Scoliosis Research Society presents

IMAST 2018

25th International Meeting
on Advanced Spine Techniques

July 11–14, 2018

LOS ANGELES
CALIFORNIA, USA

JW Marriott Los Angeles
at L.A. LIVE

FINAL PROGRAM

IMAST COMMITTEE

Ronald A. Lehman, Jr., MD, Chair
Henry F.H. Halm, MD, Co-Chair
Carlos E. Barsotti, MD
David H. Clements, III, MD
Jeffrey D. Coe, MD
Charla R. Fischer, MD
Haruki Funao, MD
Matthew J. Goldstein, MD
Munish C. Gupta, MD
Yong Hai, MD
Han Jo Kim, MD
Moyo C. Kruyt, MD, PhD
Hossein Mehdian, MD, FRCS(Ed)
Ibrahim A. Omeis, MD
Stefan Parent, MD, PhD
Michael Ruf, MD
Rick C. Sasso, MD
Rajiv K. Sethi, MD
Fernando Techy, MD
Juan S. Uribe, MD

Sponsored by the Scoliosis Research Society (SRS)

25th ANNIVERSARY OF THE INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

25th IMAST
July 11-14, 2018
LOS ANGELES, CA, USA

www.srs.org/imast2018

CORPORATE SUPPORTERS

DOUBLE DIAMOND LEVEL SUPPORT

DePuy Synthes
Globus Medical
K2M
Medtronic
NuVasive

DIAMOND LEVEL SUPPORT

Zimmer Biomet

GOLD LEVEL SUPPORT

OrthoPediatrics
Stryker

SILVER LEVEL SUPPORT

Orthofix

BRONZE LEVEL SUPPORT

Alphatec Spine
Biologica Technologies
DIERS Medical Systems
EOS Imaging
Genoss Co., Ltd.
Implanet
L&K BIOMED
Life Spine, Inc.
Medicrea
Medyssey
Mighty Oak Medical
Misonix, Inc.
NASS
Paradigm Spine
Silony Medical
Spinal Balance
Spineart
Titan Spine

25TH ANNIVERSARY OF THE INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

25

25th IMAST

July 11-14, 2018

LOS ANGELES, CA, USA

GENERAL INFORMATION

The Scoliosis Research Society gratefully acknowledges DePuy Synthes for their grant support of IMAST.

25TH ANNIVERSARY OF THE INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

25th IMAST

July 11-14, 2018

LOS ANGELES, CA, USA

TABLE OF CONTENTS

25TH IMAST VENUE

JW Marriott Los Angeles at L.A. LIVE
900 W Olympic Blvd
Los Angeles, CA 90015

FUTURE EDUCATIONAL EVENTS

11th Spine Deformity Solutions: A Hands-On Course • September 7-9, 2018 • Hong Kong, People's Republic of China
53rd Annual Meeting & Course • October 10-13, 2018 • Bologna, Italy
26th IMAST • July 17-20, 2019 • Amsterdam, the Netherlands

SRS REGIONAL COURSES

Current Concepts in Spine Deformity, an SRS Course, in cooperation with Argentine Society of Pathology of the Vertebral Column (SAPCV)
August 30-31, 2018 • Buenos Aires, Argentina

CHAIR'S MESSAGE

Dear Participant,

We would like to personally welcome you to Los Angeles, California, USA for what promises to be an inspiring academic meeting. As a Society we continue to make incredible strides in the field of spinal deformities, and are excited to showcase these advancements at the landmark 25th IMAST with our colleagues from around the world.

To continue providing a world-class meeting with the best educational value, we have streamlined the program, utilizing last year's popular program design of abstracts in the morning followed by didactic faculty driven sessions in the afternoon. For the first time we will have sessions where the audience will be included in the case discussions during the Instructional Course Lectures (ICLs). This year we will also incorporate additional opportunities for audience interaction within the sessions and introduce a pilot-program of having a dedicated "e-moderator" in certain sessions that will be taking questions submitted electronically by the audience via their mobile devices. Be sure to download the mobile (instructions on page 7) to fully participate in the meeting.

This year's Special Symposium session on Wednesday, July 12 from 14:00-15:45, is a two-part session, focusing on "Building Efficiencies and Minimizing Redundancies" and kicking off the 25th Anniversary celebration of IMAST with "25 Years of IMAST from Those Who Built It." After the symposium we encourage delegates to take part in the Hands-On Workshops which will be followed by the Welcome Reception in the exhibit hall. Be sure to plan to stay through Saturday, as we have a new general session on trauma as well as a Lunch with Experts closing session, which are sure to be very stimulating.

The program will also include the popular complication and debates series, instructional course lectures (ICLs), and case discussions; all led by an international and multidisciplinary faculty. We encourage all delegates to engage in and experience the interactive and innovative program we have planned.

We are both honored to serve as your IMAST Chair and Co-Chair again this year. We want to thank those whose leadership and diligent efforts have created such a successful meeting, including Todd J. Albert, MD; Peter O. Newton, MD; Paul D. Sponseller, MD, MBA; Kenneth MC Cheung, MD; and the IMAST Committee.

With warmest personal regards,

Ronald A. Lehman, Jr., MD
IMAST Committee Chair

Henry F. H. Halm, MD
IMAST Committee Co-Chair

IMAST MOBILE APP

A mobile app will be available to all delegates during the 25th IMAST. The app is designed to enhance the attendee experience by providing all the information about IMAST in one convenient location that can be accessed from any smart phone or tablet with an internet connection.

TO DOWNLOAD THE 25TH IMAST MOBILE APP:

1. Search for IMAST2018 in the App Store or Google Play and install.
2. Open the downloaded app to begin using the app right away!
3. To take full advantage of the app, login with your email address.

ONCE DOWNLOADED, DELEGATES CAN ACCESS ALL STATIC CONTENT ON THE APP WITHOUT AN INTERNET CONNECTION, INCLUDING:

- A detailed IMAST agenda allows delegates to create a personalized schedule (must login with an email address)
- Exhibitor information including exhibit floor plan, company descriptions and the Hands-On Workshop schedule
- Maps of the IMAST meeting space
- An alert system for real-time updates from SRS – program changes, tour and social event notifications, and breaking news as it happens
- Session and overall meeting evaluations
- Session materials selected by faculty
- Live polls and the "Ask a Question" feature allowing you to submit questions during specific sessions

** Please remember to activate your wireless access on your mobile device or tablet to utilize the mobile app without incurring international fees and charges!*

NEW THIS YEAR: ASK A QUESTION IN THE APP!

Delegates will be able to ask questions, directly through the mobile app, during the following sessions: Special Symposium, Session 2C, Session 3B, Sessions 4A & 4B, Session 10B, Session 11A, Session 12 and Lunch with the Experts (designated by a ? in the agenda).

To ask a question:

1. Click on "Meeting Agenda" and select one of the sessions listed above with the "Ask a Question" feature enabled.
2. Scroll to the bottom of the session information and click "Ask a Question" under Session Engagement. Questions already asked by attendees will be listed.
3. Click "Ask a Question" again and type your question.
4. After typing your question in the text box provided, click "Submit Question". Your question will appear within the question list.
5. If someone else has already asked your question, you can upvote the question by clicking the headphones to the right of the question in the list. When questions get upvoted they will be pushed higher up on the page as the number of votes rise.

PARTICIPATE IN LIVE SESSION POLLS!

Session polls can be found at the bottom of session pages. To participate in one, click "Join Live Poll" at the bottom of the page under "Session Engagement". Once you've started a session poll, you can move from question to question by selecting your answers and clicking "Submit" or by clicking on the navigation arrows to the left and right of the Submit button. Moderators will display the live results on screen for the entire audience to view.

STAY UP TO DATE WITH SRS DURING IMAST AND SHARE YOUR EXPERIENCES.

#SRSIMAST18

@srs_org @ScoliosisResearchSociety @srs_org /company/SRS_org

GENERAL MEETING INFORMATION

MEETING DESCRIPTION

IMAST gathers leading spine surgeons, innovative researchers, and the most advanced spine technologies for all areas of spine (cervical, thoracic and lumbar), most spinal conditions (degenerative, trauma, deformity and tumor), and a variety of treatment techniques. The IMAST program will include didactic presentations, panel discussions, and papers on current research, case discussions, debates, complication series and instructional course lectures, all led by an international and multidisciplinary faculty. IMAST is sponsored by the Scoliosis Research Society (SRS).

LEARNING OBJECTIVES

Upon completion of IMAST, participants should be able to:

- Appropriately select patients for growth guidance constructs and maintain surgical expertise.
- Describe the etiology of adult deformity, the age adjusted alignment of the spine and the natural history of long fusion.
- Assess, choose and implement appropriate value-added new technology for the specific learner's practice.
- Select the optimal approach for surgery and match it to the patient's individual pathology.
- Promote risk stratification to develop universal standards of excellence in spine surgery.

TARGET AUDIENCE

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

ACCREDITATION STATEMENT

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

CREDIT DESIGNATION

The Scoliosis Research Society (SRS) designates this live activity for a maximum of 16 *AMA PRA Category 1 Credit(s)*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

DISCLOSURE OF CONFLICT OF INTEREST

It is the policy of SRS to ensure balance, independence, objectivity and scientific rigor in all of their educational activities. In accordance with this policy, SRS identifies conflicts of interest with instructors, content managers and other individuals who are in a position to control the content of an activity. Conflicts are resolved by SRS to ensure that all scientific research referred to, reported, or used in a Continuing Medical Education (CME) activity conforms to the generally accepted standards of experimental design, data collection and analysis.

FDA STATEMENT (UNITED STATES)

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

INSURANCE/LIABILITIES AND DISCLAIMER

SRS will not be held liable for personal injuries or for loss or damage to property incurred by participants or guests at IMAST including those participating in tours and social events. Participants and guests are encouraged to take out insurance to cover loss incurred in the event of cancellation, medical expenses or damage to or loss of personal effects when traveling outside of their own countries. SRS cannot be held liable for any hindrance or disruption of IMAST 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 condition. The materials presented at this Continuing Medical Education (CME) 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 disclaims 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.

CME INFORMATION

CME certificates will be available to pre-registered delegates upon the opening of the meeting at www.srs.org/imast2018/cme-evaluations. Delegates who registered on-site may access their certificates after August 1, 2018. Certificates are NOT available to delegates registering on-site until August 1.

Delegates should log on to the website listed above and enter their last name and the ID# listed at the top of their IMAST registration confirmation form and name badge. The system will then ask delegates to indicate which sessions they attended, and then will generate a PDF certificate which may be printed or saved to the delegate's computer. Session attendance is saved in the database, and certificates may be accessed again, in the event the certificate is lost or another copy is required.

Please note that certificates will not be mailed or emailed after the meeting. The online certificate program is the only source for this documentation. Please contact SRS at cme@srs.org for any questions. SRS asks that all CME certificates be claimed no later than November 1, 2018.

Certificates of attendance will be emailed to each delegate upon checking in at the registration desk at the meeting. Delegates will not receive a paper copy of the certificate in their registration materials. If you would like a paper copy, please stop at the printing stations before the close of the meeting. Evaluations will be available to all attendees at the commencement of the meeting. Evaluations are available at www.srs.org/imast2018/.

GENERAL MEETING INFORMATION

SESSION INFORMATION

Instructional Course Lectures (ICLs)

There will be six (6) ICL sessions highlighting the latest in surgical techniques and technologies. Each session will feature concurrent didactic sessions, programmed around thematic areas and will include a balanced discussion of multiple products, techniques and advances relevant to that topic.

Debates

There will be three (3) sessions featuring multiple debates per session. Expert faculty will be assigned to different treatment options available for specific conditions for each debate. Debate topics and faculty are listed in the Meeting Agenda, beginning on p. 41.

Case Presentations

There will be six (6) case presentations sessions, the sessions will highlight many of the significant sections that surgeons encounter when choosing which type of operation to perform. Expert faculty will present cases and encourage attendee participation in deciding how to optimize treatment for various scenarios. This will facilitate the insight and understanding that will ultimately benefit our patients.

Complications Series

The complications series presents a variety of illustrative case presentations, demonstrating the most common and worst complications encountered, as well as strategies to prevent and manage them. Interaction between faculty and participants will focus on treatment options with an emphasis on reducing further morbidity and improving eventual outcomes. Complication topics and faculty are listed in the Meeting Agenda, beginning on p. 41.

Special Symposia

We encourage delegates to take part in the following afternoon activities on Wednesday, July 12.

Special Symposium – 14:00-15:45

Part 1: Building Efficiencies and Minimizing Redundancies
Part 2: 25 Years of IMAST from Those Who Built It

After the symposia we encourage delegates to take part in the Hands-On Workshops (HOWs) from 16:00-18:00 which will be followed by the Welcome Reception in the Exhibit Hall from 18:00-20:00.

ADMISSION TO SESSIONS

Official name badges will be required for admission to all sessions, workshops and the exhibit hall. All IMAST attendees receive a name badge with their registration materials. Name badges should be worn at all times inside the meeting space, as badges will be used to control access to sessions and activities. Attendees are cautioned against wearing their name badges while away from the venue, as a badges can draw unwanted attention to your status as visitors to the city.

LANGUAGE

Presentations and course materials will be provided in English.

NO SMOKING POLICY

Smoking is not permitted during any IMAST activity or event.

CELL PHONE PROTOCOL

Please ensure that cell phone ringers, pagers and electronic devices are silenced or turned off during all sessions.

EMERGENCY & FIRST AID

The JW Marriott Los Angeles at L.A. LIVE is fully prepared to handle emergency requests and first aid. Contact an SRS Staff person for support. Remember to note all emergency exits within the venue.

ATTIRE

Business casual (polo or dress shirts, sport coats) are appropriate for IMAST sessions.

LOST & FOUND

Please feel free to stop by the SRS Registration Desk if you have a lost or found an item during the course of IMAST.

EXHIBITS & HANDS-ON WORKSHOPS (HOWS)

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.

Each Hands-On Workshop (HOW) is supported and programmed by a single-supporting company and will feature presentations on topics and technologies selected by the corporate supporter. Breakfast, lunch, or beverages and snacks will be served just outside the HOWs, as noted in the program. Please note that HOWs are non-CME sessions.

INTERNET ACCESS

Wireless Internet access is available throughout the meeting space of the JW Marriott.

To log on select…
Network = JW Marriott_CONFERENCE
Password = IMAST2018

PRINTING STATION

Delegates are welcome to use the complimentary printing stations, located next to the registration desks, to print their certificate of attendance and CME certificates (pre-registered delegates only; onsite registrants will have access to their certificates beginning August 1, 2018).

CHARGING STATION

Delegates are welcome to use the complimentary charging station inside the General Session room, Diamond Salon 1-5 to recharge smartphones and small tablets. Please do not leave your electronic devices or any personal belongings at the charging station unattended.

The charging station is supported, in part, by grants from K2M, Medtronic, and Zimmer Biomet.

GENERAL MEETING INFORMATION

PRESENTATION UPLOAD AREA

Location: General Session Room – Diamond Salon 1-5

Presenters may upload their PowerPoint presentations in the Speaker Ready Area located in the back of the general session room, Diamond Salon 1-5.

Hours:

Wednesday, July 11	13:00-20:00 (during Welcome Reception)
Thursday, July 12	7:30-18:30
Friday, July 13	7:30-17:00
Saturday, July 14	7:30-12:45

Please upload presentations no later than 24 hours before the session is scheduled to begin.

REGISTRATION DESK HOURS

Location: Platinum Foyer – JW Marriott

Wednesday, July 11	13:00-19:00
Thursday, July 12	7:45-17:00
Friday, July 13	7:45-16:00
Saturday, July 14	8:30-11:00

ANNOUNCEMENT BOARD

A self-service announcement board (non-electronic) will be available by the registration desk for attendees to post notes or leave messages for other attendees. SRS staff will also post meeting updates and announcements on the board. Please remember to check for any messages that may be left for you.

The Announcement Board is supported, in part, by a grant from OrthoPediatrics.

VIDEO RECORDING PROHIBITED

SRS does not allow personal video recording of the presentations of any kind. SRS holds the right to confiscate any and all recording taken of any of the presentations. All session rooms will be recorded and will be available to delegates after the meeting on the SRS website.

VIDEO ARCHIVES

Video archives will be available to all meeting delegates on the SRS website (http://www.srs.org/professionals/online-education-and-resources/past-meeting-archives) four to six weeks after the meeting. All session rooms, both main ballrooms and break-out rooms, are being recorded. If you were unable to attend a concurrent session, don't forget to watch it on the website!

WELCOME RECEPTION

All registered delegates and registered guests are invited to pick up their registration materials and attend the IMAST Welcome Reception on Wednesday, July 11 from 18:00-20:00. The reception will be hosted in the Exhibit Hall in the Diamond Foyer at the JW Marriott, where beverages and light hors d'oeuvres will be served. There is no charge for registered delegates, though delegate badges are required for entrance. Registered guests may purchase a Welcome Reception ticket for $20 USD at the time of registration. Dress for the Welcome Reception is business casual.

We encourage delegates to take part in the following afternoon activities before the Welcome Reception on Wednesday, July 11.

14:00-15:45 ** Special Symposium**
Part 1: Building Efficiencies and Minimizing Redundancies
Part 2: 25 Years of IMAST from Those Who Built It

16:00-18:00 Hands-On Workshops with Beverages & Snacks

18:00-20:00 Welcome Reception

The Welcome Reception is supported, in part, by grants from Medtronic and NuVasive.

SRS MEMBERSHIP INFORMATION

Prospective members and new candidate members are invited to attend a membership information session on Friday, July 13 from 17:00 – 17:30 in Platinum Salon A-C. Membership information will also be available at the SRS Membership Booth (booth #1) in the exhibit hall. Don't miss the opportunity to learn more about the SRS!

EVALUATIONS

WE NEED YOUR FEEDBACK!

Complete the session and overall meeting evaluations on the app or online.

If you have questions,
contact SRS at cme@srs.org

On the App: Session Evaluations:

1. Select "Meeting Agenda" from the home screen
2. Select the Session you want to evaluate
3. Scroll to the bottom of the session description to find the evaluation

Overall Meeting Evaluation:

1. Select "Polls & Voting" from the home screen
2. Select the IMAST Evaluation

Online: http://www.srs.org/imast2018/cme-evaluations

MEETING OVERVIEW

	Wednesday, July 11	Thursday, July 12	Friday, July 13	Saturday, July 14
Morning	8:00-12:00 Final Exhibit Set-up Board of Directors Meeting	7:45-8:45 Hands on Workshops* *with Breakfast* 7:45-17:00 Delegate Registration Open 8:00-17:30 Exhibit Hall Open 8:00-8:55 Exhibit Viewing & Coffee 9:00-10:35 General Session: Whitecloud Clinical Award Nominees & Presidential Address 10:35-11:05 Exhibit Viewing & Refreshment Break* 11:05-12:30 Concurrent Abstract Sessions	7:45-8:45 Hands on Workshops* *with Breakfast* 7:45-16:00 Delegate Registration Open 8:00-16:45 Exhibit Hall Open 8:00-8:55 Exhibit Viewing & Coffee 9:00-10:00 Concurrent Abstract Sessions 10:00-10:30 Exhibit Viewing & Refreshment Break* 10:30-12:00 Concurrent Abstract Sessions	8:30-11:00 Delegate Registration Open Exhibit Hall Closed 9:00-10:00 Concurrent ICL Sessions 10:15-11:15 General Session: Surgical Video Session 11:15-11:45 Walking Break & Boxed Lunch Pick-up*
Afternoon	12:00-13:00 Final Exhibit Set-up Exhibitor Registration Open Board of Directors Meeting 13:00-19:00 Delegate Registration Open 14:00-15:45 Special Symposium 16:00-18:00 Hands-On Workshops* *with snacks & refreshments*	12:30-13:30 Hands-On Workshops* *with Lunch* Exhibit Viewing & Lunch* 13:45-14:45 Concurrent Debate Sessions 15:00-15:40 Concurrent Case Presentation Sessions 15:40-16:10 Exhibit Viewing & Refreshment Break* 16:10-17:10 Concurrent Complication Sessions	12:00-13:00 Hands-On Workshops* *with Lunch* Exhibit Viewing & Lunch* 13:10-14:10 Concurrent Sessions 14:15-15:15 Concurrent ICL Sessions 15:15-15:45 Exhibit Viewing & Refreshment Break* 15:45-16:45 Concurrent Complication Sessions 17:00-17:30 SRS Membership Information Session*	11:45-13:00 General Session: Lunch with Experts 13:00 Adjourn
Evening	18:00-20:00 Welcome Reception* *in the Exhibit Hall*	17:15-18:15 Hands-On Workshops* *with snacks & refreshments* Free Evening	Free Evening	

**Denotes non-CME session*

MEETING SPACE LAYOUT

Diamond Level

General Session
(Diamond Salon 1-5)

Exhibit Hall
(Diamond Foyer)

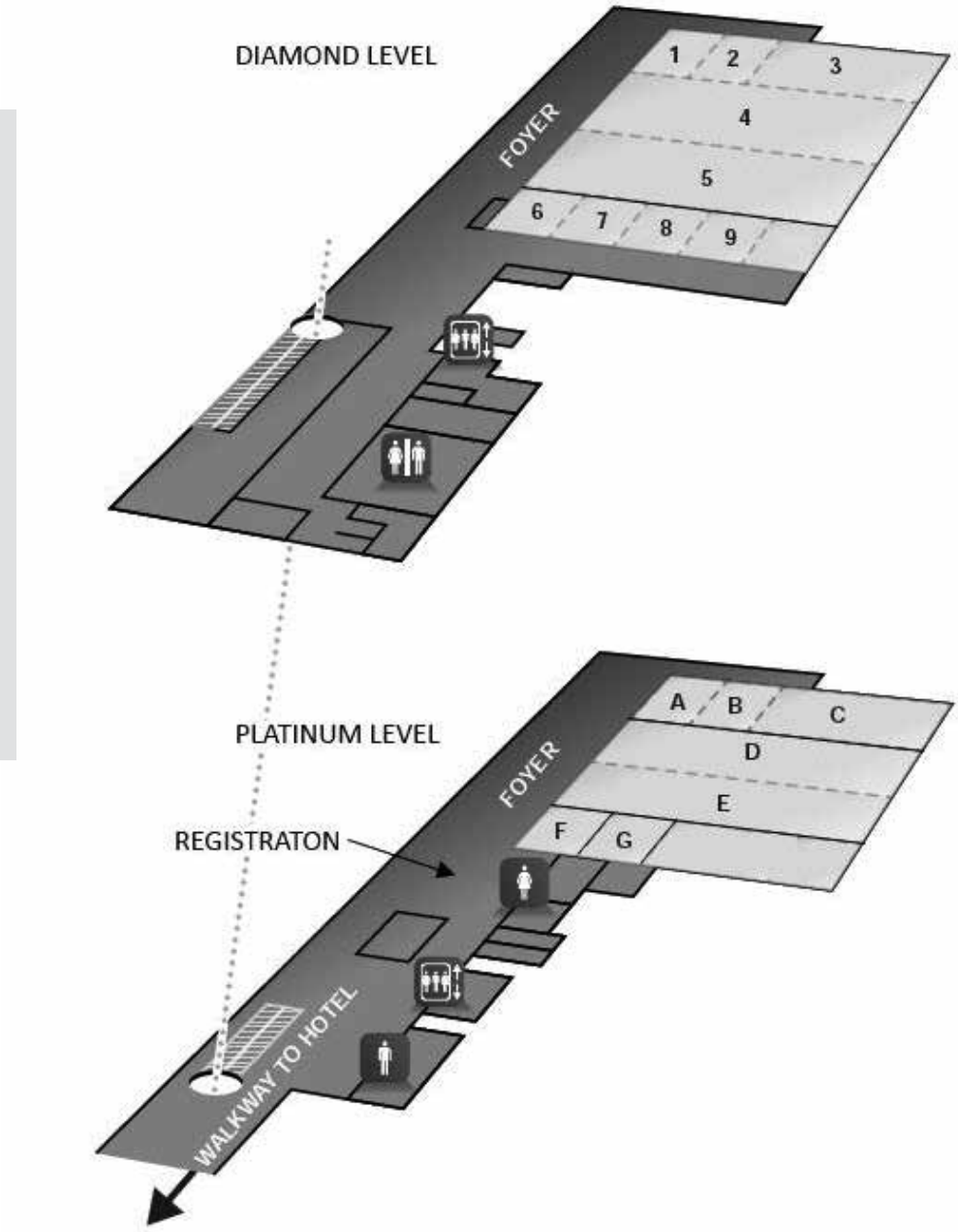
Hands-On Workshops
(Diamond Salons 6, 7, 8, & 9)

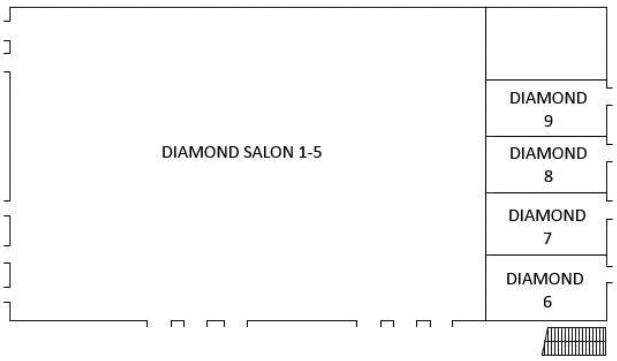
Platinum Level

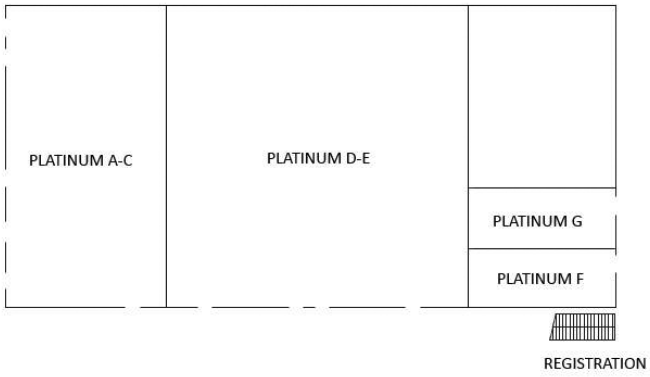
Registration
(Platinum Foyer)

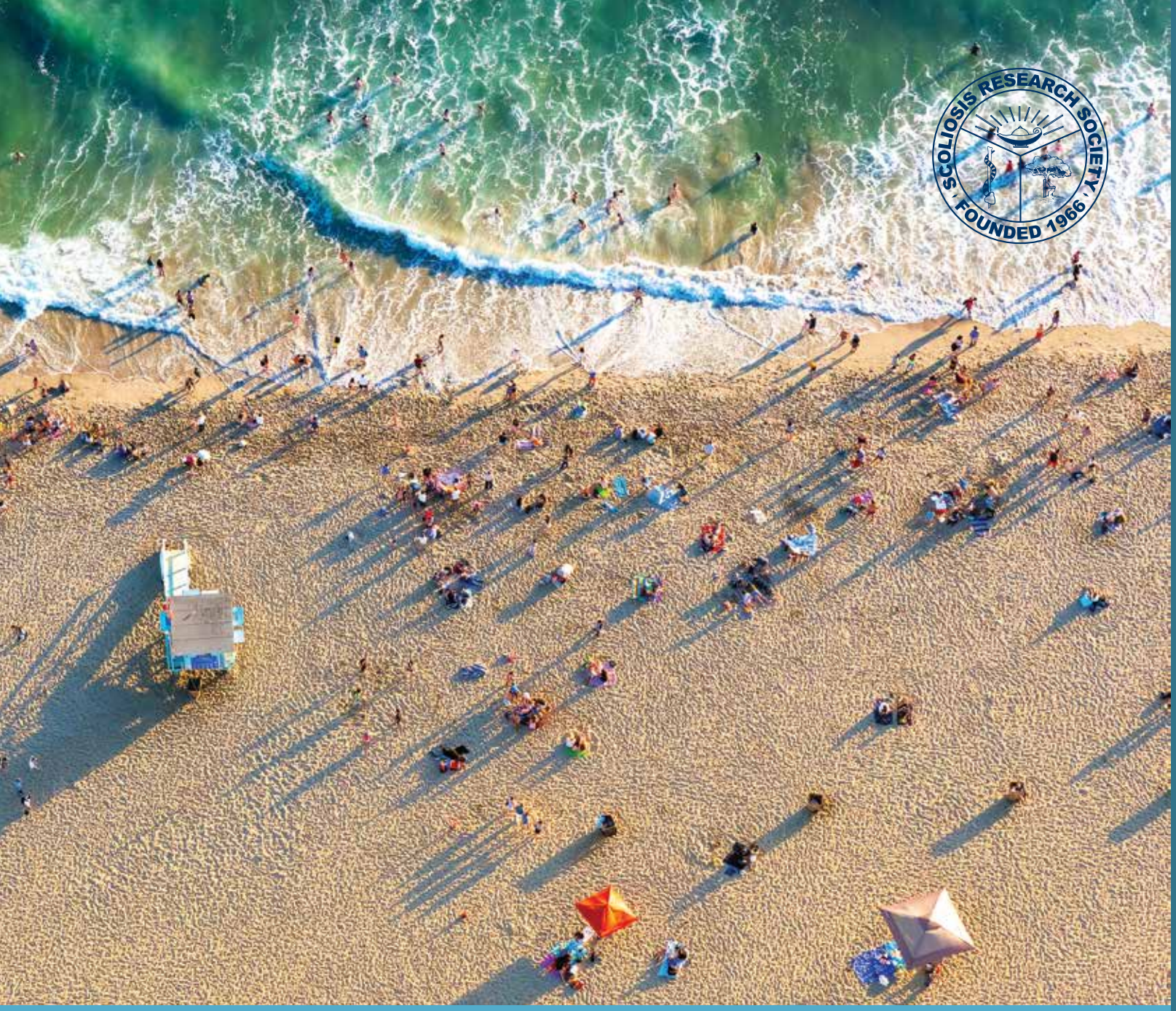
Concurrent Sessions
(Platinum A-C, Platinum D-E)

Meeting Rooms
(Platinum F & G)









AUTHOR DISCLOSURES

The Scoliosis Research Society gratefully acknowledges K2M for their grant support of the IMAST Charging Station and Ribbon Display.

25TH ANNIVERSARY OF THE INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

25th IMAST

July 11-14, 2018

LOS ANGELES, CA, USA

AUTHOR DISCLOSURES

BOARD OF DIRECTORS		
Todd J. Albert, MD	United States	Biomeric (c); Crosstrees Medical (c); DePuy Synthes (g); Facet Link (b, g); Gentis (c, e); International Orthopedic Alliance (Bonovo) (c); Invivo (c, e); Invuity (g); Paradigm Spine (c); Pulse Equity (c); Spinicity (c, e); United Healthcare (e); Vital 5 (c, e); Zimmer Biomet (g)
Sigurd H. Berven, MD	United States	AO Spine (a); Globus Medical (e); Medtronic (e,g); Stryker Spine (e,g)
Laurel C. Blakemore, MD	United States	K2M (b, g); NuVasive (d)
Douglas C. Burton, MD	United States	Bioventus (a); Depuy Spine (a, b, g); International Spine Study Group (e); Pfizer (a); Scoliosis Research Society (e); University of Kansas Physicians, Inc (e)
J. Abbott Byrd III, MD	United States	RTI (b); Surgitech (c); Zimmer Biomet (g)
Kenneth MC Cheung, MD, FRCS	Hong Kong	AO Spine (a); Avalon Spinecare (a); OrthoSmart (g)
Marinus de Kleuver, MD, PhD	Netherlands	No Relationships
John R. Dimar II, MD	United States	DePuy Synthes (b); Medtronic (b, g)
Ron El-Hawary, MD, MS	Canada	Apifix Ltd. (b); DePuy Synthes (a, b, e); Medtronic (a, b); Wishbone (b, g)
Lori A. Karol, MD	United States	No Relationships
Hani H. Mhaidli, MD, PhD	Spain	No Relationships
Peter O. Newton, MD	United States	Alphatec Spine (a); DePuy Synthes (a, g); Electrocore (c); EOS Imaging (a); Globus Medical (a); K2M (a, b); Mazor Robotics (a); NuVasive (a); OrthoPediatrics (a); Thieme Publishing (g)
David W. Polly Jr., MD	United States	No Relationships
Frank J. Schwab, MD	United States	DePuy Synthes (a); K2M (a, g); Medicrea (b, g); Medtronic (g); Nemaris INC (c); NuVasive (a, b, g); Zimmer Biomet (b, g)
Rajiv K. Sethi, MD	United States	K2M (b); NuVasive (a,b,d); Orthofix (G)
Paul D. Sponseller, MD	United States	DePuy Synthes (a, b, g); Globus Medical (g); OrthoPediatrics (a)
Mark Weidenbaum, MD	United States	No Relationships
IMAST COMMITTEE (IF NOT LISTED ABOVE)		
Carlos E. Barsotti, MD, PhD	Brazil	No Relationships
David H. Clements III, MD	United States	DePuy Synthes (a, d); NuVasive (a, b, g)
Jeffrey D. Coe, MD	United States	Alphatec Spine (c); Benvenue (a, b); NuVasive (a, b); Phygen (c); Providence Medical Technology (a, b)
Charla R. Fischer, MD	United States	Expert Connect (d); Stryker Spine (b)
Haruki Funao, MD	Japan	No Relationships
Matthew J. Goldstein, MD	No Relationships	4WEB Medical (b)
Munish C. Gupta, MD	United States	AOSpine North America-paid to institution for fellowship (a); DePuy Synthes (b, e, g); Johnson & Johnson (c); Medtronic (e); OMeGA-paid to institution for fellowship (a); Proctor & Gamble (c)
Yong Hai, MD, PhD	China	No Relationships
Henry F.H. Halm. MD	Germany	NuVasive (b, g); Silony Medical (a, e)
Han Jo Kim, MD	United States	AO Spine (e); CSRS (a); ISSGF (a); K2M (g); Zimmer Biomet (g)

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Moyo C. Kruyt, MD, PhD	Netherlands	NuVasive (a); K2M (a)
Ronald A. Lehman, MD	United States	Medtronic (b, d); Stryker Spine (b, d)
Hossein Mehdian, MD, FRCS	United Kingdom	No Relationships
Ibrahim A. Omeis, MD	United States	No Relationships
Stefan Parent, MD, PhD	Canada	AO Spine (d); Canadian Institute of Health Research (a); DePuy Synthes (b, a); EOS Imaging (b, a); K2M (b, a); Le Fonds de la recherche en santé du Québec (a); Medtronic (b, a); Orthopaedic Research and Education Foundation (a); Setting Scoliosis Straight Foundation (a); Spinologics (c); The Canada Foundation for Innovation (a); The Natural Sciences and Engineering Research Council of Canada (a)
Michael Ruf, MD	Germany	No Relationships
Rick C. Sasso	United States	Cerapedics (a); Medtronic (a, g); Parexel (a); Relievant (a); Saunders/Mosby Elsevier (g); Smith & Nephew (a); Spinal Kinetics (a); Stryker (a)
Fernando Techy, MD	United States	Amedica (b, g); AOSpine (a, d); AxioMed (a); Grafton (b, e); M6 (a); Orthofix (a, b, d); SI Bone (g)
Juan S. Uribe, MD	United States	Misonix (b); NuVasive (a, b, c, g); SI Bone (b)
CME COMMITTEE (IF NOT LISTED ABOVE)		
Michael C. Albert, MD	United States	No Relationships
Ioannis Avramis, MD	United States	DePuy Synthes (b)
Samuel K. Cho, MD	United States	Globus Medical (b); Medtronic (b); Zimmer Biomet (b)
Woojin Cho, MD, PhD	United States	No Relationships
Ujjwal K. Debnath, MD, FRCS	India	No Relationships
Bhavuk Garg, MBBS, MS, FACS, FICS, MRCS, MAMS, FIMSA	India	No Relationships
Ryan C. Goodwin, MD	United States	K2M (b); OrthoPediatrics (b); Stryker Spine (b)
Mari Louise Groves, MD	United States	No Relationships
Robert P. Huang, MD	United States	No Relationships
Manish K. Kasliwal, MD, MCh	United States	No Relationships
William F. Lavelle, MD	United States	4-Web (c); Cardan Robotics (c); DePuy Synthes (a); Innovasis (e); K2M (a); Prosydian (c,e); Signus, Inc. (a); Spinal Kinetics, Inc. (a); Vertebral Technologies, Inc. (a)
Jwalant S. Mehta, FRCS	United Kingdom	AO Spine (d); DePuy Synthes (a); K2M (b); Medtronic (a); Stryker Spine (g)
Kevin M. Neal, MD	United States	OrthoPediatrics (g)
Anthony M. Petrizzo, MD	United States	Stryker Spine (b)
Vishwas R. Talwalkar, MD	United States	No Relationships
Stacie Tran, MPH	United States	No Relationships
Burt Yaszay, MD	United States	DePuy Synthes+A43:C59 (a, b, d, e); Ethicon (b); Globus Medical (b, d, g); K2M (b, g); NuVasive (a, b, d, e); OrthoPediatrics (g); Stryker Spine (d)

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

PROGRAM COMMITTEE (IF NOT LISTED ABOVE)		
Raphael D. Adobor, MD, PhD	Norway	No Relationships
Lindsay M. Andras, MD	United States	Eli Lilly (c); Medtronic (b, d); NuVasive (b, d); Orthobullets (g); Zimmer Biomet (b, d)
Jason Pui Yin Cheung, MBBS, FRCS, MS	Hong Kong	No Relationships
Jeffrey L. Gum, MD	United States	Acuity (b, g); Alphatec Spine (b); DePuy Synthes (b); (a); K2M (b); Medtronic (b); NuVasive (b); Stryker Spine (b)
Daniel G. Kang, MD	United States	No Relationships
Michael P. Kelly, MD, MS	United States	No Relationships
Stephen J. Lewis, MD, FRCS	Canada	Augmedics (c); Covr Medical (c); DePuy Synthes (d); Medtronic (d, g); Stryker Spine (b, d); Thompson Medical (c)
Isador H. Lieberman, MD, FRCS	United States	Globus Medical (b); Mazor Robotics (b, c); Medtronic (b); Misonix (b); SI Bone (b); Stryker Spine (b); Safe Orthopaedics (b)
Firoz Miyanji, MD, FRCS(C)	Canada	DePuy Synthes (a, b)
Gregory M. Mundis, MD	United States	Allosource (e); K2M (b, g); NuVasive (b, e, g)
Ferran Pellisé, MD	Spain	AO Spine (e); DePuy Synthes (a); Medtronic (a); Zimmer Biomet (a)
Yong Qiu, MD	China	No Relationships
John T. Smith, MD	United States	DePuy Synthes (b, g); Children's Spine Foundation (e); Globus Medical (b, g); NuVasive (b); SpineGuard (b); Zimmer Biomet (d)
Muharrem Yazici, MD	Turkey	No Relationships
PROGRAM REVIEWERS (IF NOT LISTED ABOVE)		
D. Greg Anderson, MD	United States	DePuy Synthes (b, g); K2M (b); ISD (e)
Saumyajit Basu, MD	India	No Relationships
Matthew E. Cunningham, MD, PhD	United States	K2M (a); RTI (a); NuVasive (b)
Vedat Deviren, MD	United States	Alphatec Spine (b); Biomet (b); Guidepoint (b); Medicrea (b); NuVasive (a, b, g); Pfizer (b)
Bassel G. Diebo, MD,	United States	No Relationships
William F. Donaldson, III, MD	United States	No Relationships
Robert N. Dunn, FCS (SA) Orth	South Africa	AO Spine (a, d); DePuy Synthes (a, b); Medtronic (a, b)
Mohammad El-Sharkawi, MD	Egypt	No Relationships
Daniele A. Fabris-Monterumici, MD	Italy	No Relationships
Michael J. Goytan, MD, FRCSC	Canada	Stryker Spine (a)
Lawrence L. Haber, MD	United States	OrthoPediatrics (b, c, g)
Sajan Hegde, MD	India	Globus Medical (b, d, g)
Ilkka J. Helenius, MD, PhD	Finland	Medtronic (a, b)
Charles E. Johnston, MD	United States	Elsevier (g); Medtronic (g)
Khaled M. Kebaish, MD, FRCS(C)	United States	DePuy Synthes (b, g); K2M (b); Orthofix (b, g); SpineCraft (g)
Hak-Sun Kim, MD	South Korea	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Eric O. Klineberg, MD	United States	Allosource (b); AO Spine (a, d); DePuy Synthes (b); K2M (d); Springer (b); Stryker Spine (b); Trevena (b)
John P. Lubicky, MD, FAAOS, FAAP	United States	No Relationships
Jean-Marc Mac-Thiong, MD, PhD	Canada	Medtronic (a); Spinologics Inc (c, e, g)
Lotfi Miladi, MD	France	EUROS (g)
Mohammed Mostafa Mossaad, MD	Egypt	No Relationships
Colin Nnadi, MBBS, FRCS	United Kingdom	NuVasive (a, b)
Cristina Sacramento Dominguez, MD, PhD	Spain	No Relationships
Vishal Sarwahi, MBBS	United States	DePuy Synthes (b); Medtronic (b); NuVasive (b); Precision Spine (a, b, g)
Dilip K. Sengupta, MD	United States	CTL Medical (e); Globus Medical (c, e)
Ahmed M. Shawky Abdelgawaad, MD, MHBA	Germany	No Relationships
Osamu Shirado, MD, PhD	Japan	No Relationships
Vincent C. Traynelis, MD	United States	AO Spine (a); Globus Medical (a); Medtronic (b, g); Thompson (b)
Kota Watanabe, MD, PhD	Japan	No Relationships
Yat Wa Wong, MD	Hong Kong	No Relationships
FACULTY (IF NOT LISTED ABOVE)		
Ahmet Alanay, MD	Turkey	No Relationships
Christopher P. Ames, MD	United States	Biomet Spine (g); DePuy Synthes (b, g); DePuy Synthes (g); K2M (b); Medicrea (b); Medtronic (b); NuVasive (g); Stryker Spine (b, g); Stryker Spine (g)
Neel Anand, MD	United States	AF Cell (c); Bonovo (c); Elsevier (g); Globus Medical (c, e, g); GYS Tech (b, c); Medtronic (b, c, g); Paradigm Spine (c); Spinal Balance (c); Theracell (c, e)
Peter D. Angevine, MD, MPH	United States	No Relationships
Jahangir K. Asghar, MD	United States	Globus Medical (b); LifeSpine (b, g); Setting Scoliosis Straight (a)
Randal R. Betz, MD	United States	Abyrx (b, c); Advanced Vertebral Solutions (c); ApiFix (b, c); DePuy Synthes (a, b, d, g); Electrocore (c); Globus Medical (b, d, g); Medovex (c); Medtronic (b, g); Orthobond (c); SpineGuard (b, c, g); Wishbone (b);
Jacob M. Buchowski, MD, MS	United States	AO Foundation (a, g); AOSpine North America (a); Globus Medical (d, g); K2M (g); OMeGA (a); Wolters Kluwer Health, Inc. (g)
Shane Burch, MD, FRCS(C)	United States	Misonix, Inc. (b); Medtronic (a, b, e); Zimmer Biomet (b)
Sébastien Charosky, MD	France	Kisko (b); Medtronic (b)
Dean Chou, MD	United States	Globus Medical (b, g); Medtronic (b)
Mario Di Silvestre, MD	Italy	No Relationships
Thomas Errico, MD	United States	Fastenetix (g); K2M (d, e); Medtronic (a); Paradigm Spine (a); Pfizer (a)
Steven D. Glassman, MD	United States	Medtronic (b, g)
D. Kojo Hamilton, MD	United States	No Relationships
Ian J. Harding, BA, FRCS (Orth)	United Kingdom	Medtronic (b, d, g)
Patrick C. Hsieh, MD, MSc	United States	Medtronic (b, g); NuVasive (b, g); Zimmer Biomet (b, g)

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Serena S. Hu, MD	United States	NuVasive (c, g)
Andrew H. Jea, MD	United States	No Relationships
Lawrence G. Lenke, MD	United States	10. Setting Scoliosis Straight Foundation (a); 5. Seattle Science Foundation (g); AO Spine (a, g); BROADWATER (g); DePuy Synthes (b, a); EOS Imaging (a); Evans Family Donation (g); Fox Family Foundation (g); Fox Rothschild, LLC (g); K2M (b); Medtronic (b, g); Quality Medical Publishing (g); Scoliosis Research Society (a, g); Stryker Spine (g); The Spinal Research Foundation (g)
Sean Molloy, MBBS, FRCS(Orth), MSc	United Kingdom	Medtronic (a, b, d)
Mauricio Montalvo, MD	Mexico	No Relationships
Praveen V. Mummaneni, MD	United States	AO Spine (a); DePuy Synthes (b, g); Globus Medical (b); ISSG (a); NREF (a); Spinicity/ISD (c); Stryker Spine (b); Taylor and Francis Publishers (g); Thieme Publishing (g)
Luis Eduardo Munhoz Da Rocha, MD	Brazil	No Relationships
Peter S. Rose, MD	United States	K2M (b)
Amer F. Samdani, MD	United States	DePuy Synthes (b); Ethicon (b); Globus Medical (b); Misonix (b); Stryker Spine (b); Zimmer Biomet (b)
Daniel M. Sciubba, MD	United States	DePuy Synthes (b); K2M (b); Medtronic (b); NuVasive (b); Stryker Spine (b)
Christopher I. Shaffrey, MD	United States	Medtronic (b, g); NuVasive (b, c, g); Zimmer Biomet (b, g)
Harry L. Shufflebarger, MD	United States	DePuy Synthes (a, b, d); K2M (b, d, g)
David L. Skaggs, MD	United States	Ellipse (a); Grand Rounds (b); Green Sun Medical (b, c); Johnson & Johnson (d); Medtronic (b, d, g); Orthobullets (b, c); Wolters Kluwer - Lippencott Williams & Wilkens (g); Zimmer Biomet (b, d, g); Zipline Medical, Inc (b, c)
Justin S. Smith, MD, PhD	United States	AlloSource (b); AOSpine (g); DePuy Synthes (a); K2M (b); NREF (g); NuVasive (b); Zimmer Biomet (b, g)
Daniel J. Sucato, MD, MS	United States	Globus Medical (g)
STAFF		
Lily Atonio	United States	No Relationships
Alysha Chapman, CNP	United States	No Relationships
Ann D'Arienzo, CMP	United States	No Relationships
Tressa Goulding, CAE	United States	No Relationships
Jenifer Heller	United States	No Relationships
Courtney Kissinger	United States	No Relationships
Lauren Kritter	United States	No Relationships
Ashtin Neuschaefer	United States	No Relationships
Shawn Storey	United States	No Relationships
AUTHORS (IF NOT LISTED ABOVE)		
Kadir Abul, MD	Turkey	No Relationships
Emre Acaroglu, MD	Turkey	AO Spine (d, e); DePuy Synthes (a); Medtronic (a); Zimmer Biomet (d)
Behrooz A. Akbarnia, MD	United States	DePuy Synthes (g); K2M (b, g); NociMed (c); NuVasive (a, b, c, g); SeaSpine (a)

