMAST.

Exhibitors

Mizuho OSI
30031 Ahern Avenue
Union City, CA 94536
USA
Tel: 1-510-476-8154
Fax: 1-510-429-9946
www.mizuhosi.com

BOOTH **1/3**

Mizuho OSI, a U.S. manufacturer for over 30 years and located in Union City, California develops, manufactures and distributes a comprehensive range of radiolucent specialty surgical tables and positioning systems. On exhibit will be the Axis Jackson System® which uniquely synchronizes axis of rotation with the patient's biomechanical body translation during surgery. The table system supports prone, supine and lateral procedures and enhances new surgical technologies. Surgeons report that it improves their visualization and access to the surgical site. In addition, the Jackson Table System which is considered by many the "gold standard" for spinal patient positioning and which allows rotation of the patient 180 for anterior and posterior procedures will also be on display. For more information, please contact Mark Blackmore, European Sales Manager. Tel: + 44 7832 50460

NuTech Medical
174 Oxmoor Road
Birmingham, AL 35209
USA
Tel: 1-205-908-8261

BOOTH **30**

NuTech Medical, a true biological company, specializes in innovative allograft based products. Nutech distributes conventional and machined allograft from LifeNet Health. With NuCel, NuTech is able to offer the youngest adult stem cell product on the market. NuTech's product, NuFix, stabilizes the spine through facet fixation and is quickly becoming a staple in every spine surgeon's practice.

NuVasive
7475 Lusk Blvd
San Diego, CA 92121
USA
Tel: 1-858-909-1832
Fax: 1-858-909-2032
www.nuvasive.com

BOOTH **13/14**

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.

Orthofix, Inc.
1720 Bray Central Dr.
McKinney, TX 75069
USA
Tel: 1-469-742-2724
Fax: 1-469-742-2722
www.orthofix.com

BOOTH **40/41**

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.

Exhibitors

Orthovita
77 Great Valley Parkway
Malvern, PA 19355
USA
Tel: 1-484-478-1176
Fax: 1-866-205-0146
www.orthovita.com

Booth 29

Orthovita®, an orthobiologics and biosurgery company, develops and markets innovative medical implants. Our orthobiologics platform offers products for the fusion, regeneration and fracture fixation of human bone, while our biosurgery platform currently offers products for controlling intra-operative bleeding (hemostasis). Our current fusion and regeneration products are based on our proprietary, market-leading Vitoss™ Bone Graft Substitute technology which addresses the non-structural bone grafting market with synthetic, bioactive alternatives to patient and cadaver-derived bone tissue. Cortoss™ Bone Augmentation Material is an injectable polymer composite that mimics the structural characteristics of human bone. Cortoss Bone Augmentation Material is approved in certain countries outside the U.S. and is under review for clearance in the U.S. for the treatment of vertebral compression fractures. Our hemostasis portfolio includes Vitagel™ Surgical Hemostat, a unique, collagen-based matrix that controls bleeding and facilitates healing, and Vitasure™ Absorbable Hemostat, a plant-based product that can be deployed quickly throughout surgery.

Osteotech, Inc.
51 James Way
Eatontown, NJ 07724
USA
Tel: 1-732-544-6211
Fax: 1-732-578-6688
www.osteotech.com

Booth 51

Osteotech is a global leader and innovator in OsteoBiologics for musculoskeletal surgery. Focusing on spinal, and trauma procedures, Osteotech provides a full line of innovative regeneration technologies such as Grafton® DBM, Graftech® Bio-Implants, Xpanse® Bone Inserts and Plexur® Biocomposites.

Paradigm Spine, GmbH
Eisenbahnstrasse 84
Wurlingen 78573
GERMANY
Tel: +49-7461-963599-17
Fax: +49-7461-963599-20
www.paradigmspine.com

Booth 21/22

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™ interspinous implant technology Paradigm Spine develops a full non fusion product portfolio of motion preserving tissue sparing technologies. The company proudly presents three new products at IMAST 2009: The DCI™ implant for cervical dynamic stabilization, the DSS™ implant for lumbar dynamic stabilization and the coflex-F™ implant as a minimally invasive solution as an adjunct to fusion.

Sawbones Europe SAS
Krossverksgatan 3
Malmo 21616
SWEDEN
Tel: +46-40-6507000
Fax: +46-40-650-7001
www.sawbones.com

Booth 31

Worldwide leaders in orthopaedic and medical models. For over three decades, Sawbones, the originators of "hands-on" workshop models, continues to be the leader in medical models for orthopaedic and medical education. Sawbones models have been specifically developed for use in motor skills exercises where a realistic artificial anatomical model is required for the "hands-on" teaching of surgical procedures. We offer a complete range of services to enhance the world of medical education, product demonstration, and patient awareness. Sawbones has the capability to manufacture many types of models for product display, hands on training and patient education. Models range from polished clear bones to custom molded products for any application. Sawbones custom models may be made from foam, solid plastic or soft tissue, depending on customer requirements. Sawbones can also manufacture plastic replicas from implants, plates, etc. that may be used for marketing or education purposes.

Exhibitors

Showa IKA
199 S. Mt. Pleasant Road
Collierville, TN 38017
USA
Tel: 1-901-861-8186
Fax: 1-901-234-0173
www.showaika.com

BOOTH 27

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.

Spine Art
ICC 20 Route de Pre-Bois
CP 1813
Geneva 1215
SWITZERLAND
Tel: +41-22-799-4188
Fax: +41-22-799-4186
www.spineart.ch

BOOTH 26

Spine Art's objective is to be the leader of a new spinal generation with its full range of innovative fusion and motion preservation implants, focusing on the simplification of the surgical act and crafting a new breed of implants. Having successfully launched a full range of innovative fusion implants as well as unique cervical and lumbar discs, Spine Art is now concentrating on developing a full range of Minimally Invasive motion preservation implants to include:

- The first interspineous prosthesis
- A posterior lumbar dynamic system
- A transforaminal lumbar prosthesis
- The first nucleus prosthesis.

Spine Art markets its implants throughout 24 countries in Europe, Asia and Latin America, covering 90% of spinal pathologies, and has already garnered 9% of the French market. Spineart's pedicle screw system has received 510K FDA approval in December 2008. The rest of its fusion range should be approved before the opening of its US affiliate in H2 2009.

SpineGuard, Inc.
301 Howard Street
Suite 970
San Francisco, CA 94105
UNITED STATES
Tel: 1-415-512-2510
Fax: 1-415-512-8004

BOOTH 49

SpineGuard was founded earlier this year with the mission to make spine surgery safer. The primary objective of SpineGuard is to establish the PediGuard® as the standard of care for safer pedicle screw placement. PediGuard® is the first and only handheld, wireless device that can detect possible cortex perforation, thus alerting surgeons during pedicle preparation for screw placement. Real time feedback is provided via audio and visual signals. PediGuard is currently marketed in more than 20 countries and more than 7,000 procedures have been performed so far. Pierre Jérôme and Stéphane Bette, the founders of SpineGuard, have assembled a team of 15 talented individuals divided between San Francisco and Paris, all with substantial experience in the spine industry. The original inventors of PediGuard®, Ciaran Bolger MD PhD and Maurice Bourlion PhD are part of the endeavor as well as Randy Betz MD, leader of SpineGuard's international clinical study group.

Stryker Spine
ZI de Marticot
33610 Cestas
France
Tel : +33-0-608100121
www.stryker.com

BOOTH 6/8/10

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.

Exhibitors

Synthes GmbH
Einattstr. 3
Oberdorf 4436
SWITZERLAND
Tel: +41-61-965-61-11
www.synthes.com

Booth 34

Synthes. Dedicated to health.
Synthes is a leading global medical device company. We develop, produce and market instruments, implants and biomaterials for the surgical fixation, correction and regeneration of the human skeleton and its soft tissues. Our goal is to provide the safest and most advanced products and technologies that ensure reliable operating procedures, rapid recovery and a pain-free life after surgery. We avouch for high quality, constant innovation and consistent customer orientation.

Trans1
411 Landmark Drive
Wilmington, NC 28412
USA
Tel: 1-910-332-1700
Fax: 1-910-332-1701
www.trans1.com

Booth 12

TranS1 is a medical device company focused on designing, developing and marketing products that implement our proprietary surgical approach to treat disc disease affecting the lower lumbar region of the spine. Using this minimally invasive TranS1 approach to treat lumbar discs, enables fusion and motion procedures to be performed with low complication rates, short procedure times, low blood loss, short hospital stays, fast recovery times and reduced pain without compromising important surrounding soft tissue.