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Yunus Emre Akman, MD	Turkey	No Relationships
Pouya Alijanipour, MD	United States	Medicrea (g)
Abdulmajeed Alzakri, MD, MS	Saudi Arabia	No Relationships
Terry D. Amaral, MD	United States	No Relationships
Afshin Aminian, MD	United States	Medicrea (b, g)
Mikkel Østerheden Andersen, MD	Denmark	No Relationships
Andreas Andresen, MD	Denmark	No Relationships
Alexandre Ansorge, MD	Switzerland	No Relationships
Hideyuki Arima, MD, PhD	Japan	No Relationships
Joseph Baker, FRCS	New Zealand	3D4Medical (b)
Avionna Baldwin, BS	United States	No Relationships
Tomohiro Banno, MD, PhD	Japan	No Relationships
Carrie E. Bartley, MA	United States	No Relationships
Teresa Bas, MD, PhD	Spain	No Relationships
Jose Luís Bas Hermida, MD	Spain	No Relationships
Paloma Bas Hermida, MD	Spain	No Relationships
Tracey P. Bastrom, MA	United States	No Relationships
Jennifer M. Bauer, MD, MS	United States	No Relationships
Murat Baydogan, PhD	Turkey	No Relationships
Eduardo Beauchamp, MD	United States	No Relationships
Tom Bendix, MD	Denmark	No Relationships
John A. Bendo, MD	United States	No Relationships
Rebecca Bennett, MS, BSN, PPCNP-BC	United States	No Relationships
Shay Bess, MD	United States	DePuy Synthes (a); EOS Imaging (a); Globus Medical (a); K2M (e, b, a, d); Medtronic (a); NuVasive (a); Orthofix (a)
Shekhar Bhojraj, MBBS, MS, FCPS	India	No Relationships
Scott D. Boden, MD	United States	Bone Biologics Corporation (c); Medtronic (g); SeaSpine (b)
Blake Bodendorfer, MD	United States	No Relationships
Mandar Borde, MBBS, MS	India	No Relationships
Cole Bortz, BA	United States	No Relationships
Patrick P. Bosch, MD	United States	No Relationships
Felix Brassard, MD	Canada	No Relationships
Keith H. Bridwell, MD	United States	Wolters Kluwer (g)
Rachel Bronheim, BS	United States	No Relationships
Daina Brooks, BS	United States	Globus Medical (f)
Aaron Buckland, MBBS, FRACS	United States	K2M (d)
Thomas Buell, MD	United States	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Evalina L. Burger, MD	United States	DSM Biomedical (b); Innovation Medical Tech (b); K2M (b); Medicrea (b); Meditech Spine (b); Orthofix (b); Paradigm Spine (b); Spine Wave (b); X-Spine (b)
Patrick J. Cahill, MD	United States	Biogen (b); NuVasive (b)
Christopher Cain, MD, PhD	United States	DePuy Synthes (b, g); Medicrea (a); Medtronic (a); NuVasive (b); Orthofix (a); Pfizer (a); SI Bone (a)
John M. Caridi, MD	United States	Zimmer Biomet (a, b)
Leah Yacat Carreon, MD, MS	Denmark/United States	No Relationships
Andrea Castillo, BS	United States	No Relationships
Meghan Cerpa, BS, MPH	United States	No Relationships
Shann Haw Chang, MD	Korea, South	No Relationships
Wai-wang Chau,	Hong Kong	No Relationships
Chong Chen, MD	China	No Relationships
Ivan Cheng, MD	United States	Globus Medical (b, g); NuVasive (b, c, g); Spine Wave (g); SpineCraft (e); Stryker Spine (b)
Jack C.Y. Cheng, MD	Hong Kong	No Relationships
King Cheung Berry Cheung, BS	Hong Kong	Avalon SpineCare (HK) Limited (g)
Kazuhiro Chiba, MD	Japan	Astellas Pharma Inc. (a); Daiichi Sankyo Co. Ltd. (a); Eisai Co. Ltd. (a); Kaken Pharmaceutical Co. Ltd. (a); Medtronic (a); Pfizer Japan (a); Seikagaku Corporation (b); Smith & Nephew (a); Stryker Spine (a); Taisho Pharmaceutical (a); Zimmer Biomet (a)
Children's Spine Study Group	United States	DePuy Synthes (a); NuVasive (a)
Unyong Choi, MD	Korea, South	No Relationships
Simon Chow, PhD	Hong Kong	No Relationships
Godwin Choy, FRACS	New Zealand	No Relationships
Lut Hey Chu, MPhil	Hong Kong	Avalon Spinecare (HK) Limited (g)
Winnie Chu, MD	Hong Kong	No Relationships
Chun Kee Chung, MD, PhD	Korea, South	No Relationships
Tunca Cingoz, MD	Turkey	No Relationships
Bryan W. Cunningham, PhD	United States	No Relationships
Benny T. Dahl, MD, PhD	United States	K2M (a, e); Medtronic (a, d)
Kenshi Daimon, MD	Japan	No Relationships
Cecilia Dalle Ore, BS	United States	No Relationships
Charles d'Amato, MD, FRCS(C)	United States	No Relationships
Alan H. Daniels, MD	United States	Orthofix (a, b, e); SpineArt (b, e); Springer (g); Stryker Spine (b, e)
John M. Dawson, PhD	United States	ARO Medical (f); Zimmer Biomet (c)
Romain Dayer, MD	Switzerland	DePuy Synthes (a, d); Medtronic (a, b, d)
Manish De, MBBS	India	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Charlotte De Bodman, MD	Switzerland	No Relationships
Chloe Deflorimonte, BS	United States	No Relationships
Edward DelSole, MD	United States	No Relationships
Satoru Demura, MD	Japan	No Relationships
Biren Desai, MD	Germany	No Relationships
Brian Deutsch, BS	United States	No Relationships
Hamish Deverall, FRACS	New Zealand	No Relationships
Pablo Diaz-Collado, MD	United States	No Relationships
Fatih Dikici, MD	Turkey	No Relationships
Chang-Zhi Du, MD	China	No Relationships
Conor Dunn, MD	United States	No Relationships
Wesley Durand, BS	United States	No Relationships
Robert K. Eastlack, MD	United States	Alphatec Spine (a, c); AO Spine (d); Globus Medical (g); Invuity (c); K2M (e); NuTech (g); NuVasive (a, b, c, g); Seaspine (a, b, c, g); SI Bone (b); Spine Innovation (c); Titan (b)
Maria Eisenhardt, MD	Denmark	No Relationships
Mostafa H. El Dafrawy, MD	United States	No Relationships
Jonathan Charles Elysée, BS	United States	No Relationships
Arash Emami, MD	United States	No Relationships
John B. Emans, MD	United States	DePuy Synthes (g); Medtronic (b); Zimmer Biomet (e)
Eric Emanski, MD	United States	No Relationships
Naoto Endo, MD, PhD	Japan	No Relationships
Meric Enercan, MD	Turkey	No Relationships
Yesim Erol, BS	Turkey	No Relationships
Mohammadreza Etemadifar, MD	Iran	No Relationships
European Spine Study Group	Spain	No Relationships
Jeremy Fairbank, MD, FRCS	United Kingdom	No Relationships
Michael J. Faloon, MD, MS	United States	K2M (a, b)
H Francis Farhadi, MD, PhD, FRCS(C)	United States	Implanet (a)
Fan Feng, MD	China	No Relationships
Joan Ferras Tarrago, MD	Spain	No Relationships
Richard G. Fessler, MD, PhD	United States	Benvenue (b); DePuy Synthes (b, g); In Q Innovations (c)
Eric Feuchtbaum, MD	United States	No Relationships
Lorena Floccari, MD	United States	No Relationships
Yizhar Floman, MD	Israel	ApiFix (c)
John M. Flynn, MD	United States	No Relationships
Nicholas Frangella, BS	United States	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Kai-Ming Gregory Fu, MD, PhD	United States	4 web (b); SI Bone (b)
Nobuyuki Fujita, MD	Japan	No Relationships
Hirokazu Fujiwara, MD, PhD	Japan	No Relationships
Akshay Gadiya, MS	India	No Relationships
Jonathan Gal, MD, FASA	United States	No Relationships
Jesse Galina, BS	United States	No Relationships
Jesse M Galina, BS	United States	No Relationships
Juanita Garces, MD	United States	No Relationships
Timothy A. Garvey, MD	United States	Medtronic (g)
Stefan Gavriliu, MD, PhD	Romania	No Relationships
David Ge, BA	United States	No Relationships
Martin Gehrchen, MD, PhD	Denmark	K2M (a); Medtronic (a)
Halil Gemalmaz, MD	Turkey	No Relationships
Michael Gerling, MD	United States	Wolf (b)
George Ghobrial, MD	United States	No Relationships
Joseph P. Gjolaj, MD	United States	DePuy Synthes (b)
Jakub Godzik, MD	United States	No Relationships
Christopher R. Good, MD, FACS	United States	K2M (b, e, g); Mazor Robotics (b); Medtronic (b)
Barth A. Green, MD	United States	No Relationships
Growing Spine Study Group	United States	NuVasive (a)
Firat Gulagaci	Turkey	No Relationships
Purnendu Gupta, MD	United States	No Relationships
Kaveh Haddadi, MD	United States	No Relationships
Julian Haimovich, BS	United States	No Relationships
Shahnawaz Haleem, MBBS, FRCS	United Kingdom	No Relationships
Kim W. Hammerberg, MD	United States	No Relationships
Azmi Hamzaoglu, MD	Turkey	Medtronic (a, b)
Clare L. Harman, CNS	United Kingdom	No Relationships
Harms Study Group	United States	Allied Orthopedic Associates, Inc. (g); C.D. Denison Orthoaedic Appliance Corp. (g); CHU Sainte Justine (g); DePuy Synthes (a); Ellipse (g); EOS Imaging (a); Globus Medical (a); Johnson & Johnson Medical (a); K2M (a); Lawall Prosthetic & Orthotic Services (g); Mazor Robotics (a); Medtronic (a); NuVasive (a); OrthoPediatrics (a); SpineGuard (g); Stryker Spine (a); Theraplay (g); Thieme Publishing (g); Zimmer Biomet (a)
Robert A. Hart, MD	United States	No Relationships
Kazuhiro Hasegawa, MD	Japan	No Relationships
Tomohiko Hasegawa, MD, PhD	Japan	No Relationships
Hamid Hassanzadeh, MD	United States	Medtronic (d); NuVasive (b, c); Orthofix (a, b); Pfizer (a, e)

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

John Heller, MD	United States	Medtronic (b, c, d, g)
Martin J. Herman, MD	United States	Pediatric Orthopaedic Society of North America (a, e)
Tetsuro Hida, MD	United States	No Relationships
Alan S. Hilibrand, MD	United States	Amedica (g); Zimmer Biomet (g)
Toru Hirano, MD, PhD	Japan	No Relationships
Sandra Hobson, MD	United States	No Relationships
Aaron Hockley, MD, FRCS(C)	United States	No Relationships
Douglas A. Hollern, MD	United States	No Relationships
Samantha R. Horn, BA	United States	No Relationships
Naobumi Hosogane, MD, PhD	Japan	No Relationships
Richard Hostin, MD	United States	DePuy Synthes (b)
Michael T. Hresko, MD	United States	Boston Orthotics and Prosthetics (b); Medtronic (a); NuVasive (g)
Victor Hsu, MD	United States	Camber Spine (g); Mazor Robotics (b); Medicrea (g)
Zongshan Hu, MD, PhD	Hong Kong	No Relationships
Lik Hang Alec Hung, FRCS	Hong Kong	No Relationships
Samuel Hunter, MD	United States	No Relationships
Ki Hwang, MD	United States	DePuy Synthes (d)
Hideaki Imabayashi, MD, PhD	Japan	No Relationships
Shiro Imagama, MD, PhD	Japan	No Relationships
Satoshi Inami, MD, PhD	Japan	No Relationships
International Spine Study Group	United States	DePuy Synthes (a); K2M (a); Medtronic (a); NuVasive (a); Orthofix (a); Stryker Spine (a)
Hiroko Ishihama, MD	Japan	No Relationships
Ken Ishii, MD, PhD	Japan	No Relationships
Yoshimoto Ishikawa, PhD	Japan	No Relationships
Norihiro Isogai, MD	Japan	No Relationships
Kimona Issa, MD	United States	No Relationships
Sravisht Iyer, MD	United States	No Relationships
Amit Jain, MD	United States	No Relationships
Alicia January, PhD	United States	No Relationships
Japanese Spine Deformity Institute	Japan	Johnson & Johnson (a); KISCO (a); Medtronic (a); Yagami Seisakusho (a)
Li Jin, PhD	United States	No Relationships
Pablo Jorda, MD	Spain	No Relationships
Samuel Kadoury, PhD	Canada	No Relationships
Sinan Kahraman, MD	Turkey	No Relationships
Udaya kakarla, MD	United States	No Relationships
Gowthaman Kamaraj, MS, DNB Ortho	India	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Tokumi Kanemura, MD, PhD	Japan	Medtronic (b); NuVasive (b)
Adam S. Kanter, MD	United States	NuVasive (b, g); Zimmer Biomet (b, g)
Selhan Karadereler, MD	Turkey	No Relationships
Isik Karalok, MD	Turkey	No Relationships
Hiroyuki Katoh, MD, PhD	Japan	No Relationships
Noriaki Kawakami, MD	Japan	DePuy Synthes (b); Japan Spine Deformity Institute (e); KISKO (b); Medtronic (b)
Emel Kaya Aumann, MD	Turkey	No Relationships
David Kaye, MD	United States	No Relationships
Harish Kempegowda, MD	United States	No Relationships
Tanya S. Kenkre, PhD	United States	No Relationships
Christopher K. Kepler, MD	United States	No Relationships
Taleef Khan, BA	United States	No Relationships
Morsi Khashan, MD	United States	No Relationships
David C. Kieser, PhD, MBChB, FRACS, FNZOA	New Zealand	No Relationships
Chi Heon Kim, MD, PhD	Korea, South	No Relationships
KyungHyun Kim, MD, PhD	Korea, South	No Relationships
Whoan Jeang Kim, MD, PhD	Korea, South	No Relationships
Yong Kim, MD	United States	No Relationships
Yongjung J. Kim, MD	United States	No Relationships
Andrew G. King, MB.ChB, FRACS, FACS	United States	Medicrea (b)
Christopher J. Kleck, MD	United States	Globus Medical (a); Medacta (b); Medicrea (a, b); Medtronic (b); Orthofix (a); Premia (a); SI Bone (a); Spinal Kinetics (a)
Frank S. Kleinstueck, MD	Switzerland	DePuy Synthes (a)
Dejan Knez, MS	Slovenia	No Relationships
Sho Kobayashi, MD, PhD	Japan	No Relationships
Sergey Kolesov, MD, PhD	Russia	Shwabe-Carbon (b, g); Stryker Spine (b, g); Zimmer Biomet (b, g)
Jayme Koltsov, PhD	United States	No Relationships
Hitoshi Kono, MD	Japan	No Relationships
Joseph Ivan Krajbich, MD, FRCS(C)	United States	K2M (d)
Stefan Krebs, MD	Germany	human tech (a); Stryker Spine (a)
Appaji Krishnan Krishnamurthy, MBBS, MS	India	No Relationships
Anubrat Kumar, MS	Hong Kong	No Relationships
Nishant Kumar, MS	India	No Relationships
Takuto Kurakawa, MD, PhD	Japan	No Relationships
Mark Kurd, MD	United States	Duratap LLC (c, e); Rothman Institute (c)

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Kenny Kwan, FRCS	Hong Kong	No Relationships
Anthony WL Kwok, PhD	Hong Kong	No Relationships
Hubert Labelle, MD, FRCS(C)	Canada	Canadian Institute of Health Research (a); DePuy Synthes (a); Spinologics (c, g)
Renaud Lafage, MS	United States	No Relationships
Virginie Lafage, PhD	United States	AO Spine (g); DePuy Synthes (a, g); K2M (a); Nemaris (c, e); NuVasive (a); Stryker Spine (a)
Suna Lahut, PhD	Turkey	No Relationships
Tsz-Ping Lam, MBBS	Hong Kong	Telefield Medical Imaging Limited (a)
Joseph Laratta, MD	United States	No Relationships
Darryl Lau, MD	United States	No Relationships
Johnson Lau, MD	China	OrthoSmart (c)
Lawrence CM Lau, MRCS	Hong Kong	No Relationships
Lok TingTerrence Lau, PhD	Hong Kong	Avalon SpineCare (HK) Limited (e, g)
Sheung Wai Law, MD	Hong Kong	No Relationships
Nathan H. Lebwohl, MD	United States	DePuy Synthes (g)
Justin Ledesma, MD	United States	No Relationships
Jae Won Lee, MD	Korea, South	No Relationships
Robert Lee, MBBS, FRCS	United Kingdom	DePuy Synthes (d); K2M (a, b, d, e); Medtronic (d, e); SI Bone (b); Signus (e)
Daniel Lefton, MD	United States	No Relationships
Jie Li, MS	China	No Relationships
Xudong Li, MD, PhD	United States	No Relationships
Zheng Li, MD	China	No Relationships
Jayson Lian, BS	United States	No Relationships
Jae Y. Lim, MD	United States	K2M (b); Mazor Robotics (a, b); Titan (b)
James Lin, MD, MS	United States	No Relationships
Youxi Lin, MD	China	No Relationships
Amelia Lindgren, MD	United States	No Relationships
Breton G. Line, BS	United States	International Spine Study Group Foundation (b)
Zhen Liu, MD	China	No Relationships
Yungtai Lo, PhD	United States	No Relationships
Joseph M. Lombardi, MD	United States	No Relationships
Joanne Londino, RN	United States	No Relationships
Baron S. Lonner, MD	United States	Apifix (b); DePuy Synthes (a, b, d, e, g); Ethicon (b); John and Marcella Fox Fund Grant (a); K2M (d); OREF (a); Paradigm Spine (c); Setting Scoliosis Straight Foundation (a); Spine Search (c); Unyq Align (b); Zimmer Biomet (b, g)
Scott John Luhmann, MD	United States	Globus Medical (g); Medtronic (b, d); NuVasive (b); OrthoPediatrics (b, d); Stryker Spine (b, d); Wishbone Medical (b); Wolters (g)

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Russ Lyon, PhD	United States	No Relationships
Melvin Makhni, MD, MBA	United States	No Relationships
Gene C.W. Man, PhD	Hong Kong	No Relationships
Nodoka Manabe, MD, PhD	Japan	No Relationships
Jordan Manning, BA	United States	No Relationships
Dan Mihai Mardare, MD, MSc	United Kingdom	No Relationships
Michelle Claire Marks, MS, PT	United States	No Relationships
Hiroko Matsumoto, PhDc	United States	No Relationships
Morio Matsumoto, MD, PhD	Japan	Kyocera (b); NuVasive (b)
Yukihiro Matsuyama, MD, PhD	Japan	No Relationships
Marcus Mazur, MD	United States	No Relationships
Anna McClung, RN, BSN	United States	No Relationships
Amy Lynn McIntosh, MD	United States	Globus Medical (d)
Amir Mehbod, MD	United States	Stryker Spine (b, g); Zimmer Biomet (b, g)
Addisu Mesfin, MD	United States	AO Spine (a); Corelink (a); Globus Medical (a); LES Society (a)
Yuki Mihara, MD	Japan	No Relationships
Michael A. Millgram, MD	Israel	No Relationships
Paul Millhouse, MD, MBA	United States	Globus Medical (c)
Amy Minnema, MS	United States	No Relationships
Tatsuki Mizouchi, MD	Japan	No Relationships
Mohamed Moawad, MPH	United States	No Relationships
Virendra Mohan, MD, MBBS	India	No Relationships
Illina Mohd Rothi, MBBS	New Zealand	No Relationships
Michael Mokawem, FRCS	United Kingdom	No Relationships
John Moon, BS	United States	No Relationships
Jeffrey A. Moore, MD	United States	No Relationships
Jorge Morales, MD	Spain	No Relationships
Kevin Morash, MD	Canada	No Relationships
Benjamin Mueller, MD, PhD	United States	Globus Medical (b); Nexxt Spine (b)
Jeffrey P Mullin, MD	United States	No Relationships
Kenneth Mullinix, BS	United States	No Relationships
Surya Mundluru, MD	United States	No Relationships
Premik Nagad, MBBS, D.Ortho, DNB Ortho	India	No Relationships
Masaya Nakamura, MD, PhD	Japan	No Relationships
Hiroaki Nakashima, MD, PhD	Japan	No Relationships
J. Naresh-Babu, MD	India	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Hussein Nasser, MD	United States	No Relationships
Sean Neifert, BS	United States	No Relationships
Geraldine Neiss, PhD	United States	No Relationships
Brian J. Neuman, MD	United States	DePuy Synthes (a); ISGGF (a)
Bobby Kinwah Ng, MD	Hong Kong	No Relationships
James H. Nguyen, MD	United States	No Relationships
Ben Niu, PhD	China	No Relationships
Yuji Nishiwaki, MD, PhD, MS	Japan	No Relationships
Ayato Nohara, MD	Japan	No Relationships
Kenya Nojiri, MD	Japan	No Relationships
Andriy Noshchenko, PhD	United States	No Relationships
Pierce D. Nunley, MD	United States	Amedica (c); K2M (b, d, g); Paradigm Spine (c); Spineology (c); Zimmer Biomet (d, g)
Ibrahim Obeid, MD, MS	France	Alphatec Spine (g); Clariance (g); DePuy Synthes (a, b); Medtronic (a, b); Spineart (g)
Shin Oe, MD	Japan	Japan Medical Dynamic Marketing (g); Medtronic (g); Meitoku Institution Jyuzen Memorial Hosipital (g)
Tetsuya Ohara, MD	Japan	No Relationships
Masayuki Ohashi, MD, PhD	Japan	No Relationships
Eijiro Okada, MD, PhD	Japan	No Relationships
David Okonkwo, MD, PhD	United States	NuVasive (g); Zimmer Biomet (g)
Nao Otomo, MD	Japan	No Relationships
Jun Ouchida, MD	Japan	No Relationships
David Ou-Yang, MD	United States	Medicrea (a); Paradigm Spine (a); Pfizer (a); Sea spine inc. (a, b); SI Bone (a)
Okan Ozkunt, MD	Turkey	No Relationships
Wei Pan, PhD	China	No Relationships
Andrey Panteleyev, MD	Russia	No Relationships
Kun Young Park, MD, PhD	Korea, South	No Relationships
Paul Park, MD	United States	Allosource (b); Globus Medical (b, g); Medtronic (b); NuVasive (b); Pfizer (a); Vertex (a)
Peter G. Passias, MD	United States	Allosource (e); CSRS (a); DePuy Synthes (a); Medicrea (b); SpineWave (b); Zimmer Biomet (d)
Priyank Patel, MS	India	No Relationships
Vikas V. Patel, MD, BS, MA	United States	Baxter Healthcare (d); Globus Medical (a); Medicrea (a); Medtronic (a); Orthofix (a); Pfizer (a); Premia (a); SI Bone (a); Zimmer Biomet (b)
Viral Patel, MD	United States	No Relationships
Carl Paulino, MD	United States	No Relationships
Jeff Pawelek, BS	United States	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Tuna Pehlivanoglu, MD	Turkey	No Relationships
Vamsi Krishna Varma Penumatsa, MS	India	No Relationships
Silvia Pérez Vergara, MD	Spain	No Relationships
Francisco Javier Perez-Grueso, MD	Spain	DePuy Synthes (a); K2M (b)
Joseph H. Perra, MD	United States	Gillette Childrens Specialty Healthcare (f); Medtronic (g)
Colleen Peters, M.A.	United States	No Relationships
Thomas Pfandlsteiner, MD	Germany	No Relationships
Jonathan H. Phillips, MD	United States	Biomet (a, g); OrthoPediatrics (b, e, g)
Manuel Pinto, MD	United States	Globus Medical (b); Medtronic (b)
Suthipas Pongmanee, MD	Thailand/United States	No Relationships
Kiley Poppino, BS	United States	No Relationships
Tomasz Potaczek, MD, PhD	Poland	No Relationships
Tanay Prabhoo, MS	India	No Relationships
Virginia Prendergast, PhD, NP-C	United States	No Relationships
Themistocles Protopsaltis, MD	United States	Cervical Spine Research Society (a); Innovasis (b); ISSGF (a); Medicrea (b); NuVasive (b); Zimmer Biomet (a)
Varun Puvanesarajah, MD	United States	No Relationships
Bangping Qian, MD	China	No Relationships
Xiaodong Qin, PhD	China	No Relationships
Micheal Raad, MD	United States	No Relationships
Kris Radcliff, MD	United States	4 Web MEdical (c); Globus Medical (b, g); Medtronic (b); NEXXT Spine (g); NuVasive (g); Orthofix (b); Orthopedic Sciences, Inc (g); Stryker Spine (b); Zimmer Biomet (b)
Abbas Rahimian, MD	Iran	No Relationships
Tina Raman, MD	United States	No Relationships
Karl E. Rathjen, MD	United States	Mati Therapeutics (c)
Bradley Reeves, MS-II	United States	No Relationships
Yuan Ren, PhD	United States	No Relationships
John M. Rhee, MD	United States	Alphatec Spine (c); DePuy Synthes (d); Stryker Spine (g); Wolters Kluwer (g); Zimmer Biomet (b, d, g)
K. Daniel Riew, MD	United States	AO Spine (e); DePuy Synthes (g); Medtronic (b, d, g); Osprey, Expanding Orthopedics (c); Spineology (c); Spinal Kinetics (c); Nexgen (c); Amedica (c); Vertiflex (c); Benvenue (c); Paradigm (c); PSD (c); Zeiss (d); Zimmer Biomet (b, d, g)
Jessica Riggleman, BS	United States	Globus Medical (c, f)
Francisco Rodriguez-Fontan, MD	United States	No Relationships
Kenneth J. Rogers, PhD, ATC	United States	No Relationships
Patrick Rogers, DO	United States	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Benjamin D. Roye, MD, MPH	United States	No Relationships
Pedro Rubio Belmar, MD	Spain	No Relationships
Michael Safaee, MD	United States	No Relationships
Nikhil Sahai, MD	United States	No Relationships
Toshiki Saito, MD	Japan	No Relationships
Pooria Salari, MD	United States	No Relationships
Tunay Sanli, MA	Turkey	No Relationships
Kerim Sariyilmaz, MD	Turkey	No Relationships
Kotaro Satake, MD	Japan	No Relationships
Tatsuya Sato, MD	Japan	No Relationships
Jeffrey R. Sawyer, MD	United States	DePuy Synthes (d, e); NuVasive (d, e)
Justin K. Scheer, MD	United States	No Relationships
Soren Schmidt Morgen, MD, PhD	Denmark	No Relationships
Jennifer Schottler, MPT	United States	No Relationships
Gregory Schroeder, MD	United States	AO Spine (g); Medtronic (a); Stryker Spine (b); Zimmer Biomet (b)
Samuel R. Schroerlucke, MD	United States	Mazor Robotics (a); NuVasive (a)
James D. Schwender, MD	United States	Medtronic (g); Stryker Spine (g)
Naoki Segi, MD	Japan	No Relationships
Frank A. Segreto, BS	United States	No Relationships
Nick Sekouris, PhD	Greece	No Relationships
Miquel Serra-Burriel, PhD	Spain	No Relationships
Cem Sever, MD	Turkey	No Relationships
Neil V. Shah, MD, MS	United States	No Relationships
Suken A. Shah, MD	United States	DePuy Synthes (a, b, e, g); Globus Medical (g); K2M (a, g); NuVasive (b); Setting Scoliosis Straight Foundation (a, e)
Jianxiong Shen, MD	China	No Relationships
Fei Sheng, PhD	China	No Relationships
Wang Shengru, MD	China	No Relationships
Jamal Shillingford, MD	United States	No Relationships
Kentaro Shimizu, MD, PhD	Japan	No Relationships
Takachika Shimizu, MD	Japan	No Relationships
Takayoshi Shimizu, MD, PhD	Japan	No Relationships
Hirokazu Shoji, MD	Japan	No Relationships
J. Alex Sielatycki, MD	United States	No Relationships
Ane Simony, MD, PhD	Denmark	No Relationships
Kumar G Sinha, MD	United States	No Relationships
Dae Geon Song, MD	Korea, South	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Alex Soroceanu, MD, FRCS(C), MPH	Canada	No Relationships
Jeremy Steinberger, MD	United States	No Relationships
Leah Steinmetz, BA	United States	No Relationships
Nicholas Stekas, BS	United States	No Relationships
Byron Stephens, MD	United States	AO Spine (d); Stryker Spine (g)
Jonathan R. Stieber, MD	United States	Intrinsic Therapeutics (a); K2M (g); Stryker Spine (b, d)
Christian Stottrup, MD	Denmark	No Relationships
Peter Sturm, MD	United States	DePuy Synthes (b, e); NuVasive (b)
Pramod Sudarshan, MS	India	No Relationships
Xu Sun, MD	China	No Relationships
Hardik Suthar, MS	India	No Relationships
Teppei Suzuki, MD, PhD	Japan	No Relationships
Hideaki Takahashi, MD, PhD	Japan	No Relationships
Haining Tan, MD	China	No Relationships
Lee Tan, MD	United States	No Relationships
Hiroshi Taneichi, MD, PhD	Japan	No Relationships
Chadi Tannoury, MD	United States	No Relationships
Tony Tannoury, MD	United States	DePuy Synthes (b, g)
Sandip Tarpada, BS	United States	No Relationships
Chrishan Thakar, MBBS, FRCS	United Kingdom	No Relationships
Khoi D. Than, MD	United States	Bioventus (b)
Alekos Theologis, MD	United States	No Relationships
Michael To, MBBS, FRCS	Hong Kong	No Relationships
Daisuke Togawa, MD, PhD	Japan	Japan Medical Dynamic Marketing Inc (g); Medtronic (g); Meitoku Medical Institute Jyuzen Memorial Hospital (g)
Courtney Toombs, MD	United States	No Relationships
P. Justin Tortolani, MD	United States	Globus Medical (g); Innovasis (e, g); Spineology (a, b)
Yuk Lung Tsang, PhD	Hong Kong	Avalon SpineCare (HK) Limited (g)
ChangChun Tseng, MD	China	No Relationships
Takashi Tsuji, MD, PhD	Japan	No Relationships
Alexander Tuchman, MD	United States	No Relationships
Miklos Tunyogi-Csapo, MD, PhD	Hungary	No Relationships
Olivier Turcot, BS	Canada	No Relationships
Jay Turner, MD, PhD	United States	NuVasive (a, b); SeaSpine (b)
Peter Udby, MD, DC	Denmark	No Relationships
Koki Uno, MD, PhD	Japan	DePuy Synthes (d); K2M (d)
Vidyadhar Upasani, MD	United States	DePuy Synthes (d); EOS Imaging (d); OrthoPediatrics (b, d); Wolters Kluwer (g)

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Hiroki Ushirozako, MD	Japan	No Relationships
Alexander R. Vaccaro, MD, PhD	United States	Advanced Spinal Intellectual Properties (c); Aesculap (g); Alphatec Spine (g); Atlas Spine (b); Avaz Surgical (c); Bonovo Orthopaedics (c); Computational Biodynamics (c); Cytonics (c); Dimension Orthotics LLC (c); Electrocore (c); Flagship Surgical (c); FlowPharma (c); Gamma Spine (c); Globus (c, g); Guidepoint Global (b); Innovative Surgical Design (c); Insight Therapeutics (c); Medtronic (g); NuVasive (c); Orthobullets (b); Paradigm Spine (c); Parvizi Surgical Innovations (c); Prime Surgeons (c); Progressive Spinal Technologies (c); Replication Medica (c); Spine Medica (c); Spine Wave (b); Spinology (c); Stout Medical (c); Stryker Spine (b, g); Vertiflex (c); Vexim (b, g)
Jeffrey Varghese, BS	United States	No Relationships
Christopher Varlotta, BS	United States	No Relationships
Gerard Varlotta, MD	United States	No Relationships
Dennis Vasquez-Montes, MS	United States	No Relationships
Muralidharan Venkatesan, FRCS	India	No Relationships
Jonathan Vigdorchik, MD	United States	No Relationships
Stephanus Viljoen, MD	United States	DePuy Synthes (d)
Shaleen Vira, MD	United States	No Relationships
Arun Kumar Viswanadha, MBBS, MS	India	No Relationships
Vibhu Krishnan Viswanathan, MBBS	United States	No Relationships
Tomaz Vrtovec, PhD	Slovenia	No Relationships
Corey Walker, MD	United States	Medical Memory, Inc. (b)
Michael Y. Wang, MD	United States	DePuy Synthes (b, g); ISD (c); K2M (b)
Tony Wang, MD	United States	No Relationships
Wenhai Wang, PhD	United States	Globus Medical (f)
Kei Watanabe, MD, PhD	Japan	No Relationships
Masahiko Watanabe, MD, PhD	Japan	No Relationships
Chao Wei, MD	China	No Relationships
Benjamin Weisenthal, MD	United States	No Relationships
Michelle Welborn, MD	United States	DePuy Synthes (b); K2M (e)
Stephen Wendolowski, BS	United States	No Relationships
Brendan Williams, MD, Fellow	United States	No Relationships
Devin Williams, BS, MPH	United States	No Relationships
Barrett Woods, MD	United States	Altus (b, g); Precision Spine (b); Stryker Spine (b); Titan (b)
Chase Woodward, MD	United States	No Relationships
Chao Xia, PhD	China	No Relationships
Lei-Lei Xu, PhD	China	No Relationships
Bingchuan Xue, PhD	China	No Relationships
Mitsuru Yagi, MD, PhD	Japan	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

AUTHOR DISCLOSURES

Yu Yamato, MD, PhD	Japan	No Relationships
Jun Yang, MD	China	No Relationships
Seung Heon Yang, MD	Korea, South	No Relationships
Tatsuya Yasuda, MD	Japan	No Relationships
Yasemin Yavuz, PhD	Turkey	No Relationships
Chun-Po Yen, MD	United States	No Relationships
Samrat Yeramaneni, PhD, MBBS, MS	United States	No Relationships
Caglar Yilgor, MD	Turkey	No Relationships
Karen Kar-lum Yiu, MS	Hong Kong	No Relationships
Ikuho Yonezawa, MD	Japan	No Relationships
Eric Yoon	United States	No Relationships
S. Tim Yoon, MD, PhD	United States	AO Spine (a, e); Biomet (a); Meditech (b, c, g); Medyssey (c); NuVasive (b, g); Stryker Spine (g)
Petya Yorgova, MS	United States	No Relationships
Go Yoshida, MD, PhD	Japan	No Relationships
Suomao Yuan, MD	China	No Relationships
Faissal Zahrawi, MD	United States	Mazor Robotics (b, d); Osseous (b, c); Sentio (b, c, d); Spinewave (b, d, g); Zimmer Biomet (b, d, g)
Daniel Zarzycki, MD, PhD	Poland	No Relationships
Lukas P. Zebala, MD	United States	AO Spine (a); DePuy Synthes (d); K2M (b, d); Medtronic (b, d); Pacira (a, b)
Jianguo Zhang, MD	China	No Relationships
Zhihui Zhao, MD, PhD	China	No Relationships
Peter Zhou, BS	United States	No Relationships
Rongping Zhou, MD	China	No Relationships
Weiguo Zhu, PhD	China	No Relationships
Zezhang Zhu, MD	China	No Relationships
Qianyu Zhuang, MD	China	No Relationships
Chason Ziino, MD	United States	No Relationships
Corinna Zygourakis, MD	United States	No Relationships

If noted, the Relationships disclosed are as follows: *(a) Grants/Research Support (b) Consultant (c) Stock/Shareholder (self-managed) (d) Speaker's Bureau (e) Advisory Board or Panel (f) Salary, Contractual Services (industry) (g) Other Financial or Material Support (royalties, patents, etc.)*

NOTES

NOTES

NOTES

NOTES

NOTES

MEETING AGENDA

25th International Meeting On Advanced Spine Techniques **JULY 11–14, 2018** LOS ANGELES, CALIFORNIA, USA

IMAST 2018

The Scoliosis Research Society gratefully acknowledges Medtronic for their grant support of the IMAST Charging Station, Newsletter, Beverage Break, Morning Coffee in the Exhibit Hall, Welcome Reception, and Lunch with Experts.

25th ANNIVERSARY OF THE INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

25th IMAST

July 11-14, 2018

LOS ANGELES, CA, USA

MEETING AGENDA

WEDNESDAY, JULY 11, 2018

13:00-19:00

Registration Open
PLATINUM FOYER

14:00-15:45

Sessions 1: Special Symposium
Building Efficiencies and Minimizing Redundancies/ 25 Years of IMAST from Those Who Built It
DIAMOND SALON 1-5

Part 1
Moderators: Peter O. Newton, MD; David W. Polly, Jr., MD

14:00-14:15 How to Minimize Redundancies in Resource Allocation for Spine Surgery
Todd J. Albert, MD

14:15-14:30 How to Build a Spine Hospital
Lawrence G. Lenke, MD

14:30-14:45 How Do You Build a "Center of Excellence" from the Payor Perspective?
Rajiv K. Sethi, MD

14:45-15:10 Discussion

Part 2
Moderators: Henry F.H. Halm, MD; Ronald A. Lehman, Jr., MD; Christopher I. Shaffrey, MD

15:10-15:25 First IMAST Chair: How it All Started
Randal R. Betz, MD

15:25-15:35 Perspectives on the Evolution of IMAST
Lawrence G. Lenke, MD

15:35-15:40 How IMAST has had to Change with Evolving Regulation and Healthcare
Todd J. Albert, MD

15:40-15:45 Discussion

15:45-16:00

Walking Break

16:00-18:00

Hands-On Workshops (Non-CME)
DIAMOND SALONS 6 & 7
(See "Exhibits and Hands-On Workshops (HOW) section on page 144 for more information.)

18:00-20:00

Welcome Reception in the Exhibit Hall
DIAMOND FOYER

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

Cast your vote for the Whitecloud Awards on the Mobile App:
1. Select "Polls & Voting" from the app home screen 2. Select the Whitecloud Awards voting polls 3. Cast your vote!

MEETING AGENDA

THURSDAY, JULY 12, 2018

7:45-17:00

Registration Open

7:45-8:45

Hands-On Workshops with Breakfast (Non-CME)
DIAMOND SALONS 6, 7, 8, & 9
(See "Exhibits and Hands-On Workshops (HOW) section on page 144 for more information.)

8:00-17:30

Exhibits Open
DIAMOND FOYER

8:00-8:55

Exhibit Viewing & Coffee
DIAMOND FOYER

9:00-10:35

General Session and Whitecloud Clinical Award Nominees
DIAMOND SALON 1-5
Moderators: Henry F.H. Halm, MD & Paul D. Sponseller, MD, MBA

9:00-9:05 Welcome Address
Ronald A. Lehman, Jr., MD
IMAST Committee Chair

9:05-9:09 Paper #1 The Amount of Curve Correction is More Important than Upper Instrumented Vertebra Selection for Ensuring Postoperative Shoulder Balance in Lenke Type 1 Adolescent Idiopathic Scoliosis†
J. Alex Sielatycki, MD; Eduardo C. Beauchamp, MD; Takayoshi Shimizu, MD, PhD; Chao Wei, MD; Suthipas Pongmanee, MD; Meghan Cerpa, BS, MPH; Lawrence G. Lenke, MD; Harms Study Group

9:09-9:13 Paper #2 Proximal Junctional Kyphosis After Posterior Correction for Scheuermann's Kyphosis and its Risk Factors†
Chang-zhi Du, MD; Xu Sun, MD; Yong Qiu, MD; Ze-Zhang Zhu, MD

9:13-9:17 Paper #3 Back to Back Scoliosis Surgeries: Is Patient Safety and Outcomes Compromised? †
Vishal Sarwahi, MBBS; Stephen F Wendolowski, BS; Jesse Galina, BS; Yungtai Lo, PhD; Terry D. Amaral, MD

9:17-9:26 Discussion

9:26-9:30 Paper #4 Diminishing Clinical Returns of Multilevel Minimally Invasive Lumbar Interbody Fusion†
Peter G. Passias, MD; Cole Bortz, BA; Samantha R. Horn, BA; Frank A. Segreto, BS; Nicholas Stekas, BS; David H Ge, BA; Christopher G Varlotta, BS; Nicholas J Frangella, BS; Renaud Lafage, MS; Virginie Lafage, PhD; Leah Steinmetz, BA; Dennis Vasquez-Montes, MS; Mohamed A Moawad, MPH; Chloe Deflorimonte, BS; Charla R Fischer, MD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; Thomas J. Errico, MD; Michael C. Gerling, MD

9:30-9:34 Paper #5 Determination of The Cost Effective Price Point for BMP-2 in Preventing Revision for Pseudoarthrosis in Adult Deformity Surgery†
Cecilia L Dalle Ore, BS; Michael Safaee, MD; Corinna Zygourakis, MD; Vedat Deviren, MD; Christopher P. Ames, MD

9:34-9:38 Paper #6 Can We Define Clinically Relevant DJK in Cervical Deformity Surgery? †
Themistocles S. Protopsaltis, MD; Nicholas Stekas, BS; Renaud Lafage, MS; Justin S Smith, MD, PhD; Alex Soroceanu, MD, FRCS(C), MPH; Daniel M. Sciubba, MD; D. Kojo Hamilton, MD; Robert K. Eastlack, MD; Gregory M. Mundis, MD; Khaled M. Kebaish, MD, FRCS(C); Eric O. Klineberg, MD; Munish C Gupta, MD; Virginie Lafage, PhD; Robert A. A Hart, MD; Frank J. Schwab, MD; Douglas C. Burton, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; International Spine Study Group

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

Cast your vote for the Whitecloud Awards on the Mobile App:
1. Select "Polls & Voting" from the app home screen 2. Select the Whitecloud Awards voting polls 3. Cast your vote!

MEETING AGENDA

9:38-9:47 Discussion

9:47-9:51 Paper #7 Spinopelvic Compensatory Mechanisms for Reduced Hip Motion (ROM) in the Setting of Hip Osteoarthritis†
Aaron J. Buckland, MBBS, FRACS; Leah Steinmetz, BA; Peter L Zhou, BS; Nicholas J Frangella, BS; Nicholas Stekas, BS; Christopher G Varlotta, BS; David H Ge, BA; Virginie Lafage, PhD; Renaud Lafage, MS; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Jonathan Vigdorchik, MD

9:51-9:55 Paper #8 What Factors are Associated with Kyphosis Restoration in Lordotic AIS Patients? †
Peter O. Newton, MD; Tracey P. Bastrom, MA; Carrie E. Bartley, MA; Vidyadhar V Upasani, MD; Burt Yaszay, MD; Harms Study Group

9:55-9:59 Paper #9 Impact of Presenting Patient Characteristics on Surgical Complications and Morbidity in Early Onset Scoliosis†
Frank A. Segreto, BS; Samantha R Horn, BA; Cole Bortz, BA; Dennis Vasquez-Montes, MS; Bassel G. Diebo, MD, ; Shaleen Vira, MD; Nicholas Stekas, BS; David H Ge, BA; Mohamed A Moawad, MPH; Renaud Lafage, MS; Virginie Lafage, PhD; Edward M. DelSole, MD; Aaron Hockley, MD, FRCS(C); Anthony M. Petrizzo, MD; Aaron J. Buckland, MBBS, FRACS; Thomas J. Errico, MD; Michael C. Gerling, MD; Peter G. Passias, MD

9:59-10:08 Discussion

10:09-10:14 Introduction of the President
Peter O. Newton, MD

10:14-10:29 Keynote Address
Todd J. Albert, MD
Scoliosis Research Society (SRS) President

10:29-10:35 Preview of the 53rd Annual Meeting and 26th IMAST
Annual Meeting – Bologna, Italy
IMAST – Amsterdam, The Netherlands

10:35-11:05

Refreshment Break & Exhibit Viewing
DIAMOND FOYER

11:05-12:30

Concurrent Sessions
2A-C: Abstract Sessions

2A. Whitecloud Basic Science Nominees
Diamond Salon 1-5
Moderators: Kenneth MC Cheung, MD & Stephan Parent, MD, PhD

11:05-11:09 Paper #10 New Growing Rod System in Immature Swine Model*
Chong Chen, MD; Fan Feng, MD; Haining Tan, MD; Youxi Lin, MD; Zheng Li, MD; Jianxiong Shen, MD

11:09-11:13 Paper #11 Risk Factors for Disc Degeneration in Caudal Motion Segments Ten Years Following Adolescent Idiopathic Scoliosis Surgery*
Baron S. Lonner, MD; Yuan Ren, PhD; Vidyadhar V Upasani, MD; Michelle Claire Marks, MS, PT; Peter O. Newton, MD; Randal R. Betz, MD; Amer F. Samdani, MD; Harry L. Shufflebarger, MD; Suken A. Shah, MD; Daniel R Lefton, MD; Hussein Nasser, MD

11:13-11:17 Paper #12 A New Method to Measure The Cobb Angle in Idiopathic Scoliosis by Ultrasonography: A Prospective and Blinded Study*
Joan Ferras Tarrago, MD; Jorge M Morales, MD; Pedro Rubio Belmar, MD; Silvia Pérez Vergara, MD; Pablo Jorda, MD; Jose Luís Bas Hermida, MD; Paloma Bas Hermida, MD; Teresa Bas, MD, PhD

11:17-11:26 Discussion

11:26-11:30 Paper #13 Optimal Trajectory and Length of S2 Alar Iliac Screws: A Three-Dimensional Computed Tomography Analysis*
Benjamin Matthew Weisenthal, MD; Byron F. Stephens, MD

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

Cast your vote for the Whitecloud Awards on the Mobile App:
1. Select "Polls & Voting" from the app home screen 2. Select the Whitecloud Awards voting polls 3. Cast your vote!

MEETING AGENDA

11:30-11:34 Paper #14 Postoperative Change of Pelvic Incidence (PI) may impact Sagittal Spinopelvic Alignment (SSA) after Correction of Adult Spine Deformity (ASD)*
Vikas V. Patel, MD, BS, MA; Christopher J. Kleck, MD; Christopher MJ Cain, MD, PhD; Francisco Rodriguez-Fontan, MD; Andriy Noshchenko, PhD; Evalina L. Burger, MD

11:34-11:38 Paper #15 Prevalence and Predictive Factors of Concurrent Cervical Cord Compression in Adult Spinal Deformity*
Takayoshi Shimizu, MD, PhD; Ronald A. Lehman, MD; J. Alex Sielatycki, MD; Suthipas Pongmanee, MD; K. Daniel Riew, MD; Lawrence G. Lenke, MD

11:38-11:47 Discussion

11:47-11:51 Paper #16 Long Term Follow-Up of Patients with Modic Changes*
Peter Muhareb Udby, MD, DC; Tom Bendix, MD; Mikkel Østerheden Andersen, MD; Leah Yacat Carreon, MD, MS

11:51-11:55 Paper #17 A Comparison of Multiple Rods Constructs (MRC) to Two Rods Constructs (TRC) After Corrective Fusion Surgery Including Sacroiliac Fixation for Adult Spinal Deformity: Does it Prevent or Aggravate Complication?*
kyunghyun kim, MD, PhD; Unyong Choi, MD

11:55-11:59 Paper #18 Activity of Daily Living after Long Level Fusion in Adult Spinal Deformity: Compared with over 60 Years Old Degenerative Spine Patients without Adult Spinal Deformity*
Whoan Jeang Kim, MD, PhD; Jae Won Lee, MD; Shann Haw Chang, MD; Dae Geon Song, MD; Kun Young Park, MD, PhD

11:59-12:08 Discussion

12:08-12:12 Paper #19 New Evidence Supporting the Regulatory Role of LBX1 Variant in AIS*
Lei-Lei Xu, PhD; Chao Xia, PhD; Fei Sheng, PhD; Bingchuan Xue, PhD; Xiaodong Qin, PhD; Weiguo Zhu, PhD; Zezhang Zhu, MD; Yong Qiu, MD

12:12-12:16 Paper WC #20 An Investigational Study of Titanium Plasma Spray on Osseointegration of PEEK and Titanium Implants: An In Vivo Ovine Model*
Bryan W. Cunningham, PhD; Jessica R. Riggleman, BS; Kenneth P Mullinix, BS; Wenhai Wang, PhD; P. Justin Tortolani, MD; Daina M. Brooks, BS

12:16-12:20 Paper WC #21 Direct Vertebral Rotation Significantly Decreases the Pull-out Strength of the Pedicle Screw*
Kerim Sariyilmaz, MD; Okan Ozkunt, MD; Halil C Gemalmaz, MD; Tunca Cingoz, MD; Tuna Pehlivanoglu, MD; Murat Baydogan, PhD; Fatih Dikici, MD

12:20-12:29 Discussion

2B. Adult Deformity Abstracts
Platinum D-E
Moderators: Munish Chandra Gupta, MD & Daniel M. Sciubba, MD

11:05-11:09 Paper #22 Improvement in SRS-22r Self-Image and Activity Correlate Most with Patient Satisfaction after 3-Column Osteotomy
Jeffrey L Gum, MD; Samrat Yeramaneni, PhD, MBBS, MS; Micheal Raad, MD; Richard Hostin, MD; Michael P. Kelly, MD, MS; Virginie Lafage, PhD; Justin S Smith, MD, PhD; Peter G. Passias, MD; Khaled M. Kebaish, MD, FRCS(C); Christopher I. Shaffrey, MD; Douglas C. Burton, MD; Christopher P. Ames, MD; Frank J. Schwab, MD; Shay Bess, MD; International Spine Study Group

11:09-11:13 Paper #23 Rod Fracture Following Apparently Solid Radiographic Fusion in Adult Spinal Deformity Patients
Alan H Daniels, MD; Wesley M Durand, BS; D. Kojo Hamilton, MD; Peter G. Passias, MD; Han Jo Kim, MD; Themistocles S. Protopsaltis, MD; Virginie Lafage, PhD; Justin S Smith, MD, PhD; Christopher I. Shaffrey, MD; Munish C Gupta, MD; Eric O. Klineberg, MD; Frank J. Schwab, MD; Douglas C. Burton, MD; Shay Bess, MD; Christopher P. Ames, MD; Robert A. Hart, MD; International Spine Study Group

11:13-11:17 Paper #24 Incidence of Acute, Progressive, and Delayed Proximal Junctional Kyphosis over an 8-Year Period in Adult Spinal Deformity Patients
Frank A. Segreto, BS; Peter G. Passias, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Justin S Smith, MD, PhD; Breton G. Line, BS; Gregory M. Mundis, MD; Pierce D. Nunley, MD; Alan H Daniels, MD; Munish C Gupta, MD; Jeffrey L Gum, MD; D. Kojo Hamilton, MD; Eric O. Klineberg, MD; Douglas C. Burton, MD; Robert A. A Hart, MD; Frank J. Schwab, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; International Spine Study Group

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

Cast your vote for the Whitecloud Awards on the Mobile App:
1. Select "Polls & Voting" from the app home screen 2. Select the Whitecloud Awards voting polls 3. Cast your vote!