Vertiflex, Inc.
1351 Calle Avanzado
San Clemente, CA 92673
USA
Tel: 1-949-940-1473
Fax: 1-949-940-1450
www.vertiflexspine.com

Booth 32

VertiFlex® is a privately held medical device company dedicated to the advancement of minimally invasive and motion preserving technologies for disorders of the spine. Founded in 2005 and headquartered in San Clemente, CA, VertiFlex currently markets products globally in addition to conducting a pivotal human IDE trial for a next generation interspinous spacer. Key VertiFlex products include the Superion™ interspinous spacer, the Dynabolt™ dynamic rod, and the Silverbolt™ percutaneous fusion system. The Silverbolt system enables surgeons to stabilize the spine in a less invasive approach than traditional surgical fusion procedures. This allows for reduced recovery times and minimal muscle trauma. The Dynabolt dynamic stabilization rod is an adjunct to the Silverbolt system that provides stabilization while allowing a controlled range of motion. The Silverbolt and Dynabolt systems are both CE marked and commercially available in the US. The Superion interspinous spacer system is a percutaneous titanium implant that fits between the spinous processes in the lumbar spine. The Superion system received CE mark in 2007, and is currently undergoing a pivotal FDA clinical trial for the minimally invasive treatment of spinal stenosis. Additional VertiFlex products include the Oracle® expandable retractor, and the family of Octane™ PEEK interbody fusion cages for TLIF, PLIF, and ALIF applications.

Vexim SAS
75, rue St-Jean
Balma 31130
FRANCE
Tel : +33-671607207
Fax : +33-5-61-48-95-19
www.vexim.fr

Booth 28

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.

Exhibitors

Zimmer Spine
23 Parvis des Chartrons
Bordeaux 33080
France
Tel : +33-556-001870
Fax : +33-556-001821

Booth **24/25**

Abbott Spine is now part of Zimmer Spine. This new combination brings together the industry expertise and broad device portfolios of both organizations to offer one of the most comprehensive sets of solutions available today. Zimmer Spine develops, produces and markets the highest quality spine products and services that repair, replace and regenerate spine health. Zimmer Spine works directly with surgeons to share best practices, facilitate surgeon-to-surgeon training and to provide continuous access to relevant information, all to improve patient outcomes. With continual technological advancement, Zimmer constructs superior fusion and non-fusion spine systems, instrumentation systems, cervical plates, allograft bone filler and trabecular metal. We use our resources to advance industry evolution, and our products and procedures exceed doctor and patient expectations. Through the hands of skilled surgeons, Zimmer enhances patient quality of life.

Hands-On Demonstrations *

*These sessions are not CME accreditted.

Thursday, July 16, 2009

10:45 – 11:30 Hands-On Demonstrations 1A-E *(with refreshments & snacks)*

1A Cervical Pathologies
Location: Geheime Ratstube

GLOBUS MEDICAL
Products: COALATION Stand-Alone ACDF
Instructors: Paul McAfee MD

K2M
Products: CASPIAN™ Spinal System
Instructors: Hilali Noordeen, FRCS
K2M will be demonstrating the latest K2M product innovation, the CASPIAN™ Spinal System and its clinical applications. The system is based on our revolutionary MESA Zero-Torque Technology™ and offers an all-inclusive answer for rigid posterior fixation of the occipito-cervico-thoracic regions of the spine.

MEDTRONIC
Products: Vertex, Bryan Disc, Venture Plate, Prestige Disc, Atlantis Plate
Instructors: Richard G. Fessler, MD, PhD; Rick C. Sasso, MD

1B Spondylolisthesis
Location: Radetzky Apt. II & III

MEDTRONIC
Products: 3Dx + MDA, Legacy Reduction
Instructors: TBD

TRANS1
Products: AxiaLIF and AxiaLIF 2L
Instructors: William Blake Rodgers MD
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
Location: Radetzky Apt. I & Kunstlerzimmer

MEDTRONIC
Products: Legacy
Instructors: TBD

SYNTHES SPINE
Products: VEPTR and VEPTR II
Instructors: International faculty
VEPTR II and the Definite Treatment Strategy
VEPTR II – Historical Background and Current Experience
VEPTR – Longterm Follow Up and What is the Definite Treatment?