MEETING AGENDA

11:17-11:26 Discussion

11:26-11:30 Paper #25 Development of Deployable Predictive Models for MCID of 2 year Outcomes Across All Commonly Used HRQOL Instruments in Adult Spinal Deformity Surgery: Results in 570 Patients from 17 Hospitals
Miquel Serra-Burriel, PhD; Michael P. Kelly, MD, MS; Justin S Smith, MD, PhD; Jeffrey L Gum, MD; Ferran Pellisé, MD; Ahmet Alanay, MD; Emre R Acaroglu, MD; Francisco Javier sanchez Perez-Grueso, MD; Frank S. Kleinstueck, MD; Ibrahim Obeid, MD, MS; Virginie Lafage, PhD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Douglas C. Burton, MD; Shay Bess, MD; Christopher P. Ames, MD; ESSG European Spine Study Group; International Spine Study Group

11:30-11:34 Paper #26 Defining Age-Adjusted Spinopelvic Alignment Thresholds: Should we Integrate BMI?
Peter G. Passias, MD; Frank A. Segreto, BS; Samantha R Horn, BA; Cole Bortz, BA; Dennis Vasquez-Montes, MS; Leah Steinmetz, BA; John Moon, BS; Tina Raman, MD; Christopher G Varlotta, BS; Nicholas J Frangella, BS; Nicholas Stekas, BS; David H Ge, BA; Jordan H Manning, BA; Mohamed A Moawad, MPH; Chloe Deflorimonte, BS; Bassel G. Diebo, MD; Shaleen Vira, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Michael C. Gerling, MD; Charla R Fischer, MD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; Thomas J. Errico, MD

11:34-11:38 Paper #27 Complications after Spinopelvic Fixation with Iliac Screws in 260 Adult Patients with 2-year Minimum Follow-up
James H Nguyen, MD; Thomas J Buell, MD; Tony Wang, MD; Jeffrey P Mullin, MD; Marcus D Mazur, MD; Juanita Garces, MD; Chun-Po Yen, MD; Christopher I. Shaffrey, MD; Justin S Smith, MD, PhD

11:38-11:47 Discussion

11:47-11:51 Paper #28 A Comparative Analysis of Young vs Older Adult Spinal Deformity Patients Fused to the Pelvis: Who Benefits More?
Brian J Neuman, MD; Micheal Raad, MD; Daniel M. Sciubba, MD; Peter G. Passias, MD; Eric O. Klineberg, MD; Hamid Hassanzadeh, MD; Themistocles S. Protopsaltis, MD; Munish C Gupta, MD; Gregory M. Mundis, MD; Christopher P. Ames, MD; Christopher I. Shaffrey, MD; Jeffrey L Gum, MD; Justin S Smith, MD, PhD; Virginie Lafage, PhD; Shay Bess, MD; Khaled M. Kebaish, MD, FRCS(C); International Spine Study Group

11:51-11:55 Paper #29 Likelihood of Reaching Minimal Clinically Important Difference in Adult Spinal Deformity Surgery: A Comparison of Patients from North America and Japan
Hideyuki Arima, MD, PhD; Steven D Glassman, MD; Keith H. Bridwell, MD; Yu Yamato, MD, PhD; Mitsuru Yagi, MD, PhD; Kota Watanabe, MD, PhD; Morio Matsumoto, MD, PhD; Satoshi Inami, MD, PhD; Hiroshi Taneichi, MD, PhD; Yukihiro Matsuyama, MD, PhD; Leah Yacat Carreon, MD, MS

11:55-11:59 Paper #30 The Learning Curve in Three-Column Osteotomies for Adult Spinal Deformity Surgery: A Single Surgeon's 10 Year Experience with 199 Cases with 40 Months Average Follow Up
Micheal Raad, MD; Mostafa H. El Dafrawy, MD; Varun Puvanesarajah, MD; Morsi Khashan, MD; Brian J Neuman, MD; Khaled M. Kebaish, MD

11:59-12:08 Discussion

12:08-12:12 Paper #31 The Effect of Upper Instrumented Vertebra Level (T9 vs T10) on Radiologic and Functional Outcomes in the Surgical Treatment of Adult Deformity in Osteoporotic Patients with age >60 years
Isik Karalok, MD; Emel Kaya Aumann, MD; Cem Sever, MD; Yunus Emre Akman, MD; Yesim Erol, BS; Tunay Sanli, MA; Sinan Kahraman, MD; Meric Enercan, MD; Selhan Karadereler, MD; Azmi Hamzaoglu, MD

12:12-12:16 Paper #32 Preoperative Halo Gravity Traction for Treatment of Severe Adult Kyphosis and Scoliosis
Takayoshi Shimizu, MD, PhD; Ronald A. Lehman, MD; J. Alex Sielatycki, MD; Suthipas Pongmanee, MD; Chao Wei, MD; Meghan Cerpa, BS, MPH; Lawrence G. Lenke, MD

12:16-12:20 Paper #33 Poster Relationship between Global Sagittal Alignment and Severity of Vertebral Fracture in Patients with Osteoporosis
Zongshan Hu, MD, PhD; Gene C.W. Man, PhD; Sheung Wai Law, MD; Anthony Kwok, PhD; Jack C.Y. Cheng, MD;

12:20-12:24 Paper #34 Impact of Lower Thoracic vs. Upper Lumbar UIV in MIS Correction of Adult Spinal Deformity
Robert K. Eastlack, MD; Pierce D. Nunley, MD; Juan S. Uribe, MD; Paul Park, MD; Stacie Tran, MPH; Michael Y Y Wang, MD; Khoi D. Than, MD; David O Okonkwo, MD, PhD; Adam S. Kanter, MD; Neel Anand, MD; Richard G. Fessler, MD, PhD; Kai-Ming Gregory Fu, MD, PhD; Dean Chou, MD; Praveen V. Mummaneni, MD; Gregory M. Mundis, MD; International Spine Study Group

12:24-12:35 Discussion

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

2C. Early Onset Scoliosis Abstracts[?]
Platinum A-C
Moderators: Lindsay M. Andras, MD; Luiz Munhoz Da Rocha, MD; David K. Skaggs, MD, MMM

11:05-11:09 Paper #35 Did Rib-To Pelvis Constructs Deteriorate Sagittal Balance for Ambulatory Children?
Teppei Suzuki, MD, PhD; Koki Uno, MD, PhD; Noriaki Kawakami, MD; Tetsuya Ohara, MD; Toshiki Saito, MD; Kota Watanabe, MD, PhD

11:09-11:13 Paper #36 Systematic Review and Meta Analysis of the Complications Associated with Magnetically Controlled Growing Rods for the Treatment of Early Onset Scoliosis
David C. Kieser, PhD, MBChB, FRACS, FNZOA; Chrishan Thakar, MBBS, FRCS; Dan Mihai Mardare, MD, MSc; Shahnawaz Haleem, MBBS, FRCS; Jeremy CT Fairbank, MD, FRCS; Colin Nnadi, MBBS, FRCS

11:13-11:17 Paper #37 Biomechanical Effects on Adjacent Segments of Different Growing-Rod Fixation in Early Onset Scoliosis
Yong Hai, MD, PhD

11:17-11:26 *Discussion*

11:26-11:30 Paper #38 Is There an Improvement in Quality of Life with Early Onset Scoliosis Managed with Traditional Growing Rods Converted to Magnetically Controlled Growing Rods?
Jennifer M. Bauer, MD, MS; Petya Yorgova, MS; Geraldine Neiss, PhD; Kenneth J. Rogers, PhD, ATC; Peter F. Sturm, MD; Paul D. Sponseller, MD; Scott John Luhmann, MD; Jeff Pawelek, BS; Suken A. Shah, MD; Growing Spine Study Group

11:30-11:34 Paper #39 Intraspinal MRI Abnormalities in Early-Onset Scoliosis: Rates Across A Global Cohort
Anna McClung, RN, BSN; Brendan A Williams, MD, Fellow; Suken A. Shah, MD; Laurel C. Blakemore, MD; Jeff Pawelek, BS; Paul D. Sponseller, MD; Stefan Parent, MD, PhD; John B. Emans, MD; Peter F. Sturm, MD; Burt Yaszay, MD; Behrooz A. Akbarnia, MD; Growing Spine Study Group

11:34-11:38 Paper #40 Use of Magnetic Spinal Growth Rods (MCGR) With and without Preoperative Halo Gravity Traction (HGT) for the Treatment of Severe Early Onset Scoliosis (EOS)
Michelle C Welborn, MD; Charles d'Amato, MD, FRCS(C); Joseph Ivan Krajbich, MD, FRCS(C)

11:38-11:47 Discussion

11:47-11:51 Paper #41 Topographical Sagittal Profile in 620 Patients Measured By A Novel Handheld Device
Kenny Kwan, FRCS; Ben Niu, PhD; Michael To, MBBS, FRCS; Jason Pui Yin Cheung, MBBS, FRCS, MS; Karen Kar-lum Yiu, MS; King Cheung Berry Cheung, BS; Johnson YN Lau, MD; Lok TingTerrence Lau, PhD; Yuk Lung Tsang, PhD; Lut Hey Chu, MPhil; Kenneth Cheung, MD, FRCS

11:51-11:55 Paper #42 One-stage Posterior Hemivertebra Resection with Short Segmental Fusion in the Treatment of Lumbosacral Hemivertebra: A More Than 2-year Follow-up
Qianyu Zhuang, MD; Jianguo Zhang, MD

11:55-11:59 Paper #43 Outcomes of 3-column Osteotomy in Cervicothoracic Spine (C7/T1) for Congenital Cervicothoracic Scoliokyphosis in Children
Wang Shengru, MD; Jianguo Zhang, MD

11:59-12:10 Discussion

12:10-12:14 Paper #44 The Learning Curve of Minimally Invasive Surgery (MIS) in Adolescent Idiopathic Scoliosis (AIS)
Vishal Sarwahi, MBBS; Jesse M Galina, BS; Stephen F Wendolowski, BS; Alexandre Ansorge, MD; Romain Dayer, MD; Charlotte De Bodman, MD; Yungtai Lo, PhD; Terry D. Amaral, MD

Paper #45 WITHDRAWN

12:14-12:18 Paper #46 Minimal Invasive Ventral Derotation Spondylodesis (VDS) is the First Choice for AIS Lenke Type 1A and 5C Scoliosis: 100 Cases Experience
Stefan Krebs, MD; Thomas Pfandlsteiner, MD

12:18-12:29 Discussion

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper [?] = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

12:30-13:30

Exhibit Viewing & Lunch
DIAMOND FOYER

Hands-On Workshops with Lunch (Non-CME)
DIAMOND SALONS 6, 7, 8, & 9
(See "Exhibits and Hands-On Workshops (HOW) section on page 144 for more information.)

13:45-14:45

Concurrent Sessions 3A-B: Debates

3A: Controversies in Spine Surgery: Adult
DIAMOND SALON 1-5
Moderators: Steven D. Glassman, MD; Praveen V. Mummaneni, MD

Debate #1 (13:45-14:15): SI Joint Fusion: To Fuse or Not to Fuse?

13:45-13:55 SI Joint Fusion Provides Great Improvements in Pain and Function
David W. Polly, Jr., MD

13:55-14:05 Why Do You Dislike the Joint? Leave It Alone
Jeffrey D. Coe, MD

14:05-14:15 Discussion

Debate #2 (14:15-14:45) ALIF vs TLIF for Sagittal Restoration in Deformity Correction

14:15-14:25 ALIF Gets Better with Correction and Lordosis
Christopher I. Shaffrey, MD

14:25-14:35 TLIF - I Can Get Great Correction with Lordotic Cages and Good Technique without the Morbidity
Lawrence G. Lenke, MD

14:35-14:45 Discussion

3B: New and Innovative Advances in Spine Care: MIS, Lateral, Antepsoas, Navigation and Robotics[?]
PLATINUM D-E
Moderators: Douglas C. Burton, MD, PhD; Hani H. Mhaidli, MD, PhD; Juan S. Uribe, MD

Debate #1 (13:45-14:15)

13:45-13:55 MIS TLIF - How to Do the Same Operation with Smaller Incisions
Ronald A. Lehman, Jr., MD

13:55-14:05 Complications of Lateral and Antepsoas Approach: To Spare or Spear
Neel Anand, MD

14:05-14:15 Discussion

Debate #2 (14:15-14:45)

14:15-14:25 How Do I Choose to Utilize the Transpsoas Approach: Which Cases Does it Help Me Achieve Correction?
Gregory M. Mundis, Jr., MD

14:25-14:35 Navigation and Robotic Assistance: How to Incorporate These Technologies and How Do They Help?
Shane Burch, MD, FRCSC

14:35-14:45 Discussion

14:45-15:00

Walking Break

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper [?] = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

15:00-15:40

Concurrent Sessions 4A-C: Case Presentations

4A: Degenerative Conditions of the Lumbar Spine[?]
DIAMOND SALON 1-5
Moderators: Jeffrey D. Coe, MD; Steven D. Glassman, MD; Rick C. Sasso, MD

Case Presenter #1
Justin S. Smith, MD

Case Presenter #2
Sean Molloy, MBBS, FRCS(Orth), MSc

Case Presenter #3
Juan S. Uribe, MD

4B: Pediatric Deformity[?]
PLATINUM A-C
Moderators: Firoz Miyanji, MD, FRCSC; Mauricio Montalvo, MD; Daniel J. Sucato, MD, MS

Case Presenter #1
Jahangir K. Asghar, MD

Case Presenter #2
Laurel C. Blakemore, MD

Case Presenter #3
Burt Yaszay, MD

4C: Cervical and Trauma
PLATINUM D-E
Moderators: Neel Anand, MD & Dean Chou, MD

Case Presenter #1
Vincent C. Treynelis, MD

Case Presenter #2
Jacob Buchowski, MD, MS

Case Presenter #3
Michael P. Kelly, MD

15:40-16:10

Refreshment Break & Exhibit Viewing

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper [?] = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

16:10-17:10

Concurrent Sessions 5A-B: Complications and How to Treat Them

5A: Adult Degenerative and Deformity Surgery
DIAMOND SALON 1-5
Moderators: Thomas J. Errico, MD & Ian J. Harding, BA, FRCS (Orth)

16:10-16:20 Proximal Junctional Failure
Han Jo Kim, MD

16:20-16:30 Pseudarthorosis
Henry F.H. Halm, MD

16:30-16:40 Adjacent Segment Degeneration - Degenerative Cases
Patrick C. Hsieh, MD, MSc

16:40-16:50 Fixed/Stiff Sagittal Imbalance after Previous Lumbar Degenerative Surgery
Yong Qiu, MD

16:50-17:10 Discussion

5B: My Worst Complication in Pediatric, Growing Spine and Neuromuscular Surgery and How I Treated It
PLATINUM D-E
Moderators: Paul D. Sponseller, MD, MBA & Daniel J. Sucato, MD, MS

Case Presenter #1
Kota Watanabe, MD

Case Presenter #2
Laurel C. Blakemore, MD

Case Presenter #3
Firoz Miyanji, MD, FRCSC

Case Presenter #4
Lindsay M. Andras, MD

17:15-18:15

Hands-On Workshops (Non-CME)
DIAMOND SALON 6 & 7
(See "Exhibits and Hands-On Workshops (HOW) section on page 144 for more information.)

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

FRIDAY, JULY 13, 2018

7:45-16:00

Registration Open
PLATINUM FOYER

7:45-8:45

Hands-On Workshops with Breakfast (Non-CME)
DIAMOND SALONS 6 & 7
(See "Exhibits and Hands-On Workshops (HOW) section on page 144 for more information.)

8:00-16:45

Exhibits Open
DIAMOND FOYER

8:00-8:55

Exhibit Viewing & Coffee
DIAMOND FOYER

9:00-10:00

Concurrent Sessions 6A-C: Abstract Sessions

6A: Adolescent Idiopathic Scoliosis Abstracts
Diamond Salon 1-5
Moderators: Mauricio Montalvo, MD & Harry Shufflebarger, MD

9:00-9:04	Paper #47 Return to Play in the Athlete with Adolescent Idiopathic Scoliosis: Spinal Fusion Is Compatible with Sports Participation *Baron S. Lonner, MD; Suken A. Shah, MD; John M. Flynn, MD; Patrick J Rogers, DO; Courtney Toombs, MD; Andrea Castillo, BS; Yuan Ren, PhD*
9:04-9:08	Paper #48 Comparison of Coagulation Profiles of Adolescent Idiopathic Scoliosis (AIS) Patients Undergoing Posterior Spinal Fusion (PSF) with and without Transexamic acid (TXA) *Patrick P. Bosch, MD; Joanne Londino, RN; Tanya S Kenkre, PhD;*
9:08-9:12	Paper #49 Posterior Minimally Invasive Surgery for Adolescent Idiopathic Scoliosis: Results and Complications in 68 Patients with Minimum 2-year Follow-up *Charlotte De Bodman, MD; Firoz Miyanji, MD, FRCS(C); Romain Dayer, MD;*
9:12-9:20	Discussion
9:20-9:24	Paper #50 Comparison of Spontaneous Correction in Thoracic Curves After Selective Anterior Versus Posterior Fusion in Lenke Type 5C Adolescent Idiopathic Scoliosis: A Study with Minimum Five Years Follow-Up *Wei Pan, PhD; Zhen Liu, MD; Yong Qiu, MD; Jie Li, MS; ChangChun Tseng, MD; Zhihui Zhao, MD, PhD; Zezhang Zhu, MD*
9:24-9:28	Paper #51 Predictors for Postoperative Shoulder Imbalance in Lenke 2A Adolescent Idiopathic Scoliosis *Tatsuya Sato, MD; Ikuho Yonezawa, MD; Hiroko Matsumoto, PhDc; Nao Otomo, MD; Teppei Suzuki, MD, PhD; Nodoka Manabe, MD, PhD; Satoru Demura, MD; Kota Watanabe, MD, PhD; Toshiki Saito, MD; Ayato Nohara, MD; Takuto Kurakawa, MD, PhD; Takachika Shimizu, MD; Koki Uno, MD, PhD; Morio Matsumoto, MD, PhD; Noriaki Kawakami, MD; Japanese Spine Deformity Institute*
9:28-9:32	Paper #52 Where to Stop Distally in Lenke Modifier C AIS with Lumbar Curve More Than 60°: L3 or L4? *Yong Qiu, MD; Xiaodong Qin, PhD; Lei-Lei Xu, PhD; Bangping Qian, MD; Zezhang Zhu, MD*
9:32-9:42	Discussion

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

9:42-9:46 Paper #53 Sequential Spine-Hand Radiography for Assessing Skeletal Maturity in AIS with Low Radiation Dual-Beam Imaging System: A Feasibility and Reliability Study
Lik Hang Alec Hung, FRCS; Lawrence CM Lau, MRCS; Zongshan Hu, MD; Wai-Wang Chau; Simon KH Chow, PhD; Anubrat Kumar, MS; Tsz-Ping Lam, MBBS; Bobby Kinwah Ng, MD; Winnie Chiu Wing Chu, MD; Jack C.Y. Cheng, MD

9:46-9:50 Paper #54 Analysis of pre-contoured Patient Specific Rods in Adolescent Idiopathic Scoliosis: Does Rod Flattening Occur after Implantation?
Afshin Aminian, MD; Andrew G. King, MB.ChB,FRACS,FACS; Pouya Alijanipour, MD

9:50-10:00 Discussion

6B: Kyphosis/Congenital/Neuromuscular Deformity Abstracts
Platinum D-E
Moderators: Stefan Parent, MD, PhD & Paul D. Sponseller, MD, MBA

9:00-9:04 Paper #55 Restoration of Thoracic Kyphosis in Adolescent Idiopathic Scoliosis over a Twenty-Year Period: Are We Getting Better?
Blake M Bodendorfer, MD; Suken A. Shah, MD; Tracey P. Bastrom, MA; Baron S. Lonner, MD; Burt Yaszay, MD; Amer F. Samdani, MD; Firoz Miyanji, MD, FRCS(C); Patrick J. Cahill, MD; Paul D. Sponseller, MD; Randal R. Betz, MD; David H. H Clements III, MD; Lawrence G. Lenke, MD; Harry L. Shufflebarger, MD; Peter O. Newton, MD; Harms Study Group

9:04-9:08 Paper #56 Reciprocal Change in Sagittal Profiles after Adolescent vs Adult Idiopathic Scoliosis Surgery: A Comparison Using Full-Body X-ray
Takayoshi Shimizu, MD, PhD; Ronald A. Lehman, MD; J. Alex Sielatycki, MD; Suthipas Pongmanee, MD; Lawrence G. Lenke, MD

9:08-9:12 Paper #57 Is Intraoperative Traction with Posterior Only Approach an Alternative to Anterior-Posterior Strategy in Correction of Severe Adolescent Idiopathic Scoliosis? A Comparative Study
Hardik Suthar, MS; Sajan Hegde, MD; Pramod Sudarshan, MS; Vamsi Krishna Varma Penumatsa, MS; Appaji Krishnan Krishnamurthy, MBBS, MS; Muralidharan Venkatesan, FRCS

9:12-9:20 Discussion

9:20-9:24 Paper #58 The View in The Mirror: Anterior Surface Topography and the Truncal Anterior Asymmetry Scoliosis Questionnaire in AIS
Baron S. Lonner, Yuan Ren, Andrea Castillo

9:24-9:28 Paper #59 Quality Improvement in Post-Operative Opiate and Benzodiazepine Regimen in Adolescent Patients after Posterior Spinal Fusion
Vidyadhar V Upasani, MD; Amelia M Lindgren, MD; Rebecca L Bennett, MS, BSN, PPCNP-BC; Burt Yaszay, MD; Peter O. Newton, MD

9:28-9:32 Paper #60 Two AIS Spine Surgeries on the Same Day by the Same Surgeon: Is Performance and Outcome the Same?
Lorena Floccari, MD; Daniel J. Sucato, MD, MS; Kiley Poppino, BS; Surya N Mundluru, MD; Amy Lynn McIntosh, MD; Karl E. Rathjen, MD

9:32-9:40 Discussion

9:40-9:44 Paper #61 A New Posterior Dynamic Device for Correction of Moderate Adolescent Idiopathic Scoliosis: 27 Cases with Two to Five Years of Follow up
Yizhar Floman, MD; Stefan Gavriliu, MD, PhD; Tomasz Potaczek, MD, PhD; Daniel Zarzycki, MD, PhD; Biren Desai, MD; Miklos Tunyogi-Csapo, MD, PhD; Nick Sekouris, PhD; Michael A. Millgram, MD; Ron El-Hawary, MD, MS; Baron S. Lonner, MD; Randal R. Betz, MD

9:44-9:48 Paper #62 Predictive Model of Spine Correction Following Anterior Vertebral Body Growth Modulation in Adolescent with Idiopathic Scoliosis.
Olivier Turcot, BS; Dejan Knez, MS; Tomaz Vrtovec, PhD; Samuel Kadoury, PhD; Stefan Parent, MD, PhD

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

9:48-9:52 Paper #63 Can Posterior Implant Removal Protect Device-Related Vertebral Osteopenia After Posterior Fusion in Adolescent Idiopathic Scoliosis? The Mean 29 Years Follow-Up Study
Kei Watanabe, MD, PhD; Masayuki Ohashi, MD, PhD; Toru Hirano, MD, PhD; Hirokazu Shoji, MD; Tatsuki Mizouchi, MD; Naoto Endo, MD, PhD; Kazuhiro Hasegawa, MD; Hideaki E. Takahashi, MD, PhD

9:52-10:00 Discussion

6C: Trauma & Tumor Abstracts
Platinum A-C
Moderators: Andrew H. Jea, MD & Peter S. Rose, MD

9:00-9:04 Paper #64 Revision Procedures Do Not Affect the One-Year Survival in Patients Operated for Acute Metastatic Spinal Cord Compression
Maria Ferm Eisenhardt, MD; Soren Schmidt Morgen, MD, PhD; Martin Gehrchen, MD, PhD; Benny T. Dahl, MD, PhD

9:04-9:08 Paper #65 Prevention of Surgical Site Infections in Spine Tumor Surgery: A Comparison of Three Methods
Avionna Baldwin, BS; Eric L Emanski, MD; Devin Williams, BS, MPH; Addisu Mesfin, MD

9:08-9:12 Paper #66 Modified Frailty Index Does Not Predict Survival in Patients with Metastatic Spine Disease
Illina Mohd Rothi, MBBS; Godwin G H Choy, FRACS; Hamish H Deverall, FRACS; Joseph F Baker, FRCS

9:12-9:20 Discussion

9:20-9:24 Paper #67 Pediatric Cervical Spine Clearance: A Multi-Disciplinary Consensus Statement and Algorithm from the Pediatric Cervical Spine Clearance Working Group
Martin J. Herman, MD; Burt Yaszay, MD; Jonathan H. Phillips, MD

9:24-9:28 Paper #68 Surgical Treatment for Non-union after Osteoporotic Vertebral Fracture. Multicenter Study by Japan Association of Spine Surgeons with Ambition (JASA)
Naobumi Hosogane, MD, PhD; Ken Ishii, MD, PhD, Professor and Chairman; Hitoshi Kono, MD; Norihiro Isogai, MD; Kota Watanabe, MD, PhD; Hideaki Imabayashi, MD, PhD; Kazuhiro Chiba, MD

9:28-9:32 Paper #69 Utility of Neuromonitoring During Lumbar Pedicle Subtraction Osteotomy for Adult Spinal Deformity
Darryl Lau, MD; Russ Lyon, PhD; Cecilia L Dalle Ore, BS; Vedat Deviren, MD; Justin S Smith, MD, PhD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD

9:32-9:40 Discussion

9:40-9:44 Paper #70 The Posterior Superior Iliac Spine (PSIS) and Sacral Laminar Slope (SLS) are Key Anatomic Landmarks for Freehand S2AI Screw Placement
James D. Lin, MD, MS; Lee Tan, MD; Chao Wei, MD; Jamal Shillingford, MD; Joseph L Laratta, MD; Joseph M. Lombardi, MD; Yongjung J. Kim, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

9:44-9:48 Paper #71 Single Position Versus Lateral-then-Prone Positioning for Lateral Interbody Fusions and Pedicle Screw Fixation
Chason Ziino, MD; Justin B Ledesma, MD; Ivan Cheng, MD; Jayme Koltsov, PhD

9:48-9:52 Paper #72 Accuracy and Efficiency of Robot-Assisted Pedicle and S2AI Screw Cannulation for Adult Thoracolumbar and Lumbar Fusion: Success and Failure in a Single Surgeon's First 92 cases
J. Alex Sielatycki MD, Melvin C Makhni MD, MBA, Joseph M. Lombardi MD, Jamal Shillingford MD, Ronald A. Lehman MD

9:52-10:00 Discussion

10:00-10:30

Refreshment Break & Exhibit Viewing
DIAMOND FOYER

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

10:30-11:50

Concurrent Sessions 7A-C: Abstract Sessions

7A: Lumbar Degenerative/Spondylolisthesis Abstracts
PLATINUM D-E
Moderators: Ian J. Harding, BA, FRCS (Orth) & Patrick C. Hsieh, MD, MSc

10:30-10:34 Paper #73 Coccydynia, Outcome 1 year after Surgical Treatment of 138 Consecutive Patients *Ane Simony, MD, PhD; Mikkel Østerheden Andersen, MD*

10:34-10:38 Paper #74 Increasing Reoperation Rates and Inferior Outcome with Prolonged Symptom Duration in Lumbar Disc Herniation Surgery
Christian C Stottrup, MD; Andreas K. Andresen, MD; Leah Yacat Carreon, MD, MS; Mikkel Østerheden Andersen, MD

10:38-10:42 Paper #75 Lumbar Interbody Fusion Rates In 3D Printed Lamellar Titanium Cages Using a Silicate Substituted Calcium Phosphate Bone Graft
Robert S Lee, MBBS, FRCS; Michael Mokawem, FRCS; Clare L Harman

10:42-10:54 Discussion

10:54-10:58 Paper #76 MRI Radiological Predictors of Requiring Microscopic Lumbar Discectomy after Lumbar Disc Herniation
Christopher G Varlotta, BS; David H Ge, BA; Nicholas Stekas, BS; Nicholas J Frangella, BS; Jordan H Manning, BA; Leah Steinmetz, BA; Dennis Vasquez-Montes, MS; Thomas J. Errico, MD; John A. Bendo, MD; Yong H Kim, MD; Jonathan R. Stieber, MD; Gerard Varlotta, MD; Charla R Fischer, MD; Themistocles S. Protopsaltis, MD; Peter G. Passias, MD; Aaron J. Buckland, MBBS, FRACS

10:58-11:02 Paper #77 ASA Status is Associated with Cost and Length of Stay in Lumbar Laminectomy and Fusion: Results from an Institutional Database
Rachel S. Bronheim, BS; Jeremy Steinberger, MD; Samuel Hunter, MD; Sean Neifert, BS; Brian C. Deutsch, BS; Jonathan S Gal, MD, FASA; John M. Caridi, MD

11:02-11:06 Paper #78 Implementation of a Standardized Multimodal Analgesia Protocol Reduces Pain Scores, Opioid Consumption, Opioid-related Adverse Events, and Length of Hospital Stay after Posterior Lumbar Fusion
Corey T Walker, MD; Virginia Prendergast, PhD, NP-C; Jakub Godzik, MD; Udaya K kakarla, MD; Juan S. Uribe, MD; Jay D. Turner, MD, PhD

Paper #79 WITHDRAWN

Paper #80 WITHDRAWN

11:06-11:10 Paper #81 Complications and Revisions in Robotic vs. Fluoro-Guided Minimally Invasive Lumbar Fusions: Report from MIS ReFRESH
Samuel R. Schroerlucke, MD; Michael Y Y Wang, MD; Christopher R. Good, MD, FACS; Jae Y Lim, MD; Victor Hsu, MD; Faissal Zahrawi, MD

11:10-11:26 Discussion

11:26-11:30 Paper #82 Restoration of Normal Pelvic Balance from Surgical Reduction of High-Grade Spondylolisthesis
Abdulmajeed Alzakri, MD, MS; Hubert Labelle, MD, FRCS(C); Michael T. Hresko, MD; Stefan Parent, MD, PhD; Daniel J. Sucato, MD, MS; Lawrence G. Lenke, MD; Michelle Claire Marks, MS, PT; Harms Study Group, ; Jean-Marc Mac-Thiong, MD, PhD

11:30-11:34 Paper #83 Patient-Reported Outcomes Using ODI, VAS Back and Leg Pain, and PROMIS in Low-Grade Degenerative Lumbar Spondylolisthesis Patients with High Versus Low Pelvic Incidence
Pablo J Diaz-Collado, MD; Taleef Khan, BA; Chase Woodward, MD; Colleen M Peters, M.A.; pooria salari, MD; Michael P. Kelly, MD, MS; Jacob M. Buchowski, MD, MS; Munish C Gupta, MD; Keith H. Bridwell, MD; Lukas P. Zebala, MD

11:34-11:38 Paper #84 Surgeon's Neck Syndrome: Postural Analysis of Surgeons Neck during Lumbar Spine Surgeries.
J. Naresh-Babu, MD; Arun Kumar Viswanadha, MBBS, MS

11:38-11:50 Discussion

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

7B: Cervical Spine Abstracts
PLATINUM A-C
Moderators: D. Kojo Hamilton, MD, FAANS & Peter S. Rose, MD

10:30-10:34 **Paper #85 Prospective Assessment Mid-Term Radiological Outcomes Following Sublaminar Band Placement for Prevention of Proximal Junctional Kyphosis**
Vibhu Krishnan Viswanathan, MBBS; Amy Minnema, MS; Stephanus Viljoen, MD; H Francis Farhadi, MD, PhD, FRCS(C)

10:34-10:38 **Paper #86 Proximal Junctional Kyphosis Prevention with Strap Stabilization Technique on Supra-Adjacent Level of Posterior Spinal Fusion**
Francisco Rodriguez-Fontan, MD; Bradley Reeves, MS-II; Andriy Noshchenko, PhD; David C Ou-Yang, MD; Christopher J. Kleck, MD; Christopher MJ Cain, MD, PhD; Evalina L. Burger, MD; Vikas V. Patel, MD, BS, MA

10:38-10:42 **Paper #87 Prophylactic Vertebral Cement Augmentation at the Uppermost Instrumented Vertebra and Rostral Adjacent Vertebra For The Prevention of Proximal Junctional Failure Following Long Segment Fusion For Adult Spinal Deformity**
Joseph P. Gjolaj, MD; George M Ghobrial, MD; Barth A. Green, MD; Nathan H Lebwohl, MD

10:42-10:50 **Discussion**

10:50-10:54 **Paper #88 Minimally-Invasive Posterior Cervical Foraminotomy (mis-PCF) with Tubes Prevents Undesired Fusion with Long-term Follow-up**
Conor J Dunn, MD; Jeffrey A Moore, MD; Nikhil Sahai, MD; Kimona Issa, MD; Michael J. Faloon, MD, MS; Kumar G Sinha, MD; Ki S Hwang, MD; Arash Emami, MD

10:54-10:58 **Paper #89 Does The Sagittal Alignment of The Cervical Spine Have an Impact on Disc Degeneration? 20-Year Follow-Up of Asymptomatic Volunteers**
Eijiro Okada, MD, PhD; Kenshi Daimon, MD; Hirokazu Fujiwara, MD, PhD; Yuji Nishiwaki, MD, PhD, MS; Kenya Nojiri, MD; Masahiko Watanabe, MD, PhD; Hiroyuki Katoh, MD, PhD; Kentaro Shimizu, MD, PhD; Hiroko Ishihama, MD; Nobuyuki Fujita, MD; Takashi Tsuji, MD, PhD; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD, PhD; Kota Watanabe, MD, PhD

10:58-11:02 **Paper #90 Cervical and Cervicothoracic Sagittal Alignment By Roussouly Thoracolumbar Subtypes in Asymptomatic Volunteers**
Alekos A. Theologis, MD; Sravisht Iyer, MD; Han Jo Kim, MD; Lawrence G. Lenke, MD; Michael P. Kelly, MD, MS

11:02-11:10 **Discussion**

11:10-11:14 **Paper #91 Magnetically Controlled Growing Rods: Sagittal Plane Analysis and the Risk of Proximal Junctional Kyphosis**
Purnendu Gupta, MD; Jennifer Schottler, MPT; Alicia M January, PhD; Felix L Brassard, MD; Kevin A Morash, MD; Ron El-Hawary, MD, MS; Benjamin D. Roye, MD, MPH; Jeffrey R. Sawyer, MD; Kim W. Hammerberg, MD; Children's Spine Study Group

11:14-11:18 **Paper #92 Recovery Kinetics following Spinal Deformity Correction: A Comparison of Isolated Cervical, Thoracolumbar, and Combined Deformity Morphometries**
Peter G. Passias, MD; Frank A. Segreto, BS; Renaud Lafage, MS; Virginie Lafage, PhD; Justin S Smith, MD, PhD; Breton G. Line, BS; Justin K. Scheer, MD; Gregory M. Mundis, MD; D. Kojo Hamilton, MD; Han Jo Kim, MD; Bassel G. Diebo, MD, ; Munish C Gupta, MD; Eric O. Klineberg, MD; Douglas C. Burton, MD; Robert A. A Hart, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; Shay Bess, MD; International Spine Study Group

11:18-11:22 **Paper #93 Cervical Pedicle Screw Placement with Use of a Navigated High-speed Drill**
Kotaro Satake, MD; Tokumi Kanemura, MD, PhD; Hiroaki Nakashima, MD, PhD; Yoshimoto Ishikawa, PhD; Naoki Segi, MD; Jun Ouchida, MD

11:22-11:30 **Discussion**

11:30-11:34 **Paper #94 Effect of Race, Age and Gender on Lumbar Muscle Volume and Fat Infiltration in the Degenerative Spine**
Tetsuro Hida, MD; Robert K. Eastlack, MD; Tokumi Kanemura, MD, PhD; Gregory M. Mundis, MD; Shiro Imagama, MD, PhD; Behrooz A. Akbarnia, MD

11:34-11:38 **Paper #95 Lumbar Spine Degeneration and Flatback Deformity alter Sitting-Standing Spinopelvic Mechanics - A Detailed Analysis of Segmental Spinal Alignment Change**
Aaron J. Buckland, MBBS, FRACS; Peter L Zhou, BS; Leah Steinmetz, BA; Nicholas J Frangella, BS; Nicholas Stekas, BS; David H Ge, BA; Christopher G Varlotta, BS; Dennis Vasquez-Montes, MS; Virginie Lafage, PhD; Renaud Lafage, MS; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Jonathan Vigdorchik, MD

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

11:38-11:42 Paper #96 Efficacy of Retroperitoneal Approached Interbody Fusion Surgery on The Sagittal Balance in the Degenerative Spinal Deformity
Seung Heon Yang, MD; Chi Heon Kim, MD, PhD; Chun Kee Chung, MD, PhD

11:42-11:50 Discussion

7C: Complications/Infections Abstracts
DIAMOND 1-5
Moderators: Sébastien Charosky, MD & Mario DiSilvestre, MD

10:30-10:34 Paper #97 Obesity is Associated with Increased OR Time, Hospital Stay, and Postoperative Wound Complications in Lumbar Fusion Surgery: Analysis of 1,196 Cases at a Single Institution
Amit Jain, MD; Sandra Hobson, MD; Eric Yoon, ; Scott D. D Boden, MD; John Heller, MD; John M. Rhee, MD; S. Tim Yoon, MD, PhD

10:34-10:38 Paper #98 Risk Factors for Pseudarthrosis after a Surgical Site Infection of the Spine
Douglas A Hollern, MD; Barrett Woods, MD; Neil V. Shah, MD, MS; Gregory Schroeder, MD; Christopher K. Kepler, MD; Mark F Kurd, MD; David Kaye, MD; Paul W Millhouse, MD, MBA; Bassel G. Diebo, MD; Carl B Paulino, MD; Alan S. Hilibrand, MD; Alexander R. Vaccaro, MD, PhD; Kris Radcliff, MD

10:38-10:42 Paper #99 Postoperative Deep Wound Infections: Do The Implants Really Need To Be Removed?
Viral R. Patel, MD; John M. Dawson, PhD; Benjamin Mueller, MD, PhD; Amir A Mehbod, MD; Manuel R Pinto, MD; James D. Schwender, MD; Joseph H. Perra, MD; Timothy A. Garvey, MD

10:42-10:50 Discussion

10:50-10:54 Paper #100 Complications Associated With Minimally Invasive Anterior to the Psoas (ATP) Fusion of the Lumbosacral Spine: A Review of 909 Patients
Tony Tannoury, MD; Harish Kempegowda, MD; Kaveh Haddadi, MD; Chadi Tannoury, MD

10:54-10:58 Paper #101 The Influence of Pedicle Screws on Nonunion of Lateral Lumbar Interbody Fusion
Kotaro Satake, MD; Tokumi Kanemura, MD, PhD; Hiroaki Nakashima, MD, PhD; Yoshimoto Ishikawa, PhD; Naoki Segi, MD; Jun Ouchida, MD

10:58-11:02 Paper #102 Survival of Multiple-Rod Constructs Across 3-Column Osteotomies in Long Fusions to The Sacrum for Adult Spinal Deformity
Jun Yang, MD; rongping zhou, MD; Suomao Yuan, MD; Meghan Cerpa, BS, MPH; Lawrence G. Lenke, MD

11:02-11:10 Discussion

11:10-11:14 Paper #103 "Reconstruction of the Basement" Rather than "Adding a Storey" is More Effective in Preventing Re-PJK in Adult Spinal Deformity Patients
Caglar Yilgor, MD; Suna Lahut, PhD; Kadir Abul, MD; Yasemin Yavuz, PhD; Firat Gulagaci, ; Ibrahim Obeid, MD, MS; Frank S. Kleinstueck, MD; Francisco Javier Sanchez Perez-Grueso, MD; Emre R Acaroglu, MD; Ferran Pellisé, MD; Ahmet Alanay, MD; ESSG European Spine Study Group

11:14-11:18 Paper #104 Long Satellite Rod Constructs Can Reduce the Incidence of Rod Fractures Following 3-Column Osteotomy
Yu Yamato, MD, PhD; Tomohiko Hasegawa, MD, PhD; Daisuke Togawa, MD, PhD; Go Yoshida, MD, PhD; Tomohiro Banno, MD, PhD; Shin Oe, MD; Hideyuki Arima, MD, PhD; Sho Kobayashi, MD, PhD; Tatsuya Yasuda, MD; Yuki Mihara, MD; Hiroki Ushirozako, MD; Yukihiro Matsuyama, MD, PhD

11:18-11:22 Paper #105 Effectiveness of Four-Rod Fixation in Pedicle Subtraction Osteotomy
Sergey Kolesov, MD, PhD; Andrey Panteleyev, MD

11:22-11:30 Discussion

11:30-11:34 Paper #106 Surgeon Specific Risk Stratification Model for Complex Adult Spinal Deformity Surgery
Lawrence G. Lenke, MD; Meghan Cerpa, BS, MPH; Xudong Joshua Li, MD, PhD; Alexander Tuchman, MD; Lee A. Tan, MD; Li Jin, PhD

11:34-11:38 Paper #107 Rapid Bodyweight Reduction Prior to Lumbar Fusion Surgery Associated with Poorer Post-operative Outcomes
Sandip P. Tarpada, BS; Woojin Cho, MD, PhD; Jayson Lian, BS; Julian S Haimovich, BS

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

11:38-11:42 Paper #108 Correlations between Anterior Malalignment and Fat Infiltration Using a CT-Scan Based Approach
Jonathan Charles Elysée, BS; Renaud Lafage, MS; Jeffrey J Varghese, BS; Eric Feuchtbaum, MD; Frank J. Schwab, MD; Han Jo Kim, MD; Virginie Lafage, PhD

11:42-11:50 Discussion

12:00-13:00

Exhibit Viewing & Lunch
DIAMOND FOYER

Hands-On Workshops with Lunch (Non-CME)
DIAMOND SALON 6, 7, 8, & 9
(See "Exhibits and Hands-On Workshops (HOW) section on page 144 for more information.)

13:10-14:10

Concurrent Sessions 8A-C: Debates, Cases, and Instructional Course Lectures

8A: Spinal Deformity: De Novo/Degenerative Adult Lumbar Scoliosis
DIAMOND SALON 1-5
Moderators: John R. Dimar, II, MD & Jacob M. Buchowski, MD, MS

13:10-13:20 For Which Lumbar Degenerative States Should Sagittal Balance be a Priority: 1 -2 Level, Degen Scoli or Both?
Steven D. Glassman, MD

13:20-13:30 When Can You Perform Limited Decompression or Fusion without Correcting the Scoliosis?
Thomas J. Errico, MD

13:30-13:40 Discussion

Debate (13:40-14:10) How Many Spinopelvic Parameters are Necessary for a Good Result in Adult Deformity?

13:40-13:50 We Only Need Very Few Spinopelvic Parameters for a Good Outcome
Hani H. Mhaidli, MD

13:50-14:00 We Need Many Spinopelvic Parameters for a Good Outcome
Han Jo Kim, MD

14:00-14:10 Discussion

8B: Debates: Cervical Considerations for Deformity and Degenerative Spine
PLATINUM D-E
Moderators: Todd J. Albert, MD & D. Kojo Hamilton, MD, FAANS

Debate #1 (13:10-13:40) Cervical Deformity and Alignment

13:10-13:20 C2-7 SVA Tells Us Everything
Christopher P. Ames, MD

13:20-13:30 Cervical Alignment Numbers Don't Tell the Whole Story
Vincent C. Traynelis, MD

13:30-13:40 Discussion

Debate #2 (13:40-14:10) Cervical Spondylotic Myelopathy

13:40-13:50 Use of ACDF and Corpectomy for the Treatment of SCM: When I Use the Anterior Approach
Rick C. Sasso, MD

13:50-14:00 Posterior Laminectomy/Laminoplasty +/- Fusion: Posterior is Optimal
Praveen V. Mummaneni, MD

14:00-14:10 Discussion

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

8C: The Growing Spine - Current State of the Art: Which Patients are Candidates, Technologies and Treatment Decisions: Case Presentations
Platinum A-C
Moderators: Peter O. Newton, MD & Amer F. Samdani, MD

Case Presenter #1
Amer F. Samdani, MD

Case Presenter #2
Ron El-Hawary, MD

Case Presenter #3
Ahmet Alanay, MD

Case Presenter #4
David L. Skaggs, MD, MMM

14:15-15:15

Concurrent Sessions 9A-B: Instructional Course Lectures

9A: Value and Quality: Where are We Now and Where Do We Have to Go?
PLATINUM D-E
Moderators: Todd J. Albert, MD & Rajiv K. Sethi, MD

14:15-14:25 What is Population Health and Why Does this Matter?
Steven D. Glassman, MD

14:25-14:35 Predictive Analytics and Risk Stratification: Future Directions
Marinus De Kleuver, MD, PhD

14:35-14:45 What is the MCID and How do We Achieve in Spine Surgery
Michael P. Kelly, MD

14:45-14:55 To Stage or Not to Stage: Convenience, Physiologic Benefit and Reimbursement Implications
Serena S. Hu, MD

14:55-15:15 Discussion

9B: Coronal Plane Balance in Adult Deformity Surgery: The Forgotten Stepchild!
DIAMOND SALON 1-5
Moderators: Shane Burch, MD, FRCSC & Mario DiSilvestre, MD

14:15-14:23 Recognizing and Correcting the Stiff Fractional Lumbosacral Curve
Yong Qiu, MD

14:23-14:31 Intraop Techniques to Analyze and Confirm Optimal Coronal Alignment and How Does that Translate to Postop Balance in AIS
Kota Watanabe, MD

14:31-14:39 Avoiding and Treating the Dilemma of Preop Coronal Balance with Intraop Imbalance: What are the Options
Munish C. Gupta, MD

14:39-14:47 Intraop Correction of Flexible vs. Stiff Coronal Plane Imbalance: Role of the "Kickstand" Screw-Rod Construct
Peter Angevine, MD, MPH

14:47-14:55 Postop Coronal Imbalance: What are the Options?
Sébastien Charosky, MD

14:55-15:15 Discussion

15:15-15:45

Refreshment Break & Exhibit Viewing

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

15:45-16:45

Concurrent 10A-C: Case Presentations

10A. Common Challenges in Adult Spinal Deformity: Treatment Based Case Approach
DIAMOND SALON 1-5
Moderators: Munish Chandra Gupta, MD & Henry F. H. Halm, MD

15:45-15:55 Proximal Junctional Kyphosis T10 vs T3/4
Christopher I. Shaffrey, MD

15:55-16:05 Postop Nerve Root Deficit
John R. Dimar, II, MD

16:05-16:15 Lessons for Performing Pedicle Subtraction Osteotomy: These Have Kept Me Out of Trouble
Lawrence G. Lenke, MD

16:15-16:25 Intraoperative Bleeding: How to Control and How to Prophylaxis
Shane Burch, MD, FRCSC

16:25-16:45 Discussion

10B. Common Challenges in Pediatric Spine Surgery: Case Presentations[?]
Platinum D-E
Moderators: Jahangir K. Asghar, MD; Kenneth MC Cheung, MD; Marinus De Kleuver, MD

15:45-15:55 Failure to Achieve Desired Correction
Ron El-Hawary, MD

15:55-16:05 Intraoperative Neuromonitoring Data Loss
Daniel J. Sucato, MD, MS

16:05-16:15 Postoperative Distal Curve that Doesn't Correct: How to Follow and When to Revise
Ahmet Alanay, MD

16:15-16:25 Blood Loss and Fixation Concerns in Neuromuscular Patients
Lindsay M. Andras, MD

16:25-16:45 Discussion

10C. The Latest in Spine Tumor Treatment: Case Presentations
Platinum A-C
Moderators: Dean Chou, MD & Andrew H. Jea, MD

15:45-15:55 Metastatic Spine Disease: How Do We Classify and Determine Who Needs Surgery?
Peter Angevine, MD, MPH

15:55-16:05 Innovative Treatments for Spinal Tumors (MIS, Technologies, etc)
Daniel M. Sciubba, MD

16:05-16:15 En Bloc Spondylectomy for Primary Malignant Tumors. Technique, Tips and Tricks
Peter Rose, MD

16:15-16:25 Cervical Tumors: Special Considerations and Treatment
Christopher P. Ames, MD

16:25-16:45 Discussion

17:00-17:30

SRS Membership Information Session (Non-CME)
PLATINUM A-C

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper [?] = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

SATURDAY, JULY 14, 2018

8:30-11:00

Registration Open
PLATINUM FOYER

9:00-10:00

Concurrent Sessions 11A-B: Instructional Course Lectures

11A: AIS - Most Current Practices: How the Experts Decide?
PLATINUM D-E
Moderators: Laurel C. Blakemore, MD; J. Abbott Byrd, III, MD; Harry L. Shufflebarger, MD

9:00-9:10 Best Practices for Bracing and Nonsurgical Care: Role of Bracing (which type), PT, and When to Operate
Luiz Munhoz Da Rocha, MD

9:10-9:20 Decision Making for Lenke 1 and 3 Curves: What Degree Do We Operate, When to Intervene in Athletes, and When to Perform STF vs. Fusing to L3/4 - S
Burt Yaszay, MD

9:20-9:30 When Do I Brace and When Do I Tether?
Amer F. Samdani, MD

9:30-9:40 Complex Decision Making in JIS and AIS
Peter O. Newton, MD

9:40-10:00 Controversial Cases - Panel and Audience Interactive

11B: Adult Spinal Deformity: Expert Decision Making and Practices
DIAMOND SALON 1-5
Moderators: Douglas C. Burton, MD, Christopher I. Shaffrey, MD

9:00-9:10 Correction Mechanics for Denovo Scoliosis: Addressing the Coronal and Sagittal Plane - Recipe for Success
Serena S. Hu, MD

9:10-9:20 How to Recognize Patients At Risk for PJK, Treatment Strategies, How to Address when Failure Occurs
Munish C. Gupta, MD

9:20-9:30 How I Sift through the Numbers: Which Ones Do I Use When Choosing the Right Surgery
Christopher P. Ames, MD

9:30-9:40 When Do I Choose Interbody and PCO vs 3 Column Osteotomy: Decision Making, Controversies and Treatment
Yong Qiu, MD

9:40-10:00 Controversial Cases - Panel and Audience Interactive

10:00-10:15

Walking Break

10:15-11:15

Session 12: Surgical Video Session: How I Do It?
DIAMOND SALON 1-5
Moderators: J. Abbott Byrd, III, MD; John R. Dimar, II, MD; David W. Polly, Jr., MD

10:15-10:23 Use of Lateral and Antepsoas Approach to Assist with Correction
Neel Anand, MD

10:23-10:31 Robotic Assisted Spine Surgery: What Does it Look Like, Benefits and Workflow Changes
Ronald A Lehman, Jr., MD

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

MEETING AGENDA

10:31-10:39 Open Thoracoabdominal Approach: When to Use and Hope to Achieve; Still a Useful tool
Sean Molloy, MBBS,FRCS(Orth),MSc

10:39-10:47 AIS Derotation: How I Correct a Lenke 1 vs Lenke 3
Ron El-Hawary, MD

10:47-10:55 Three Column Osteotomy (PSO)
Henry F.H. Halm, MD

10:55-11:15 Discussion

11:15-11:45

Walking Break & Boxed Lunch Pick-up

11:45-13:00

Session 13: Lunch with the Experts: Real Life Surgical Dilemmas: React Quickly to Minimize Complications - The Next Five Minutes is Critical - Step by Step?
DIAMOND SALON 1-5
Moderators: Todd J. Albert, MD; Kenneth MC Cheung, MD; Ronald A. Lehman, Jr., MD

11:45-11:55 How Researchers Unraveled the Mysteries of Human Upright Sagittal Balance
John R. Dimar II, MD

11:55-12:05 What I Do When I'm Having Difficulty Achieving Fixation: Alternatives and Back-up Options
Peter O. Newton, MD

12:05-12:15 Managing Massive Dural Tear During Decompression: Pack, Repair, Call for Help?
Christopher I. Shaffrey, MD

12:15-12:25 Vertebral Artery Injury During Cervical Surgery: What to Do
Christopher P. Ames

12:25-12:35 Severe Blood Loss with MIS Approaches: Lateral, Antepsoas, MIS TLIF: How I Get Myself Out of It
Juan S. Uribe, MD

12:35-1:00 Discussion

The Lunch with Experts session is supported, in part, by Medtronic.

13:00

Adjourn

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science Paper ? = Mobile App "Ask a Question" Session – See page 7 for instructions

ABSTRACTS

The Scoliosis Research Society gratefully acknowledges NuVasive for their grant support of the IMAST Newsletter, Pocket Guide, Directional Signage, Beverage Break in the Exhibit Hall, and Welcome Reception.

25TH ANNIVERSARY OF THE INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

25th IMAST

July 11-14, 2018

LOS ANGELES, CA, USA

ABSTRACTS

1. The Amount of Curve Correction is More Important than Upper Instrumented Vertebra Selection for Ensuring Postoperative Shoulder Balance in Lenke Type 1 Adolescent Idiopathic Scoliosis

J. Alex Sielatycki, MD; Eduardo Beauchamp, MD; Takayoshi Shimizu, MD, PhD; Chao Wei, MD; Suthipas Pongmanee, MD; Meghan Cerpa, BS, MPH; Lawrence G. Lenke, MD; Harms Study Group

Summary
In this 13-surgeon radiographic review of Lenke type 1 Adolescent Idiopathic Scoliosis patients, multivariate analysis demonstrated that "over-correction" of the main thoracic curve (>54%) with simultaneous "under-correction" of the proximal thoracic curve (<52%) resulted in balanced shoulders in only 41.3% of patients. Adequate correction of the proximal curve (>52%) and/or "under-correction" of the main thoracic curve (< 54%) resulted in balanced shoulders in 80-87% of patients (p=0.049), regardless of the upper instrumented vertebra level.

Hypothesis
"Overcorrection" of the main thoracic curve without control of the proximal curve increases the risk for shoulder imbalance in Lenke type 1 Adolescent Idiopathic Scoliosis (AIS).

Design
Clinical photo and radiograph review of patients with Lenke 1 Main Thoracic AIS curves.

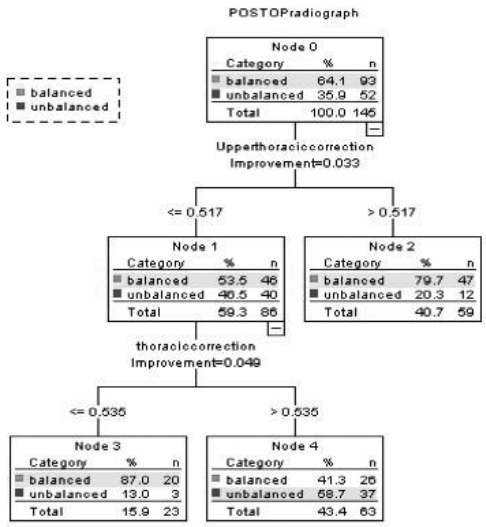
Introduction
Shoulder height imbalance is a common complication following AIS surgery. It is thought that a more cephalad upper instrumented vertebra (UIV) decreases the risk of shoulder imbalance in Lenke type 1 curves, however this has not been proven.

Methods
13 surgeons reviewed pre-op and 5-year postop clinical photos and PA radiographs of patients from a large multicenter database with Lenke type 1 AIS curves who were corrected with pedicle screw/rod constructs. Predictors of postop shoulder imbalance were identified by univariate analysis; multivariate analysis was done using the classification and regression tree (CART) method to identify independent drivers of shoulder imbalance.

Results
145 patients were reviewed with an average age of 14.6 years. The UIV was T3-T5 in 87% of patients, with 8.9% instrumented up to T1 or T2. 52 (36%) had shoulder imbalance at 5 years. On CART analysis (Figure 1): when the proximal thoracic (PT) Cobb angle was corrected more than 52%, 80% of the patients had balanced shoulders. Similarly, when the PT curve was corrected less than 52% and the main thoracic (MT) curve was corrected less than 54%, 87% were balanced. However, when the PT curve was corrected less than 52%, and the MT curve was corrected more than 54%, only 41% of patients had balanced shoulders (p=0.05). This relationship was maintained regardless of the UIV level.

Conclusion
In Lenke type 1 AIS curves, "over-correction" of the main thoracic curve (>54%) with simultaneous "under-correction" (<52%) of the upper thoracic curve resulted in shoulder height imbalance in 59% of patients, regardless of the UIV. These findings highlight the importance of considering, and controlling when necessary, the PT curve to optimize shoulder balance; especially when larger correction of the MT curve is performed.

Figure 1: Classification and regression tree (CART) analysis for predicting shoulder imbalance



2. Proximal Junctional Kyphosis after Posterior Correction for Scheuermann's Kyphosis and its Risk Factors

Chang-zhi Du, MD; Xu Sun, MD; Yong Qiu, MD; *Zezhang Zhu, MD*

Summary
Postoperative PJK in adolescent patients with SK remains poorly understood. The present study investigated the incidence and associated risk factors of PJK in such patients received multi-level Ponte osteotomies combined with pedicle screw fixation via a posterior approach

Hypothesis
Adolescent SK patients are in high risk of postoperative PJK. PJK is more than just a simple radiologic finding and correlates poorly with clinical outcome

Design
Retrospective study

Introduction
Proximal junctional kyphosis (PJK) is an undesired postoperative complication with unclear pathomechanism. The present study was performed to investigate the incidence and risk factors of PJK after posterior spinal instrumented correction

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Methods
Sixty SK patients with age of (17.6 ± 4.1) years old were recruited in this retrospective study. All patients received posterior spinal instrumented correction and fusion from April 2006 to July 2015. Radiographic measurements including global kyphosis (GK), proximal junctional angle (PJA), thoracic kyphosis (TK), lumbar lordorsis (LL), sagittal vertical axis (SVA) and upper instrumented vertebra (UIV)-C7 sagittal distance were collected on the lateral radiographs of the spine before and after surgery .

Results
The mean follow-up period was 31.1±11.9 months. The GK decreased from 71.0±6.0°to 42.7°±11.7°at the final follow-up, with correction rate of 44.9%±13.4%. The incidence of PJK was 31.7% (19/60) and the most common type of PJK was ligamentous failure. The PJA increased from 3.0±1.8° to 18.8±4.8° in the PJK group. UIV in PJK group was significantly lower than that in non-PJK group (T(6.0±1.9) vs T□2.7±1.1□,P=0.017). The preoperative UIV slope angle (20.7±11.3° vs. 12.5±14.1°) and UIV-C7 sagittal distance (46.5±23.0 vs 31.4±21.5) of PJK group were significantly higher than those in non-PJK group (P□0.05). SVA change of PJK group were significantly higher than that in non-PJK group (30.8±30.7 vs 11.9± 34.4, P=0.045). Two patients with PJK received brace treatment and one underwent revision surgery for intractable back pain.

Conclusion
The incidence of PJK after posterior correction is approximately 31.7%. The lower selection of UIV location, over-correction of SVA and larger UIV-C7 sagittal distance were associated with PJK. Proper extending upper fusion segments and combined with satellite rods may have an effect on preventing PJK in some extent.

3. Back to Back Scoliosis Surgeries: Is Patient Safety and Outcomes Compromised?

Vishal Sarwahi, MBBS; Stephen Wendolowski, BS; Jesse Galina, BS; Yungtai Lo, PhD; Terry D. Amaral, MD

Summary
The second surgery of the day has similar outcomes and complication rates compared to the first surgery. The second surgery had similar results to single day scoliosis surgeries.

Hypothesis
Two scoliosis surgeries in a single day is safe and have similar outcomes.

Design
Ambispective Review

Introduction
Scoliosis correction is an extensive surgery. During the summer, surgeons often book multiple cases a day. The demands of scoliosis surgery call into question patient safety, and compromised outcomes. Change of OR staff including anesthesiologists, nurses, and neurologists may introduce new risks.

Methods
Scoliosis surgeries between 2011-2017 were analyzed. Four groups were studied. Groups 1, 2, and 3 were performed by a single surgeon. Group 4 cases were performed by other institutional surgeons. Group 1: patients were the first scoliosis surgery of the day, Group 2: the second scoliosis surgery of the day, Group 3: only surgery of the day, Group 4: surgeries performed by surgeons who perform only one scoliosis surgery per day. Periop parameters such as surgery time, EBL, and complications were collected. XR parameters were collected preop and postop. Wilcoxon rank sum test and Fisher's exact test were used.

Results
Group 1(n=23) and Group 2(n=23) had similar age(14.6 vs 15.4, p=0.617), BMI(22.7 vs 22.6, p=0.949) and preop Cobb(51.5 vs 46.7, p =0.108). Surgical time(224 min vs 214, p=0.742), EBL(400 vs 350, p=0.949), postop Cobb(17.9 vs 16.3,p=0.428), were also similar. Group 1 had more levels fused (13 vs 11,p=0.022) and fixation points (24.5 vs 20,p=0.019). Compared to Group 3 (n=61), Group 2 had a smaller preop Cobb (46.7 vs 56.6,p=0.007),but similar age (15.4 vs 15.2,p=0.923), and BMI (22.6 vs 21.1,p=0.387). Group 2 had significantly shorter surgical time (214 vs 267,p=0.001), but similar complication rates(4.3%vs8.3%,p=1.00). Compared to Group 4(n=144), Group 2 had a smaller preop Cobb(46.7 vs 56.4, p=0.0004), but similar age (15.4 vs 14.6,p=0.132) and BMI (22.6 vs 20.9,p=0.244). Group 2 also had significantly shorter surgical time (214 vs 307,p<0.0001), less EBL(350 vs 600,p=0.002) and lower complication rates (4.3% vs 11.8%,p=0.473).

Conclusion
Multiple scoliosis surgeries in one day can be performed safely without compromising radiographic or periop outcomes. Changes in the operating team for the second case does not appear to impact safety, efficiency or outcomes.

4. Diminishing Clinical Returns of Multilevel Minimally Invasive Lumbar Interbody Fusion

Peter Passias, MD; Cole Bortz, BA; Samantha Horn, BA; Frank Segreto, BS; Nicholas Stekas, BS; David Ge, BA; Christopher Varlotta, BS; Nicholas Frangella, BS; Renaud Lafage, MS; Virginie Lafage, PhD; Leah Steinmetz, BA; Dennis Vasquez-Montes, MS; Mohamed Moawad, MPH; chloe deflorimonte, BS; Charla Fischer, MD; Themistocles Protopsaltis, MD; Aaron Buckland, MBBS, FRACS; Thomas Errico, MD; Michael Gerling, MD

Summary
Minimally invasive surgical (MIS) lumbar fusion aims to reduce the morbidity and soft-tissue damage associated with open surgery. As multilevel arthrodesis procedures are increasingly performed using MIS techniques, it is necessary to weigh risks and benefits of MIS lumbar fusion as a function of fusion length. Compared to open procedures, MIS fusions had lower operative times and complication

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

rates at 1-level. At 3+ levels, however, MIS fusions were longer in duration and resulted in higher rates of adverse events.

Hypothesis
Compared to open cases, there are diminishing clinical returns to multilevel MIS lumbar fusions.

Design
Retrospective review

Introduction
This study investigates the relationship between fusion length and clinical outcomes in open and MIS lumbar fusion patients.

Methods
Patients undergoing <4 level lumbar interbody fusion were stratified by surgical technique(MIS or open), and grouped by fusion length: 1-level, 2-levels, 3+ levels. Demographics, Charlson Comorbidity Index(CCI), surgical factors, and complication rates were compared between MIS and open groups at different fusion lengths using parametric and non-parametric means comparison tests, as appropriate.

Results
Included: 437 patients(57yr, 51%F) undergoing lumbar interbody fusion(37.5% MIS, 62.5% open; 1.6±0.9 lvls; 72% transforaminal approach, 18% anterior, 14% lateral). Overall breakdown by fusion length: 64% 1-level, 21% 2-level, 16% 3+ level. Open patients were older(58yr vs 55,p=0.022) and more comorbid(mean CCI: 1.5 vs 0.9,p<0.001) than MIS. While op-time did not differ between groups at 1-level, MIS cases at 2-levels and 3+ levels were clinically, but not statistically, longer than open(Table 1). Postop complication rates were lower for MIS at 1- and 2-levels, but at 3+ levels, rates were comparable between MIS and open(38% vs 36%). Despite no differences in pulmonary and ileus events between groups at 1- and 2-levels, 3+ level MIS patients had higher rates of ileus and pulmonary complications(Table 1). For all fusion lengths, MIS resulted in less EBL, corresponding with lower rates of anemia complications at 1- and 2-levels. At 3+ levels, however, anemia complication rates were similar between MIS and open(13% vs 14%).

Conclusion
Compared to open surgery, multilevel MIS lumbar fusion provided diminishing clinical returns. MIS patients had lower rates of postop complications for 1- and 2-level fusions, but at 3+ levels, complication rates were comparable between MIS and open, with MIS showing higher rates ileus and pulmonary events. These results can be used to improve counseling of patients indicated for multilevel lumbar interbody fusion.

	1-Level Fusion			2-Level Fusion			3+ Level Fusion		
	MIS (N=122)	Open (N=157)	P value	MIS (N=34)	Open (N=56)	P value	MIS (N=8)	Open (N=70)	P value
Operative Factors									
EBL (cc's)	225	481	***<0.001**	460	929	***<0.001**	531	1430	***0.009**
Operative Time (min)	232	235	0.684	322	298	0.326	373	343	0.415
Inpatient LOS (days)	2.6	3.8	***<0.001**	3.6	4.1	***<0.001**	4	5.9	***0.014**
ICU LOS (days)	0.02	0.03	0.570	0.06	0.11	0.437	0.14	0.96	0.250
Complication Rates									
Overall Intraoperative	4.9%	3.2%	0.461	5.9%	5.4%	0.916	0.0%	5.7%	0.488
Overall Postoperative	16.4%	29.3%	***0.012**	11.8%	30.4%	***0.043**	37.5%	35.7%	0.921
Cardiac	2.5%	1.3%	0.459	0.0%	1.8%	0.433	0.0%	8.6%	0.389
Neurologic	3.3%	5.1%	0.466	0.0%	7.1%	0.111	12.5%	5.7%	0.458
Pulmonary	1.6%	2.5%	0.604	0.0%	0.0%		25.0%	5.7%	0.052
Ileus	3.3%	3.2%	0.965	0.0%	0.0%		12.5%	0.0%	***0.003**
Urinary	2.5%	4.5%	0.373	5.9%	3.6%	0.606	12.5%	5.7%	0.458
Immobility	0.8%	0.6%	0.858	0.0%	0.0%		0.0%	2.9%	0.628
Anemia	4.9%	14%	***0.012**	2.9%	16.1%	***0.055**	12.5%	14.3%	0.891
Infection	3.3%	3.8%	0.809	5.9%	1.8%	0.294	0.0%	0.0%	

5. Determination of the Cost Effective Price Point for BMP-2 in Preventing Revision for Pseudoarthrosis in Adult Deformity Surgery

Cecilia Dalle Ore, BS; Michael Safaee, MD; Corinna Zygourakis, MD; Vedat Deviren, MD; Christopher Ames, MD

Summary
The goal of this study was to assess the efficacy, costs, and benefits of bone morphogenetic protein (BMP) use for prevention of pseudarthrosis. Use of BMP was associated with decreased rates of pseudarthrosis in a multivariate model; however, the direct costs of implementing BMP in an adult spinal deformity cohort exceeded the reduction in direct costs related to reoperation for pseudarthrosis.

Hypothesis
BMP utilization is a cost-effective strategy for pseudarthrosis prevention.

Design
Single-center retrospective review

Introduction
Pseudarthrosis is a major indication for revision surgery for adult spinal deformity correction. Bone morphogenetic protein (BMP) has been shown to reduce the rate of pseudarthrosis, but entails significant upfront costs. Cost/benefit analyses are thus warranted.

Methods
Demographics, surgical characteristics, direct and total cost, and need for revision surgery for pseudarthrosis were collected in a population of adult spinal deformity patients.

Results
A total of 195 patients were identified. Mean age was 64 years and 135 were female (69%). A mean 10 levels were fused, and BMP was used in 132 cases. Overall, 17 patients (9%) underwent revision surgery for pseudarthrosis. BMP was associated with an 8% reduction in the rate of reoperation for pseudarthrosis (6% versus 14%, p = 0.050), with a number needed to treat of 12.5. In a multivariate analysis accounting for age, gender, number of levels, and three column osteotomies, use of BMP was an independent predictor of reoperation for pseudarthrosis (p = 0.031, OR 0.311). The overall

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

mean cost of the primary surgery was $80,368. In patients who received BMP, a mean 13.2 ml BMP was used at a mean direct cost of $9,099. Use of BMP to prevent one revision cost $113,737.50. The mean direct cost of reoperation for pseudarthrosis was $59,395. In a cost sensitivity analysis, BMP was only cost effective in the scenario in which BMP price was reduced by 50%, and BMP use became cost neutral at $4,751.

Conclusion
Use of BMP was associated with a reduction in pseudarthrosis. At the current prices for BMP and pseudarthrosis revision surgery, BMP use is not cost effective when direct inpatient costs are considered.

Table 1. Sensitivity analysis for cost-benefit analysis of BMP utilization for pseudarthrosis prevention

Parameter (base case)	Cost revision	NNT	BMP cost	Cost to prevent 1 Pseudo	Cost effectiveness
Base case	$59,395	12.5	$9,099	$113,737.50	-$54,342.50
Reduction in pseudarthrosis (8%)					
4.00%	$59,395	25	$9,099	$227,475.00	-$168,080.00
12.00%	$59,395	8.3	$9,099	$75,825.00	-$16,430.00
Cost of BMP ($9,099)					
$4,549.50	$59,395	12.5	$4,550	$56,868.75	$2,526.25
$13,648.50	$59,395	12.5	$13,649	$170,606.25	-$111,211.25
Cost of reoperation ($59,395)					
$29,697.50	$29,697.50	12.5	$9,099	$113,737.50	-$84,040.00
$89,092.50	$89,092.50	12.5	$9,099	$113,737.50	-$24,645.00

Abbreviations: BMP, bone morphogenetic protein; NNT, number needed to treat

6. Can We Define Clinically Relevant DJK in Cervical Deformity Surgery?

Themistocles Protopsaltis, MD; Nicholas Stekas, BS; Renaud Lafage, MS; Justin Smith, MD, PhD; Alex Soroceanu, MD, FRCS(C), MPH; Daniel M. Sciubba, MD; D. Kojo Hamilton, MD; Robert K. Eastlack, MD; Gregory Mundis, MD; Khaled M. Kebaish, MD, FRCS(C); Eric O. Klineberg, MD; Munish Gupta, MD; Virginie Lafage, PhD; Robert A. Hart, MD; Frank J. Schwab, MD; Douglas C. Burton, MD; Shay Bess, MD; Christopher Shaffrey, MD; Christopher Ames, MD; International Spine Study Group

Summary
Distal junctional kyphosis (DJK) is becoming a more commonly recognized complication of cervical deformity (CD) surgery. DJK can erode corrections and postoperative cervical malalignment has been correlated with poor health outcomes (HRQL). The traditional definition of DJK is arbitrary (DJK angle (DJKA) change<-10˚) and its clinical relevance is unproven. A new "Severe DJK" definition is explored demonstrating better specificity, precision and accuracy with DJK revisions. Severe DJK patients had the worst cervical alignment by cSVA and C2 Slope (C2S).

Hypothesis
The definition of DJK can be improved for more clinical relevance.

Design
Prospective cohort study

Introduction
Recently, DJK has been described as a complication of CD correction. However, the current definition of DJK has failed to correlate with HRQL or revision rates.

Methods
A prospective database of operative CD patients was analyzed. Inclusion criteria were cervical kyphosis>10˚, cervical scoliosis>10˚, cSVA>4cm or CBVA>25˚. DJKA was defined as a change from preop to postop kyphosis between LIV to LIV-2. Traditional DJK was defined as DJKA<-10˚ at any time point while "Severe DJK" was defined as DJKA less than one SD of mean DJKA (-20˚). Patients without DJK (noDJK) were compared to Traditional and Severe. Cervical alignment was compared between the three groups using ANOVA.

Results
112 patients were included. The mean maximum DJKA for the whole cohort was -9.00˚ (SD = 10.0). There were 41 traditional DJK (35.7%) and 11 Severe DJK (9.8%). Traditional DJK was not associated with any preop alignment parameters, but Severe DJK was associated with an increased CTPA, C2S, cSVA and TSCL at baseline (p<0.05). TSCL, C2S, and CTPA were increased in the Traditional and Severe DJK compared to noDJK at 1 year (p<0.05); postop T1S and cSVA was increased in the Severe DJK group only. Severe DJK had more posterior levels fused and more caudal posterior LIV. There was no significant difference in HRQL change at 3months, 6months and 1 year for either DJK group compared to noDJK. The DJK revision surgery rate was 27.3% for Severe DJK and 8.20% for traditional DJK (p=0.041). The Severe DJK criteria had better specificity (0.92 vs 0.63), precision (0.27 vs 0.12) and accuracy (0.86vs0.62) for revision surgery. Severe DJK patients had the largest cSVA (61.2, 41.60, 38.56mm, p<.001) and C2S (52.78, 27.70, 24.73˚, p<.001). The mean time to revision was 4.72 months for the whole cohort.

Conclusion
The modified Severe DJK definition had better specificity, precision and accuracy for DJK revision surgery. Severe DJK patients had the worst cervical alignment by cSVA and C2 slope with mean alignments well beyond the established thresholds for moderate disability.

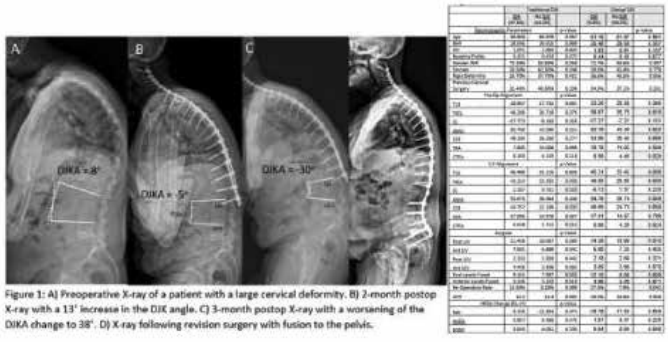


Figure 1: A) Preoperative X-ray of a patient with a large cervical deformity. B) 2-month postop X-ray with a 13˚ increase in the DJK angle. C) 3-month postop X-ray with a worsening of the DJKA change to 38˚. D) X-ray following revision surgery with fusion to the pelvis.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

7. Spinopelvic Compensatory Mechanisms for Reduced Hip Motion (ROM) in the Setting of Hip Osteoarthritis

Aaron Buckland, MBBS, FRACS; Leah Steinmetz, BA; Peter Zhou, BS; Nicholas Frangella, BS; Nicholas Stekas, BS; Christopher Varlotta, BS; David Ge, BA; Virginie Lafage, PhD; Renaud Lafage, MS; Peter Passias, MD; Themistocles Protopsaltis, MD; Jonathan Vigdorchik, MD

Summary
Hip osteoarthritis (OA) results in reduced hip range of motion, which effects sitting and standing posture. Spinal pathology (eg fusion or deformity) may alter the ability to compensate for reduced joint mobility associated with hip OA in sitting and standing postures, however the effect of Hip OA on postural spinal alignment between sitting and standing remains unreported. We demonstrate that patients with severe hip OA exhibit spinopelvic compensatory mechanisms for the reduction in hip motion from standing to sitting.

Hypothesis
Severe hip osteoarthritis (SOA) will result in more pelvic tilt (PT) and Lumbar Lordosis (LL) change.

Design
Retrospective clinical and radiographic analysis at a single institution of patients with Hip Osteoarthritis(OA) between 2012 and 2017

Introduction
The effect of hip OA on standing spinal alignment has been reported, but not the effects on postural spinal alignment change in sitting and standing.

Methods
Retrospective radiographic review at a single center of patients with sitting & standing full-body radiographs from 2012-2017. Patients exclusions: transitional lumbosacral anatomy, prior spinal fusion or hip prostheses. Hip OA severity was graded by Kellgren-Lawrence scale & divided into 2 groups: low-grade(LOA; grade 0-2) and severe(SOA; grade 3-4). Spinal and lower limb alignment Pelvic Incidence (PI), Pelvic Tilt (PT), Lumbar Lordosis (LL), PI-LL, Thoracic Kyphosis (TK), Global alignment (SVA & T1-Pelvic Angle (TPA), T10-L2, proximal femoral shaft angle (PFSA), sacrofemoral angle (SFA), Knee Flexion (KA) and hip ROM (difference between ΔPT and ΔPFSA) were measured. Changes in sit-stand alignment were compared between LOA and SOA by unpaired t-test.

Results
548 patients were included, 311 LOA & 237 SOA. After propensity score matching for Age, BMI, PI & standing SVA, 183 LOA & 183 SOA patients were analyzed SOA and LOA groups demonstrated differences in standing and sitting spinopelvic alignment for all global and regional parameters except PI, SVA, SFA & KA (fig). When examining the postural changes from standing to sitting, hip ROM was less in SOA than LOA (71.95 vs 80.67, p<0.001). As a result, SOA patients had more change in PT (14.91 vs 7.9, p<0.001), PI-LL (20.35 vs 14.88, p<0.001), LL (-20.89 vs -14.41, p<0.001), and T10-L2 (-4.48 vs -0.9, p<0.001) to compensate. SOA group had a small but statistically significant improvement in SVA (28.31 vs 37.43, p=0.04), more change in TPA (14.85 vs 10.35, p<0.001), and less change in PFSA (86.65 vs 88.81, p<0.001) compared to LOA. TK change was not significantly different compared to LOA.

Conclusion
Spinopelvic compensatory mechanisms are adapted for reduced hip ROM in SOA between standing and sitting.

Table 1: Comparison of standing and sitting spinopelvic alignment for global and region parameters

	Standing			Sitting			ΔSitStand		
	LOA	SOA	p	LOA	SOA	p	LOA	SOA	p
ROM	*			*			80.67 ± 12.69	71.95 ± 17.7	0.00
PT	16.78 ± 8.14	14.49 ± 9.2	0.00	24.68 ± 12.07	29.4 ± 15.09	0.00	7.9 ± 10.16	14.91 ± 16.01	0.00
PI	54.32 ± 12.91	53.85 ± 12.5	0.40	54.71 ± 14.82	53.31 ± 17.3	0.4	0.47 ± 8.05	-0.54 ± 12.88	0.37
PI-LL	0.09 ± 11.96	0.82 ± 12.17	0.00	14.91 ± 14.93	21.17 ± 17.34	0.00	14.88 ± 11.56	20.35 ± 16.84	0.00
L1-S1	54.24 ± 12.2	53.03 ± 13.11	0.00	39.81 ± 14.23	32.14 ± 16.43	0.00	-14.41 ± 12.59	-20.89 ± 15.4	0.00
T10-L2	-1.36 ± 11.1	-0.22 ± 10.07	0.05	-2.35 ± 11.87	-4.7 ± 10.69	0.05	-0.9 ± 5.39	-4.48 ± 7.16	0.00
TK	-40.43 ± 11.62	-36.32 ± 12.18	0.01	-37.52 ± 13.5	-33.47 ± 16.14	0.01	2.95 ± 7.63	2.85 ± 10.32	0.92
SVA	38.3 ± 43.58	44.1 ± 40.73	0.41	75.47 ± 33.96	72.41 ± 37.21	0.41	37.43 ± 40.27	28.31 ± 43.1	0.04
TPA	13.65 ± 8.74	12.68 ± 8.71	0.01	23.98 ± 11.09	27.53 ± 13.85	0.01	10.35 ± 8.47	14.85 ± 13.65	0.00
L4-S1	33.19 ± 8.21	34.71 ± 8.81	0.02	23.51 ± 9.31	21.05 ± 10.32	0.02	-9.43 ± 11.83	-13.78 ± 13.94	0.00
PFSA	96.2 ± 3.78	95.74 ± 4.07	0.27	7.41 ± 4.48	9.09 ± 5.19	0.00	88.81 ± 5.24	86.65 ± 6.05	0.00
SFA	198.04 ± 17.19	194.81 ± 17.31	0.09	**			**		
KA	1.12 ± 14.59	3.53 ± 14.93	0.13	**			**		

** Femoral angles only visible on standing image acquisition, SFA+KA therefore not calculated for sitting

8. What Factors are Associated with Kyphosis Restoration in Lordotic AIS Patients?

Peter Newton, MD; Tracey P. Bastrom, MA; Carrie E. Bartley, MA; Vidyadhar Upasani, MD; Burt Yaszay, MD; Harms Study Group

Summary
Prior work on kyphosis-producing techniques has yielded mixed findings and has primarily focused on the sagittal plane in 2D, which has been shown to overestimate kyphosis in patients with AIS.

Hypothesis
Certain techniques are responsible for kyphosis restoration in adolescent idiopathic scoliosis (AIS) patients with a 3D thoracic sagittal profile that is lordotic.

Design
Retrospective review of a prospective multi-center database (19 surgeons).

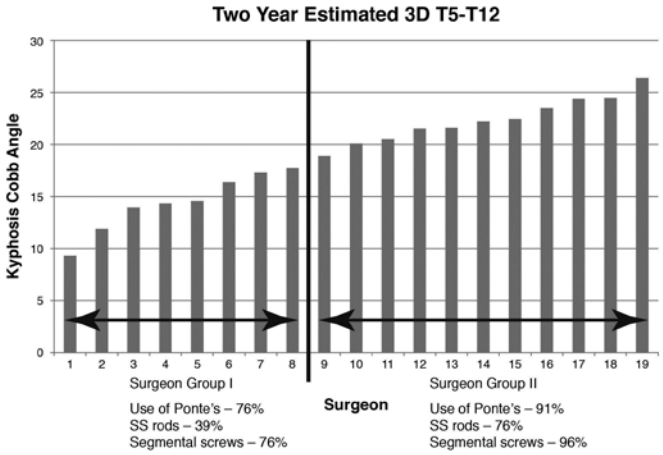
Introduction
Predictors of kyphosis restoration in AIS patients with the most lordotic thoracic sagittal profiles were evaluated.

Methods
A validated formula to predict 3D T5-T12 sagittal alignment utilizing standard 2D measures [Spine Deformity 5 (2017)] was applied in a cohort of Lenke 1-4 patients treated with posterior instrumentation (PSF) utilizing 5.5 diameter rods. The patients identified as 1 standard deviation (12.2°) below the mean 3D kyphosis (5.3°) in 1614 patients were identified as the study cohort of the 15% most lordotic patients. Predictors of estimated 3D T5-T12 kyphosis at 2 years were evaluated utilizing univariate analysis followed by a Classification and Regression Tree (CART).

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Results
There were 134 patients identified. All patients had a pre-operative estimated 3D T5-T12 kyphosis of < -6.9°. The group average 3D kyphosis was -13±5°, which improved to 21±7° at first erect, and 20±7° at 2 years (p<0.001). Primary thoracic coronal Cobb improved from 62±12° to 19±7° at first erect, and 21±8° at 2 years (p<0.001). Of the 11 predictor variables analyzed, multivariate CART analysis identified only surgeon as a predictor of 2 year kyphosis. Two surgeon groups were identified by CART which included those who restored kyphosis versus those who did not. Subsequent analysis demonstrated significant differences between groups in the rate of Ponte's utilized (p<0.023), stainless steel vs cobalt chromium rods (p<0.001), and segmental screw fixation (p<0.001, Figure).

Conclusion
Kyphosis restoration in patients with pre-operative lordosis in the thoracic sagittal plane is possible. In this analysis, there was not one single technique identified as being solely responsible for the ability to restore kyphosis. The most predictive factor identified was the surgeon performing the correction, which is likely a reflection of focus on deformity correction in three planes, as well as a combination of methods utilized to restore kyphosis.



9. Impact of Presenting Patient Characteristics on Surgical Complications and Morbidity in Early Onset Scoliosis

Frank Segreto, BS; Samantha Horn, BA; Cole Bortz, BA; Dennis Vasquez-Montes, MS; Bassel Diebo, MD; Shaleen Vira, MD; Nicholas Stekas, BS; David Ge, BA; Mohamed Moawad, MPH; Renaud Lafage, MS; Virginie Lafage, PhD; Edward DelSole, MD; Aaron Hockley, MD, FRCS(C); Anthony M. Petrizzo, MD; Aaron Buckland, MBBS, FRACS; Thomas Errico, MD; Michael Gerling, MD; *Peter Passias, MD*

Summary
Early-onset-scoliosis(EOS) can be associated with significant comorbidity, complicating management decisions. The rarity of this condition has resulted in a paucity of sufficiently powered studies describing comorbidity profiles and associated risks to the EOS population. Our analysis identified cardiovascular and renal anomalies as a significant risk for EOS patients presenting with musculoskeletal conditions, while epilepsy and pulmonary failure are significant risks for patients presenting with pulmonary disease. Clustered musculoskeletal, cardiovascular, and renal anomalies increased mortality risk by as much as 296%.

Hypothesis
EOS patients have multiple comorbidity profiles, with unique associated management risks.

Design
Retrospective review of HCUPs Kids' Inpatient Database(KID).

Introduction
There is a paucity of sufficiently powered studies describing comorbidity profiles and associated management risks in the EOS population.

Methods
The KID was queried for ICD-9 codes pertaining to congenital and idiopathic scoliosis from 2003-2012. Patients <10 y/o(EOS group) were included. Comorbidities were stratified by neurological, musculoskeletal, pulmonary, cardiovascular, and renal systems. K-means cluster analysis and X2 identified comorbidity profiles; logistic regression models gauged risk of perioperative complication, mortality, and extended LOS(≥75th percentile).

Results
25,747 patients were included(Age: 4.34, White: 56.1%, Female: 52.1%, LOS: 7.19, CCI: 0.64, Medicaid 47.7% Private I: 43.7%). Incidence was 8.9 per 100,000 annual discharges. 55.2% presented with pulmonary comorbidities, 48.7% musculoskeletal, 43.8% neurological, 18.6% cardiovascular, and 11.9% renal; 38% had concurrent neurological+pulmonary. Top inter-bodysystem clusters: Pulmonary disease(17.2%) with epilepsy(17.8%), pulmonary failure(12.2%), restrictive lung disease(10.5%), or microcephaly+quadriplegia(2.1%). Musculoskeletal comorbidities(48.7%) with renal+cardiovascular comorbidities(8.2%). Top intra-bodysystem clusters: Epilepsy (11.7%) with quadriplegia(25.8%) or microcephaly(20.5%). Regression analysis determined neurological+pulmonary clusters had higher odds of perioperative complication devlopment (OR:1.87[1.76-1.98], p<0.001). Musculoskeletal with cardiovascular+renal anomalies had higher odds of mortality (OR:3.96[2.98-5.24],p<0.001) and extLOS (OR:3.29[2.90-3.73],p<0.001).

Conclusion
Cardiovascular+renal anomalies were a significant risk for EOS patients with musculoskeletal conditions, while epilepsy and pulmonary failure are risks for patients with pulmonary disease. Clustered musculoskeletal, cardiovascular, and renal anomalies increased mortality risk by as much as 296%. These relationships may benefit pre-operative risk assessment for concurrent anomalies and adverse outcomes.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

ABSTRACTS

10. New Growing Rod System in Immature Swine Model

Chong Chen, MD; Fan Feng, MD; Haining Tan, MD; Youxi Lin, MD; Zheng Li, MD; Jianxiong Shen, MD

Summary
Study involved in twelve immature swine and lengthening operation was performed at 4-week intervals, with a total observation period of 12 weeks. The average lengthening operation time and incision length were significantly less than the traditional growing rod system. The new growing rod system is a safe and effective instruments, preserves the ability of the spine to grow, and imposes less surgical trauma. Motion and normal spinal discs between the instrumented segments were conserved.

Hypothesis
To investigate the efficacy and safety of a new growing rod system and evaluate its effect on subsequent spine growth in immature swine.

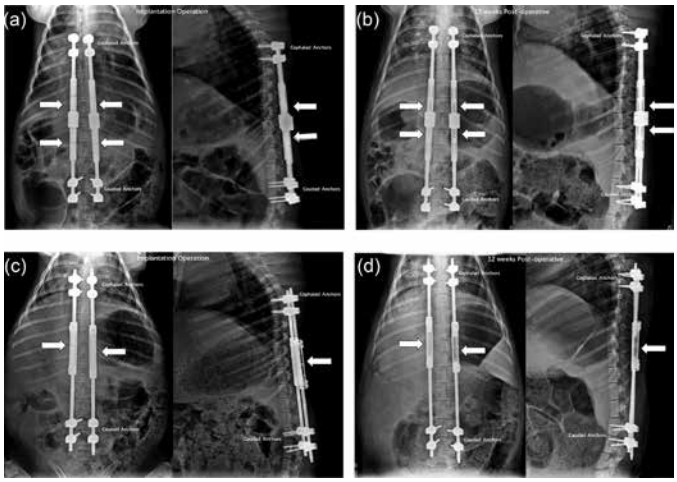
Design
An animal study in immature swine to apply a new growing rod system.

Introduction
Growing rod techniques have been demonstrated a valuably treatment in early-onset scoliosis (EOS), however, repeated operations and general anesthesia cannot be avoided. Although magnetic controlled growing rods theoretically will escape from re-operations and general anesthesia, clinically, complications and re-operations have been reported gradually in short to medium-term follow-up. A new system which could keep the correction ability and reduce the surgical trauma to EOS is expected.

Methods
Twelve immature swine were randomly assigned to receive either the new growing rod system (experimental group) or a traditional growing rod system (control group). Dual growing rods were implanted to fix the spine. Lengthening was performed at 4-week intervals, with a total observation period of 12 weeks. Radiography, computed tomography, and motion analysis of the spine were conducted to evaluate the fixation, rod extension, and growth and non-fusion of the spine.

Results
One swine in the control group had a deep wound infection at one week after the initial operation and was excluded from analysis. No complications were observed in the remaining 11 swine. The average lengthening operation lasted 12.1 ± 3.1 min and the incision length was 1.1 ± 0.2 cm in the experimental group; both significantly less than the control group ($P < 0.001$). There was no significant difference in mean trunk length, body mass, or thickness of cephalad- or caudad-instrumented vertebrae and intervertebral disks between groups before the initial operation or at the end point of the experiment (12 weeks post-operation) ($P > 0.05$). Spine growth and motion of the instrumented spinal segments was conserved.

Conclusion
The new growing rod system is safe and effective in immature swine, preserving the spine's potential growth and involving less surgical trauma.



11. Risk Factors for Disc Degeneration in Caudal Motion Segments Ten Years Following Adolescent Idiopathic Scoliosis Surgery

Baron Lonner, MD; Yuan Ren, PhD; Vidyadhar Upasani, MD; Michelle Claire Marks, MS, PT; Peter Newton, MD; Randal R. Betz, MD; Amer F. Samdani, MD; Harry L. Shufflebarger, MD; Suken Shah, MD; Daniel Lefton, MD; Hussein Nasser, MD

Summary
Radiographic markers of disc degeneration were used to define the incidence of and identify risk factors for disc degeneration (DD) 10 years following surgery for adolescent idiopathic scoliosis (AIS). 7.3% of patients had significant DD. Rates of DD increased over the post-operative period. Lowest instrumented vertebra (LIV) translation > 2cm and LIV caudal to L3 were predictors for developing significant DD.

Hypothesis
The frequency of disc degeneration (DD) in distal mobile segments will increase with deviations of various radiographic parameters following surgery for AIS.

Design
Retrospective review of a prospective AIS registry

Introduction
Durability of surgical outcomes is essential for maintenance of quality of life, family decision-making and assessment of the value of a healthcare intervention. We assessed risk factors for DD caudal to arthrodesis 10 years following AIS surgery.

Methods
Five radiographic markers of DD, previously validated, were evaluated pre-operatively, 1 month, 1 year, 2, 5 and 10 years postoperatively by a radiologist in consecutive operative AIS patients. A composite

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

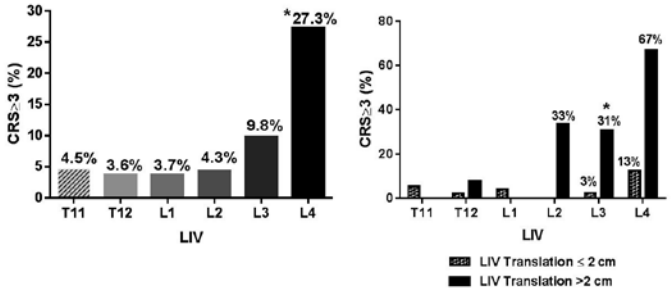
radiographic score (CRS) [0-10] was calculated using the sum of each of the DD indicators. CRS≥ 3 was chosen to indicate significant DD. CRS severity in relation to various risk factors was assessed using multivariate analysis.

Results

193 patients (mean age 14.4 years; 86% female) were assessed at a mean follow-up of 10.5 years (range 9.4-14). Surgical approach included 102 posterior and 91 anterior fusions. CRS≥3 occurred in 7.3% of patients at 10 years. The multivariate analysis showed that post-operative LIV translation ($p<0.0001$) and LIV location ($p=0.0083$) were significantly associated with 10-year CRS. LIV translation > 2cm (OR=8.0; $p=0.0004$), and LIV caudal to L3 (OR=5.2; $p=0.0455$) were predictors for developing significant DD 10 years after surgery. DD of the disc immediately below the LIV correlated with LIV translation ($p=0.0002$) and LIV location ($p=0.0089$) but not disc wedging (angulation) or LIV tilt. Operative approach and sagittal parameters did not correlate with DD. There was no significant association between 10-year CRS and SRS-22 scores.

Conclusion

We found that 7.3% of patients had significant DD 10 years following surgical correction of AIS and the rates of DD gradually increased over time. LIV translation > 2cm and LIV caudal to L3 were predictors for developing significant DD in all levels below the fusion 10 years after surgery. LIV translation and a more distal LIV are also associated with DD in the disc immediately below the LIV.



12. A New Method to Measure the Cobb Angle in Idiopathic Scoliosis by Ultrasonography: A Prospective and Blinded Study

Joan Ferras Tarrago, MD; Jorge Morales, MD; Pedro Rubio Belmar, MD; Silvia Pérez Vergara, MD; Pablo Jorda, MD; Jose Luís Bas Hermida, MD; Paloma Bas Hermida, MD; Teresa Bas, MD, PhD

Summary

Idiopathic Scoliosis is a spinal deformity that requires ionizing radiations for control of progression of the deformity, which increase the risk of developing breast cancer. We propose an ultrasonography protocol to evaluate the Cobb angle. Prospectively, the Cobb angle of 30 children was evaluated with ultrasonography, and independently with conventional radiography. There is a intraclass correlation of 90% between the two methods. There is evidence that ultrasound can be useful for the measurement of the Cobb angle in idiopathic scoliosis

Hypothesis

It is possible to assess the degrees of spinal deformity in idiopathic scoliosis by ultrasonography. It can reduce the accumulated radiation in the pre-surgical follow-up of these patients with a great reliability and reproducibility.

Design

Prospective and blinded study.

Introduction

Idiopathic scoliosis (IS) is a three-dimensional spinal deformity that appears in approximately 3% of adolescents, being more prevalent in the female sex. Serial x-rays needed during the follow-up represent a considerable accumulated radiation. Due to the age at which IS appears, radiographies increase the risk of developing associated diseases such as breast cancer. There have been described several systems of measurement of the deformity by ultrasonography, but due to the technical difficulty of the protocols described, and the need of additional software, they are not still used in the daily practice of surgeons of spine

Methods

Prospectively, the Cobb angle of 30 children was studied by echography by three independent researchers. The ultrasound protocol was based on the location of the facet joints of the same vertebral level. The protocol was performed in standing. Secondly, the Cobb angle was measured by two different spine surgeons using conventional X-rays. The intraclass correlation was studied between ultrasonography measurement and X-ray measurement as main result. Secondary results were the variability between the different observers on echography and the variability on the x-ray measurement.