Hands-On Demonstrations *

**These sessions are not CME accreditted.*

1D Adult Deformity I: Degenerative
Location: Rittersaal

GLOBUS MEDICAL
Products: REVERE Coupled Derotators and Uniplanar Screws
Instructors: Courtney Brown MD

MEDTRONIC
Products: X-STOP IPD System for Symptoms of Lumbar Spinal Stenosis
Instructors: TBD
The X-STOP IPD System is the first interspinous spacer shown to be superior to nonsurgical treatment in patients with neurogenic intermittent claudication (NIC) due to lumbar spinal stenosis (LSS). The FDA approved the X-STOP Spacer using data from a 2-year, multicenter, randomized, controlled study in which the X-STOP Spacer was shown to be superior to nonsurgical care based on: device performance measures, need for additional surgery for LSS, and the Zurich Claudication Questionnaire (ZCQ).

NUVASIVE
Products: TBD
Instructors: TBD

STRYKER SPINE
Products: Thor ALIF and VLIFT
Instructors: Jacob Buchowski, MD; Mr. Matt Pickens; Ms. Sophie Cheylac

1E Prinicples and Practice in the Treatment of Kyphotic Problems
Location: Trabantenstube

K2M
Products: RANGE™ Spinal System
Instructors: Oheneba Boachie-Adjei, MD; Ms. Yasmine Bercy
K2M will be demonstrating the RANGE™ Spinal System and its clinical applications for treating kyphotic deformities. The system is a fusion of DENALI™ and MESA™, offering a complete array of unique screws, rod connectors and hooks, coupled with exciting innovations in instrumentation.

STRYKER SPINE
Products: XIA 3
Instructors: Nicholas Theodore, MD; Mr. Andy Choi

13:45 – 14:30 HANDS-ON DEMONSTRATIONS 2A-E *(with lunch)*

2A Options in Cervical Fixation and Motion
Location: Geheime Ratstube

BIOMET SPINE
Products: MaxAN
Instructors: Alan S. Hilibrand, MD; Christopher I. Shaffrey, MD
The demonstration features treatment solutions for different stages of the degeneration process in the cervical spine. The demonstration will additionally focus on methods for avoiding adjacent segmant disease and other complications and discuss revisions and reoperations. The indications and contraindications for arthrodesis will also be examined.

DEPUY SPINE
Products: DISCOVER™ Cervical Disc
Instructors: TBD
Cervical arthroplasty with DISCOVER Cervical Disc

MEDTRONIC
Products: Vertex, Bryan Disc, Venture Plate, Prestige Disc, Atlantis Plate
Instructors: Richard G. Fessler, MD, PhD; Rick C. Sasso, MD

STRYKER SPINE
Products: Cervical Arthroplasty, CerviCore
Instructors: Ms. Sophie Cheylac; Mr. Matt Pickens

Hands-On Demonstrations *

*These sessions are not CME accreditted.

2B Lumbar Posterior Motion Sparing
Location: Radetzky Apt. II & III

GLOBUS MEDICAL
Products: TRANSITION Stabilization System
Instructors: Paul McAfee MD

PARADIGM SPINE
Products: DSS™ Dynamic Stabilzation System
Instructors: Rudolf Bertagnoli, MD
The DSS™ system provides options for dynamic and rigid stabilization to treat hypermobile segments and segments that require fusion. The implant is axially compliant and allows pedicle displacement during motion restoring the natural center of rotation. Cannulated screws allow for MIS approaches*.
**Hybrid use not cleared in the United States. See US package insert for labeling limitations.*

2C Adolescent Idiopathic Scoliosis I
Location: Radetzky Apt. I & Kunstlerzimmer

DEPUY SPINE
Products: EXPEDIUM™ Spine System
Instructors: TBD
Techniques for fixation and correction of AIS using the EXPEDIUM Spine System.

K2M
Products: RANGE™ Spinal System
Instructors: Behrooz Akbarnia, 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 and hooks, coupled with exciting innovations in instrumentation.

STRYKER SPINE
Products: XIA 3
Instructors: Se-Il Suk, MD, PhD; Ms. Yasmine Bercy; Mr. Andy Choi

2D Adult Deformity II
Location: Rittersaal

DEPUY SPINE
Products: EXPEDIUM™ Spine System, VIPER™2 Spine System, CONCORDE™ Bullet System, COUGAR™ System
Instructors: TBD
Treatment and correction of adult deformity through posterior open, minimally invasive techniques, including anterior column support.