Results

It was found a great correlation between the degrees of scoliosis measured by ultrasound system proposed and measured in x-rays in standing of 30 x 90. The intraclass correlation was 0.87 (IC 95% 0.79 - 0.91). The average time of measurement was 10 minutes (IC 95% 8.3 - 13.4).

Conclusion

It is possible to make an approximation to the measurement of the Cobb angle by ultrasonography, using the facet joint as reference. This is a fast, simple and radiation free method to the study the most frequently used angle to the follow-up of children with IS, with a great correlation with the conventional x-ray studies.

13. Optimal Trajectory and Length of S2 Alar Iliac Screws: A Three-Dimensional Computed Tomography Analysis

Benjamin Weisenthal, MD; Byron Stephens, MD

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

ABSTRACTS

Summary
The purpose of the study was to use three-dimensional computer-aided design (CAD) software model to place screws in the optimal position and determine angles of trajectory, length of screw, and distance from the sciatic notch. In our study, the optimal lateral angle in the transverse plane was 43 degrees and caudal angle was 17 degrees. This suggests that the ideal trajectory of the caudal angle to stay superior to the hip joint is different than the previously described trajectory.

Hypothesis
Determine the optimal trajectory and screw length for S2 alar-iliac screws.

Design
A radiographic study of Computed Tomography (CT) scans converted to 3-dimensional imaging via a 3D CAD software program.

Introduction
Solid pelvic fixation is necessary in thoracolumbar deformity surgery to protect sacral fixation and promote arthrodesis. Radiographic studies describe use of 3-dimensional imaging to guide placement of S2 alar-iliac screws and their optimal trajectory on CT. However, no study has used a 3-dimensional computer-aided design (CAD) software model to place screws in the optimal position and determine angles of trajectory, length of screw, and distance from the sciatic notch.

Methods
20 patients were randomly selected from our institution's spine trauma registry, including 10 males and 10 females. Their pelvic CT scans were converted to three-dimensional imaging. Three-dimensional pedicle screws were imported into the program. The startpoint was at the mid-point between the lateral aspect of the S1 and S2 dorsal foramen. The screw was aimed at the inferior third of the anterior inferior iliac spine (AIIS). It was confirmed there was no breach on either side of the ilium or the sciatic notch. The angles were determined on planes which bisected the pelvis. Each screw was reviewed by a fellowship-trained spine surgeon to confirm the correct starting point and trajectory.

Results
The average angle was 43 degrees (SD=2.5) laterally in the transverse plane and 16.8 degrees (SD=2.0) caudally in the sagittal plane. 100mm screws fit bilaterally in all 20 patients without cortical breakthrough. The average remaining distance from the tip of the screw was 41mm (SD=7.2mm) in male patients and 42mm in females (SD=11). The average distance from the notch was 14.2mm (SD=4mm).

Conclusion
We found an average caudal angle of 16.8 degrees. This suggests the previous described caudal angle of 20-30 degrees is too distal to avoid the hip joint. With optimal trajectory a 100mm screw can fit in all patients without concern for cortical breakthrough and on average this can be extended by approximately 40mm in both males and females.

14. Postoperative Change of Pelvic Incidence (PI) may impact Sagittal Spinopelvic Alignment (SSA) after Correction of Adult Spine Deformity (ASD)

Vikas Patel, MD, BS, MA; Christopher Kleck, MD; Christopher Cain, MD, PhD; Francisco Rodriguez-Fontan, MD; Andriy Noshchenko, PhD; Evalina Burger, MD

Summary
PI may be variable after correction of ASD due to instability of sacroiliac joint; postop. change exceeding ±8° may be observed in 25% of cases. This may impact correction of SSA, in particular PI-lumbar lordosis (LL) mismatch. This factor should be considered during planning of the ASD correction.

Hypothesis
PI is a constant characteristic which does not change after surgical correction of ASD at short and long term follow-up periods.

Design
Single center retrospective case series

Introduction
A criterion of optimal SSA is PI-LL mismatch, ±10°. Historically, postop. correction of this parameter to optimal was observed in 51%; with deterioration from optimal postoperatively, in 14%. Postop. variability of PI as a potential confounding factor has not been studied yet. The purpose of the current study was to assess variability of PI after surgical correction of ASD versus preop. values at short and long term follow-ups.

Methods
Inclusion criteria: age >20 yrs old; male and female; ASD; long instrumented spinal fusion; 2-yr follow-up or revision; radiographic evaluation, preop. and postop. at 3-, 12-, and 24-mth follow-up. Parameters studied: sacral slope (SS), pelvic tilt (PT), PI, LL (L1-S1), and PI-LL. Correspondence between preop. and postop. PI was defined as R2 and variability (Var) as root mean square error (RMSE) by linear regression. The same analysis was applied for inter-measurement reliability assessment. Risk of measurement bias was evaluated. Statistical significance was defined as $P<0.05$.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Results
80 pts were included: mean age, 62.3(SD, 11.1); male, 36%; previous spinal operations, 74%; osteoporosis, 35%; number of levels fused, 3-15; osteotomy, 43%. Correspondence between preop. and postop. PI was moderate and decreased with time: at 3mth, R2=0.65(Var., 7.3), P<0.001; 12mth, R2=0.57(Var., 8.1), P<0.001; and at 24mth, R2=0.45(Var., 8.9), P<0.001. The inter-measurement variability was significantly less, 1.9, P<0.05. The postop. PI changes had opposite directions, exceeding ±8° in 25%, with maximum, ±20°. These PI deviations were caused by disproportional changes of SS and PT progressed during 2 yrs. Correspondence between postop. PI-LL and LL changes was moderate, R2=0.7(P<0.001). Input into correction of PI-LL provided also changes of SS, R2= 0.1(P<0.003) and PT, R2= 0.34(P<0.001)

Conclusion
PI may change after ASD correction due to sacroiliac joint mobility. This effect should considered when planning correction.

15. Prevalence and Predictive Factors of Concurrent Cervical Cord Compression in Adult Spinal Deformity

Takayoshi Shimizu, MD, PhD; Ronald A. Lehman, MD; J. Alex Sielatycki, MD; Suthipas Pongmanee, MD; K. Daniel Riew, MD; Lawrence G. Lenke, MD

Summary
This study reported the prevalence and predictive factors for concurrent cervical spinal cord compression based on magnetic resonance imagings (MRIs) in patients with adult spinal deformity (ASD) undergoing major thoracolumbar corrective surgery. 33.8% of the study cohort showed significant cervical cord compression. Age, body mass index (BMI), and PI-LL (pelvic incidence – lumbar lordosis) mismatch independently predicted the severity of cervical cord compression.

Hypothesis
The prevalence of cervical spinal cord compression (CSCC) is relatively high in ASD patients. The severity of CSCC depends on the extent of sagittal malalignment of thoracolumbar deformity.

Design
Retrospective, single-center, cross-sectional analysis

Introduction
In ASD patients undergoing major thoracolumbar realignment surgery, concurrent CSCC potentially increases the risk of progressive myelopathy or cord injury due to a variety of perioperative factors including prone positioning, intraoperative hypotension, and acute blood loss. However, the prevalence of CSCC in ASD patients has not been previously studied.

Methods
This study included ASD patients who were indicated for major thoracolumbar corrective surgery (>5 levels). The presence of CSCC was determined using Cord Compression Index (CCI: Grade 0-3, Table 1) based on the cervical MRI. The significant CSCC was defined as Grade >2 and the distribution of compression level as well as the number of Grade >2 segments were investigated in each patient. A multivariate regression analysis was performed to identify the predictors for CSCC with variables being the patients' characteristics including sagittal alignment parameters.

Results
Of 121 ASD patients, 41 patients (33.8%) demonstrated significant CSCC on MRIs. Cord signal change on T2 weighted imaging was present in 8 patients (6.6%). Significant CSCC was most commonly observed at C4/5 level. Nineteen out of the 41 significant CSCC patients had more than 2-level cord compression. Four patients (3.3%) underwent cervical spine surgery prior to the thoracolumbar reconstruction. The multivariate regression analysis revealed that old age, increased BMI, and PI-LL mismatch independently predicted the grade of CSCC.

Conclusion
The prevalence of concurrent cervical cord compression in adult spinal deformity (ASD) patients is extremely high at 33.8%. Preoperative evaluation of cervical MRIs and examinations for signs/symptoms of myelopathy is essential for 1) older patients, 2) have increased BMI, and 3) high PI-LL mismatch in order to avoid progressive myelopathy or cord injury during ASD surgery.

Table 1. Modified Cord Compression Index (CCI)

Anterior compression score	Description
0	No compression
1	Disc bulging or OPLL with adequate CSF space
2	No CSF space without cord compression
3	Obvious cord compression
Posterior compression score	
0	No compression
1	Enlargement of ligamentum flavum with adequate CSF space
2	No CSF space without cord compression
3	Obvious cord compression
CCI = Anterior + Posterior compression scores	
Grade 0	0
Grade 1	1-2
Grade 2	3-4
Grade 3	5-6

Anterior and posterior compression was evaluated on axial view at each level
OPLL, ossification of posterior longitudinal ligament; CSF, cerebrospinal fluid

16. Long Term Follow-Up of Patients with Modic Changes

Peter Udby, MD, DC; Tom Bendix, MD; Mikkel Østerheden Andersen, MD; Leah Yacat Carreon, MD, MS

Summary
This study evaluates if Modic changes (MC) are associated with long-term disability and pain. In total 204 cases with MRIs and low back pain, including 82 (40%) with MC, were enrolled in 2004 and 167, including 65 (39%) with MC, were available for follow-up in 2017. No differences were found at baseline. At 13-year follow-up Roland-Morris Disability Questionnaire-score was worse in patients without MC. No differences were found for inflammatory pain pattern, back- or leg-pain.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Hypothesis
Patients with Modic changes (MC) have worse long-term outcomes compared to patients without.

Design
Longitudinal prospective follow-up study of a consecutive cohort of patients with chronic low back pain.

Introduction
Back pain is the leading global cause of disability. Some studies have shown that MC are strongly associated with low back pain (LBP) compared to disc degeneration alone. However, the long-term consequences in terms of Patient-Reported Outcomes (PROs) have not been reported. This study evaluated if MC is associated with long-term disability and pain.

Methods
In 2002, 207 patients with chronic low back pain were enrolled in an RCT comparing cognitive training with physical therapy. Inclusion criteria were age 18-60, almost daily LBP of ≥ 4 for more than 4 months in the past year. In 2017, these patients were then asked to complete the same PROs collected at baseline: back and leg pain (0-10), Roland-Morris Disability Questionnaire (RMDQ) and Inflammatory pain pattern (IPP). Patients were then stratified based on the presence or absence of MC on their initial low-Tesla MRI.

Results
Of the 204 cases with MRIs in 2002, 82 (40%) had MC in a least one lumbar segment. In 2017, 167 cases (82%) were available for follow-up including 65 (39%) with MC. There were no differences in demographics, smoking status, back- or leg-pain or IPP scores at baseline and at 13-year follow-up between patients with and without MC. RMDQ was similar in both groups at baseline but worse in patients without MC at follow-up.

Conclusion
Various population-based studies have shown that a higher fraction of people with MC have LBP than those without. However, the current study showed that even patients without MC who had pain and were referred to a back clinic have the same clinical presentation as patients with MC. Patients with MC thus seemed to fare similar to patients without MC. However, LBP patients with MC had less long-term disability compared to LBP patients without.

	No Modic	Modic	p-value
N	122	82	
Mean Age (years)	38 (4.7)	41 (5.3)	0.382
BMI, mean (SD)	25.8 (3.2)	25.7 (3.8)	0.854
Females, N (%)	66 (53%)	44 (54%)	0.871
Smoker, N (%)	52 (43%)	27 (33%)	0.207
Back Pain, Mean (SD)			
Baseline	6.3 (1.4)	6.0 (1.5)	0.296
13-year follow-up	4.8 (2.7)	4.2 (2.5)	0.163
Leg Pain, Mean (SD)			
Baseline	2.2 (2.2)	1.9 (2.0)	0.466
13-year follow-up	3.4 (3.0)	2.6 (2.8)	0.099
RMDQ, Mean (SD)			
Baseline	12.5 (5.0)	12.3 (4.3)	0.945
13-year follow-up	9.6 (6.8)	7.4 (5.6)	0.024
Inflammatory pattern, N (%)	82 (67%)	54 (66%)	0.492

17. A Comparison of Multiple Rods Constructs (MRC) to Two Rods Constructs (TRC) after Corrective Fusion Surgery Including Sacroiliac Fixation for Adult Spinal Deformity: Does it Prevent or Aggravate Complication?

Kyunghyun Kim, MD, PhD; Unyong Choi, MD

Summary
The use of MRC prevents rod fracture and increases the stability of the surgical site, but increases the incidence of proximal junctional kyphosis and causes rapid onset.

Hypothesis
Increased stiffness increases the stability of the surgical site, but can cause other complications.

Design
Restrospective cohort study

Introduction
Rod fracture is one of complications that frequently happened in adult spinal deformity surgery. Three column osteotomy and magnitude of correction compared to previous deformation have higher rate of rod fracture. And also previous study reported that the use of multiple rods constructs(MRC) could prevent the rod fracture after adult spinal deformity surgery because of their greater strength and resistance to fatigue relative to two rods system. In this study, we investigated the influences of MRC on proximal junctional kyphosis(PJK) and rod fracture compared to TRC.

Methods
We retrospectively reviewed data from 59 patients who had undergone adult spinal deformity surgery with sacropelvic fixation at a single institution between June 2011 and May 2017. We divide these patients into two groups (MRC and TRC). Preoperative demographic data were reviewed and radiographic parameters were measured preoperatively, immediate postoperatively, 1 month, 3 month, 6 months and at the final follow-up. Kaplan-Meier analysis was used for evaluating the timing and incidence of PJK and Rod fracture between two groups.

Results
There were no significant differences between two group in terms of age, gender, preoperative diagnosis, fused levels, BMD, BMI, HTN, DM, Smoking history and preoperative radiological parameters. However, the rate of rod breakage was higher in MRC group than TRC group (TRC: 12 [31.5%] vs. MRC: 1 [4.7%], p=.002) although the rate of PJK was not significantly different between two group. The timing of PJK was much more faster in MRC group than TRC group according to survival analysis.

Conclusion
The use of MRC is a simple and effective way to increase the stability of the surgical site and to prevent problems such as rod fractures compared to TRC. However, continuous attention is needed because there is a tendency to increase the rate and the faster timing of proximal junctional kyphosis in MRC group.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Table 1.

Patient dermographics

	TRC(n=38)	MRC(n=21)	P
Age	64.63 ± 11.52	66.43 ± 6.72	0.520
Age > 55	21(55.3)	13(61.9)	0.784
Male : Female	7 : 31	3 : 18	0.737
BMI(kg/m2)	23.67 ± 3.53	24.38 ± 2.78	0.430
Follow up (days)	753 ± 394	669 ± 206	0.289
BMD	-2.38 ± 1.1	-2.30 ± 0.80	0.790
Osteopenia	30(78.9)	19(90.4)	0.547
Osteoporosis	13(52.0)	8(42.9)	0.571
Previous surgery	13(52.0)	12(48.0)	0.067
HTN	16(42.1)	14(66.7)	0.103
DM	8(21.1)	3(14.3)	0.730
Smoking status	4(11.4)	1(5.3)	0.646
Diagnosis			0.439
Degenerative deformity	21(55.2)	9(42.9)	
Iatrogenic flat back	13(34.2)	12(57.1)	
Posttraumatic	2(5.3)	0	
Infection	2(5.3)	0	

BMI : body mass index; BMD : bone mineral density; HTN : hypertension; DM : diabetes mellitus.

18. Activity of Daily Living after Long Level Fusion in Adult Spinal Deformity: Compared with Over 60 Years Old Degenerative Spine Patients Without Adult Spinal Deformity

Whoan Jeang Kim, MD, PhD; Jae Won Lee, MD; Shann Haw Chang, MD; Dae Geon Song, MD; Kun Young Park, MD, PhD

Summary
Old aged degenerative spine patients without deformity showed nearly full function of daily activity. Activity of daily living of non-operative adult spinal deformity patients was similar to old aged degenerative spine patients without deformity. However, get up from bottom, and pick up object were impaired Activity of daily living was impaired after long level fusion, however it would improve as time goes by. From postoperative 1 year, ADL recovered to acceptable range. About 2 years postoperatively, activities associated sedentary lifestyle were still impaired.

Hypothesis
The aim of this study was to evaluate 1) the activity of daily living (ADL) of three categorized patients group; over sixty-year old degenerative spine patients without adult spinal deformity (ASD), non-operative ASD patients, and operative ASD patients, 2) what kinds of activities would be impaired, and 3) how the ADL changes over time after long level fusion.

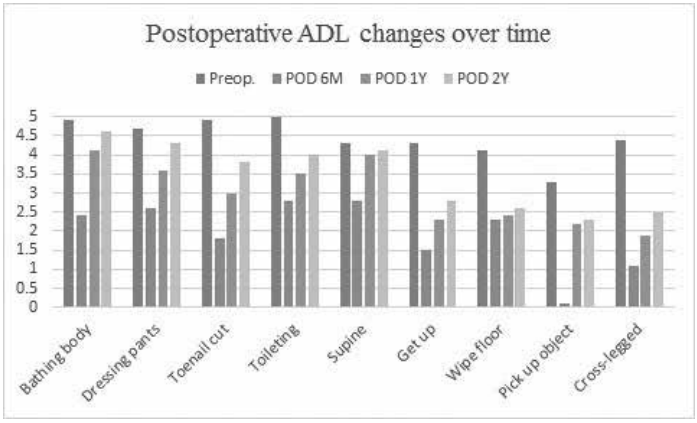
Design
Prospective single center study.

Introduction
There is still debate how surgeons could decide treatment methods for old aged adult spinal deformity, operatively or not. There were lack of information how long level fusion impact daily activities, especially sedentary Asian lifestyle. In Asia, impaired ADL is a much more important issue because of different lifestyles.

Methods
Patients were categorized 3 groups; group 1 was over 60-year old aged degenerative spine disease without deformity, group 2 was ASD patients who did not have surgery, and group 3 was ASD patients who had surgery for deformity correction. Patients were evaluated using answer Oswestry Low Back Pain Disability Questionnaire (ODI), and Assessment activities of daily living for sedentary Asian culture (ADL-SA) questionnaire.

Results
Group 1 showed nearly full functions in every activity (ADL-SA: 41.4). ADL-SA scores of group 2 was similar to group 1 ($p=0.452$). However, get up from bottom ($p<0.001$), and pick up object ($p<0.001$) were impaired. After long level fusion, ADL was impaired but gradually improved by time. From postoperative 1 year, total ADL score recovered to acceptable range. However, among ADL, activities associated sedentary lifestyle (get up from bottom, wipe floor, pick up object, and sit cross-legged) were still impaired after 2 years postoperatively.

Conclusion
ADL was impaired after long level fusion however it would improve as time goes by. However, among ADL, activities associated sedentary lifestyle were still impaired. Hence give enough information to patients about limited activities before decided operation.



19. New Evidence Supporting the Regulatory Role of LBX1 Variant in AIS

Lei-Lei Xu, PhD; Chao Xia, PhD; Fei Sheng, PhD; Bingchuan Xue, PhD; Xiaodong Qin, PhD; Weiguo Zhu, PhD; Zezhang Zhu, MD; Yong Qiu, MD

Summary
Previous studies showed that LBX1 may be involved in the etiology of AIS. For the first time, rs1322330 located in the promoter region of LBX1 was found associated with AIS in the Chinese population. The luciferase assay indicated that the T allele of rs1322330 was a functional allele. The EMSA showed that the DNA-protein complex of the T allele had weaker binding affinity. To summarize, rs1322330 was a novel regulatory variant of LBX1 that may be asscociated with AIS.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Hypothesis
Regulatory variant of LBX1 may influence the expression of LBX1 in AIS.

Design
A genetic association study.

Introduction
Previous studies have shown that genetic variants of LBX1 are associated with AIS in the Caucasian, the Japanese population and the Chinese population. In addition, AIS patients were reported to have remarkably lower expression of LBX1 as compared with the healthy controls. However, there is a paucity of knowledge concerning the regulatory mechanism of down-expressed LBX1 in the AIS patients. SNP rs1322330 is a tag SNP located in the promoter of LBX1. Our purposes were to explore the regulatory role of rs1322330

Methods
A tag SNP rs1322330 located in the promoter of LBX1 was genotyped in 1452 patients and 2177 controls. The differences of genotype and allele distributions between patients and controls were calculated using chi-square test. Paraspinal muscles were collected from the 98 AIS patients during surgery. Total RNA was extracted for the expression analysis of LBX1. The One-way ANOVA test was used to compare the mRNA expression of LBX1 among different genotypes of rs1322330. The luciferase assay was performed to explore the influence of rs1322330 on transcriptional activity of LBX1. The allelic difference in the binding of genomic DNA containing rs1322330 to nuclear proteins was analyzed by the electrophoretic mobility shift assay (EMSA).

Results
Allele T of rs1322330 can significantly add to the risk of AIS with an odds ratio of 1.43. Patients with genotype TT had significantly decreased expression of LBX1 than those with genotype CC. For both 293T cell line and Hela cell line, constructs containing the allele T of rs1322330 showed remarkably lower enhancer activity than those containing the allele C, indicating that the variant can affect the LBX1 transcription level. EMSA showed that the DNA-protein complex of the T allele had weaker binding affinity than that of C allele.

Conclusion
SNP rs1322330 is associated with AIS in Chinese Han population. The T allele of rs1322330 is a novel functional allele regulating the expression of LBX1 in the paraspinal muscles of AIS. Further functional analysis is warranted for a comprehensive knowledge

20. An Investigational Study of Titanium Plasma Spray on Osseointegration of PEEK and Titanium Implants: An In Vivo Ovine Model

Bryan Cunningham, PhD; Jessica Riggleman, BS; Kenneth Mullinix, BS; Wenhai Wang, PhD; P. Justin Tortolani, MD; Daina Brooks, BS

Summary
The current in-vivo investigation compared the effects of titanium plasma spray on osseointegration of PEEK and titanium implants versus non-plasma sprayed controls. Endpoints included micro-computed tomography, biomechanical testing and histomorphometry. The results demonstrate the acute biomechanical and biological advantages of plasma spray coatings and inherent osseous affinity of titanium compared to PEEK, regardless of coating. Plasma spray coatings may offer clinical benefit by improving acute implant fixation and biologic osseointegration during the critical healing period of spinal reconstruction procedures.

Hypothesis
Using an in-vivo model, titanium plasma spray serves to increase the rate and magnitude of trabecular osseointegration of PEEK and titanium implants versus uncoated controls.

Design
Time-course study using an in vivo animal model

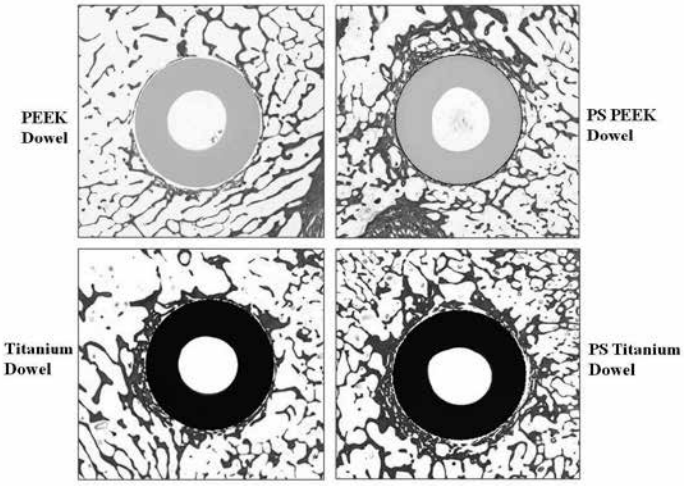
Introduction
Methods to improve osseointegration of orthopaedic implants remains a clinical challenge. Using and in-vivo ovine model and time-course study, the current investigation compared the osseointegration of titanium plasma sprayed PEEK and titanium implants versus non-plasma sprayed controls.

Methods
Twelve skeletally mature crossbred sheep were equally randomized into postoperative periods of 6 and 12 weeks. Four types of dowel implants - PEEK, plasma sprayed PEEK (PS PEEK), titanium and plasma sprayed titanium (PS T) were implanted into cylindrical metaphyseal defects in the distal femurs and proximal humeri (one defect per limb, n=48 sites). 16 additional specimens served as zero time-point controls. Specimens were divided - half underwent destructive pullout testing and the remaining half - quantitative microCT to calculate bone volume within 2mm, 1mm and 100 microns of the implant surface and histomorphometry to calculate direct trabecular apposition.

Results
Plasma spay coated implants demonstrated higher pullout forces at 6 and 12 weeks compared to uncoated implants ($p<0.05$). The importance of biological osseointegration is demonstrated by the zero week biomechanical data, which showed no differences across treatments ($p>0.05$). MicroCT results exhibited greater bone volume within 100 microns of the plasma sprayed surfaces than uncoated implants at all time points for both materials ($p<0.05$). Histomorphometry indicated direct trabecular apposition was higher at 6 weeks for PS titanium and PS PEEK groups and at 12 weeks for the PS titanium group, compared to uncoated treatments ($p<0.05$) (Figure 1).

Conclusion
The current study demonstrates the acute biological and biomechanical advantages of plasma spray coatings and inherent osseous affinity of titanium compared to PEEK, regardless of coating. Titanium plasma spray may offer acute and long term clinical benefit by improving implant osseointegration

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*



21. Direct Vertebral Rotation Significantly Decreases the Pull-out Strength of the Pedicle Screw

Kerim Sariyilmaz, MD; Okan Ozkunt, MD; Halil Gemalmaz, MD; Tunca Cingoz, MD; Tuna Pehlivanoglu, MD; Murat Baydogan, PhD; Fatih Dikici, MD

Summary
In this biomechanical study we used 30 pedicles of 15 human cadaveric vertebrae. Two groups were formed. One group was DVR group and each screw was rotated with a screw driver rigidly attached to the screw head simulating the posterior vertebral derotation maneuver. Second group was the control group. Samples were placed on a universal testing machine and pull-out loads were measured. We found significantly reduced pull-out strength in DVR group when compared with the control group.

Hypothesis
Direct vertebral rotation (DVR) maneuver decreases the pull-out strength of the pedicle screws due to the rotational force and micromotion in the trabecular bone.

Design
In vitro biomechanical investigation using human cadaveric vertebrae

Introduction
The use of pedicle screws in spinal surgery has become standard due to biomechanical and corrective advantages by means of three-column fixation. Direct vertebral rotation(DVR) has produced improved correction of thoracic and lumbar coronal curves compared to traditional rod derotation techniques. Although, it is reported that excessive forces while DVR maneuver may cause an anatomic failure, the pull-out strength of the pedicle screws after DVR maneuver is not known. Thus, this biomechanical study was performed to quantitatively analyze the pullout strength of a pedicle screw after DVR maneuver.

Methods
Thoracic vertebral bodies from 3 cadavers were harvested and stripped of soft tissues. Thirty pedicules of 15 vertebrae were separated to 2 groups after bone mineral density measurements. Polyaxial 5.5 mm pedicle screws with appropriate length were inserted with a free hand technique for each pedicle. One Kirschner wire was inserted to the anterior part of the each vertebral corpus, and the half depth of each corpus were embedded into PVC pipes using polyester paste. In the DVR group, each screw was pulled horizontally with 2 kg (20 N) load over a screwdriver rigidly attached to the screw, and a posterior vertebra derotation maneuver was simulated. Control group did not load with a DVR maneuver. Samples were placed on a universal testing machine and pullout loads were measured (Figure 1). Mann Whitney_U test was utilized within 95% confidence interval and p value <0.05 to test for the statistical significance.

Results
In DVR group mean pull-out strength was 183.35 N(SD±100.12) and in the control group mean pull-out strength was 279.95 N(SD±76.26). Inter-group comparisons revealed that DVR maneuver significantly decreases the pullout strength (p=0.12)

Conclusion
The results of this study confirm that pullout strength of pedicle screw significantly decreases by approximately 35% when DVR maneuver is applied.

22. Improvement in SRS-22r Self-Image and Activity Correlate Most with Patient Satisfaction after 3-Column Osteotomy

Jeffrey Gum, MD; Samrat Yeramaneni, PhD, MBBS, MS; Micheal Raad, MD; Richard Hostin, MD; Michael P. Kelly, MD, MS; Virginie Lafage, PhD; Justin Smith, MD, PhD; Peter Passias, MD; Khaled M. Kebaish, MD, FRCS(C); Christopher Shaffrey, MD; Douglas C. Burton, MD; Christopher Ames, MD; Frank J. Schwab, MD; Shay Bess, MD; International Spine Study Group

Summary
In 99 ASD patients undergoing a 3-column osteotomy (84 PSO, 15 VCR) a statistically significant improvement was seen in all

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

the SRS22r domain scores at minimum 2-year follow-up. SRS Appearance and Activity had the strongest correlation with patient satisfaction while all other SRS domains had only weak or very weak correlation. Although there was significant improvement in most radiographic parameters, no radiographic or operative parameters had a correlation with patient satisfaction at 2-years.

Hypothesis
SRS Self-image correlates with patient satisfaction after 3-column osteotomy (3CO)

Design
Longitudinal Cohort

Introduction
Identification of factors that influence patient satisfaction in adult spinal deformity (ASD) is important. Evidence suggests SRS22r Self-image domain correlates with patient satisfaction in AIS and ASD. Our goal was to examine the relationship in ASD patients undergoing a 3CO (PSO:VCR) between patient satisfaction, HRQOLs and radiographic parameters.

Methods
This is a retrospective review of ASD patients enrolled in a prospective, multicenter database undergoing a 3CO with complete SRS22r pre- and minimum 2-yrs postop scores. Spearman correlations were used to evaluate associations between the 2-yr SRS Satisfaction score and changes in SRS22r domain scores, ODI, and radiographic parameters. Radiographic parameters analyzed included major Cobb, CVA, SVA, TK, LL, PI, LL-PI, PT, T1-, and T9-spinopelvic inclination.

Results
Of 135 patients eligible for 2-year follow-up, 99 patients (73%) had complete pre- and 2-yr postop data. The cohort was mostly female (72%) with mean BMI of 29.3 kg/m2 and age of 61.6 yrs. Mean levels fused was 12.6 with EBL of 2478cc and OR time of 398 minutes. 25% were revision surgeries. There was a statistically significant improvement between pre- and 2-year post-op HRQOLs and all radiographic parameters except CVA. The majority of patients had an SRS Satisfaction score of $\geq$ 3.0 (90%) or $\geq$ 4.0 (69%), consistent with a moderate ceiling effect. Correlations of patient satisfaction with SRS mental domain was not significant (0.17, p=0.09) but was significant for pain (0.34, p=0.001), activity (0.40, p<0.001), and self-image (0.40, p<0.001). ODI and SF-36 PCS had a moderate correlation as well, with MCS being weak. There was no statistical correlation between any radiographic or operative parameters and patient satisfaction.

Conclusion
There was statistically significant improvement in all HRQOL outcomes and radiographic parameters, except CVA at 2-years in ASD patients undergoing 3CO. Improvement in SRS Self-image and Activity domains have the strongest correlation with patient satisfaction.

23. Rod Fracture Following Apparently Solid Radiographic Fusion in Adult Spinal Deformity Patients

Alan Daniels, MD; Wesley Durand, BS; D. Kojo Hamilton, MD; Peter Passias, MD; Han Jo Kim, MD; Themistocles Protopsaltis, MD; Virginie Lafage, PhD; Justin Smith, MD, PhD; Christopher Shaffrey, MD; Munish Gupta, MD; Eric O. Klineberg, MD; Frank J. Schwab, MD; Douglas C. Burton, MD; Shay Bess, MD; Christopher Ames, MD; Robert A. Hart, MD; International Spine Study Group

Summary
Rod fracture occurred in 9.5% of adult spinal deformity patients after being deemed solidly fused by a committee of 3 spinal deformity surgeons. Risk factors for rod fracture were advanced age, obesity, lower comorbidity burden, small diameter rods, stainless steel rods, posterior-only approach, osteotomy, and interbody fusion.

Hypothesis
Advanced age, higher comorbidity burden, 3-CO, smaller diameter rods, surgical approach, osteotomy, and interbody fusion, may be associated with rod fracture after radiographically confirmed fusion.

Design
Retrospective review of a multi-center ASD database.

Introduction
Rod fracture is known to occur due to delayed fusion or pseudarthrosis following ASD surgery. Rod fracture following radiographic evidence of fusion has not been previously investigated.

Methods
ASD patients in a multicenter prospective database were assessed for radiographic fusion by a committee of 3 spinal deformity surgeons. Fusions were rated as bilaterally solidly fused (A), unilaterally solidly fused (B), partially fused (C), or no fusion (D). Ratings required agreement of a minimum of 2 judges. Inclusion criteria were 2-year follow-up and radiographically-confirmed fusion (grade A or B). Patients were defined as rod fracture after fusion (RFAF) if rod fracture was documented following radiographically confirmed fusion. Adjusted analyses were conducted with multiple logistic regression, utilizing backwards variable selection to a threshold of p<0.2 to assess for factors associated with RFAF.

Results
Of 402 patients with solid fusion on 2-year follow-up radiographs, 9.5% (n=38) subsequently suffered RFAF. On multivariate analysis, higher rates of RFAF were seen among patients of age group 60-69 (vs. 18-49, OR 6.28, p=0.0091), BMI 30-34 (vs. <25.0, OR 4.66, p=0.0158) and 35+ (OR 13.03, p=0.0005), posterior-only vs. combined approach (OR 3.68, p=0.0394), osteotomy (OR 3.10, p=0.0389), interbody fusion (OR 2.99, p=0.0413), stainless steel vs. titanium rods (OR 12.28, p=0.0180), rod diameter 5.5 vs. 6.35mm (OR 10.53, p=0.0152), and patients with Charlson score 0 vs. $\geq$3 (OR 6.71, p=0.0055).

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Conclusion
RFAF occurred in 9.5% of patients with apparently solid radiographic fusion following ASD surgery. Advanced age, obesity, smaller diameter rods, stainless steel rods, osteotomy, posterior-only approach, interbody fusion, and lower comorbidity burden were significantly associated with RFAF. This study suggests that assessment of solid fusion by plain radiographs is insensitive to probable pseudarthrosis.

Variable	OR	95% CI		p-value
Age Group (ref = 18-49)				
50-59	1.84	0.45	7.59	0.3965
60-69	6.28	1.58	24.99	**0.0091**
70+	3.03	0.55	16.73	0.2037
BMI (ref = <25)				
25.0-29.9	2.37	0.76	7.42	0.1388
30.0-34.9	4.66	1.34	16.24	**0.0158**
35.0+	13.03	3.04	55.75	**0.0005**
Approach (ref = Posterior Only)				
Combined	0.27	0.08	0.94	**0.0394**
Osteotomy (ref = No)				
Yes	3.10	1.06	9.04	**0.0389**
BMP (ref = No)				
Yes	0.43	0.15	1.18	0.1018
Interbody Fusion (ref = No)				
Yes	2.99	1.04	8.57	**0.0413**
Supplemental Rod (ref = No)				
Yes	0.32	0.08	1.26	0.1029
Operative Duration (ref = <5)				
5-6	0.46	0.12	1.68	0.2375
7-8	0.83	0.23	2.96	0.7752
9+	2.90	0.67	12.58	0.1559
Rod Material (ref = Titanium)				
Cobalt Chrome	2.87	0.69	11.98	0.1490
Stainless Steel	12.28	1.54	98.05	**0.0180**
Rod Diameter (ref = 6.35mm)				
6.0mm	1.57	0.11	21.80	0.7356
5.5mm	10.53	1.57	70.43	**0.0152**
CCI (ref = 0)				
1	0.49	0.16	1.45	0.1966
2	0.47	0.15	1.53	0.2102
3+	0.15	0.04	0.57	**0.0055**
Revision Surgery (ref = No)				
Yes	1.89	0.82	4.38	0.1370

24. Incidence of Acute, Progressive, and Delayed Proximal Junctional Kyphosis over an 8-Year Period in Adult Spinal Deformity Patients

Frank Segreto, BS; *Peter Passias, MD;* Renaud Lafage, MS; Virginie Lafage, PhD; Justin Smith, MD, PhD; Breton G. Line, BS; Gregory Mundis, MD; Pierce D. Nunley, MD; Alan Daniels, MD; Munish Gupta, MD; Jeffrey Gum, MD; D. Kojo Hamilton, MD; Eric O. Klineberg, MD; Douglas C. Burton, MD; Robert A. Hart, MD; Frank J. Schwab, MD; Shay Bess, MD; Christopher Shaffrey, MD; Christopher Ames, MD; International Spine Study Group

Summary
Proximal junctional kyphosis (PJK), a common radiographic finding after long spinal fusions, is one of the greatest challenges facing spinal surgeons. Our analysis determined overall incidence of PJK was 59.1%, slightly above previously reports. While the insidious progression of acute PJK has been a challenge for physicians (exemplified by the recent increased incidence of progressive PJK), lower incidences of acute and delayed PJK development in recent years may indicate successful clinical implementation of preventative treatment strategies.

Hypothesis
PJK incidence has varied over the past 8 years.

Design
Retrospective review of a prospective multicenter ASD database.

Introduction
While previous literature have reported the incidence of PJK to range from 5%-46%, these studies are limited by small sample sizes.

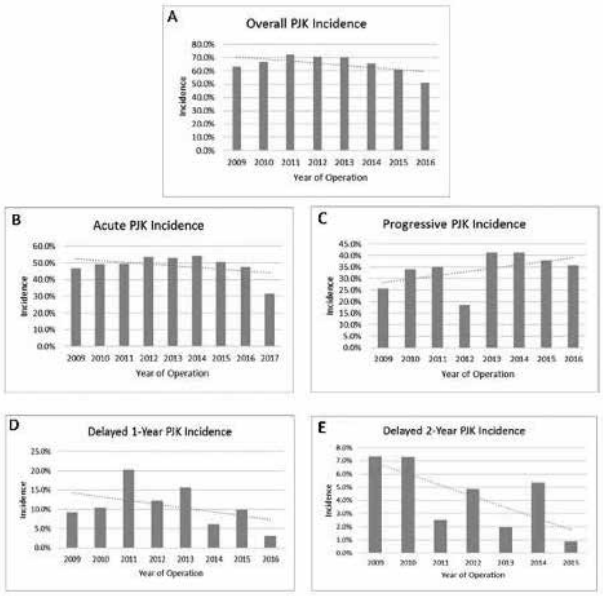
Methods
Operative ASD patients (Coronal scoliosis≥20°, SVA≥5cm, PT≥25°, and/or TK≥60°) >18 y/o from 2009-2017 were included. PJK was defined as ≥10° measure for the sagittal Cobb angle between the inferior endplate of the UIV and the superior endplate of the UIV+2. X2 analysis and post-hoc testing assessed annual and overall incidence of acute (6W follow-up(f/u)), progressive (increase in ° of PJK from 6W to 1Y) and delayed (PJK development at 1Y, 2Y, or 3Y f/u) PJK development among operative (op) and re-operative patients(reop).

Results
1005 patients were included (421 r-op) (Age: 59.3, 73.5%F, BMI: 27.99, 92.9% white). No differences were observed between op and reop regarding acute, progressive, or delayed PJK at all f/u intervals($p>0.50$). Overall incidence of any type of PJK from 2009-2016 was 59.1%, with lower annual rates observed in 2016 (50.9%, $p<0.05$). Overall incidence of Acute PJK was 48.0%. Annual incidence of Acute PJK has decreased from 53.7% in 2012 to 47.7% in 2016 ($p=0.038$). Overall incidence of progressive PJK was 35.0%. Annual incidence of progressive PJK has increased from 25.8% in 2009 to 35.7% 2016 ($p=0.297$). Overall incidence of 1Y delayed PJK was 9.3%. Annual incidence of 1Y delayed PJK has decreased from 9.2% in 2009 to 3.2% in 2016 ($p<0.001$). Overall incidence of 2Y delayed PJK development was 5.0%. Annual incidence of 2Y delayed PJK has decreased from 7.3% in 2009 to 0.9% 2015 ($p<0.05$). No patients developed PJK at 3 years postoperative or greater.

Conclusion
While the progression of acute PJK has been a challenge for physicians (exemplified by the recent increased incidence of progressive PJK), significantly lower incidences of overall, acute and delayed PJK in recent years may indicate successful implementation of preventative treatment strategies and improved operative decision-making.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Figure 1: Annual Incidences of Acute, Progressive, and Delayed PJK from 2009-2017



25. Development of Deployable Predictive Models for MCID of 2 Year Outcomes Across All Commonly Used HRQOL Instruments in Adult Spinal Deformity Surgery: Results in 570 Patients from 17 Hospitals

Miquel Serra-Burriel, PhD; Michael P. Kelly, MD, MS; Justin Smith, MD, PhD; Jeffrey Gum, MD; Ferran Pellisé, MD, PhD; Ahmet Alanay, MD; Emre Acaroglu, MD; Francisco Javier Perez-Grueso, MD; Frank S. Kleinstueck, MD; Ibrahim Obeid, MD, MS; Virginie Lafage, PhD; Frank J. Schwab, MD; Christopher Shaffrey, MD; Douglas C. Burton, MD; Shay Bess, MD; *Christopher Ames, MD;* European Spine Study Group; International Spine Study Group

Summary
Predictive analytics were used to model 1-yr and 2-yr SRS-22 / ODI / SF-36v2 scores in a large cohort of ASD patients. The final model had predictive power greater than 80%. Patients with lower baseline HRQOL measures were likely to appreciate the greatest improvements in HRQOL at 2-yr followup. Surgeon and site were important covariates, explaining variance in outcomes. These data can be used in decision making and patient counseling in ASD surgery.

Hypothesis
Predictive analytics may accurately model HRQOL improvements after ASD surgery.

Design
Retrospective modeling analysis with validation

Introduction
ASD surgery is costly with variable outcomes; in some series only 50% of patients achieve MCID improvements. Predictive modeling may be useful in shared-decision making and surgical planning. The objective of this study was to model health-related quality of life (HRQOL) overall improvement, including the likelihood of achieving clinically important improvement, at 2 years postoperatively.

Methods
Two prospective observational cohorts were queried for ASD patients with SRS-22 / ODI / SF-36v2 data at baseline, 1 year and 2 years after surgery. 75 variables were used in the training of the models including demographic data, enrollment HRQOL, and modifiable surgical data. 8 different prediction algorithms were trained with 3-time horizons: baseline to 1-yr, baseline to 2-yr and 1-yr to 2-yr. External validation was accomplished via an 80/20 data split for training and testing each model, respectively. 5-Fold cross validation within the training sample was performed. Accuracy was measured as the mean average error (MAE; smaller is better) and R^2 values.

Results
570 patients were included in the analysis. Models with the lowest MAE for each of the 5-time points were selected; ultimately the model had 82.4% predictive power. Patients with lower enrollment HRQOL were likely to achieve the greatest improvements. Addition of surgeon and site to preoperative data increased the predictive power 1.8%. Site and surgeon fixed-effects played a crucial role in explaining outcome variance.

Conclusion
We present an accurate and consistent way of predicting outcome scores for ASD surgery in the largest-to-date prospective operative multicenter cohort with 2-year follow-up. This study has significant clinical implications for shared-decision making, surgical planning and postoperative counseling. Surgeon and site were important components of the model, explaining variance in predicted 2-yr HRQOL.

Table 1: Sample patient output from outcome predictor with simulation of delaying surgery 5 and 10 years

	HRQL Instrument	Baseline Score	Baseline probability to achieve surgical improvement	10% higher baseline HRQL scores	Waiting 5 years with a reduction of 10 % HRQL	Waiting 10 years with a reduction of 20 % HRQL	Number of Levels from 10 to 15	Range of variation across options
(1) Overall improvement	ODI	68	54.4%	43.6%	67.6%	72.6%	54.4%	29.1%
(2) Improvement over MCID	ODI	68	38.4%	28.4%	52.0%	57.7%	38.4%	29.3%
(1) Overall improvement	SRS22 function	3.2	68.0%	51.4%	76.9%	83.5%	68.0%	32.1%
(2) Improvement over MCID	SRS function	3.2	35.4%	23.4%	48.3%	58.4%	35.4%	35.0%
(1) Overall improvement	SRS22 MH	2.4	80.6%	82.0%	86.0%	90.3%	78.6%	11.7%
(2) Improvement over MCID	SRS22 MH	2.4	64.7%	66.6%	72.4%	79.2%	62.0%	17.2%
(1) Overall improvement	SRS22 pain	2	61.4%	67.1%	76.2%	82.6%	62.2%	21.2%
(2) Improvement over MCID	SRS22 pain	2	46.2%	52.3%	62.9%	71.0%	47.0%	24.8%
(1) Overall improvement	SRS22 SI	2.4	81.5%	83.7%	84.3%	86.9%	81.5%	5.4%
(2) Improvement over MCID	SRS22 SI	2.4	34.6%	37.8%	38.8%	43.3%	34.6%	8.7%
(1) Overall improvement	SRS22 subtotal	2.38	69.8%	74.7%	84.8%	91.7%	70.7%	21.9%
(2) Improvement over MCID	SRS22 subtotal	2.38	45.6%	51.7%	65.6%	77.7%	46.8%	31.9%
(1) Overall improvement	SF36v2 MCS	22.18	95.6%	95.6%	97.0%	98.0%	95.6%	2.4%
(2) Improvement over MCID	SF36v2 MCS	22.18	81.5%	81.5%	85.9%	89.5%	81.5%	8.0%
(1) Overall improvement	SF36v2 PCS	39.68	44.9%	34.8%	60.4%	63.4%	43.5%	28.6%
(2) Improvement over MCID	SF36v2 PCS	39.68	17.4%	11.6%	29.7%	32.4%	16.9%	20.8%

Patient: Female with 1 prior spine surgery, with loss of balance, without comorbidities, employed, steady gait, 60 years old, 167.6cm height, 63.9 kgs weight, 71.6ß sagittal balance, 11.8° of major curve cobb angle, 30.5ß° pelvic tilt. **Surgery:** pelvic fixation, 7 fused vertebrae, posterior instrumentation, 1 PSOs, 0 SPOs, no PLIF, no TLIF, no ALIF, 10 levels between UIV and LIV and no interbody fusion.

26. Defining Age-Adjusted Spinopelvic Alignment Thresholds: Should we Integrate BMI?

Peter Passias, MD; Frank Segreto, BS; Samantha Horn, BA; Cole Bortz, BA; Dennis Vasquez-Montes, MS; Leah Steinmetz, BA; John Moon, BS; Tina Raman, MD; Christopher Varlotta, BS; Nicholas Frangella, BS; Nicholas Stekas, BS; David Ge, BA; Jordan Manning, BA; Mohamed

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Moawad, MPH; Chloe Deflorimonte, BS; Bassel Diebo, MD; Shaleen Vira, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Michael Gerling, MD; Charla Fischer, MD; Themistocles Protopsaltis, MD; Aaron Buckland, MBBS, FRACS; Thomas Errico, MD

Summary
The International Spine Study Group recently developed age-adjusted alignment targets for ASD patients, indicating more rigorous alignment of younger patients. Previous literature has also described significant associations between body mass index(BMI), spinal alignment, and patient-reported-outcome-measures(PROMS). Using previously publish US-Normative ODI values, our analysis identified significant associations between age, BMI, and sagittal alignment. BMI influenced age-adjusted alignment norms for PT, SVA, PILL, and TPA at all-ages, calling for less-rigorous alignments in older and obese patients.

Hypothesis
Age and BMI influence spinopelvic alignment.

Design
Retrospective review of a single-center stereographic database.

Introduction
While age related changes account for significant variance among PROMs and spinal alignment; associations between BMI, spinal alignment, and PROMS exist and should be accounted for.

Methods
ASD patients receiving operative or nonoperative treatment, ≥18y/o with complete baseline (BL) ODI scores and radiographic parameters (PT, SVA, PILL, TPA) were included. Patients were stratified by age consistent with US-Normative values of SF-36 (<35, 35-55, 45-54, 55-64, 65-74, ≥75y/o), and dichotomized by BMI (Non Obese <30; Obese ≥30). Linear regression analysis established normative age and BMI specific radiographic thresholds, utilizing previously published age specific US-Normative ODI values (Lafage et al.) in conjunction with BL age and BMI means.