MEDTRONIC
Products: Legacy, MPA, PSO
Instructors: TBD

2E Principles and Practice in the Treatment of Metastatic Spine Disease
Location: Trabantenstube

No Demonstrations

Hands-On Demonstrations *

**These sessions are not CME accreditted.*

FRIDAY, JULY 17

8:30 – 9:15 HANDS-ON DEMONSTRATIONS 3A-E *(with refreshments & snacks)*

3A Cervical Trauma
Location: Geheime Ratstube

DEPUY SPINE
Products: MOUNTAINEER™ OCT System, SWIFT™ Plus Corpectomy Plate, BENGAL™ Stackable System
Instructors: TBD
Posterior and anterior techniques and solutions for the treatment of cervical trauma.

STRYKER SPINE
Products: Oasys, Reflex
Instructors: Naresh P. Patel, MD; Mr. Matt Pickens; Ms. Sophie Cheylac

3B Lumbar Posterior Fusion Options/ Instrumentation (Degenerative)
Location: Radetzky Apt. II & III

MEDTRONIC
Products: Legacy, 3Dx
Instructors: TBD

MIZUHO OSI
Products: Axis Jackson System®
Instructors: Roger P. Jackson, MD
Hands-on demonstration and discussion of the Axis Jackson System®, a new spine surgery table featuring breaking hinge technology. The presentation will focus on how the table's axis of rotation and the arc of motion generated provide multiple benefits to surgeons performing all types of posterior thoracolumbar procedures.

NUVASIVE
Products: TBD
Instructors: TBD

STRYKER SPINE
Products: Mantis with UniLIF; XIA 3
Instructors: Jacob Buchowski, MD; Mr. Andy Choi; Ms. Yasmine Bercy

3C Early Onset Scoliosis
Location: Radetzky Apt. I & Kunstlerzimmer

SYNTHES
Products: TBD
Instructors: TBD

3D Adult Deformity III: Decision Making Relative to the Sacrum Pelvis
Location: Rittersaal

BIOMET SPINE
Products: The Polaris System, featuring the Trivium 3-D Deformity Correction System
Instructors: Michael W. Groff, MD; J. Abbott Byrd, MD
This symposium features The Polaris System, featuring the Trivium 3-D Deformity Correction System. This is a new system by Biomet which incorporates Enbloc vertebral body derotation, an innovative posterior spinal deformity correction technique. The system utilizes the power of pedicle screw fixation and enables surgeons to correct most spinal deformities in three dimensions.

DEPUY SPINE
Products: EXPEDIUM™ Spine System
Instructors: TBD
Techniques for sacro-pelvic fixation using the EXPEDIUM™ Spine System.

K2M
Products: RANGE™ Spinal System
Instructors: Khaled Kebaish, MD; Dr. John Kostuik
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 and hooks, coupled with exciting innovations in instrumentation.

Hands-On Demonstrations *

*These sessions are not CME accreditted.

3E Thoracolumbar Trauma
Location: Trabantenstube

DEPUY SPINE
Products: EXPEDIUM™ Anterior Spine System, VIPER™ 2 Spine System, OCELOT™ System, X-MESH™ Expandable Cage System
Instructors: TBD
Posterior and anterior minimally invasive and open solutions for the treatment of thoracolumbar trauma.

12:45 – 13:30 Hands-On Demonstrations 4A-E *(with lunch)*

4A Infection and Post Infectious Deformity
Location: Geheime Ratstube

No Demonstrations

4B Lumbar Anterior Fusion Options/ Instrumentation (Including Lateral Anterior Approaches)
Location: Radetzky Apt. II & III

GLOBUS MEDICAL
Products: INDEPENDENCE Stand-Alone ALIF
Instructors: Courtney Brown MD

ORTHOFIX
Products: PILLAR™ SA PEEK
Instructors: TBD
The PILLAR™ SA PEEK Spacer System provides surgeons with an intervertebral body fusion device that incorporates screw fixation to optimize implant stability. The instrumentation was designed by spine surgeons for spine surgeons. The multiple instrumentation options allows for easier access for implanting the screws in difficult to reach areas among varied patient anatomy. The unique ultra-thin Cover Plate retains the Bone Screws in place. With no internal fixation required, the PILLAR SA PEEK Spacer System can reduce hospital cost, reduce operative time, and increase surgical efficiencies.

NUVASIVE
Products: TBD
Instructors: TBD

TRANS1
Products: AxiaLIF and AxiaLIF 2L
Instructors: Gary D. Fleischer MD
Hands-on demonstration and discussion of AxiaLIF technology, a safe, reproducible, pre-sacral approach for L5/S1 fusion. AxiaLIF is a soft-tissue sparring approach that keeps native anatomy intact, restores disc height, and creates immediate rigid segmental fixation. Patients often have shorter hospital stays and shorter recovery periods as compared to traditional techniques.