Results
478 patients were included (Age: 52.53, Gender: 68.7%F, BMI: 26.2). Initial analysis identified significant correlations between age, BMI, PT, PILL, TPA, and ODI (R: 0.129-0.488, all p<0.001). Obese patients also had higher ODI scores compared to non-obese patients (40.6 vs 29.6, p<0.001). Regression analysis (all R > 0.50, p<0.001) developed age and BMI specific alignment thresholds, indicating PT, SVA, PILL, and TPA to increase with both increased age and increased BMI. For non-obese patients, PT, SVA, PILL, and TPA ranged from 10.0, -25.8, -9.0, 3.1 in patients <35 y/o to 22.3, 53.4, 17.7, 25.8 in patients ≥75 y/o. Obese patients' PT, SVA, PILL, and TPA ranged from 8.9, -7.6, -7.1, 3.1 in patients <35 y/o to 22.71, 67.0, 19.15, 27.7 in patients ≥75y/o. Normative SVA values in obese patients were consistently ≥10mm greater compared to non-obese values at all ages.(Table 1)

Conclusion
Significant associations exist between age, BMI, and sagittal alignment. While BMI influenced age-adjusted alignment norms for PT, SVA, PILL, and TPA at all-ages, obesity most greatly influenced SVA, with normative values similar to non-obese patients who were 10 years older. Age-adjusted alignment thresholds should account for BMI, calling for less rigorous alignment objectives in older and obese patients.

Table 1: Radiographic Thresholds Based on Age-Specific ODI US-Norms, Incorporating Patient Age and BMI

Age Group	% in Database	Mean Age	ODI-Norms	BMI Group	% in Database	Mean BMI	PT	SVA	PILL	TPA
<35	20%	24.37	9.49	Normal	18.80%	22.1841	9.95	-25.73	-8.98	3.10
				Obese	1.50%	34.5350	8.91	-7.62	-7.09	5.68
35-44	10.10%	39.58	11.77	Normal	7.50%	24.1390	13.25	-1.35	-0.98	9.99
				Obese	2.70%	32.8382	13.70	11.38	0.36	11.81
45-54	16.50%	49.48	15.43	Normal	11.50%	23.9415	15.97	12.80	3.98	14.16
				Obese	5.20%	34.0399	16.44	27.61	5.50	16.02
55-64	25.10%	59.80	20.87	Normal	16.30%	24.5656	18.54	29.12	9.25	18.68
				Obese	8.60%	34.2472	18.99	40.37	10.72	20.70
65-74	18.90%	68.94	24.62	Normal	13.00%	23.8772	21.27	41.52	13.74	22.45
				Obese	5.20%	33.5796	21.72	55.73	15.22	24.45
≥75	9.50%	77.22	32.54	Normal	6.50%	23.0875	22.28	53.41	17.73	25.76
				Obese	3.10%	32.3647	22.71	67.00	19.15	27.70

27. Complications after Spinopelvic Fixation with Iliac Screws in 260 Adult Patients with 2-year Minimum Follow-up

James Nguyen, MD; Thomas Buell, MD; Tony Wang, MD; Jeffrey P Mullin, MD; Marcus Mazur, MD; Juanita Garces, MD; Chun-Po Yen, MD; Christopher Shaffrey, MD; Justin Smith, MD, PhD

Summary
Recent literature describing complications associated with spinopelvic fixation with iliac screws has been limited. We analyzed 260 consecutive patients undergoing iliac screw placement. Complications included iliac screw fracture/loosening (7.7%), L5/S1 pseudarthrosis (8.8%), S1 screw failure (1.5%), wound dehiscence/infection (2.7%), and reoperation (17.7%). No patients had iliac screw head prominence. In this large, single-center study, iliac screw fixation was effective with high rates of lumbosacral fusion and lower complication rates than previously reported.

Hypothesis
Iliac screws are an effective method of spinopelvic fixation with reasonable complication rates

Design
Retrospective review of a prospectively maintained single-institution, multi-surgeon database

Introduction
Recent literature describing complications associated with spinopelvic fixation with iliac screws in adult patients has been limited. This study's objective was to report our experience with iliac screw fixation in a large series of adult patients.

Methods
We analyzed 260 consecutive patients undergoing spinopelvic fixation with iliac screws with 2-year minimum follow-up. Clinical and

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

radiographic data were obtained and then analyzed. Univariate and/or multivariate analyses were used to assess complications.

Results
Complications included iliac screw fracture/loosening (7.7%), rod fracture below S1 (4.2%), L5/S1 pseudarthrosis (8.8%), S1 screw failure (1.5%), wound dehiscence/infection (2.7%), and reoperation excluding revisions for proximal junctional kyphosis (17.7%). Of the patients with iliac screw fracture/loosening, solid fusion at L5/S1 was seen in 60.0%. All patients with rod fracture below S1 had solid fusion at L5/S1. No patients had iliac screw head prominence. On univariate analysis, iliac screw failure was significantly associated with revision fusion (70.0% vs. 41.2%, p=0.013), greater number of instrumented vertebra (12.6 vs. 10.3, p=0.014), and greater post-operative pelvic tilt (27.7 vs. 23.2, p=0.04). Lumbosacral junction complication was significantly associated with greater number of instrumented vertebra (12.6 vs 10.3, p=0.014). Reoperation was significantly associated with younger age at surgery (61.8 vs 65.8, p=0.014, greater number of instrumented vertebra (12.2 vs. 10.2, p=0.001), and longer clinical and radiographic follow-up (55.8 vs. 44.5, p<0.001; 55.8 vs. 44.6, p<0.001). On multivariate analysis (Cox proportional hazards regression), reoperation was significantly associated with longer clinical follow-up (p<0.001).

Conclusion
In this large, single-center study, iliac screws were an effective method of spinopelvic fixation with high rates of lumbosacral fusion and lower complication rates than previously reported.

Iliac screw failure[1]	20 (7.7)
Iliac screw fracture[2]	12 (4.6)
Iliac screw loosening[3]	9 (3.5)
Iliac screw prominence	0 (0)
Rod fracture below S1	11 (4.2)
L5/S1 pseudarthrosis	23 (8.8)
S1 screw complication (fracture)	4 (1.5)
Wound dehiscence or infection	7 (2.7)
Reoperation for any reason	83 (31.9)
Revision for PJK	37 (14.2)
Reoperation (excluding PJK)	46 (17.7)
SI joint pain	37 (14.2)

[1]One patient with both iliac screw fracture and iliac screw loosening
[2]Four patients with concomitant L5/S1 pseudarthrosis
[3]Four patients with concomitant L5/S1 pseudarthrosis

28. A Comparative Analysis of Young vs Older Adult Spinal Deformity Patients Fused to the Pelvis: Who Benefits More?

Brian Neuman, MD; Micheal Raad, MD; Daniel M. Sciubba, MD; Peter Passias, MD; Eric O. Klineberg, MD; Hamid Hassanzadeh, MD; Themistocles Protopsaltis, MD; Munish Gupta, MD; Gregory Mundis, MD; Christopher Ames, MD; Christopher Shaffrey, MD; Jeffrey Gum, MD; Justin Smith, MD, PhD; Virginie Lafage, PhD; Shay Bess, MD; Khaled M. Kebaish, MD, FRCS(C); International Spine Study Group

Summary
Our results show that younger and older patients fused to the pelvis seem to have similar health related quality of life (HRQOL) and disability levels at baseline but different radiographic findings. (Greater thoracolumbar coronal Cobb angle for younger patients vs greater SVA for older patients). However, long term improvement in those domains was significantly lower in younger patients irrespective of the surgical procedure performed. 13% of patients younger than 50 weren't able to go back to work after surgery.

Hypothesis
Baseline and long-term improvements in outcomes are likely to differ between younger and older patients with posterior spinal fusions to the pelvis.

Design
Retrospective review, prospective data

Introduction
Posterior spinal fusions to the pelvis may result in increased stiffness and lower functionality, especially in a younger more active population. We therefore attempted to understand the preop and postop differences between younger and older patients fused to the pelvis in terms of outcomes and functionality.

Methods
Patients undergoing primary thoracolumbar fusion to the pelvis in an adult spinal deformity (ASD) surgical database were separated into three groups based on their age: ≤ 50, 51-65, >65. ANOVA was used to assess the differences in baseline HRQOL measures and radiographic parameters between various groups. Multi-variable regression analysis controlling for surgical invasiveness was used to compare 2-year improvements in outcomes between the three groups.

Results
454 ASD patients met inclusion criteria (75% of these had 2 year follow up). 11% were ≤ 50, 51% 51-65 and 38% >65. All three groups had similar baseline SRS domain and ODI scores (p>0.05). Patients > 65 had a significantly higher SVA at baseline (8.9) when compared to younger patients (6.1/6.7cm, p<0.01), however they had lower thoracolumbar Cobb angles (28° vs 46°/ 38° p < 0.01). After controlling for surgical invasiveness, patients belonging to >65 group had greater improvements in their SRS-physical function (Diff=0.48, 0.16-0.79, p<0.01), SRS-Mental Health (Diff:0.4, 0.1 – 0.7, p=0.01) and ODI (Diff:-9.5,-16 - -3, p<0.01) compared to ≤50 at 2 years postop. Similar results were seen in patients 51-65 compared to <50 (Diff 0.32, 0.02 – 0.63, p=0.036; diff 0.31, 0.01 – 0.6, p=0.04; diff -6.6, -0.3 - -13, p=0.042). Regarding return to work at 2 years postop, 13% in the ≤50 group, 14% in the 51-65 group, and 7% in the >65 group did not return to work.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Conclusion
Compared to older patients, younger patients fused to the pelvis seem to show less long-term improvement in HRQOL and 13% do not return to work. These findings may prove useful for preop patient counseling

29. Likelihood of Reaching Minimal Clinically Important Difference in Adult Spinal Deformity Surgery: A Comparison of Patients from North America and Japan

Hideyuki Arima, MD, PhD; Steven Glassman, MD; Keith Bridwell, MD; Yu Yamato, MD, PhD; Mitsuru Yagi, MD, PhD; Kota Watanabe, MD, PhD; Morio Matsumoto, MD, PhD; Satoshi Inami, MD, PhD; Hiroshi Taneichi, MD, PhD; Yukihiro Matsuyama, MD, PhD; Leah Yacat Carreon, MD, MS

Summary
We compared the proportion of adult spinal deformity patients achieving SRS22R MCID thresholds after corrective surgery in North America (NA) and Japan (Jp). Except for Self-Image (NA:57%, Jp:58%), the proportion of patients achieving MCID was higher in in North America for Function (NA:51%, Jp:30%), Pain (NA:80%, Jp:47%) and Subtotal (NA:72%, Jp:35%).

Hypothesis
Proportion of patients achieving Scoliosis Research Society-22R (SRS-22R) Minimum Clinical Important Difference (MCID) after surgical treatment of adult spinal deformity (ASD) differ between ethnic groups.

Design
Retrospective review of prospectively collected data

Introduction
As anchors for defining MCID thresholds are determined by individual values, we sought to evaluate if MCID thresholds can be affected by cultural differences. In this study, we compared the MCID threshold and the proportion of ASD patients achieving SRS-22R MCID in North America (NA) versus Japan (Jp).

Methods
There were 148 cases from NA (132 females, mean age=59.8yrs) and 60 cases from Jp (56 females, mean age=65.5yrs) with at least 2 year follow-up after corrective spine surgery for ASD. Except for Self-image, published Jp MCID values are higher (Function=0.90, Pain=0.85 and Self-image=1.05, Subtotal=1.05) than the published NA MCID values (Function=0.60, Pain=0.40, Self-image=1.23, Subtotal=0.43).

Results
There was statistically significant improvement in all domain scores at 2-year follow-up compared to baseline in both cohorts. Except for mental health(NA:0.32, Jp:0.72, p=0.005), the mean improvement from baseline to 2-years was similar between the between the North American and Japanese cohorts. Except for Self-Image (NA:57%, Jp:58%, p=0.877), the proportion of patients achieving MCID was higher in in North America for Function (NA:51%, Jp:30%, p=0.006), Pain (NA:80%, Jp:47%, p<0.001),and Subtotal (NA:72%, Jp:35%, p<0.001).

Conclusion
Despite similar improvements in SRS22R domain scores from baseline to 2 years post-op, the proportion of patients reaching SRS22R MCID for Function, Pain and Subtotal after ASD surgery are higher in a North American cohort compared to a Japanese cohort. This may imply that patients in North America and Japan may regard the value of these changes differently.

	North America				Japan				
Domain	Pre-OP	2yr Post-OP	2 yr change from Pre-Op	*p* value†	Pre-OP	2yr Post-OP	2 yr change from Pre-Op	*p* value†	*p* value+
Function	3.18 ± 0.69	3.67 ± 0.70	0.49	**<0.001**	2.76 ± 0.83	3.3 ± 0.80	0.54	**<0.001**	0.618
Pain	2.83 ± 0.72	3.83 ± 0.80	1.00	**<0.001**	2.82 ± 0.86	3.69 ± 0.86	0.87	**<0.001**	0.343
Self-image	2.74 ±0.65	4.02 ± 0.73	1.28	**<0.001**	2.33 ± 0.83	3.44 ± 0.78	1.11	**<0.001**	0.334
Mental health	3.72 ± 0.77	4.07 ± 0.74	0.32	**<0.001**	2.66 ± 0.67	3.38 ± 0.79	0.72	**<0.001**	**0.005**
Subtotal	3.14 ± 0.52	3.91 ± 0.60	0.58	**<0.001**	2.64 ± 0.59	3.45 ± 0.66	0.68	**0.009**	0.635

SD, standard deviation; SRS, Scoliosis Research Society; * Bold type indicates statistical significance. †Comparison between Pre-Op and 2yr Post-OP +Comparison 2 yr change values between North America and Japan.

.

30. The Learning Curve in Three-Column Osteotomies for Adult Spinal Deformity Surgery: A Single Surgeon's 10 Year Experience with 199 Cases with 40 Months Average Follow Up

Micheal Raad , MD; Mostafa H. El Dafrawy, MD; Varun Puvanesarajah, MD; Morsi Khashan, MD; Brian J Neuman, MD; Khaled M. Kebaish, MD

Summary
This is the first study looking into the learning curve for performing three column osteotomies (3CO) in adult spinal deformity (ASD) patients. Based on a single surgeon's experience over a ten year period, there is a learning curve resulting in decreased blood loss, lower reoperation rates for rod fractures and a lower risk of developing a new nerve root deficit. Although revealing, these results may need to be a validated in a multi-surgeon experience.

Hypothesis
We hypothesize that there is a learning curve associated with the performance of 3CO in adult spinal deformity surgery (ASD).

Design
Retrospective case series.

Introduction
Although 3CO offer surgeons a powerful tool for correction of spinal deformity, they have been shown to be associated with a risk of neurologic deficit, extensive blood loss and reoperation rates. To our knowledge, no previous studies investigate the learning curve for 3CO in the ASD population.

Methods
Retrospective case series of ASD patients undergoing a 3CO between the years 2004 and 2014 who were operated on by the senior author and completed at least 1 year follow-up. Patient demographics, surgical factors and postoperative outcomes were analyzed over 10-years. A cumulative case load variable (ID) based on the date of surgery was generated. Lowess smoother plots confirmed by spline/linear regression analyses were used to establish appropriate cutoffs in the learning curve.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Results
Of the 240 patients who underwent a 3CO during that time period, 199met our inclusion criteria and were included in the analysis. 92 patients (46%) underwent a vertebral column resection (VCR) and 107 (54%) underwent a pedicle subtraction osteotomy (PSO). 154 (77%) completed 2 year-follow up (mean=40 months, range 12-121). Patients operated on after the year 2009 were more likely to be older than 65 (76% vs 60%, p=0.02), have a Charlson Comorbidity Index of 2 or more (55% vs. 38%, p=0.01) and have prior surgeries (71% vs 57%, p=0.04). The average blood loss per level fused decreased significantly with each subsequent case (Diff=-2 mL, p<0.01). A spline model showed the risk of developing a nerve root deficit to decrease by 2% with each subsequent case after the 75th case (p=0.04) only. Interestingly, the risk of reoperation for rod fracture/ non-union decreased by 2% up until the 100th case (p=0.02) and plateaued thereafter. Figure1.

Conclusion
Our results show that the learning curve for performing 3CO exhibits improvement in blood loss per level fused, reoperation rates for rod fractures as well as neurologic deficits.

31. The Effect of Upper Instrumented Vertebra Level (T9 vs T10) on Radiologic and Functional Outcomes in the Surgical Treatment of Adult Deformity in Osteoporotic Patients with age >60 years

Isik Karalok, MD; Emel Kaya Aumann, MD; Cem Sever, MD; Yunus Emre Akman, MD; Yesim Erol, BS; Tunay Sanli, MA; *Sinan Kahraman, MD*; Meric Enercan, MD; Selhan Karadereler, MD; Azmi Hamzaoglu, MD

Summary
Comparison of the clinical and radiologic outcomes of spinal deformity patients who have undergone long fusion to the sacrum have shown that patients who have T9 as the UIV have better outcomes than those with T10. Despite application of prophylactic vertebroplasty in both groups, patients having UIV T10 have higher proximal junctional kyphosis (PJK)(15.3%) and proximal junctional failure (PJF) (10.2%) rates, whereas there are no PJK and PJF in T9 patients.

Hypothesis
T9 as UIV compared to T10 will be more stable and provide better radiologic and clinical outcomes in adult osteoporotic spinal deformity patients.

Design
Retrospective

Introduction
For long years, the UIV in the midthoracic area has been selected as T10 which is lowest immobile vertebra.There are numerous studies on this subject.Compared to T10, T9 carries different anatomical, biomechanical, and sagittal plane characteristics. In this study, we compared the radiologic and clinical outcomes of 2 groups in which T9 or T10 were selected as the UIV, especially with respect to PJK and PJF rates.

Methods
63 pts, >60yrs with osteoporosis, who underwent long fusion to sacrum for adult spinal deformity were reviewed.The pts were divided in 2 groups based on their upper instrumented vertebra (UIV) levels. T9 Group (T9G) included 24 pts(18F,6M) and T10 Group (T10G) included 39 pts(26F,13M). Preop, postop & f/up pelvic & sagittal parameters including PJK angle were measured. ODI and NRS were used for clinical evaluation.

Results
Mean age was 69.1 (60-84)yrs and mean f/up was 51.6 (24-133) months in T9G. Mean age was 66.8 (60-83)yrs and mean f/up was 53.4 (24-138)months in T10G. 3 pts (12.5%) in T9G and 8 pts (20.5%) in T10G underwent revision surgery. Indications of revision in T9G were development of implant failure in 3 pts. In T10G the indications were PJF in 2 pts, implant failure/pseudoarthrosis in 6 pts. Clinical results at final f/up were significantly better in T9G. The deformities were corrected in both groups in early postop period. The correction was preserved better in T9G at f/up. Radiologically, no pts had PJK/ PJF in T9G, and 6 pts had PJK/PJF in T10G (15.3%).

Conclusion
Despite the application of prophylactic vertebroplasty, the development of PJK (15.3%) and PJF (10.2%) were more frequent in patients with UIV at T10, compared to T9. The early clinical and radiologic outcomes were similar in both groups, however at 2 years f/up the patients in whom the UIV was T9 had higher rates of maintaining the corrections in sagittal plane and also had better clinical outcomes.

	Group T9 n=24	Group T10 n=39
PJK	0	6 (15.3%)
PJF	0	4 (10.2%)
PVF	0	4 (10.2%)
ASD	1 (4.1%)	12(30.7%)

PJK: Proximal junctional kyphosis, PJF: Proximal junctional failure, PVF: Proximal vertebra fracture, ASD: Adjacent segment disease

32. Preoperative Halo Gravity Traction for Treatment of Severe Adult Kyphosis and Scoliosis

Takayoshi Shimizu, MD, PhD; Ronald A. Lehman, MD; J. Alex Sielatycki, MD; Suthipas Pongmanee, MD; Chao Wei, MD; Meghan Cerpa, BS, MPH; Lawrence G. Lenke, MD

Summary
This case series assessed the clinical and radiographic benefit of halo gravity traction (HGT) prior to definitive corrective surgery on severe adult kyphosis and scoliosis patients. The major coronal and sagittal curves were mean 92.0° and 111.3°, respectively, and reduced by 14.7° (18.4%) and 18.8° (16.8%) after HGT, and 50.4° (54.7%) and

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

49.4° (44.2%) after definitive fusion. Significant improvement in pulmonary function and effective weight gain was observed following HGT.

Hypothesis
Pre-op halo gravity traction (HGT) reduces major coronal and sagittal curve magnitude, and improves pulmonary function and nutritional status in severe adult kyphosis and scoliosis patients.

Design
Single-center cohort study

Introduction
Preo-op HGT improves severe curve magnitude and the clinical condition in pediatric spinal deformity. However, the efficacy of HGT on severe adult spinal deformity has rarely been studied.

Methods
This study included 18 patients with severe adult kyphosis and scoliosis (age≥18) who underwent a pre-op HGT (mean: 4 weeks), and subsequent definitive posterior-alone corrective fusion. Etiologies were neurofibromatosis (n=5), adult idiopathic (n=3), multiple vertebral fractures due to osteoporosis (n=1) and multiple myeloma (n=1), degenerative failed back syndrome (n=1), Scheuerman's kyphosis (n=1), Marphan syndrome (n=1), and other genetic and connective tissue disorders (n=5).We reviewed baseline demographics, including coronal and sagittal radiographic profiles. The change in major curve magnitude, pulmonary function tests (PFTs), and nutritional status were assessed between pre-, post-traction, and immediate post-definitive corrective surgery.

Results
There were 11 male and 7 female patients, aged 18-69 years with their major coronal and sagittal curves being 92.0°±25.2 and 111.6°±40.1, respectively. The cobb angles were reduced by 18.4% and 16.8% after halo-traction, and 54.7% and 44.2% after definitive fusion, respectively. PFT's showed significant increase in %FEV1 and %FVC when comparing pre and post-traction (43.0 vs 49.6%, and 44.8 vs 54.3%, respectively, P<0.01 [n=11]). Effective weight gain was observed following traction (46.8 vs 49.3 kg, P<0.01).

Conclusion
Halo gravity traction (HGT) for severe coronal and sagittal plane spinal deformity in adult patients significantly reduced cobb angles, improved PFTs, and allowed for effective weight gain in the preoperative period. The use of preoperative HGT is extremely beneficial to optimize the alignment and overall health of severe adult spinal deformity patients prior to their spinal reconstruction.

33. Relationship Between Global Sagittal Alignment and Severity of Vertebral Fracture in Patients with Osteoporosis

Zongshan Hu, MD, PhD; Gene C.W. Man, PhD; Sheung Wai Law, MD; Anthony Kwok, PhD; Jack C.Y. Cheng, MD

Summary
This study compared the global sagittal alignment between osteoporotic patients with and without vertebral fracture (VF). The patients with VF had a worse overall global sagittal alignment. There was a negative effect of the number and severity of VF on global alignment. The osteoporotic patients with a poorer sagittal global alignment may imply more severe VF.

Hypothesis
The patients with VF had a worse sagittal alignment when compared with those without VF. The number and severity of VFs are determinants of the global sagittal balance in patients with osteoporosis.

Design
Prospective, observational study

Introduction
Osteoporotic vertebral fracture of the spine is very common and associated with the increased mortality, morbidity and overall decline in quality of life in the elderly. Studies showed that osteoporotic patients with VF had significantly higher thoracic kyphosis and lower lumbar lordosis. However, the influence of VF on whole-body compensatory mechanism, including pelvic retroversion and knee flexion, remains unclear. The aim of this study was to investigate the relationship between the global sagittal alignment and severity of VF in patients with osteoporosis.

Methods
A cohort of 72 osteoporotic subjects with or withour VF were prospectively enrolled. Clinical assessment, including age, BMD and bone mineral density were recorded. Global sagittal alignment was taken with biplanar low-dose imaging system. The number and location of VF were assessed, and the severity of VF was evaluated by Spinal Deformity Index. Measurement on global sagittal alignment was done by using T1 pelvic angle (TPA) and global sagittal angle (GSA) (Fig 1). Quality of life was assessed by Oswestry Disability Index (ODI) and Short-form (SF)-12.

Results
The TPA and GSA were significantly correlated with SF-12 and ODI. The patients with VF had significantly higher TPA and GSA (Table 1). The number and severity of VF significantly correlated with global sagittal alignment. Discriminative value for identification of patients with at least one VF, assessed by Area Under the Curves were 0.652 and 0.706 for TPA and GSA, respectively. Multivariate analysis showed parameters significantly associated with abnormal global alignment were the number and severity of VF.

Conclusion
The osteoporotic patients with VF had a worse overall global sagittal alignment. The number and severity of VF are strong determinants of global sagittal balance. The patients with a poorer sagittal global alignment may imply more severe vertebral fracture.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Fig 1. Illustration of T1 pelvic angle (TPA) and global sagittal angle (GSA).

Table 1 Comparisons between the patients with and without vertebral fracture (VF) in terms of baseline characters and radiographic measurements

Variables	Presence of VF (n=37)	Absence of VF (n=35)	*p* value
Age (yrs)	71.8±9.3	69.3±9.8	0.34
BMI (kg/m^2)	23.3±3.7	24.2±3.8	0.12
Lumbar spine BMD (g/cm^2)	0.849±0.17	0.791±0.13	0.02
Femoral neck BMD (g/cm^2)	0.736±0.11	0.718±0.09	0.11
T1 pelvic angle (°)	26.6±10.9	16.5±7.4	<0.001
Global sagittal angle (°)	25.7±6.4	18.2±6.9	0.001

.

34. Impact of Lower Thoracic vs. Upper Lumbar UIV in MIS Correction of Adult Spinal Deformity

Robert K. Eastlack, MD; Pierce D. Nunley, MD; Juan S. Uribe, MD; Paul Park, MD; Stacie Tran, MPH; Michael Y. Wang, MD; Khoi D. Than, MD; David Okonkwo, MD, PhD; Adam S. Kanter, MD; Neel Anand, MD; Richard G. Fessler, MD, PhD; Kai-Ming Gregory Fu, MD, PhD; Dean Chou, MD; Praveen V. Mummaneni, MD; Gregory Mundis, MD; International Spine Study Group

Summary
The impact of lower thoracic (LT) and upper lumbar (UL) UIV location were compared via clinical and radiographic outcomes following MIS correction of adult spinal deformity. Upper lumbar UIV location resulted in lower reoperation rates, shorter operative times, and less EBL. Lower thoracic UIV location was associated with higher lumbar lordosis and greater coronal Cobb change, but there were no differences in clinical outcomes between LT and UL UIV groups.

Hypothesis
Clinical and radiographic outcomes differ when the upper instrumented vertebra (UIV) level crosses the thoracolumbar junction in lumbar ASD surgery.

Design
Multicenter retrospective review of an adult spinal deformity database.

Introduction
Selecting the UIV in the region of the thoracolumbar junction when using MIS for ASD correction may allow for greater feasibility in choosing the upper lumbar (UL) region. The impact of choosing the upper lumbar vs. lower thoracic spine for the UIV when correcting ASD via MIS techniques has not been well-elucidated.

Methods
Inclusion criteria were age ≥18 years, and one of the following: coronal cobb>20°, SVA>5cm, PT>20°, pelvic incidence-lumbar lordosis >10°. Patients were treated with circumferential or hybrid minimally invasive techniques at ≥3 spinal levels, and had 2-year minimum follow-up. They were then divided by UIV location of L1-2 (UL) or T10-12 (LT).

Results
112 patients met inclusion criteria (68 LT and 46 UL). The UL group was older (67.5 vs. 62.3; p=0.015), but preoperative spinopelvic parameters were similar, except for sacral slope, which was higher in the UL group (30.5 vs. 26.5; p=<0.001). The percentage of patients with fixation crossing the lumbosacral junction was also similar (70.6% vs. 67.4%, p=0.717). Postop LL (41.4 vs. 37.3; p=0.01) and Δ Cobb (-23.2 vs. -9.6; p<0.001) were greater in the LT group, but the remainder of postop spinopelvic parameters and changes, as well as HRQOLs were similar between groups. Reoperation rates were lower in the UL group (17.4% vs. 36.8%; p=0.025), largely as a result of less frequent radiographic failures (UL=10.9% vs. LT=26.5%; p=0.042); however, overall complication rates were not different (60.3% vs. 43.5%; p=0.077).

Conclusion
Choosing an upper lumbar vertebra for UIV when correcting ASD with MIS techniques results in lower reoperation rates than when extending fixation to the lower thoracic region. It was also associated with shorter operative times and less EBL. Extending fixation to the LT was associated with slightly higher LL and greater change in coronal Cobb, but this was not associated with better clinical outcomes compared to when the UIV was in the UL region.

	T10-T12 (LT)	L1-L2 (UL)	*p*
N	68	46	
Age	62.3 (19, 81)	67.5 (51, 84)	0.015
BMI	28.3 (16.8, 45.4)	27.8 (20.0, 40.2)	0.849
Follow-up	40.8 (22, 75)	40.0 (22, 74)	0.855
Posterior fused levels	7.5 (3, 10)	4.3 (1, 7)	<0.001
Levels Instrumented	7.6 (4, 10)	4.7 (4, 7)	<0.001
IBF Levels	3.9 (0, 8)	3.9 (1, 7)	0.78
Pelvic Fixation	48 (70.6%)	31 (67.4%)	0.717
Total OR Time	587.0 (234, 1235)	460.0 (180, 772)	0.011
Total EBL	1293.3 (50, 8020)	594.0 (75, 2750)	0.001
Total LOS	8.9 (3, 26)	8.4 (2, 23)	0.511
Preop Back Pain	6.7 (0, 10)	7.0 (0, 10)	0.498
Preop Leg Pain	5.8 (0, 10)	5.6 (0, 10)	0.929
Preop ODI	52.1 (18.0, 85.1)	49.3 (13, 86)	0.428
Preop Max Cobb	37.3 (6.5, 68.3)	25.6 (10.3, 51.9)	0.063
Preop PT	26.0 (2.0, 59.9)	23.8 (5.2, 43.7)	0.372
Preop PI	53.0 (30.3, 85.0)	54.3 (30.3, 88.5)	0.553
Preop PI-LL	19.4 (-15.6, 60.6)	17.9 (-10.7, 53.6)	0.616
Preop LL	33.3 (-20.4, 65.9)	36.4 (1.5, 67.5)	0.34
Preop SVA	44.6 (-63.9, 196.5)	47.1 (-32.3, 163.9)	0.524
Postop Back Pain	3.3 (2.6, 4.1)	3.5 (2.5, 4.4)	0.816
Postop Leg Pain	2.8 (2.0, 3.6)	2.5 (1.5, 3.4)	0.602
Postop ODI	32.3 (27.3, 37.4)	32.1 (25.4, 38.8)	0.96
Postop Max Cobb	13.6 (11.2, 16.1)	16.2 (13.1, 19.3)	0.215
Postop PT	26.3 (23.6, 29.0)	23.3 (19.9, 26.7)	0.176
Postop PI-LL	12.3 (8.4, 16.3)	15.4 (10.4, 20.5)	0.35
Postop LL	42.5 (39.3, 45.6)	35.5 (31.5, 39.6)	0.01
Postop SVA	57.0 (41.6, 72.3)	54.9 (35.7, 74.1)	0.87
Complication	41 (60.3%)	20 (43.5%)	0.077
Reoperation	25 (36.8%)	8 (17.4%)	0.025

.

35. Did Rib-To Pelvis Constructs Deteriorate Sagittal Balance for Ambulatory Children?

Teppei Suzuki, MD, PhD; Koki Uno, MD, PhD; Noriaki Kawakami, MD; Tetsuya Ohara, MD; Toshiki Saito, MD; Kota Watanabe, MD, PhD

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Summary
The spine alignment analysis of rib-to pelvis constructs showed the deterioration of the sagittal profiles with retroversion of the pelvis compared with that of the rib-to spine cases.

Hypothesis
A sagittal imbalance might develop in ambulatory patients who had rib-to pelvis constructs.

Design
Retrospective multi-center study

Introduction
Previous papers reported that ambulatory patients after rib-to pelvis technique developed substantial crouched gait. However, there is no radiological evaluation in those patients. The objective of this study is to evaluate sagittal parameters of those patients and to compare with ambulatory patients after rib-to spine technique.

Methods
A multicenter series of consecutive rib-based construct patients with various etiologies were divided into two groups: Rib-to-pelvis (group P) and rib-to-spine implant (group S) as a caudal anchor. The patients who had rib-to-rib construct only and unreliable X-ray and non-ambulatory status were excluded in this study. A total of 83 patients were identified (10 patients in group P and 73 patients in group S). There was no significant difference between the two groups in demographic data including age at the initial surgery, number of lengthenings, magnitude of the major curve, thoracic height, sagittal profiles (SVA, TK, LL, PI, T1 pelvic angle) with the exception of sacral slope (18±26ºvs 28±9º, p=0.014). Radiographic measurements were performed before and after the initial surgery and the latest follow-up at minimum 2-year follow-up.

Results
In group S, SS was slightly decreased after initial surgery, and was improved at the latest follow-up. In group P, SS did not change at post-initial surgery, however was significantly decreased at the latest follow-up (p=0.046). SVA was increased after initial surgery (p=0.035), and further at latest follow-up (p<0.01). Between the two groups, at the latest follow-up, there were statistically significant differences in the SVA (69±29mm vs 0±25mm, p<0.01), LL (21±35ºvs 44±14º, p<0.01), SS (11±23ºvs 28±9º, p<0.01), and TPA (30±9ºvs 6±6º, p<0.01).

Conclusion
In the ambulatory children who had rib-to pelvis constructs, the sagittal alignments were deteriorated due to retroversion of the pelvis.

36. Systematic Review and Meta Analysis of the Complications Associated with Magnetically Controlled Growing Rods for the Treatment of Early Onset Scoliosis

David Kieser, PhD, MBChB, FRACS, FNZOA; Chrishan Thakar, MBBS, FRCS; Dan Mihai Mardare, MD, MSc; Shahnawaz Haleem, MBBS, FRCS; Jeremy Fairbank, MD, FRCS; Colin Nnadi, MBBS, FRCS

Summary
This review analysed the published complication rates of magnetically controlled growing rods (MCGRs) in the treatment of early onset scoliosis (EOS) and found that MCGRs reliably improve the coronal deformity in EOS while maintaining spinal growth. However, they are associated with a 44.5% non-medical complication rate and a 33% unplanned revision rate, with anchor pull-out, implant failure and rod breakage being the most common complications. Conversion procedures do not increase this risk, but single rods should be avoided.

Hypothesis
MCGR are able to correct spinal deformity while maintaining growth, but are associated with a high complication rate

Design
Systematic review and meta-analysis

Introduction
EOS is a challenging condition to treat. MCGR have been introduced to reduce the preoperative requirement of traditional growing rods. However, the complication profile of this technique remains unknown.

Methods
Systematic review using PUBMED, Medline, Embase, Google Scholar and the Cochrane Library (Keywords: MAGEC, Magnetically controlled growing rods and early onset scoliosis) of all studies written in English with a minimum of five patients and a one-year follow-up. We evaluated coronal correction, growth progression (T1-S1, T1-T12) and complications.

Results
Fifteen studies (336 patients) were included (42.5% male, mean age 7.9 years, average follow-up 29.7 months). Coronal improvement was achieved in all studies (pre-operative 64.80, latest follow-up 34.9o p=0.000), as was growth progression (p=0.001). Mean complication rate was 44.5%, excluding the 50.8% medical complication rate. The unplanned revision rate was 33%. The most common complications were anchor pull-out (11.8%), implant failure (11.7%) and rod breakage (10.6%). There was no significant difference between primary (39.8%) and conversion (33.3%) procedures (p=0.462). There was a non-statistically significant increased complication rate with single rods (40% vs. 27% p=0.588).

Conclusion
MCGRs improve coronal deformity and maintain spinal growth, but carry a 44.5% complication and 33% unplanned revision rate. Conversion procedures do not increase this risk. Single rods should be avoided.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

37. Biomechanical Effects on Adjacent Segments of Different Growing-Rod Fixation in Early Onset Scoliosis

Yong Hai, MD, PhD

Summary
The finite element analysis based on a severe early-onset scoliosis data showed that dual-rod growing-rod and the application of hook (s) on the upper instrumented vertebrae reduced the stress on the adjacent segments.

Hypothesis
This study aimed to analyse the biomechanical effects on adjacent segments of different growing-rod (GR) fixation in early onset scoliosis by finite element analysis.

Design
A finite element analysis

Introduction
The biomechanical stress on the adjacent segments will change after growing rod surgery in EOS. Finite element analysis is a good method to evaluate the spinal biomechanical environment after the surgery.

Methods
A severe early-onset scoliosis patient was selected and the pre-operation and post-GR-operation (Upper instrumented levels: T4, T5. Lower instrumented levels: L3, L4) whole spine 3-dimentional CT scan data were collected to build the finite models. Based on the different models, biomechanical differences on adjacent segments were analysed.

Results
The stress on the adjacent structures decreased after the GR surgery compared with the pre-operation. Compared with the single GR, stress on T3 vertebrae decreased by 6.2%, stress on T3/4 disc decreased by 6.7%, stress on T3/4 ligament decreased by 27.7%, stress on T6 vertebrae decreased by 16.9%, stress on T5/6 disc decreased by 1.2%, stress on T5/6 ligament decreased by 40.4%, stress on L2 vertebrae decreased by 32.6%, stress on L2/3 disc decreased by 30%, stress on L2/3 ligament decreased by 15.6%, stress on L5 vertebrae decreased by 1.2%, stress on L4/5 disc decreased by 15.7%, stress on L4/5 ligament decreased by 100.0% in dual GR structure. The application of hook (s) on the upper instrumented vertebrae (s) could decrease the stress on the cranial adjacent segment. Stress on T3 vertebrae decreased by 2.8% and 2.2%, stress on T3/4 disc decreased by 2.4% and 1.5%, stress on T3/4 ligament decreased by 3.6% and 5.7% in single GR and dual GR models separately when the hook (s) been utilized. In the meanwhile, the stress on the adjacent segment was more concentrated in the single GR model.

Conclusion
The finite element analysis showed that dual-rod growing-rod and the application of hook (s) on the upper instrumented vertebrae could reduce the stress on the adjacent segments more effectively.

38. Is There an Improvement in Quality of Life with Early Onset Scoliosis Managed with Traditional Growing Rods Converted to Magnetically Controlled Growing Rods?

Jennifer M. Bauer, MD, MS; Petya Yorgova, MS; Geraldine Neiss, PhD; Kenneth J. Rogers, PhD, ATC; Peter Sturm, MD; Paul D. Sponseller, MD; Scott John Luhmann, MD; Jeff Pawelek, BS; Suken Shah, MD; Growing Spine Study Group

Summary
Introduction of magnetically controlled growing rods (MCGR) for early onset scoliosis treatment was anticipated to improve the health-related quality of life (HRQoL) for patients and their families. A cohort of patients converted from traditional growing rods (TGR) to MCGR may be best suited to detect this improvement, which has not been previously examined. Using the validated EOSQ-24, no HRQoL differences were detected between TGR, MCGR, or converted patient cohorts.

Hypothesis
HRQoL domain scores are better in TGR patients after conversion to MCGR compared to TGR patients who were not converted.

Design
Retrospective review of a prospective multicenter database.

Introduction
Modern treatment of early onset scoliosis (EOS) includes traditional growing rods (TGR) and magnetically controlled growing rods (MCGR). MCGR innovation has been expected to improve family and patient burden by avoiding frequent return to the operating room. At least one study has showed minor HRQoL differences between TGR and MCGR (Doany ME, et al.), but no prior studies have specifically investigated a cohort of converted patients.

Methods
A multi-center EOS database was queried for all patients treated with TGR, MCGR, and those converted from TGR to MCGR who had at least one pre-and one post-treatment EOSQ-24. Data on demographics, diagnoses, major curve size, and complications, as well as EOSQ-24 domain scores were collected. Post hoc sample size analysis was included in statistical analysis.

Results
There were 156 TGR, 114 MCGR, and 32 conversion patients, with an overall average of 2.0yr between first and final EOSQ-24 data. There was no significant difference in outcome in any EOSQ-24 domain between the three cohorts, including parental burden domain (TGR+4.2, MCGR+4.1, conversion+4.5; p=0.99). A sample size analysis found the data powered to 0.94 (94%). There was also no difference after controlling for neuromuscular patients, major curve size, or by grouping MCGR+conversion group versus TGR.

Conclusion
Although patient families and their surgeons may subjectively report improved QoL after conversion from frequent surgical TGR lengthenings to in-office MCGR lengthenings, these improvements were not evident

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

in HRQoL surveys. While the EOSQ-24 is a well-validated EOS metric, it may not be able to overcome the baseline QoL associated with the diagnosis itself to detect differences made by treatment, if they exist, or perhaps, the improvement in QoL must be assessed over a longer interval than 2 years to assess meaningful change.

EOSQ-24 Domain	MCGR		TGR		Conversion	
	1st EOSQ	final EOSQ	1st EOSQ	final EOSQ	1st EOSQ	final EOSQ
general health	72.9	73.9	73.6	78.2	71.7	73.0
pain/discomfort	74.8	76.1	71.5	70.6	77.3	74.2
pulmonary function	84.6	88.4	88.0	88.1	83.9	83.1
transfer	77.0	84.2	75.5	72.3	78.1	75.0
physical function	63.4	68.4	71.9	73.1	74.4	77.9
daily living	52.6	54.7	59.5	62.7	49.6	53.3
fatigue/energy level	72.2	76.4	71.7	68.0	72.6	69.5
emotion	78.1	78.8	75.6	73.0	74.6	73.0
parental burden	68.3	72.7	67.4	70.8	68.3	72.7
financial burden	64.5	76.6	71.3	77.0	61.7	73.3
satisfaction	67.8	70.7	66.1	68.0	67.2	66.5
child satisfaction	67.8	69.4	65.1	67.1	66.4	65.3
parent satisfaction	67.4	72.1	66.4	68.6	68.3	66.4

Change in final EOSQ-first EOSQ			
EOSQ-24 Domain	MCGR	TGR	Convers.
general health	1.11	4.65	0
pain/discomfort	1.59	-0.76	-3.13
pulmonary function	4.05	0.1	-1.21
transfer	7.3	-3.17	-3.13
physical function	5.23	1.43	0.64
daily living	1.79	3.39	7.08
fatigue/energy level	4.62	-5.1	-4.03
emotion	0.35	-1.46	-1.29
parental burden	4.07	4.21	4.46
financial burden	8.95	6.33	13.39
satisfaction	3.41	2.2	0.86

.

39. Intraspinal MRI Abnormalities in Early-Onset Scoliosis - Rates Across A Global Cohort

Anna McClung, RN, BSN; Brendan Williams, MD, Fellow; Suken Shah, MD; *Laurel C. Blakemore, MD;* Jeff Pawelek, BS; Paul D. Sponseller, MD; Stefan Parent, MD, PhD; John Emans, MD; Peter Sturm, MD; Burt Yaszay, MD; Behrooz Akbarnia, MD; Growing Spine Study Group

Summary
Review of 836 MRIs performed in EOS patients from an international, multi-center database demonstrated a 24% rate of abnormality. MRI+ within etiologies is comparable to prior reports in the literature, ranging from 13% in presumed idiopathics to 39% among patients with neuromuscular scoliosis. When comparing MRI+ between etiologies the highest was congenital 28%, and lowest presumed idiopathic 21%. The most common abnormalities identified were syrinx, tether and Chiari. Other demographics were similar between patients with and without abnormal findings.

Hypothesis
The rate of intraspinal MRI abnormality in a multi-center EOS registry is similar to previous reports in the literature.

Design
Retrospective Review of a Multi-Center Database

Introduction
Spinal MRI is a necessary consideration during the treatment of EOS, as abnormalities may be more common in this population. MRI findings across a diverse, multi-center cohort have not been previously described. The purpose of this study was to report on the rate and type of abnormalities identified by spinal MRI within an international EOS patient registry.

Methods
A retrospective review of a multi-center EOS registry was performed. Patients with incomplete or unverifiable data and those with structural deformities secondary to infection and tumor were excluded. Demographics, major curve size prior to treatment, type of treatment and spinal MRI results were examined. Patients were grouped based on the presence (MRI+) or absence (MRI-) of MRI abnormality.

Results
MRI was obtained in 62% (836/1343) of registry patients meeting inclusion criteria. There was an overall MRI+ rate of 24%. MRI+ rates differed when comparing within an etiology the highest rates were among neuromuscular and the lowest in presumed idiopathics. When comparing between etiologies the highest rates were congenital and idiopathic the lowest (Table 1). However, treatment type, pre-treatment major curve size, age at MRI, and age at treatment showed no association with MRI+ status (Table 1). There were 247 abnormalities present among the 197 MRI+ patients (2 findings [n=47], 3 findings [n=4]). The most common findings were syrinx, tethered cord and Chiari malformation (Table 1).

Conclusion
Among a large and diverse EOS cohort abnormalities were present in 24% of patients. Abnormal rates were lowest among presumed idiopathics and highest among congenital. Other factors were not predictive of MRI abnormalities. Abnormal findings most often were syrinx, tethered cord or Chiari. These findings serve to validate previous studies within smaller, homogenous cohorts and enable the development of best practice guidelines for use of MRI in children with EOS.

Table 1 Characteristics and Abnormality Frequencies

CHARACTERISTICS OF MRI+ and MRI- PATIENTS			
	Abnormal (MRI+) n = 197 (24%)	Normal (MRI-) n = 639 (76%)	P value
Between Etiology			
Idiopathic (presumed)	42 (21%)	272 (43%)	
Syndromic	48 (25%)	184 (29%)	
Neuromuscular	52 (26%)	82 (13%)	p < 0.001
Congenital	55 (28%)	101 (15%)	
Within Etiology			
Idiopathic (presumed)	42 (13%)	272 (87%)	
Syndromic	48 (21%)	184 (79%)	NS
Neuromuscular	52 (39%)	82 (61%)	
Congenital	55 (35%)	101 (65%)	
Major Curve (prior to treatment) - °	66.6±23.5	64.4±24.0	NS
Age at MRI - years	5.1±11.5	5.1±8.6	NS
Age at Treatment - years	5.5±8.3	6.3±3.6	NS
Treatment Type			
Operative	159 (25%)	475 (75%)	NS
Non-Operative	38 (19%)	164 (81%)	
FREQUENCY OF MRI ABNORMALTIES (n = 247)			
Syrinx	67 (27%)		
Tethered Cord	55 (22%)		
Chiari Malformation	40 (17%)		
Canal Stenosis or Abnormality	26 (11%)		
Fatty Filum	18 (7%)		
Spina Bifida	15 (6%)		
Lipoma/lipomeningocele	13 (5%)		
Other	8 (3%)		
Dural Ectasia	5 (2%)		

.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

ABSTRACTS

40. Use of Magnetic Spinal Growth Rods (MCGR) With and Without Preoperative Halo Gravity Traction (HGT) for the Treatment of Severe Early Onset Scoliosis (EOS)

Michelle Welborn, MD; Charles d'Amato, MD, FRCS(C); Joseph Ivan Krajbich, MD, FRCS(C)

Summary
Single center prospectively collected database retrospectively analyzed for the effect of HGT on patients with severe EOS treated with MCGR. HGT allows you to obtain similar correction in patients with large rigid curves to patients with smaller more flexible curves not treated with HGT. Furthermore, the Cobb angle correction is maintained over time

Hypothesis
We hypothesize that pre-op HGT for patients with larger more ridged curves will result in comparable major Cobb correction to those achieved with smaller more flexible curves treated without HGT

Design
IRB approved retrospective cohort study of a prospectively collected database

Introduction
Correction of severe scoliosis through distraction based techniques poses a challenge. MCGR hardware complications are common with a 27.8-46.7% revision rate in under 2 years[1-3]. The purpose of this study was to assess our initial correction, maintenance of correction and complication rate in patients with severe scoliosis

Methods
42 patients underwent MCGR between 2014-17. 12 w/ prior growing constructs were excluded. Imaging was reviewed for major Cobb, T1-S1 height and their medical records for gender, age, diagnosis, previous treatments, and complications

Results
HGT group had larger, rigid curves and 50% were syndromic scoliosis. Non-HGT group had smaller more flexible curves and 61% were neuromuscular scoliosis. EBL, postop change in T1-S1 and postop Cobb and Cobb correction were not significant Average follow-up was 712 vs 561 days in the HGT vs non-HGT groups. 13% of patients experienced complications

Conclusion
Large, rigid curves can achieve equivalent correction to flexible curves with HGT. HGT resulted in an additional 22% correction in their traction film vs flexibility films. The HGT group then corrected an additional 29% more than their traction film at MCGR implantation. Non HGT pts corrected an additional 29% more than their flexibility film at MCGR implantation. At most recent follow-up HGT patients had statistically maintained their major Cobb correction better than non-HGT patients. Complication rates were comparable in the two groups. Thus, for patients with very flexible curves HGT is not necessary, but for a larger stiffer curve, HGT allows you to obtain similar correction to smaller more flexible curves

	Preop Cobb	Flexibility film Cobb	Absolute correction flexibility film	Percent correction flexibility film	Post traction Cobb	Postop Cobb	Ave Absolute Correction	Most recent Cobb	Change in Cobb postop vs most recent
Traction n=12	90° (69-114°)	78° (60-100°)	12° (3-59°)	13% (3-29)	59° (40-86°)	46° (31-57°)	44° (37-59°)	44° (28-65°)	-2° (-13-9)
No traction n=18	77° (56-113°)	46° (19-66°)	32° (5-70°)	40% (7-66)	na	34° (18-50°)	43° (19-74°)	40° (17-63°)	6° (-5–17)
P value	0.027	0.000	0.002	0.000	na	0.421	.743	.838	0.019

.

41. Topographical Sagittal Profile in 620 Patients Measured by a Novel Handheld Device

Kenny Kwan, FRCS; Ben NIU, PhD; Michael To, MBBS, FRCS; Jason Pui Yin Cheung, MBBS, FRCS, MS; Karen Kar-lum Yiu, MS; King Cheung Berry Cheung, BS; Johnson Lau, MD; Lok TingTerrence Lau, PhD; Yuk Lung Tsang, PhD; Lut Hey Chu, MPhil; Kenneth Cheung, MD, FRCS

Summary
There is increased understanding on radiographic global sagittal balance in health and in disease but assessment tools of sagittal profile without radiographs has not been well-studied. The authors' novel handheld device utilizes a gyroscope to measure 3-dimensional topographical parameters of the spine. The sagittal profile of 620 spine patients was assessed in the standing posture. Results showed that 36.3% patients had a forward posture, 55.9% had a neutral posture and 7.7% patients had a backward posture.

Hypothesis
The topographical sagittal profile of most patients is in a forward posture.

Design
Cross-sectional study.

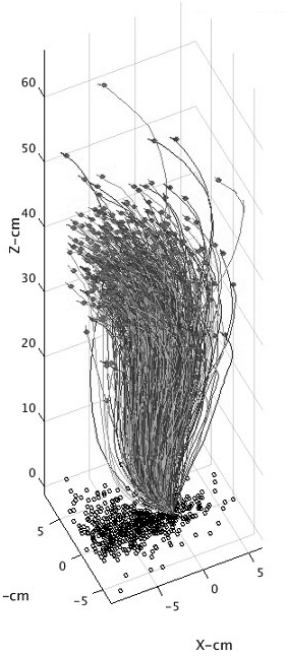
Introduction
The authors created a novel handheld device that produces 3D assessment of the spinal column by capturing topographical changes of the patients' back. The objective of this study was to utilize this tool to identify sagittal profiles of patients presenting to an orthopaedic specialist clinic.

Methods
A novel handheld device was used to detect 3D topographical parameters of the back contour in real-time from C7 to L5 in standing position. Consecutive patients who attended the orthopaedic clinic were invited to participate in the study. The sagittal parameters were analysed, and the distance between the "C7 plumb line" and L5 was determined. Utilizing the criteria of sagittal vertical axis, a neutral posture was defined as a distance of 0 to +5cm, forward posture as > +5cm, and backward posture was <0.

Results
620 patients who presented to the clinic primarily for adolescent idiopathic scoliosis and degenerative spinal conditions participated in the study. Results showed that 36.3% patients had a forward posture, 55.9% had a neutral posture and 7.7% patients had a backward posture.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Conclusion
Although radiographic global sagittal balance is well-studied in the normal and diseased populations, there are no well-studied tools to assess the sagittal profile without radiographs. The authors developed a handheld device that systematically documents the topographical sagittal profile and validation of its use has been performed in over 600 patients. A large percentage of patients presenting to an orthopedic clinic is in a forward posture suggesting that a vast number of patients with scoliosis or degenerative conditions may be in positive sagittal balance. Further studies are required to correlate our findings with radiographs. However, we have shown that this novel tool has the ability to measure sagittal balance during daily activities without radiographs and can be used to further understand the importance of sagittal balance to daily life.



.

42. One-Stage Posterior Hemivertebra Resection with Short Segmental Fusion in the Treatment of Lumbosacral Hemivertebra: A More Than 2-year Follow-up

Qianyu Zhuang, MD; Jianguo Zhang, MD

Summary
A Retrospective study of prospective database from a consecutive series of congenital scoliosis due to lumbosacral hemivertebra indicates one-stage HV resection and short segment fusion by a posterior approach can offer excellent scoliosis correction and trunk shift improvement with acceptable neurological complications, while saving motion segments as much as possible.

Hypothesis
Even in lumbosacral area, one-stage HV resection and short segment fusion via posterior-only approach can offer excellent scoliosis correction and trunk shift improvement, while saving motion segments as much as possible.

Design
Retrospective review of prospective database.

Introduction
Although hemivertebra resection has become a popular strategy in treating congenial scoliosis, lumbosacral hemivertebra still poses a unique problem due to the special anatomy structure and high stress concentration. There has been no reports on the results and complications of hemivertebra resection via a posterior-only procedure with especially short fusion in large series of patients.

Methods
From 2002 to 2015, a consecutive series of 25 congenital scoliosis due to lumbosacral hemivertebra treated by 1- stage posterior hemivertebra resection with short segmental fusion were investigated retrospectively, with at least a 2 year follow-up period (24-144 months). Radiographical evaluation included measured changes in segmental scoliosis, compensatory scoliosis, lumbar lordosis, trunk shift. Operative data, peri-operative complications and SRS-22 questionnaires were also collected.

Results
The mean follow-up period was 38.6 months. The mean segmental scoliosis curve was 32.6° preoperatively, 5.5° postoperativey, and 4.8° at the latest follow-up. Trunk shift was significantly improved on both coronal (63.2%) and sagittal plane (55.6%) after the surgery, and kept stable during the follow-up. Mean operation time was 236 minutes with the average blood loss of 528.7 mL. The total SRS-22 score, the self-image domain score and the satisfaction domain score demonstrated significant improvement.

Conclusion
Despite the special characteristic of lumbaosacral hemivertebra, this study demonstrate that one-stage HV resection and short segment fusion by a posterior approach can offer excellent scoliosis correction and trunk shift improvement, while saving motion segments as much as possible. The early surgery is able to avert severe lumbosacral deformities and prevent secondary structural deformities so as to avoid extensive fusions.

.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

43. Outcomes of 3-Column Osteotomy in Cervicothoracic Spine(C7/T1) for Congenital Cervicothoracic Scoliokyphosis in Children

Wang Shengru, MD; Jianguo Zhang, MD

Summary
There have been many reports on the treatment of congenital scoliokyphosis. However, the characteristics and surgical treatment of the congenital deformities in the cervicothoracic spine(C7/T1) has not been well described because of the rarity of the condition.In this study we try to characterize the clinical presentation of congenital deformities in the cervicothoracic spine and report the outcomes of 3-column osteotomy in cervicothoracic spine(C7/T1) for congenital scoliokyphosis.

Hypothesis
The characteristics and treatment of the congenital deformities in the cervicothoracic spine may be unique.

Design
Retrospective study

Introduction
This study was conducted to characterize the clinical presentation of congenital deformities in the cervicothoracic spine and report the outcomes of 3-column osteotomy in cervicothoracic spine(C7/T1) for congenital scoliokyphosis.

Methods
Thirty patients(M/16, F/14) averaged 11.0years with congenital deformities in the cervicothoracic spine(C7/T1) were included in the study. All of them were treated with 3-column osteotomy in cervicothoracic spine(C7/T1): 21 hemivertebra resection, 8 vertebral column resection and 1 pedicle substraction osteotomy. Eleven patients received osteotomies at C7 and nineteen at T1. The patients' charts and radiographs were reviewed.

Results
Twenty-eight patients had congenital deformities in other regions of the spine. 7 patients has 9 intraspinal deformities. Preoperative neurological deficits were found in 3 patients. The averaged operation time was 253.8 hours and the mean blood loss was 960.0ml. The cervicothoracic curve was corrected from 55.4°to 15.3°. The segmental kyphosis was corrected from 25.4°to 13.1°. And the head tilting improved from 15.2°to 4.8°.Fifteen complications occurred in 12 patients:6 transient root injuries,1 transient cord injury, 2 progressions of compensatory cuve,2 implants failures, 2 hemothoraxs, 1 wound delayed union and 1 atelectasis.

Conclusion
Most congenital cervicothoracic deformities are fixed and have concurrent other congenital spinal deformities. Patients often have cosmetic problems due to pronounced heading tilting and uneven of the shoulder. A 3-column osteotomy in cervicothoracic spine(C7/T1) is an effective but challenging procedure for high risk complications. The use of spinal cord monitoring, especially motor tract monitoring is imperative. Sufficient evaluation of the bilateral vertebra arteries should be made with CTA before the surgery. One stage or staged surgical treatment may be needed if the compensatory thoracic curve was severe and rigid.

44. The Learning Curve of Minimally Invasive Surgery (MIS) in Adolescent Idiopathic Scoliosis (AIS)

Vishal Sarwahi, MBBS; Jesse M Galina, BS; Stephen Wendolowski, BS; Alexandre Ansorge, MD; Romain Dayer, MD; *Charlotte De Bodman, MD;* Yungtai Lo, PhD; Terry D. Amaral, MD

Summary
Over time, the benefits of MIS in AIS increase and surgical time is significantly reduced. Surgeons should continue to evaluate MIS feasibility in AIS which has significant soft tissue and blood preservation benefits.

Hypothesis
Perioperative outcomes improve over time for MIS in AIS

Design
Ambispective review

Introduction
MIS has gained popularity as surgeons move towards soft tissue and blood preservation. However, MIS has technical demands and increased surgical time compared to the standard PSF approach. MIS, like any other new surgical approach, has a learning curve. The objective of this study is to describe this learning curve of 2 surgeon's at 2 separate institutes.

Methods
An ambispective chart and XR review of AIS patients undergoing MIS from 2 surgeons. Group 1 consisted of the first 20 MIS patients (2008-2014), and Group 2 contained the most recent patients (2015-2017). Group 3 was the first 20 patients of a second surgeon (2013-2014), and Group 4 was the next 30 cases (2015-2016). Demo, periop and XR data was collected, and compared between group 1 and 2. A second analysis was done comparing group 3 and 4. Fisher's exact test and Wilcoxon signed-rank test were used.

Results
Group 1 (n=21), Group 2(n=19), Group 3(n=21), and Group 4(n=30) were similar in demo data($p>0.05$). Preop Cobb was similar between Group 1 and 2 (48 vs 50.5,$p=0.49$) as was kyphosis (28.6 vs 21,$p=0.15$). Levels fused was similar (10 vs 11, $p=0.19$). Postop Cobb was similar (15.5 vs 13.6,$p=0.60$), however postop kyphosis was significantly higher in Group 1 (31.4 vs 19.9,$p=0.014$). Surgical time was significantly less in Group 2 (456 vs 285,$p<0.001$). EBL was similar (400 vs 300,$p=0.88$). Hospital stay was significantly less in Group 2(5 vs 6,$p=0.028$). In Group 3 and 4, preop Cobb(53 vs 61,$p=0.070$) and kyphosis(28 vs 25,$p=0.503$) were similar. Cobb correction was similar(72% vs 72.2,$p=0.829$) but postop kyphosis was significantly less in Group 4(33 vs 28,$p=0.024$). EBL was similar

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

(350vs350,p=0.272). Surgical time was significantly less for Group 4(444 vs 303,p=0.002). Hospital stay was similar (5 vs 5,p=0.074).

Conclusion
The main critique of MIS is length of surgery. However, MIS in AIS has significant benefits in terms of soft tissue preservation and blood loss. With increasing surgical experience the operative time decreases significantly. These improvements occur after approximately twenty cases.

45. WITHDRAWN

46. Minimal Invasive Ventral Derotation Spondylodesis (VDS) is the First Choice for AIS Lenke Type 1A and 5C Scoliosis: 100 Cases Experience

Stefan Krebs, MD; Thomas Pfandlsteiner, MD

Summary
VDS is a save technique for high experienced deformity surgeons with excellent results in Lenke 1A and 5C scoliosis.

Hypothesis
VDS for Lenke 1A and 5C

Design
Single Center, retrospective, Consecutive

Introduction
Arguments against VDS are higher approach morbidity with more blood loss, longer time for surgery and hospital stay, postoperative pulmonary dysfunction and postthoractomy syndrome. In this retrospective study we want to show, that with right surgical experience, the opposite is real.

Methods
In cases of Lenke type 1A and 5C, the VDS is the standard procedure used for scoliosis. For short skin incision length for minimal invasive approach, a special angulated device was developed. 100 consecutive patients in the last 10 years (a) were included. Cobb angle, sagittal balance, blood loss, time of surgery and length of skin incision were measured. In Lenke Type 1A single rod instrumentation is enough. In the thoracolumbar junction for more stability only double rod instrumentation is used.

Results
In 24 patients a combined surgical treatment was used in one hospital stay or in EOS in follow up over some years. 83% female, mean age 16.5 a, 76 patients just got anterior surgery, 2/3 Lenke 5C -curves. In thoracic spine Lenke 1A or 1B, in rare cases Lenke Type 2 curves. Fusion length 5 segments. Cobb angle pre-/post OP: 56° (40-100°)/(0- 48°). Sagittal profile was improved in all cases. Mean Blood loss 380ml, time for surgery 230 minutes, incision length 11.5 cm, increase of body length 2.9 cm and follow up after surgery 4.2 a. Complications in the beginning by the use of single rod technique in the thoracolumbar junction were one rod breakage without any symptoms and one case of micro-instability with persistent pain with additional posterior surgery. No pulmonary insufficiency or post-thoracotomy syndrome occurred.

Conclusion
The VDS technique is very demanding and it is mandatory to have a savvy technique for the anterior approach. The results are excellent. With more than ten years of experience the skin incision length decreased rapidly. A real derotation is just possible by disc resection from anterior. With the right indication we recommend the VDS technique, also in case of cosmesis and patient satisfaction.

47. Return to Play in the Athlete with Adolescent Idiopathic Scoliosis: Spinal Fusion Is Compatible with Sports Participation

Baron Lonner, MD; Suken Shah, MD; John M. Flynn, MD; Patrick Rogers, DO; Courtney Toombs, MD; Andrea Castillo, BS; Yuan Ren, PhD

Summary
Families often inquire about the impact of a spinal fusion for AIS on the ability of the patient to resume their sport. The purpose of this study was to assess sports participation following AIS surgery. The majority of patients(87%) returned to sport following surgery for AIS. Although there was no change in self-reported physical potential in participating sport, level of contact decreased in 32% of patients. Contact sports were dropped in 14/18, 50% had a LIV of L3 or distal.

Hypothesis
Spinal fusion in Adolescent idiopathic scoliosis (AIS) will result in diminished sports participation

Design
Multicenter observational study

Introduction
AIS is largely an asymptomatic condition with little effect on function in a young, active population. Families often inquire about the impact of a spinal fusion on the ability of the patient to resume sports after surgery. The purpose of this study was to assess sports participation following AIS surgery.

Methods
101 consecutive AIS patients who were engaged in an organized sport before surgery were enrolled (retrospectively n=50 and prospectively n=51) and evaluated postoperatively. They were administered 3 (two validated and one customized) questionnaires. Level of contact (LOC), physical potential and time spent in the sport were analyzed using Wilcoxon signed-rank test for pre-/post-operative comparisons.

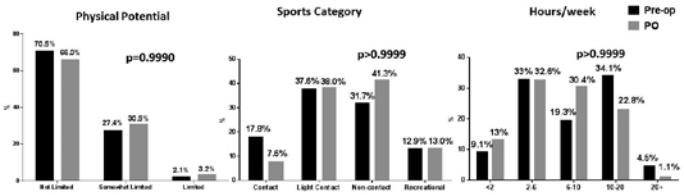
Results
Age at surgery was 14.4 yrs, 72.3% female; 94 posterior, 6 combined, 1 anterior procedures; levels fused 10.4; mean FU 1.5 yrs. 88 (87%) resumed a sport, 69% remained in the same LOC, 83.3% returned to their previous or a higher level of physical potential. Number of levels fused and LIV did not correlate with LOC or physical potential

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

(p=0.4007; p=0.2369), however, a higher PO VAS score was associated with less physical potential (p=0.0069). For those who participated in contact sports (n=18), 11 changed to light or non-contact sports, 3 did not return to sport. Among these 14 patients with diminished LOC, 7 (50%) were fused to or caudal to L3. Median time in sport remained 6-10 hrs/wk pre- to post-operatively.

Conclusion

The majority of patients (87%) returned to sports following surgery for AIS. Although there was no change in self-reported physical potential or time in sports, LOC decreased in 32% of patients. Contact sports were dropped in 14/18; half had a LIV of L3 or distal.



.

48. Comparison of Coagulation Profiles of Adolescent Idiopathic Scoliosis (AIS) Patients Undergoing Posterior Spinal Fusion (PSF) with and without Transexamic acid (TXA)

Patrick P. Bosch, MD; Joanne Londino, RN; Tanya S Kenkre, PhD

Summary

The use of TXA in AIS patients undergoing PSF significantly decreases signs of fibrinolysis, confirming its mechanism of effect. Fibrinolysis scoring is a more accurate and quantifiable means of evaluating anti-fibrinolytic treatment than estimated blood loss (EBL) or transfusion rates.

Hypothesis

TXA for AIS patients undergoing PSF will decrease fibrinolysis which will be quantifiable by a Fibrinolysis score.

Design

Prospective analysis of coagulation profile of AIS patients undergoing PSF receiving TXA compared with published cohort which did not receive TXA.

Introduction

We previously demonstrated a "Fibrinolysis score" (DIC score) in AIS patients undergoing PSF without use of TXA correlated with blood loss and need for transfusion. The efficacy of TXA for AIS patients is debated in the literature. Applying the same protocol to monitor the coagulation profile of AIS patients undergoing PSF with TXA would provide more in depth analysis of the effect of TXA.

Methods

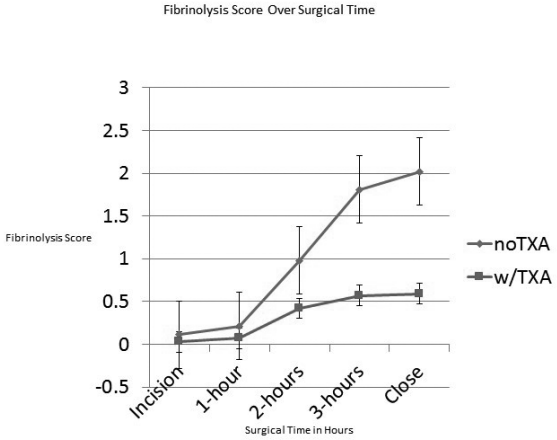
Eighty eight patients undergoing PSF for AIS were analyzed by pre-operative and hourly intraoperative coagulation labs. Investigations included standard labs and thromboelastography (TEG). A Fibrinolysis score, previously described in hematology literature as a DIC score, was calculated from PT, presence of FDPs or d-dimer, platelet counts and Fibrinogen level. Peri-operative data such as transfusion, estimated blood loss per level (EBL/lev) were recorded. Fifty eight patients were part of a published cohort that did not receive TXA. Thirty patients received intra-operative TXA per standard protocol (30µg/kg loading and 10µg/kg continuous dose) and are compared to earlier cohort.

Results

Patients receiving TXA during PSF for AIS had similar EBL/lev (mean 70.9cc versus 76.4cc, p=0.56) but required less pRBC transfusion(20% versus 46%, p=0.01). The use of TXA significantly decreased the Fibrinolysis score between the cohorts; while the score went up 1.9 in the non-TXA cohort, it went up only 0.6 (p<0.0001) in patients receiving TXA. The change in LY30% (fibrinolysis marker in TEG) also decreased with TXA from 3.0 to 1.1 (p=0.08).

Conclusion

The comprehensive analysis of coagulation parameters in AIS patients confirms the utility of antifibrinolytic treatment during PSF. It also provides a useful outcome marker for future studies on specific drug regiments.



49. Posterior Minimally Invasive Surgery for Adolescent Idiopathic Scoliosis:
Results and Complications in 68 Patients with Minimum 2-year Follow-up

Charlotte De Bodman, MD; *Firoz Miyanji, MD, FRCS(C);* Romain Dayer, MD

Summary

Prospectively collected data of consecutive adolescent idiopathic scoliosis (AIS) patients treated with minimally invasive surgery (MIS) were retrospectively reviewed to evaluate deformity correction, estimated blood loss (EBL), length of stay (LOS) and additional complication at minimum 2-year follow-up. Results show significant correction of spine deformity in both planes, together with low

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

EBL and short LOS. According to complication rate, posterior MIS technique seems to be a safe technique in the short- and mid-term.

Hypothesis
Posterior MIS technique seems to be a safe technique in the short- and mid-term for AIS patients.

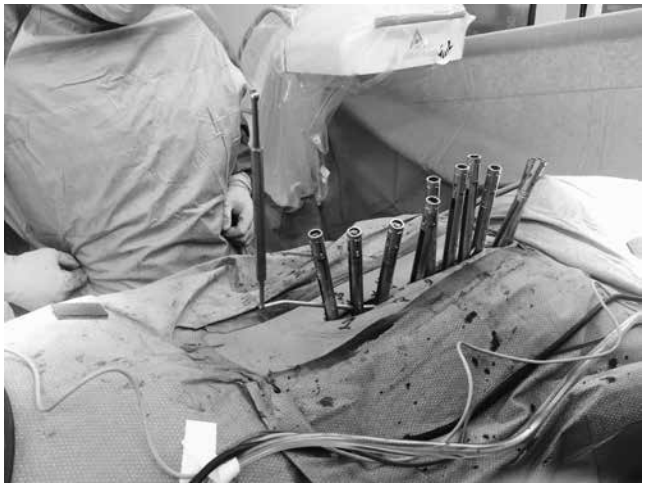
Design
Prospective collected data

Introduction
MIS techniques have been increasingly used over the last decade in adult spinal deformity. The pediatric spine, because of its inherent flexibility and ability to fuse, is theoretically ideal for MIS. Given the positive results obtained with MIS to treat adult spine pathologies, the next logical step is the application of less invasive surgical techniques to the the treatment of spine deformity at the pediatric age, and in particular AIS.

Methods
Given the learning curve associated with posterior MIS, the first 25 AIS patients treated with MIS technique were excluded. Consecutive AIS patients treated with the MIS technique at 2 tertiary centers from March 2014 to March 2016 were retrospectively included. Preoperative patient and deformity characteristics, operative parameters, power of deformity correction and complications were studied.

Results
68 patients were included with a mean follow-up of 3 ± 0.6 years (Female=62 ; age 14.8 ± 6.4 years ; BMI = 20 ± 6.7 kg/m2). Operative time (OR) averaged 283 ± 89.69 mn. Preoperative major Cobb angle averaged 58.4 ± 9.2 ° and significantly corrected to 20.1 ± 7.1° (65% curve correction). Preoperative T2-T12 kyphosis was 35.0 ± 12.9° and was significantly increased to 42.6 ± 8.3 (19% correction). Mean OR per level fused was 24 ± 6.4 mn. Mean estimated blood loss (EBL) was 294.4 ± 162 ml representing 24 ± 12.3 ml per level. Average length of stay (LOS) was 4.3 ± 0.8 days. Perioperative (30 days) complication rate was 1.4%: 1 subcutaneous hematoma. One additional complication occurred in 1 patient: 1 delayed deep surgical site infection. No pseudarthrosis was noticed.

Conclusion
MIS for AIS is associated with a significant correction of spine deformity in frontal and sagittal planes, together with low EBL and short LOS. Perioperative and 2 year complication rate seems to be acceptable. The longer-term safety of MIS procedure for AIS needs to be documented with a larger cohort.



.

50. Comparison of Spontaneous Correction in Thoracic Curves after Selective Anterior Versus Posterior Fusion in Lenke Type 5C Adolescent Idiopathic Scoliosis: A Study with Minimum Five Years Follow-up

Wei Pan, PhD; Zhen Liu, MD; Yong Qiu, MD; Jie Li, MS; ChangChun Tseng, MD; Zhihui Zhao, MD, PhD; Zezhang Zhu, MD

Summary
Selective fusion of the thoracolumbar/lumbar (TL/L) curve is an effective method for the treatment of Lenke type 5C curves. Several studies have demonstrated that spontaneous correction of the thoracic curve does indeed occur.

Hypothesis
This study was design to compare the results and to explore the influence factors of spontaneous correction of the unfused thoracic curves in Lenke type 5C adolescent idiopathic scoliosis (AIS) between selective anterior and posterior spinal fusion with long-term follow-up.

Design
Retrospective study

Introduction
Whether there has different result of spontaneous correction in thoracic curves between selective anterior and posterior fusion in Lenke type 5C adolescent idiopathic scoliosis is still unclear.

Methods
89 Lenke type 5c AIS patients who underwent selective thoracolumbar/lumbar (TL/L) spinal fusion in our center from January 2005 to December 2011 with a minimum follow-up of 5 years were reviewed 43 patients underwent anterior approach, while the others underwent posterior approach. The following radiological parameters were measured and analyzed pre- and postoperatively: curve magnitude of primary thoracolumbar/lumbar and secondary thoracic curve, trunk shift, thoracic apical vertebral translation, upper instrumented vertebra tilt, thoracic kyphosis, proximal junctional angle, sagittal vertical axis.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Results
The mean spontaneous correction rates of the thoracic curve were 49.5% and 56.1% in anterior and posterior groups, respectively, showing no significant difference between two groups (p=0.140). At the final follow-up, the spontaneous correction rate of thoracic curve was maintained at 45.5% and 48.6% (p=0.484), showing no significant correction loss (p=0.408). According to the Pearson assessment, the spontaneous correction rate was negatively correlated with UIV tilt in both groups (anterior r=-0.526, P<0.001 vs. posterior: r=-0.399, P=0.016).

Conclusion
Both anterior and posterior spinal fusion could achieve satisfactory spontaneous correction of the unfused thoracic curves in Lenke type 5C AIS, with no significant difference between the two surgical approaches. The better UIV levelization obtained postoperatively, the more magnitude of unfused thoracic curve can be corrected spontaneously.

51. Predictors for Postoperative Shoulder Imbalance in Lenke 2A Adolescent Idiopathic Scoliosis

Tatsuya Sato, MD; Ikuho Yonezawa, MD; Hiroko Matsumoto, PhDc; Nao Otomo, MD; Teppei Suzuki, MD, PhD; Nodoka Manabe, MD, PhD; Satoru Demura, MD; Kota Watanabe, MD, PhD; Toshiki Saito, MD; Ayato Nohara, MD; Takuto Kurakawa, MD, PhD; Takachika Shimizu, MD; Koki Uno, MD, PhD; Morio Matsumoto, MD, PhD; Noriaki Kawakami, MD; Japanese Spine Deformity Institute

Summary
Among Lenke type 2A adolescent idiopathic scoliosis (AIS) patients undergoing posterior correction and fusion, patients not undergoing proximal thoracic curve Ponte osteotomy had a 6.54-fold risk of developing postoperative shoulder imbalance.

Hypothesis
Ponte osteotomy is associated with postoperative shoulder imbalance in patients with Lenke type 2A AIS undergoing spinal fusion.

Design
Multicenter, retrospective cohort study

Introduction
Factors associated with postoperative shoulder imbalance in Lenke type 2 AIS are not determined in large cohorts. The purpose was to investigate the association between Ponte osteotomy and postoperative shoulder imbalance at minimum of 2 years after spinal fusion.

Methods
Patients with Lenke Type 2A AIS were identified. Inclusion criteria were: age 10-20 years at surgery; UIV=T2; major curve 40-90°; and minimum 2 years after the surgery. Exclusion criteria was anterior-posterior approach and reoperation. Obtained data were patient and clinical characteristics as well as radiographic parameters including implant density, adding-on, LIV and stable vertebrae relationship, coronal balance, curve flexibility and major curve. Shoulder imbalance was defined as Radiographic Shoulder Height (RSH) >20 or <-20 mm at follow-up. Cox regression analyses were performed to count for unequal follow-up in individuals.

Results
106 consecutive patients with 2.7 years (2-8 years) follow up were identified. 14 patients (13.2%) had shoulder imbalance at preop. The imbalance was seen in 31 (29.2%) patients immediately postop and in 19 (17.9%) at 2-year postop. 87 patients (81%) underwent multiple osteotomy. Significant increased risk was found in patients without osteotomy (HR: 6.25, 95% CI: 1.46-26.87, p=0.014) controlling for all confounders.

Conclusion
Ponte osteotomy was associated with decreased risk of postoperative shoulder imbalance in patients with AIS Lenke type 2A curve at minimum 2 years. There may be a benefit in performing osteotomy in posterior correction and fusion for Lenke type 2A AIS.

52. Where to Stop Distally in Lenke Modifier C AIS with Lumbar Curve More Than 60°: L3 or L4?

Yong Qiu, MD; Xiaodong Qin, PhD; Lei-Lei Xu, PhD; Bangping Qian, MD; Zezhang Zhu, MD

Summary
Selecting the lower instrumented vertebra (LIV) in adolescent idiopathic scoliosis (AIS) with large lumbar curve can be difficult. Multiple factors were associated with the selection of LIV, among which, preoperative L3 translation on concave side-bending film was the most important predictor, with a concave bending L3 translation less than 10mm being a potential threshold for selecting L3 as LIV.

Hypothesis
Several factors such as the L3 translation on side-bending film are associated with the selection of LIV for AIS patients with large lumbar curve.

Design
A retrospective comparative study.

Introduction
The selection of LIV in AIS patients with large lumbar curve remains controversial. Stopping the distal fusion at L3 could save more mobile lumbar spinal segments but may increase the risk of decompensation. The purpose of the study was to evaluate pre-operative radiographic factors that were associated with the selection of either L3 or L4 as LIV in posteriorly treated AIS patients with large lumbar curve (>60°).

Methods
84 patients with lumbar curve > 60°were recruited with a minimum of 2-year FU after posterior instrumentation with lumbar curves included in fusion. Patients were grouped according to the selection of LIV, either L3 group or L4 group. All radiograph parameters were measured pre- and post-operatively including lumbar Cobb angle, lumbar flexibility and L3 translation and rotation on upright

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

posteroanterior film and supine side-bending film, etc. The SRS-22 score was used to assess clinical outcomes. Radiographic and clinical parameters were compared between the two groups. Multivariate regression analysis was performed to determine the factors most predictive of LIV selection.

Results
There were 24 patients in L3 group and 60 patients in L4 group. The average duration of follow-up was 3.1 years. At last follow-up, no difference was found in the clinical and radiographic parameters between the two groups. Preoperatively, the L3 group had lower L3 translation on AP view, L3 translation on concave side-bending film, L3 rotation on convex side-bending film and larger lumbar flexibility . Multivariate regression found that L3 translation on concave side-bending film was the single most important predictor of LIV selection. Specifically, concave bending L3 translation < 10mm was a potential threshold for selecting L3 as LIV.

Conclusion
For AIS patients with lumbar curve larger than 60°, one can reliably stop at L3 if preoperative L3 translation on concave side-bending film was less than 10mm, with the same radiographic and clinical outcomes as fusing to L4.

53. Sequential Spine-Hand Radiography for Assessing Skeletal Maturity in AIS with Low Radiation Dual-Beam Imaging System – A Feasibility and Reliability Study

Lik Hang Alec Hung, FRCS; Lawrence CM Lau, MRCS; Zongshan Hu, MD, PhD; Wai-wang Chau; Simon Chow, PhD; Anubrat Kumar, MS; Tsz-Ping Lam, MBBS; Bobby Kinwah Ng, MD; Winnie Chu, MD; Jack C.Y. Cheng, MD

Summary
Low radiation dual-beam imaging system for spinal radiography is widely adopted for scoliosis follow-up but its role in skeletal maturity assessment is uncertain. The sequential Spine-Hand radiography workflow proposed was feasible with excellent reliability for all hand radiograph imaging, subjected to multicenter validation with larger sample sizes.

Hypothesis
We hypothesized that the image quality of the low dose hand radiograph can allow reliably assessment of skeletal maturity in AIS patients.

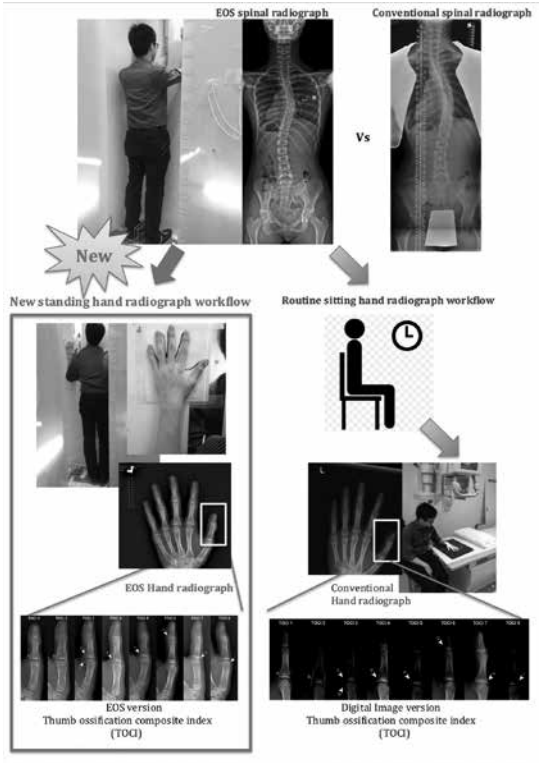
Design
Retrospective cross-sectional study

Introduction
Low radiation dual-beam imaging system is increasingly adopted for clinical follow-up in scoliosis with the advantages of simultaneous biplanar imaging of the whole spine in erect position with relatively low radiation. Skeletal maturity assessment using hand radiograph is an essential adjunct to spinal radiography in scoliosis follow up. The former was taken conventionally using digital radiography system. A new workflow was proposed in this study with aim of incorporating hand radiography immediately after spinal imaging within the same imaging setting.

Methods
Hand radiographs from patients with clinical diagnosis of idiopathic scoliosis, including both sexes and age range of 10-14 years old, were retrospectively reviewed and scored by five raters using both conventional Tanner-Whitehouse (TW3) staging over thumb epiphyses and validated Thumb Ossification Composite Index (TOCI) methods. Intraclass correlation coefficients (ICCs) were calculated for interobserver agreement and intraobserver test-retest reliability was tested by Cronbach's alpha values.

Results
Sixty hand radiographs were selected randomly from all new subjects with diagnosis of AIS, including 32 males (mean age 11.53, range 10-14), and 28 females (mean age 11.50, range 10-13) who underwent sequential spine-hand low dose imaging with a total of 600 TW3 staging scores were generated for analysis. The overall inter-observer (ICC = 0.997) and intra-observer agreement ($\alpha > 0.9$) demonstrated excellent agreement for all TW3 and TOCI staging.

Conclusion
The proposed new sequential Spine-Hand radiography with low dose workflow was feasible to produce high image quality of hand radiography that allows skeletal maturity assessment with excellent reliability. The overall efficiency and throughput of the radiology department can thus be enhanced. Further validation on larger samples and across different centers would be helpful.



.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

54. Analysis of Pre-Contoured Patient Specific Rods in Adolescent Idiopathic Scoliosis: Does Rod Flattening Occur After Implantation?

Afshin Aminian, MD; Andrew King, MB.ChB,FRACS,FACS; Pouya Alijanipour, MD

Summary
Achieving the ideal sagittal balance is one of the main goals of Adolescent Idiopathic Scoliosis (AIS) surgery. Rod flattening can affect restoration of thoracic kyphosis and achievement of the sagittal balance. Preoperative planning and design of the pre-contoured rod for the ideal postoperative sagittal balance is one factor that decreased rod flattening.

Hypothesis
The use of Patient Specific Rods (PSR) are associated with less rod flattening in patients undergoing correction of AIS.

Design
Retrospective analysis of two multicenter prospectively collected databases

Introduction
Previous studies have shown a significant difference between pre- and postoperative conventional rod contour for patients undergoing surgical correction of AIS. PSR are made based on pre-op analysis of the sagittal plane deformity using spine measuring software. After applying the corrective measures to achieve the ideal sagittal balance, the pre-contoured PSR is made based on the ideal contour of the rod to achieve the surgeon goal.

Methods
22 AIS patients with a minimum 1Y follow-up were retrospectively evaluated. Calibrated 1st Erect and 1Y radiographs were assessed for spinal alignment and rod contour change. The rod deflection distance [MRDD] and angle of tangents to rod endpoints [AT]) was calculated by a custom computer software program. Means were compared using Student t-tests

Results
There was a mean age of 15 with 82% females. Major Cobb angle was reduced by 68% (from 56.7° to 18.4°) at 1Y postoperatively and Sagittal vertical axis (SVA) was changed from -11.9 to -16.2.mm. The PSR used were 6.0mm diameter, either 2 Titanium (n=10), 2 Cobalt-chromium (n=3) or Hybrid constructs with one of each (n=9). The concave rods flattened by 3.3 mm in MRDD (22.7mm to 19.3mm, $p<0.001$) and 2.3° in AT (39.7° to 37.4°, $p<0.001$). Surprisingly, Titanium constructs remain more stable. Overall the flattening was noted on the initial post op radiograph and rod shape remained stable at 12-month follow-up.

Conclusion
In AIS surgery, pre-contoured PSRs (based on planning using preoperative X-rays) are associated with much less rod flattening compared to reports of conventional manually contoured rods. The use of PSRs allows maintenance of the sagittal profile obtained from preoperative planning.

Means Δ 1Y - Baseline		Cohort	Ti rods	CoCr Rods	Hybrid constructs	Literature
N =		22	10 (45%)	3 (14%)	9 (41%)	27
Concave rods	rod deflection distance [MRDD]	-3.3mm $p<0.001$	0.97mm	-10.64mm	-3.57mm	-13mm
	angle of tangents to rod endpoints [AT]	-2.3° ($p<0.001$)	-1.59°	-9.31°	-4.25°	-21°

55. Restoration of Thoracic Kyphosis in Adolescent Idiopathic Scoliosis over a Twenty-Year Period: Are We Getting Better?

Blake Bodendorfer, MD; Suken Shah, MD; Tracey P. Bastrom, MA; Baron Lonner, MD; Burt Yaszay, MD; Amer F. Samdani, MD; Firoz Miyanji, MD, FRCS(C); Patrick Cahill, MD; Paul D. Sponseller, MD; Randal R. Betz, MD; David H. Clements III, MD; Lawrence G. Lenke, MD; Harry L. Shufflebarger, MD; Peter Newton, MD; Harms Study Group

Summary
Operatively treated adolescent idiopathic scoliosis (AIS) patients with thoracic hypokyphosis in the 1995-2000 cohort had excellent restoration of thoracic kyphosis (TK), which worsened between 2001-2009 and improved to near the 1995-2000 cohort between 2010-2015. These differences can be accounted for by earlier use of anterior approaches to address TK restoration, the shift to posterior approaches using pedicle screws, and the eventual adoption of posterior column osteotomies, aggressive rod contouring and 3D correction.

Hypothesis
Operatively treated AIS patients with preop thoracic hypokyphosis (<10°) prior to 2000 would have superior TK restoration, but the learning curve with pedicle screws would reflect an inferior restoration of TK and eventual improvement.

Design
A multicenter, prospectively collected database of operatively treated thoracic major AIS over 20 years was used to retrospectively examine pre- and postoperative TK in patients with minimum 2 years follow-up.

Introduction
In 20 years, there has been an evolution of operative treatment for AIS, with more emphasis on sagittal and axial plane correction than just the coronal plane. Thoracic hypokyphosis, an essential lesion of AIS, was well treated with an anterior approach, but early posterior approaches with posterior spinal fusion (PSF) using pedicle screws did not address this issue well. With the recognition and teaching of advanced techniques for 3D correction, this has been addressed and its confirmation is the aim of this study.

Methods
From 1995-2015, 1063 patients with preoperative thoracic hypokyphosis (TK <10°) were identified. A validated formula for assessing 3D T5-T12 sagittal alignment using measured 2D T5-

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

T12 kyphosis for thoracic AIS was applied, since true kyphosis is undermeasured in a rotated spine. Patients were divided into the following operative cohorts: 1995-2000, 2001-2009 and 2010-2015. Two-way repeated measures ANOVA grouped by time interaction and post-hoc Bonferroni correction to adjust for multiple comparisons was utilized, with $p<0.05$ considered significant.

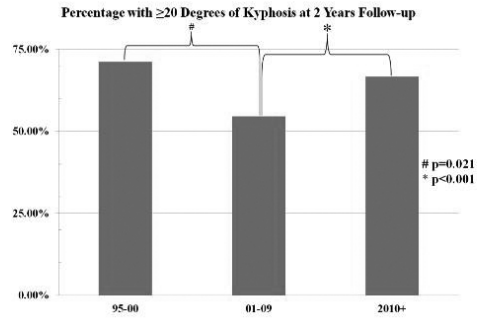
Results

Significant changes were seen in the 3 time periods. Improvement in TK was achieved in the latest time cohort compared to the middle cohort. Those patients restored to >20° kyphosis with a contemporary posterior approach has steadily improved to that of the era when anterior approaches were more common. See Table and Graph.

Conclusion

Although the shift from anterior to posterior approaches in AIS was initialy associated with inferior TK restoration, it improved with time. This may be related to the adoption of new techniques such as posterior column osteotomies, aggressive rod contouring and 3D correction.

1995-2000	2001-2009	2010-2015	
Preoperative 3D Thoracic Kyphosis			
0.28±7.30°	-1.13±8.62°	-1.00±8.51°	
Postoperative 3D Thoracic Kyphosis			
25.81±7.97°	21.05±7.53°	23.37±7.03°	
Approach Used			2-way ANOVA (time x group) *p*-value
73.10% ASF 25.0% PSF 1.90% PSF+AR	10.00% ASF 84.10% PSF 5.90% PSF+AR	0.00% ASF 95.70% PSF 4.30% PSF+AR	**0.001**
Change in 3D Thoracic Kyphosis			2-way ANOVA (time x group) *p*-value
25.53±10.07°	22.17±9.31°	24.37±8.99°	**<0.001**
Bonferroni correction *p*-values		1995-2000 vs. 2001-2009	**0.037**
		1995-2000 vs. 2010-2015	0.990
		2001-2009 vs. 2010-2015	**<0.001**
Percentage with ≥20 Degrees of Kyphosis at 2 Years Follow-up			2-way ANOVA (time x group) *p*-value
71.20%	54.50%	66.70%	**0.001**
Bonferroni correction *p*-values		1995-2000 vs. 2001-2009	**0.021**
		1995-2000 vs. 2010-2015	0.513
		2001-2009 vs. 2010-2015	**<0.001**



.

56. Reciprocal Change in Sagittal Profiles after Adolescent vs Adult Idiopathic Scoliosis Surgery: A Comparison Using Full-Body X-ray

Takayoshi Shimizu, MD, PhD; Ronald A. Lehman, MD; J. Alex Sielatycki, MD; Suthipas Pongmanee, MD; Lawrence G. Lenke, MD

Summary

This radiographic analysis using a full-body X-ray evaluated the ways in which the sagittal profiles of the unfused segments and lower extremities spontaneously changed after adolescent and adult idiopathic scoliosis surgery. There was a linear correlation between the lordotic changes in the cervical and lumbar spines and adequate restoration of TK in AIS patients. Conversely, in AdIS patients, the pelvis and lower extremities demonstrated significant correlation with iatrogenic thoracolumbar alignment change, while showing relatively small changes in the cervical spine.

Hypothesis

The compensatory mechanisms in the cervical and lumbar spine spontaneously improve after adequate restoration of TK in adolescent idiopathic scoliosis (AIS) pts. In adult idiopathic scoliosis (AdIS) pts., the change in cervical spine is small due to degenerative loss of flexibility.

Design

Single-center cohort study

Introduction

Reciprocal lordotic changes in unfused spinal segments after AIS surgery have been reported. However, a full-body analysis and a comparison with AdIS have not been studied.

Methods

The sagittal profile of 51 AIS and 45 AdIS pts were compared. The pts. were preoperatively subcategorized according to thoracic kyphosis (TK: T5-12): hypokyphotic (TK<20°) and normo-hyperkyphotc (TK>20°). The postoperative change in the sagittal parameters and the correlation between the iatrogenic changes and reciprocal changes of unfused segments were analyzed.

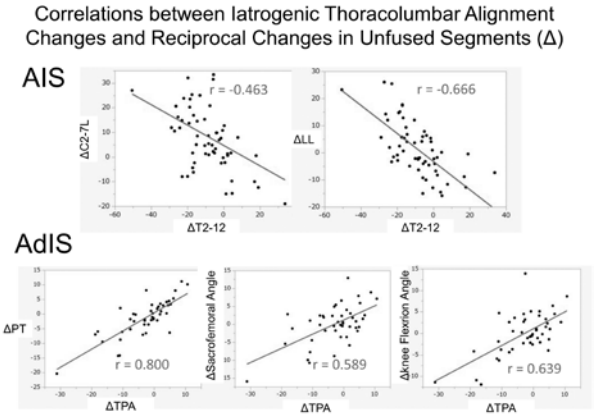
Results

At the baseline, the AdIS pts. showed more subaxial lordosis (C2-7L; 2.0±2.0° vs -7.6±1.9°, P<0.01), loss of lumbar lordosis (LL; -44.2±2.4° vs -60.5±2.3°, P<0.01), and reliance on compensation by the pelvis, hip extension, and knee flexion than the AIS pts. Postoperatively, the cervical alignment changed significantly lordotic after the preservation of TK in both hypo and normo-hyper kyphotic groups in the AIS pts, while those changes were small in the AdIS pts. Linear correlations were observed between iatrogenic change of TK (T2-12) and reciprocal changes of C2-7L (r= -0.463) and LL (r= -0.666) in the AIS pts., whereas, there were linear correlations between the iatrogenic change in T1-pelvic angle (TPA) and pelvic tilt (r= 0.800) and the lower extremity parameters in the ADIS pts (Figure).

Conclusion

There was a linear correlation between the lordotic reciprocal change in the cervical spine alignment, as well as increases in lumbar lordosis with adequate restoration of thoracic kyphosis in AIS patients. Conversely, in AdIS patients, the pelvis and lower extremities demonstrated significant correlation with iatrogenic thoracolumbar alignment change, while showing relatively small changes in the cervical spine, likely due to degenerative loss of flexibility

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*



.

57. Is Intraoperative Traction With Posterior Only Approach an Alternative to Anterior-Posterior Strategy in Correction of Severe Adolescent Idiopathic Scoliosis? A Comparative Study

Hardik Suthar, MS; Sajan Hegde, MD; Pramod Sudarshan, MS; Vamsi Krishna Varma Penumatsa, MS; Appaji Krishnan Krishnamurthy, MBBS, MS; Muralidharan Venkatesan, FRCS

Summary
Traditionally anterior release followed by posterior instrumented correction has been recommended for large and stiff scoliotic curves in the adolescent. Recently, posterior based segmental spinal instrumentation has shown increased correction of larger curves, but it is not without need for osteotomies and iatrogenic spinal cord injury. The use of intraoperative traction as an adjunct for posterior only approach reduces the pre-instrumentation deformity magnitude and obviates the need for complex osteotomies and excessive correction manoeuvres.

Hypothesis
To evaluate the effect of intraoperative traction as an adjunct for posterior only approach on surgical correction of severe adolescent idiopathic scoliosis (AIS)

Design
Single center retrospective study comparing cohort of patients having intra-op traction during posterior spinal instrumentation and fusion (PSIF) and a historical control group who had anterior release followed by posterior approach correction strategy for severe AIS.

Introduction
Morbidity associated with combined approach and increase risks of neurological injury with posterior based complex osteotomies and also increase blood loss and prolonged operative duration have been documented. Pre-operative Halo traction requires long period of hospital stay which add to the total cost of surgery. The use of intraoperative traction to facilitate pre-instrumentation curve correction is not widely practiced.