4C Adolescent Idiopathic Scoliosis II
Location: Radetzky Apt. I & Kunstlerzimmer

DEPUY SPINE
Products: EXPEDIUM™ Spine System, VIPER™2 Spine System
Instructors: TBD
Posterior open and minimally invasive techniques for the treatment of adult deformity.

K2M
Products: RANGE™ Spinal System
Instructors: Kamal Ibrahim, MD, FRCS(C), MA
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 and hooks, coupled with exciting innovations in instrumentation.

Hands-On Demonstrations *

**These sessions are not CME accreditted.*

4D Adult Deformity IV: Non-Fusion and MIS Alternatives in Adult Scoliosis
Location: Rittersaal

K2M
Products: SERENGETI™ Minimally Invasive Retractor System
Instructors: Richard Guyer, MD; Pierce Nunley, 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 with Longitude
Instructors: TBD

TRANS1
Products: AxiaLIF and AxiaLIF 2L
Instructors: A. Atiq Durrani 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
Location: Trabantenstube

ALPHATEC SPINE
Products: Osseoscrew
Instructors: Richard Guyer, MD

DEPUY SPINE
Products: EXPEDIUM™ Spine System, VIPTER™2 Spine System, CONFIDENCE Spinal Cement System™
Instructors: TBD
Open and minimally invasive posterior fixation options for the osteoporotic spine.

Hands-On Demonstrations *

*These sessions are not CME accreditted.

Saturday, July 18, 2009

8:30 – 9:15 Hands-On Demonstrations 5A-E *(with refreshments & snacks)*

5A Cervical Degenerative Techniques *Location: Geheime Ratstube*	MEDTRONIC Products: Vertex, Bryan Disc, Venture Plate, Prestige Disc, Atlantis Plate Instructors: Richard G. Fessler, MD, PhD; Rick C. Sasso, MD
	NUVASIVE Products: TBD Instructors: TBD
5B Lumbar Disc Replacement *Location: Radetzky Apt. II & III*	GLOBUS MEDICAL Products: TBD Instructors: TBD
5C Adolescent Idiopathic Scoliosis III *Location: Radetzky Apt. I & Kunstlerzimmer*	MEDTRONIC Products: Legacy with RMAS, VCM Instructors: TBD
5D Treatment of Vertebral Compression Fractures *Location: Rittersaal*	ALPHATEC SPINE Products: OsseoFix & OsseoFix+ Instructors: James Yue, MD
	DEPUY SPINE Products: CONFIDENCE Spinal Cement System™ Instructors: TBD Treatment for osteoporotic compression fractures with CONFIDENCE Spinal Cement System.
	MEDTRONIC Products: Balloon Kyphoplasty Instructors: TBD
	ORTHOVITA Products: Cortoss Bone Augmentation Material & Aliquot Delivery System Instructors: Maarten Persenaire, MD; Troy Wilford Cortoss is approved for vertebral augmentation and screw augmentation in Europe under the CE Mark, and also approved for sale in Australia. Cortoss is pending 510(k) clearance for vertebral augmentation in the US. This demonstration will highlight cortoss in vertebroplasty model.
5E Adult/Pediatric Deformity: My Worst Complication and How I Treated It *Location: Trabantenstube*	No demonstrations

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The Scoliosis Research Society gratefully acknowledges the following companies for their support of the Meeting Guide:

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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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555 E. Wells Street
Suite 1100
Milwaukee, WI 53202
USA
Tel: +1-414-289-9107
Fax: +1-414-276-3349
info@srs.org
www.srs.org

Scoliosis Research Society

Future Educational Events

Save *the* Dates

17TH IMAST
July 21-24, **2010**
TORONTO, CANADA

44th Annual Meeting & Course
September, 23-26, **2009**
SAN ANTONIO, TEXAS, USA

Worldwide Conferences

CAIRO, EGYPT December 14-15, **2009**
in conjunction with the
Egyptian Orthopedic Association Annual Congress

SRS-1008-222

Scoliosis Research Society presents

IMAST

17th International Meeting on Advanced Spine Techniques

July 21-24, 2010 - Toronto, Canada

Registration open - November 1, 2009
Abstract submission open - November 1, 2009
Abstract deadline - February 1, 2010

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