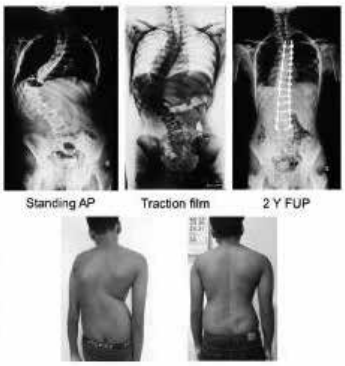
Methods
Medical records of 217 AIS patients operated from 2006 to 2015 have been reviewed. 29 severe AIS whose primary curve was more than 90° were included in this study and divided into two groups. Group A included 13 patients who had combined anterior release ± instrumentation followed by posterior instrumented fusion (2006-2011) and Group B included 16 patients having intraoperative skull tong-lower limb skin traction during posterior spinal instrumentation and fusion (2012-2015). Operative time, blood loss, hospital stay, correction of Cobb's angle, spinal balance and functional assessment with SRS-22 score were done.

Results
With a minimum 2-year follow-up, similar results were found between the groups in terms of correction rate and functional outcome. However, Operative time, blood loss and length of hospital stay were significantly less in Group B (Fig.1). Post-operative spinal balance was achieved in both the groups.

Conclusion
In this study, we found that posterior only approach with intraoperative traction as adjunct could provide a correction similar to that of an anterior-posterior approach in AIS patients with severe curves without doing complex osteotomies. It decreases the operative time and blood loss.

Table: Comparative analysis b/w groups

	Group A	Group B	P value
No. of patients	13	16	
Mean Age (Years)	17+2	16+4	0.12
Pre-op Cobb's °	98.9	100.8	0.51
Bending Cobb's°	73.1	71.2	0.34
Post-op Cobb's °	38.8	34.8	0.22
% of correction	60.7	65.9	0.12
Operative time (minutes)	412± 76	236±48	<0.0001
Blood loss (ml)	1241±304	860±213	<0.0001
Average days of Hospital stay	7.7	5.1	<0.0001
Mean SRS score	4.01	4.12	0.89



58. Paper #58 The View in The Mirror: Anterior Surface Topography and the Truncal Anterior Asymmetry Scoliosis Questionnaire in AIS

Baron S. Lonner, MD; Yuan Ren, PhD; Andrea Castillo, MD

Summary
Patients undergoing corrective surgery for AIS are most affected by self-image and body shape. There is a lack of data on the impact of scoliosis on anterior trunk shape. In this study, we developed an Anterior Asymmetry Scoring (AAS) system using surface topography. Anterior truncal deformity in operative AIS has been defined and several correlations between a number of radiographic, ST, and clinical parameters with a validated anterior asymmetry questionnaire have been established.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Hypothesis
Surface Topography (ST) directly assesses the anterior deformity in female AIS patients and correlates with HRQOL outcomes.

Design
Prospective observational study

Introduction
Patients undergoing corrective surgery for AIS are most affected by self-image and body shape. There is a lack of data on the impact of scoliosis on anterior trunk shape. In this study, we developed an Anterior Asymmetry Scoring (AAS) system using ST, a validated, radiation-free assessment tool, to directly assess the anterior deformity in female AIS patients.

Methods
Twenty-seven consecutive operative AIS patients had radiographs, anterior ST, and completed questionnaires. AAS which measures shoulder line imbalance, breast and waist asymmetry was calculated (range 0-100; higher AAS indicates more severe deformity). The relationship between AAS, SRS-22r and Truncal Anterior Asymmetry Scoliosis Questionnaire (TAASQ) scores were evaluated by linear regression.

Results
Mean age was 14.8±2.6 years. Major Cobb angle was 49.3±7.4° with a corresponding ST scoliosis angle of 37.5±13.9° (p=0.0522; r=0.38). Pre-op AAS was 26.3±8, which correlated with radiographic Cobb magnitude (p=0.0461; r=0.39), ST scoliosis angle (p=0.0226; r=0.44) and thoracolumbar inclinometer (p=0.0511; r=0.39). Significant associations were observed between AAS shoulder domain and TAASQ clothing (p=0.0227; p=0.45) and breast domains (p=0.0045; r=0.55). AAS breast slope and protrusion domains were highly correlated with TAASQ breast location (p=0.0030; r=0.57) and size domains (p=0.03; r=0.46), respectively. AAS waist slope domain was associated with TAASQ breast shape (p=0.0111; r=0.50) and size domains (p=0.0020; r=0.59).

Conclusion
Anterior truncal deformity in operative AIS has been defined using ST, radiographs, and a previously validated anterior asymmetry questionnaire. Correlations between a number of radiographic, ST, and clinical parameters with the TAASQ have been established and will serve as a basis for assessing post-operative improvements that can be used to counsel families

59. Quality Improvement in Post-Operative Opiate and Benzodiazepine Regimen in Adolescent Patients after Posterior Spinal Fusion

Vidyadhar Upasani, MD; Amelia Lindgren, MD; Rebecca Bennett, MS, BSN, PPCNP-BC; Burt Yaszay, MD; Peter Newton, MD

Summary
Prescription opiate abuse is increasing in the United States and adolescents are susceptible to misuse. This study evaluates the opiate and benzodiazepine consumption by adolescents after posterior spinal fusion with the aim to refine post-operative pain prescriptions. Seventeen patients completed pain diaries to track prescription use, and received a median of 27 oxycodone doses and 7 diazepam doses for an average of 15 days. This data has directly impacted clinical practice. Prescriptions have decreased substantially and initiated further research.

Hypothesis
Adolescents are prescribed excess opiates and benzodiazepines after posterior spinal fusion (PSF). By evaluating the opiate and benzodiazepine consumption post-operatively, outpatient prescriptions will be refined.

Design
Prospective cohort study

Introduction
The incidence of prescription opiate abuse is increasing in the United States. Orthopedic spine surgeons often prescribe opiates post-operatively for pain control, and it is known that adolescents are highly susceptible to opiate misuse. Previous efforts on pain control have focused on decreasing variability in in-patient post-operative pain regimen and decreasing hospital stay after PSF. This study highlights the importance of analyzing the outpatient pain management regimen to avoid over prescribing opiate medications that could lead to future misuse.

Methods
Between 2/1/17-12/31/17, 67 adolescents who underwent PSF for adolescent idiopathic scoliosis (AIS) or Scheuermann's kyphosis (SK) were sent home with a detailed pain diary. They recorded daily opiate and adjunctive medication use, pain scores, functional level, and pain control satisfaction. An opiate dose is defined as 5mg of oxycodone and a benzodiazepine dose as 1mg of diazepam. The pain diaries were collected at the 4-week post-op visit. Data were reviewed and descriptive statistics were performed.

Results
Pain diaries were collected on 17 patients (25%; 5 males, 12 females; 15 AIS, 2 SK; mean age 14.3 years). Patients required opiates for 15 days on average after surgery (5-33, SD=7.4), and a median of 27 doses of oxycodone (0-129; SD=33.2) and 7 doses of diazepam (0-210; SD=51.7) post discharge. The mean pain score on the last day of opiate use was 3.4 (0-7.5; SD=2.1). 87.5% of patients were satisfied with pain control on the day of last opiate use, and all had returned to school prior to the 4-week post-operative visit

Conclusion
This analysis has directly impacted clinical practice. Prescribed opiate and benzodiazepine doses have been decreased substantially and more resources are being directed towards determining the disparity between the amount of medications prescribed and consumed in our post-operative patients.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

60. Two AIS Spine Surgeries on the Same Day by the Same Surgeon: Is Performance and Outcome the Same?

Lorena Floccari, MD; Daniel J. Sucato, MD, MS; Kiley Poppino, BS; Surya Mundluru, MD; Amy McIntosh, MD; Karl E. Rathjen, MD

Summary
Performing two AIS cases in one day by the same surgeon is a new approach to increase efficiency and value. In this series, operative time was reduced by 44 minutes ($p = 0.008$) in the first case compared to a matched control, despite no difference in implant density, curve correction, or complication rate. This represents a direct cost savings of $9183.68 per patient. Performing two AIS cases in one day by the same surgeon is efficient, safe, and cost-effective.

Hypothesis
There is no difference in overall performance and complication rate in two-a-day AIS surgery days when compared to single surgery days.

Design
Retrospective matched cohort using prospectively collected data

Introduction
As a method to improve efficiency and operating room utilization, some surgeons are now performing two AIS surgeries with the same team in a single day. However, there are concerns with this new model, as the performance, outcomes, and risk profile have not been studied.

Methods
A prospectively collected series of AIS patients who underwent posterior spinal fusion on the same day as a second AIS patient by the same surgeon/surgical team were retrospectively reviewed. Patients were grouped based on whether they were the first (S1) or second (S2) AIS case of the day. These patients were matched (M1 and M2) by surgeon, curve magnitude, Lenke classification, and fusion levels.

Results
There were 56 patients without differences between the S1, S2, M1, and M2 cohorts in age, gender, BMI, or curve magnitude (66° vs. 62° vs. 65° vs. 63°). Surgical time was shorter for the S1 group (17.2 min/level) compared to M1 (20.5) for an operative time reduction of 44 minutes ($p=0.008$), despite no difference in implant density (1.29 vs. 1.26, $p=0.37$). This represents a 15% reduction in OR time ($9183.68 per patient). The patients in S2 left the operating room at 5:33 PM (3:41 to 7:17 PM). There were no differences between the S1, S2, M1, and M2 groups in curve correction (65.8% vs. 62.8% vs. 66.1% vs. 58.5%), estimated blood loss (EBL) (45 vs. 47 vs. 47 vs. 54 cc/level), length of stay (3.1 vs. 3.4 vs. 3.2 vs. 3.3 days), or complication rate. One S2 patient had a medial breech that required screw revision. There were no permanent neurologic deficits in any patient.

Conclusion
When performing two AIS surgeries on the same day, surgical time was shortened by 44 minutes on the first case for a direct cost savings of $9183.68 per patient. This may be a reflection of the team moving along more efficiently, given the full operative day scheduled. The performance measures of curve correction, EBL, complications, and length of stay did not decline in this new model.

61. A New Posterior Dynamic Device for Correction of Moderate Adolescent Idiopathic Scoliosis: 27 Cases with Two to Five Years of Follow up

Yizhar Floman, MD; Stefan Gavriliu, MD, PhD; Tomasz Potaczek, MD, PhD; Daniel Zarzycki, MD, PhD; Biren Desai, MD; Miklos Tunyogi-Csapo, MD, PhD; Nick Sekouris, PhD; Michael A. Millgram, MD; Ron El-Hawary, MD, MS; Baron Lonner, MD; Randal R. Betz, MD

Summary
A posterior dynamic deformity correction device, consisting of an expandable ratcheting rod anchored by two pedicle screws to the concave side of the scoliotic spine, was evaluated. This study of 27 patients with 2-5 year follow-up demonstrated that consistent curve improvement and stabilization of moderate (30°-60°) AIS curves can be achieved with this device.

Hypothesis
This non-fusion posterior dynamic deformity correction device will reduce and maintain correction of moderate AIS at short term follow-up.

Design
A retrospective multicenter trial

Introduction
The standard surgical management of AIS is spinal fusion. Nonfusion solutions are desirable. The dynamic device used in this study was developed to address moderate Lenke type 1 or 5 curves. The objective of this study was to analyze the results of this device in reducing and maintaining the correction of moderate AIS.

Methods
The inclusion criteria for this study were: AIS (12-17 years), Lenke 1 (40°-60°), Lenke 5 (30°-60°), and flexibility to ≤ 35□. The concavity of the major curve was instrumented with two pedicle screws that were connected to an expandable ratcheting rod with unique ceramic coating. Each device/screw connection allows 50□ of freedom in all directions. Curve reduction was performed intraoperatively via the device and further corrected post-operatively with stretching exercises performed by the patient.

Results
Of the 40 patients identified, 28 patients met the inclusion criteria. One patient had deep wound infection at 1 year and the implant was removed, leaving 27 patients for clinical and radiographic follow up > 24 months (average 2.8, range 2-5) with > Risser 4 at final follow up. The average preoperative major curve was 44° (32°-55°) which improved to 29° (6°-45°) at final follow up ($p<0.05$) with major curve correction of 38% (15%-81%). The sagittal profile was minimally changed toward more normal after surgery. Trunk shift was reduced by average 10 mm (0-13 mm). The average preoperative SRS-22 self-image score was 3.1 (2.4-3.8), improving to 3.7 (3.2-4.4) 3-6 months

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

after surgery and remained stable thereafter (P<0.05). There was no adding on, curve progression, or implant failures.

Conclusion
This study, with 2-5 years of follow-up, showed consistent curve improvement and stabilization. It lends support to the concept that this new posterior dynamic deformity correction device may be a viable alternative to fusion and failed bracing for managing moderate AIS.

62. Predictive Model of Spine Correction Following Anterior Vertebral Body Growth Modulation in Adolescent with Idiopathic Scoliosis.

Olivier Turcot, BS; Dejan Knez, MS; Tomaz Vrtovec, PhD; Samuel Kadoury, PhD; *Stefan Parent, MD, PhD*

Summary
Anterior Vertebral Body Growth Modulation (AVBGM) aims to gradually correct scoliosis while preserving spine motion. The selection of surgical patients is currently based on clinical judgment but would be facilitated by the identification of patients that would respond to AVBGM. We developed a progression prediction model, which predicts the 3D geometry of instrumented spine segments based on clinical and radiological data acquired pre- and postoperatively. This model offers accurate predictions of the immediate and long-term postoperative Cobb angle correction.

Hypothesis
Postoperative reduction of the Cobb angle following AVBGM can be predicted with a data-driven model using preoperative anatomical and clinical data with known postoperative outcomes.

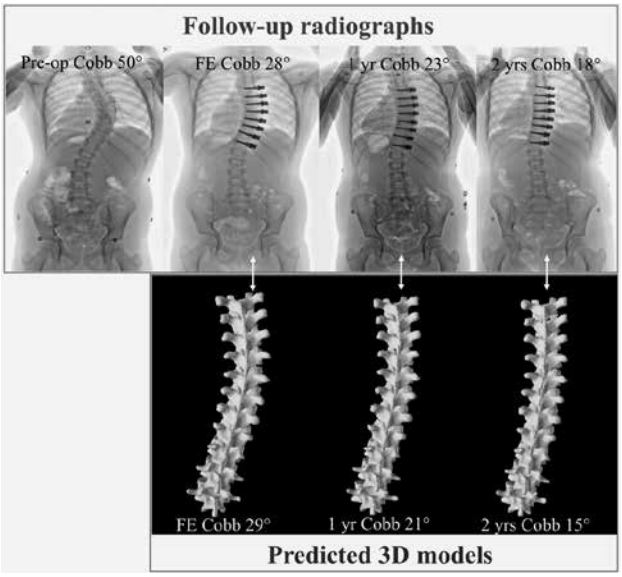
Design
To train a machine-learning algorithm from a prospectively collected cohort who underwent AVBGM.

Introduction
The selection of patients operated with AVBGM remains a challenge and is based on the surgeon's experience. Developing a predictive tool of Cobb angle correction using 3D spine reconstructions at the First Erect (FE), 1-year and 2-year postoperative exam from scoliotic patients undergoing AVBGM can help identify patients better suited for this procedure.

Methods
Clinical and radiological data of 58 patients who underwent AVBGM at our institution was collected prior to surgery, at the FE, at 1-year and 2-year visits. At each visit, a 3D reconstruction of the spine was obtained from calibrated bi-planar radiographs. A Procrustes alignment was applied on all 3D reconstructions, followed by training of a Support Vector Machine (SVM) using preoperative clinical data (age, menarche, Risser stage, triradiate cartilage and spine flexibility). At testing, given an input preoperative 3D reconstruction with clinical data, the model predicts the 3D geometry at each time-point, from which the 3D Cobb angle can be calculated. Validation was performed in a leave-one-out fashion, where the difference between the original and predicted Cobb angle and 3D spine geometry are reported.

Results
At the FE, the predicted Cobb angles differed on average by 4.0±0.8° to the actual correction (n=58), with a 3.3±1.0mm error in 3D geometry prediction. At one year follow-up, the predicted Cobb angle error was of 6.8±0.7° (n=32), with a 3.8±1.1mm error in geometry prediction. For the 2-year follow-up, the predicted Cobb angle difference was of 5.4±1.0° (n=24), with a 3.3±1.0mm error in 3D geometry.

Conclusion
The trained SVM model offers an accurate prediction of spine morphology and Cobb angle correction obtained at the FE, 1-year and 2-years postoperatively. The predictive model could be used for patient selection of AVBGM as a decision-sharing tool prior to surgery.



.

63. Can Posterior Implant Removal Protect Device-Related Vertebral Osteopenia After Posterior Fusion In Adolescent Idiopathic Scoliosis?: The Mean 29 Years Follow-Up Study

Kei Watanabe, MD, PhD; *Masayuki Ohashi, MD, PhD;* Toru Hirano, MD, PhD; Hirokazu Shoji, MD; Tatsuki Mizouchi, MD; Naoto Endo, MD, PhD; Kazuhiro Hasegawa, MD; Hideaki Takahashi, MD, PhD

Summary
Instrumented PSF caused lower HU values of the vertebral body within fusion are during 20 years and over follow-up period. Posterior implant removal could not protect the secondary vertebral osteopenia, whereas no adverse events including deformity correction loss were found.

Hypothesis
Posterior implant removal protect stress shielding induced vertebral osteopenia within fusion area in surgically treated patients with adolescent idiopathic scoliosis(AIS).

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Design
Long-term follow-up study.

Introduction
There have been several reports regarding secondary vertebral osteoporosis after rigid spinal stabilization; however, the long-term effect of device-related vertebral osteopenia after posterior spinal fusion (PSF) for AIS has not been clarified.

Methods
Eighteen major thoracic AIS patients [mean age at op. 14.5 years (11–20); mean follow-up 28.8 years (20–39)] who underwent PSF alone between 1973 and 1994 were included. Participants were divided into: an implant removal group (group R, n=10, mean interval until implant removal 50 months) and a non-implant removal group (group NR, n=8). Bone mineral density was evaluated by Hounsfield units (HU), a standardized computed tomography attenuation coefficient, from full spine computed tomography (CT). The HU values of the following vertebrae were obtained;1 level below the uppermost instrumented vertebra (UIV-1), apex, 1 level above the lowermost instrumented vertebra (LIV+1), and 1 level below the lowermost instrumented vertebra (LIV-1) as a standard value. The stress shielding induced vertebral osteopenia was assessed by the UIV-1-, apex-, LIV+1-to-LIV-1 HU ratio (×100).

Results
On the whole, the apex (140.1±50.1), and LIV+1 (151.7±40.6) demonstrated lower HU values than the LIV-1 (179.4±33.9) (both comparisons, $p<0.05$). In comparison between the group R and NR, there were no significant differences in scoliosis correction rates, bone mineral density of proximal femur, and HU values of the investigating vertebrae. All HU ratios of the investigating vertebrae demonstrated no significant differences between the 2 groups. (see, Table)

Conclusion
Instrumented PSF cause stress shielding induced osteopenia of vertebral body within fusion area in adulthood. Posterior implant removal can not protect the secondary osteopenia probably due to formation of stable fusion mass.

Table: Comparisons of investigating parameters between the group R and NR

	R group (n=10)	NR group (n=8)	p value
Age at survey, mean (SD), [year]	49.2 (4.7)	35.9 (5.1)	0.0007
Number of fused segments, mean (SD), [segment]	9.5 (0.7)	8.7 (3.3)	0.6807
Follow-up period, mean (SD), [year]	34.5 (4.1)	21.6 (1.9)	0.0005
Correction rate of MT curve, mean (SD), [°]	20.1 (23.1)	31.8 (13.0)	0.2863
Correction loss of MT curve between PO2Y and final follow-up, mean (SD), [°]	6.0 (9.1)	4.2 (4.6)	0.7749
Correction rate of TL/L curve, mean (SD), [°]	25.3 (33.0)	22.6 (26.9)	0.8474
Correction loss of TL/L curve between PO2Y and final follow-up, mean (SD), [°]	4.3 (8.2)	1.3 (6.1)	0.4289
BMD of the proximal femur, mean (SD), [g/cm^2]	0.752 (0.097)	0.810 (0.117)	0.2076
T-score, mean (SD)	-1.088 (0.876)	-0.488 (1.051)	0.1719
HU value of the vertebral body calculated using CT			
UIV-1, mean (SD), [HU]	164.7 (35.5)	181.7 (55.8)	0.4772
Apex, mean (SD), [HU]	126.9 (50.0)	156.6 (48.2)	0.2135
LIV+1, mean (SD), [HU]	142.8 (33.7)	162.9 (47.9)	0.2481
LIV-1 (standard value), mean (SD), [HU]	171.4 (30.1)	189.4 (37.7)	0.2481
UIV-1-to-LIV-1 ratio, mean (SD), [%]	96.2 (13.8)	94.5 (15.8)	0.7898
Apex-to-LIV-1 ratio, mean (SD), [%]	72.6 (24.1)	81.3 (15.6)	0.4239
LIV+1-to-LIV-1 ratio, mean (SD), [%]	82.8 (13.5)	84.5 (10.6)	>0.9999

Abbreviations: SD, standard deviation; MT, main thoracic; TL/L, thoracolumbar/lumbar; BMD, bone mineral density

64. Revision Procedures Do Not Affect the One-Year Survival in Patients Operated for Acute Metastatic Spinal Cord Compression

Maria Eisenhardt, MD; *Soren Schmidt Morgen, MD, PhD;* Martin Gehrchen, MD, PhD; Benny T. Dahl, MD, PhD

Summary
In a one-center prospective cohort study we assessed whether survival in MSCC patients is affected by revision, body mass index (BMI) and the ASA – score. One-year mortality was not significantly affected by revision (P=0.659) or BMI (P=0.314), but increasing ASA-score was significantly associated with a shorter survival ($P < 0.001$).

Hypothesis
The survival of MSCC patients operated is affected by revision surgery, BMI and ASA - score.

Design
A one-center, prospective, cohort study.

Introduction
Patients with metastatic spinal cord compression (MSCC) often benefit from surgical treatment. But due to the poor general condition in the majority of these patients, revision surgery may result in significant morbidity. The purpose of the present study was to assess whether survival in MSCC patients is affected by re-operations, body mass index (BMI) or the American society of anesthesiologists (ASA) – score.

Methods
A total of 479 patients underwent surgery for MSCC from Febuary 2008 through December 2013 and were enrolled in a one-center, prospective, cohort study. Information on BMI, ASA-score, revision surgery, and survival status was analyzed with minimum follow-up period of one-year. Chi-square or Fischer's exact tests were used to compare survival between groups categorized according to revision (yes/no), BMI and ASA-score. A p values < 0.05 was considered significant.

Results
A total of 47 patients had one or more revision procedures. There was no significant difference in the one-year survival between the patients undergoing one or more revision procedures compared to patients who did no undergo revision surgery (P=0.659). BMI did not affect the one-year mortality significantly (P=0.314) but one-year survival was negatively associated with increased ASA-score ($P < 0.001$).

Conclusion
Revision surgery and BMI do not affect one-year survival in patients operated for MSCC, whereas an increasing ASA-score is associated with a shorter survival.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

65. Prevention Of Surgical Site Infections in Spine Tumor Surgery: A Comparison Of Three Methods

Avionna Baldwin, BS; Eric Emanski, MD; Devin Williams, BS, MPH; *Addisu Mesfin, MD*

Summary
Wound complications and infections are common following spine tumor surgery. We compared three methods to decrease SSI: Intrawound vancomycin powder and betadine irrigation (IVB), intrawound vancomycin only (IV) and a control group (none). A combination of intrawound vancomycin powder and betadine irrigation appeared to have a synergistic effect and led to a significant reduction in surgical site infection rates in spine tumor patients (3% IVB, 15% IV, 16% None).

Hypothesis
Intrawound vancomycin combined with betadine irrigation (IVB) will lead to a decrease in surgical site infections in spine tumor patients

Design
Retrospective review of prospectively collected data

Introduction
Surgical site infections (SSI) occur in 5% to 30% of spine tumor surgeries. Risk factors include malnutrition, pre-operative radiation treatment and weakened immune system. Intrawound vancomycin (IV) powder has been shown to decrease infections following spine tumor surgery. The synergistic effects of intrawound vancomycin and betadine irrigation (IVB) in decrease SSI rates following spine tumor surgery have not been studied.

Methods
Patients undergoing spine tumor surgery at a tertiary referral center 6/2003 to 8/2017 were enrolled. Patients with intradural tumors and missing medical information were excluded. The use of intraoperative intrawound antibiotics, betadine irrigation and other operative information (surgical time, EBL, intraoperative complications, and levels instrumented). were collected along with demographics. Patients were grouped into Intrawound vancomycin powder (IV), Intawound vancomycin powder and betadine irrigation (IVB) and patients receiving neither (None). Rates of SSI among the three groups were evaluated.

Results
144 patients underwent 167 surgeries. Average age was 58.2. Between the three groups there was no significant differences in the following parameters: age, gender, race, and primary, secondary, or hematologic malignancy. Within total procedures, the overall infection rate was 11% (18/167). The rate of SSI in the IVB group was significantly decreased (3%) as compared to the IV (15%), and None (16%) ($p<0.05$) groups. The presence of pre-operative radiation in patients with infections was similar between groups: IVB (16.7%), IV (11.1%), and None (18.2%) (Fig. 1C).

Conclusion
Wound complications and infections are common following spine tumor surgery. A combination of intrawound vancomycin powder and betadine irrigation appeared to have a synergistic effect and led to a significant reduction in surgical site infection rates in spine tumor patients.

66. Modified Frailty Index Does Not Predict Survival in Patients with Metastatic Spine Disease

Illina Mohd Rothi, MBBS; Godwin Choy, FRACS; *Hamish Deverall, FRACS;* Joseph Baker, FRCS

Summary
A comparison of the mFI with recognized prognostic scores for metastatic spine disease demonstrated the mFI to be markedly inferior in predicting survival.

Hypothesis
The Modified Frailty Index (mFI) has been shown to correlate with the risk of morbidity and mortality after a variety of spinal pathologies. We hypothesized that the same may hold true in the setting of metastatic spine disease.

Design
Retrospective analysis of spinal column metastases treated surgically in a tertiary referral centre.

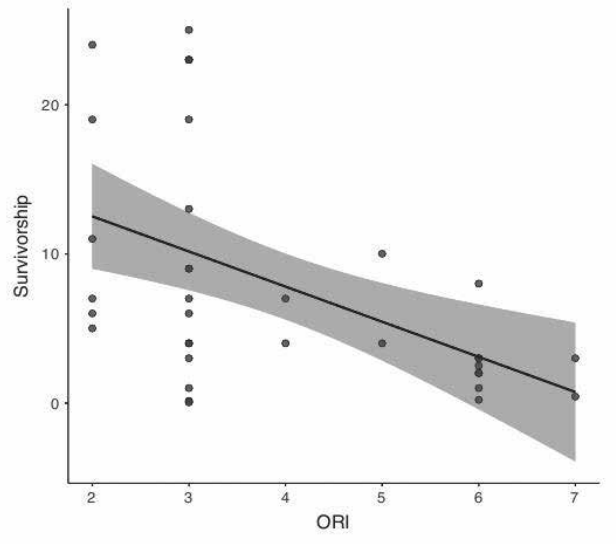
Introduction
A variety of scoring systems are available to give prognosis in the setting of metastatic spine disease and aid clinicians and patients in making treatment decisions. The modified Frailty Index (mFI) is a proportional score (0-1) based on the presence or absence of 11 diseases with a higher score indicative of frailer state. The aim of this study was the compare the mFI to other disease-specific prognostic scores for metastatic spine disease.

Methods
A retrospective analysis of patients treated surgically for metastatic spine disease was perfumed. Survivorship was assessed and correlation analysis perfumed with each of the mFI and recognized prognostic scoring tools including the Oswestry Spine Risk Index (OSRI), the modified Tokuhashi, the modified Bauer and the modified Tomita Scores. Correlation matrices were used and significant variable analyses further with regression analysis.

Results
41 patients (15 female) with a mean age 64 years were included. 11 had prostate cancer, 6 breast, 5 lung. 37/41 were deceased at time of analysis with mean survival of 29 weeks. None of patient age, duration of symptoms, preoperative neurological status nor pre-operative functional status correlated significantly with survival. The mFI poorly correlated with survivorship ($r=-0.089$, $p=0.6$). The modified Tokuhashi ($r=0.376$), Tomita ($r=-0.419$) and Bauer Scores ($r=0.360$) as well as the OSRI ($r=-0.503$) were all significantly correlated with survival (all $p<0.03$).

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Conclusion
The mFI correlated poorly with survival in this study while the recognized prognostic tools all performed similarly. To aid in prognosis a disease-specific tool should be used.



.

67. Pediatric Cervical Spine Clearance: A Multi-Disciplinary Consensus Statement and Algorithm from the Pediatric Cervical Spine Clearance Working Group

Martin Herman, MD; *Burt Yaszay, MD;* Jonathan H. Phillips, MD

Summary
By employing a modified Delphi method, the Pediatric Cervical Spine Working Group has created a multi-disciplinary consensus statement and algorithm for pediatric cervical spine clearance. The group consisted of 25 physicians in 5 different pediatric specialties from 20 institutions across the country. The algorithm focuses on minimizing the risk of missed injury and protecting patients from unnecessary imaging. This approach may serve as a starting point for institutions creating a protocol and as a template for future study.

Hypothesis
A multi-disciplinary group of experts can create a consensus statement and algorithm for pediatric cervical spine clearance using a modified Delphi Method.

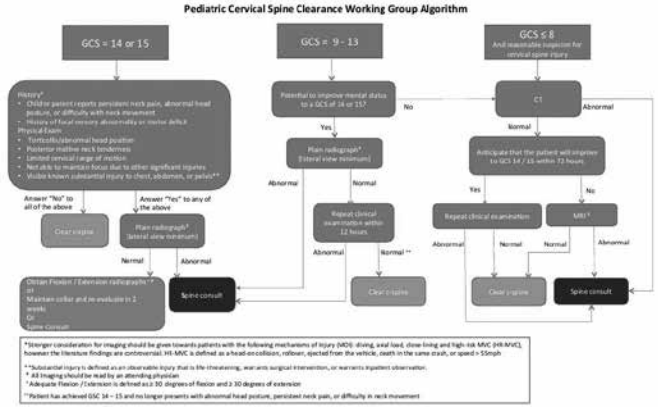
Design
A modified Delphi method was employed to create a multi-disciplinary consensus statement and algorithm.

Introduction
One recent survey of Level One Pediatric Trauma Centers shows only 46% of institutions utilize a standardized, written pediatric cervical spine clearance protocol. This study aims to create an expert, multi-disciplinary consensus statement and algorithm for pediatric cervical spine clearance by employing a modified Delphi method.

Methods
The Pediatric Cervical Spine Working Group was comprised of pediatric orthopedic surgeons (n=15), pediatric emergency medicine physicians (n=3), pediatric trauma surgeons (n=2), pediatric neurosurgeons (n=3), and pediatric radiologists (n=2). In total, 25 physicians from 20 different institutions participated in a modified Delphi process using on-line surveys and a face-to-face meeting. Consensus was defined as ≥80% agreement. The results were then converted into an algorithm. The project was supported by grants from the Texas Scottish Rite Hospital and the Pediatric Orthopedic Society of North America.

Results
Overall, consensus was reached on 22 statements. Three ranges of Glasgow Coma Scale scores determine the algorithmic pathways: GCS 14 or 15, GCS ≤ 8 and GCS 9-13. The GCS 14 or 15 pathway focuses on clinical clearance with the goal of minimizing patient radiation exposure. The GCS ≤ 8 pathway focuses on appropriate imaging when physical exam is incomplete and neurological function is unlikely to be restored within 72 hours of injury. The GCS 9-13 pathway focuses on use of clinical judgment and judicious use of CT upon admission for patients with potential for normalization of GCS score within 72 hours of injury.

Conclusion
Using a modified Delphi method, a multi-disciplinary consensus statement and algorithm for pediatric cervical spine clearance was created. This approach focused on minimizing the risk of missed injury while protecting patients from unnecessary imaging.



.

68. Surgical Treatment for Non-union after Osteoporotic Vertebral Fracture: Multicenter Study by Japan Association of Spine Surgeons with Ambition (JASA)

Naobumi Hosogane, MD, PhD; Ken Ishii, MD, PhD; Hitoshi Kono, MD; Norihiro Isogai, MD; Kota Watanabe, MD, PhD; Hideaki Imabayashi, MD, PhD; Kazuhiro Chiba, MD

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Summary
This was a multicenter retrospective study of 405 patients with non-union after osteoporotic vertebral fracture (OVF) who underwent fusion surgery with minimum 1-year follow-up. Posterior fusion was performed in 86.4% of the patients. Perioperative complications and implant failure were found in 18 and 41% of the patients, respectively. VAS scores of low back pain and leg pain, and walking ability improved significantly at the final follow-up. This study indicates that fusion surgery is beneficial for elderly OVF patients with non-union.

Hypothesis
Fusion surgery is effective for OVF patients with non-union.

Design
Multicenter-retrospective study.

Introduction
Failure in conservative treatment for osteoporotic vertebral fracture (OVF) may lead to non-union or vertebral collapse resulting in neurological deficit and severe deterioration of ADL. In this study, a nation-wide multicenter study was conducted in Japan to elucidate the outcomes of surgical treatments for OVF non-union.

Methods
Total 405 patients (90 males, 315 females, mean age 73.8 years, mean follow-up 3.8 years) with neurological deficit due to vertebral collapse or non-union after OVF at T10-L5 who underwent fusion surgery with minimum 1 year follow-up were included. Patients with back pain due to kyphotic deformity without any neurological deficit or patients who underwent BKP were excluded. Radiological and clinical outcomes at baseline and at the final follow-up (FU) were evaluated.

Results
OVF was present at thoracolumbar junction in 329 patients (125 at T12, 117 at L1) and at mid to lower lumbar spine (L3-5) in 76 patients. Majority of OVFs occurred after a minor trauma such as falling down (55.3%) or lifting objects (8.4%). Short segment fusion including affected vertebra was conducted (mean 4.0 ± 2.0 vertebrae) with 255.9 minutes of surgery and 673.1g of blood loss. Posterior approach was employed in 86.4% of the patients, followed by combined anterior and posterior (8.1%), and anterior (5.4%) approach. Perioperative complication and implant failure were observed in 18% and 41%, respectively. VAS scores of low back pain (74.1 to 30.1mm) and leg pain (56.3 to 20.5mm) improved significantly at FU. Preoperatively, 52.6% of the patients were unable to walk and the rate of unambulatory patients decreased to 7.7% at FU. The rates of complication, implant failure, or improvement in clinical outcomes were equivalent among different surgical approach groups.

Conclusion
This study demonstrated substantial improvement in ADL was achieved by fusion surgery. Although, there was a considerable rate of complications, fusion surgery is beneficial for elderly OVF patients with non-union.

69. Utility of Neuromonitoring during Lumbar Pedicle Subtraction Osteotomy for Adult Spinal Deformity

Darryl Lau. MD; Russ Lyon, PhD, Cecilia L Dalle Ore, Vedat Deviren, MD, Justin S. Smith, MD, PhD, Christopher I. Shaffrey, MD, Christopher P. Ames, MD

Summary
The utility of intraoperative neuromonitoring via transcranial motor evoked potentials (MEP) was evaluated in 242 adult spinal deformity patients who under lumbar pedicle subtraction osteotomy. MEPs changes occurred in 15.7% of cases and new neurological deficit rate was 4.1%. With the threshold of 50% decrease in signals, the performance measures of MEPs to detect neurological deficits were low; sensitivity and positive predictive value were 30.0% and 7.9%, respectively. In addition, specificity and negative predictive value rates were only modest.

Hypothesis
Intraoperative neuromonitoring via transcranial motor evoked potentials (MEP) are limited in being able to consistently detect new postoperative neurological deficits.

Design
Retrospective review of large single surgeon cohort.

Introduction
The benefits and utility of routine neuromonitoring with MEP during lumbar spine surgery remain unclear. This study assesses the measures of performance and utility of transcranial MEP during lumbar pedicle subtraction osteotomy (PSO).

Methods
A retrospective study was performed of a single surgeon cohort of consecutive adult spinal deformity patients who underwent lumbar PSO from 2006 to 2016. A blinded neurophysiologist reviewed individual cases for MEP changes. Multivariate analysis was performed to determine whether changes correlated with neurological deficits. Measures of performance were calculated.

Results
A total of 242 lumbar PSO cases were included. MEP changes occurred in 38 (15.7%) cases: 21 (55.3%) transient and 17 (44.7%) permanent. Of permanent changes, 9 (52.9%) had no recovery and 8 (47.1%) had partial recovery of MEP signals. Changes occurred at a mean time of 8.8 minutes following PSO closure (range: during closure to 55 minutes after closure). Average MEP signal loss was 72.9%. Overall complication rate was 25.2% and incidence of new neurological deficits was 4.1%. On multivariate analysis, MEP signal loss of at least 50% was not associated or able to predict postoperative neurological deficits (p=0.429). Of the 38 MEP changes, a true positive was seen in 3 cases. Postoperative neurologic deficits without MEP changes occurred in 7 cases. Calculated measures of performance were as follows: sensitivity of 30.0%, specificity of 84.9%, positive predictive value of 7.9%, and negative

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

predictive value of 96.6%. Greater than 80% percent signal loss was significantly associated with a higher rate of neurological deficit (23.0% vs. 0.0%, p=0.021).

Conclusion
Neuromonitoring has a low positive predictive value and sensitivity for detection of new neurological deficits. Even when neuromonitoring is unchanged, patients still develop new neurological deficits. MEPs has significant limitations in lumbar PSO.

70. The Posterior Superior Iliac Spine (PSIS) and Sacral Laminar Slope (SLS) are Key Anatomic Landmarks for Freehand S2AI Screw Placement

James Lin, MD, MS; Lee Tan, MD; Chao Wei, MD; Jamal Shillingford, MD; Joseph Laratta, MD; Joseph M. Lombardi, MD; Yongjung J. Kim, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

Summary
Freehand placement of S2AI screws without fluoroscopy can be challenging given the variations in pelvic tilt between patients, especially in the setting of transitional lumbosacral anatomy, where unilateral lumbarization/sacralization of the transitional vertebra occasionally elevates the hemi-pelvis (Fig 1). We demonstrate that the PSIS and SLS are two key landmarks for reliable placement of freehand S2AI screws. The PSIS acts as a proxy for the location of the sciatic notch, and the SLS helps account for differences in pelvic tilt/orientation.

Hypothesis
We hypothesize that screw trajectories based on the PSIS and sacral laminar slope result in reliable freehand S2AI trajectories that traverse above the sciatic notch.

Design
A CT imaging study with two observers.

Introduction
S2AI screws for spinopelvic fixation have increased in popularity. Multiple techniques have been described to optimize screw placement, including fluoroscopy and navigation. Freehand placement of S2AI screws has been recently described. However, freehand placement without fluoroscopy can be challenging given variations in pelvic tilt and presence of transitional lumbosacral anatomy. We believe 2 anatomic landmarks are critical to reliable freehand placement S2AI screws: the PSIS the sacral laminar slope.

Methods
50 consecutive adult patients who underwent primary spinal deformity surgery were included in the study. Simulated S2AI screw trajectories were analyzed with 3D visualization software. Cephalocaudal coordinate for the starting point was 15mm cephalad to the PSIS. Mediolateral coordinate for the starting point was in line with the lateral border of the dorsal foramina. The cephalocaudal screw trajectory was perpendicular the sacral laminar slope.

Results
100 screw trajectories were measured. The mean sagittal screw angle was 44.0 ± 8.4 and the mean transverse angle was 37.3 ± 4.3. The mean starting point was 5.9 ± 5.8mm distal to caudal border of the S1 foramen. Mean screw length was 99.9 ± 18.6mm. Screw trajectories were on average 8.5 ± 4.3mm above the sciatic notch. 97 out of 100 screws were placed above the sciatic notch. In patients with transitional lumbosacral anatomy, the starting point on the lumbarized/sacralized side was 3.4mm higher than the contralateral unaffected side. (p=0.02)

Conclusion
The PSIS and sacral laminar slope are two key anatomic landmarks for safe and reliable placement of freehand S2AI screws. In the absence of fluoroscopy, a point 15mm cephalad to the PSIS acts as a proxy for the location of the sciatic notch, and the sacral laminar slope helps account for differences in pelvic tilt/orientation.

.

71. Single Position Versus Lateral-then-Prone Positioning for Lateral Interbody Fusions and Pedicle Screw Fixation

Chason Ziino, MD; Justin Ledesma, MD; Ivan Cheng, MD; Jayme Koltsov, PhD

Summary
Patients in the lateral position for the entire lateral interbody and placement of pedicle screws saves significant time and has equivalent short term outcomes to patients that are switched prone for posterior instrumentation.

Hypothesis
Lateral surgery will significantly reduce OR time

Design
Prospective cohort study

Introduction
Lateral interbody fusions have gained significant popularity over the past 10 years, and the traditional method of fixation after the lateral procedure is to re-position the patient prone for placement of pedicle screws. More recently, some surgeons have advocated maintaining the patient in the lateral position for both the interbody procedure as well as placement of supplemental fixation. It is unknown, however, how single position surgery may affect perioperative outcomes.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Methods
Prospective, non-randomized controlled study to determine differences in patient-reported outcomes, perioperative parameters, and complications between patients undergoing single position procedures for lateral interbody and pedicle screws (Group L) versus repositioning patients prone for placement of screws (Group L-P). Outcomes will include ODI, VAS-Back, VAS-Leg, OR time, EBL, BMI, smoking status, medical co-morbidities, hospital length-of-stay, perioperative complications, degree of correction and return to OR within 30 days.

Results
Lateral-prone procedures involved more levels [median(range): lateral-prone 2 (1, 4); lateral 1 (1, 3)] ($p = 0.043$) and required more OR time [median(range): lateral-prone 231 (114 – 392), lateral 132 (84 – 290)] ($p < 0.001$) than procedures that were lateral only. However, there were no significant differences in EBL ($p = 0.825$) or LOS ($p = 0.198$). After adjusting for the difference in number of levels operated, OR time was still longer for the lateral-prone group than for the prone-only group ($p < 0.001$), suggesting that the difference in OR time was not fully explained by lateral-prone patients having more levels operated on. Two position surgery was on average 49 minutes longer. No significant differences in pre op or post op lordosis.

Conclusion
Single positioning for LLIF and percutaneous pedicle screw placement is a reasonable option given shorter operative time and equivalent blood loss, length of stay, and degree of correction. Patients generally tolerate lateral positioning for prolonged periods of time better than the prone position.

72. Accuracy and Efficiency of Robot-Assisted Pedicle and S2AI Screw Cannulation for Adult Thoracolumbar and Lumbar Fusion: Success and Failure in a Single Surgeon's First 92 cases

J. Alex Sielatycki MD; Melvin C. Makhni MD, MBA; Joseph M. Lombardi MD; Jamal Shillingford MD; Ronald A. Lehman MD

Summary
This study reports on the safety, accuracy, and efficiency of a single surgeon's experience in the first 92 cases of robotic-assisted pedicle and S2AI screw placement. We report 94.5% accuracy with robot-assisted screw placement in the first 92 patients, 708 pedicles, and 62 S2AI screws. 4% of pedicle screws required re-direction either after initial cannulation or screw placement. On average, robot time was 9 minutes per vertebra instrumented (including total registration time).

Hypothesis
Robotic-assisted pedicle cannulation is a safe and accurate technique in posterior spinal instrumentation.

Design
Review of safety and accuracy of robotic-assisted pedicle and S2-sacral alar-iliac screws (S2AI)

Introduction
Safety and efficiency are paramount when evaluating robotic-assisted spine surgery. Here we present a single surgeon's first 92 patients undergoing thoracic/lumbar pedicle and S2AI instrumentation with robotic assistance.

Methods
We reviewed adult patients undergoing posterior lumbar/thoracolumbar instrumentation and fusion with robotic assistance. All cases were performed at a single academic institution from 2016 to 2017 by a single surgeon for both degenerative and deformity diagnoses. Reports were independently generated for each case to record the success/failure of each pedicle screw. Overall rate of successful pedicle cannulation was evaluated and compared between the two robot models. Pedicle screw placement was checked by fluoroscopy, palpation of the screw tract, and intra-operative CT (23) in deformity cases.

Results
92 adult patients were reviewd (Table 1). 75% of cases were for degenerative diagnoses and 25% were performed for deformity correction. 76% were "open" vs. 24% minimally invasive (MIS). 708 pedicles were instrumented; 669 (94.5%) were accurately placed, while 29 (4.1%) pedicle screws were determined to be misplaced, requiring re-direction using freehand technique (open) or fluoroscopy (MIS). 10 (1.4%) screws were aborted for registration failure. The robot was dismounted completely/aborted in 6 (6.5%) cases due to registration failure. 12 (4.2%) pedicles were "missed" using the Mazor X vs. 17 (4%) using the Renaissance ($p=0.33$). 59 of 62 (95%) S2-Sacral Alar-Iliac screws were placed successfully.

Conclusion
We report 94.5% accuracy with robot-assisted screw placement in the first 92 patients, 708 pedicles, and 62 S2AI screws by a single surgeon. 4% of pedicle screws requiring re-direction either after initial cannulation or screw placement.

73. Coccydynia, Outcome 1 Year After Surgical Treatment of 138 Consecutive Patients

Ane Simony, MD, PhD; Mikkel Østerheden Andersen, MD

Summary
Patients suffering from coccydynia caused by trauma, are reporting severe pain and reduced Health related quality of life. This study reports the outcome, after surgical removal of coccyx in 138 consecutive patients.

Hypothesis
Surgical removal of the coccyx bone, can relieve persistent pain in patients suffering from coccydynia.

Design
A prospective cohort study

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Introduction
Coccydynia caused by trauma or giving birth is mostly reported in females in the age 30-60 years. Many treatment modalities have been suggested including special pillows, steroid injections, special physiotherapy and pain medication. Patients suffering from coccydynia are suffering, due to the severity of pain in sitting position which often causes problems working and disruption of family activities. The purpose of this study is to report the outcome, 1 year after surgery with partial or complete removal of the coccyx.

Methods
Patients are evaluated by examination bimanual palpation of the coccyx, and examination of the pelvic ligaments. If abnormal movement is present and the pain mechanism can be activated during examination of the coccyx, surgery with full or partially removal of the coccyx bone is suggested. All patients are treated with steroid injections prior to surgery, with only short term relief.

Results
138 consecutive patients was treated at the Sector for Spine Surgery, Middelfart Hospital and evaluated 3 and 12 months after surgery. 3 months after surgery, 40 % of the patients are pain free in sitting position, 47 % of the patients are experiencing some degree of discomfort in sitting position but are improved and 13 % of the patients are still experiencing pain while sitting. 99 patients are satisfied, 1 year after the surgery. 22 patients have hoped to have a bigger improvement and 17 patients are not satisfied. 32 patients developed infections after surgery and received antibiotics, 5 reoperations was performed, 3 due to infections and 2 due to rupture of the skin after return to normal daily living 3 months after surgery.

Conclusion
Pain in the coccyx after trauma or birth, are a quite common condition in women. Patients with severe symptoms and a history of pain duration of more than 12-18 months, should be referred for spine surgical evaluation. Partial or complete resection of the coccyx, is a safe procedure with in most patients will relieve the pain and restore the ability to sit.

Kolonne1	MEAN pre [95% CI]	Mean 1 year [95% CI]	p-value
VAS Back pain	41,12 [35,41-46,83]	24,63 [17,29-31,97]	0,0006
VAS Leg pain	65,23 [59,39-71,07]	40,1 [31,39-48,81]	< 0,0001
EQ5D Index	0,59 [0,54-0,64]	0,73 [0,72-0,74]	0,0005
EQ5D Health	50,1 [45,31-54,89]	67,1 [60,95-73,25]	< 0,0001
ODI	33,97 [31,14-36,8]	21,79 [16,94-26,64]	<0,0001
SF36 PCS	36,78 [34,96-38,6]	42,67 [39,43-45,91]	0,0002
SF36 MCS	44,57 [42,27-46,87]	43,95 [40,51-47,39]	0,96

.

74. Increasing Reoperation Rates and Inferior Outcome with Prolonged Symptom Duration in Lumbar Disc Herniation Surgery

Christian Stottrup, MD; Andreas Andresen, MD; Leah Yacat Carreon, MD, MS; Mikkel Østerheden Andersen, MD

Summary
Surgical treatment of lumbar disc herniation (LDH) is known to produce good clinical relief, however the timing of intervention has often been debated. 1,834 first-time LDH patients were consecutively included in a single-center cohort and underwent lumbar discectomy. One-year follow-up was available for 79%, showing significant difference in clinical outcome, depending on duration of preoperative radicular leg pain. Furthermore, the incidence of recurrent LDH was increasing with longer preoperative symptom duration.

Hypothesis
Patients with prolonged preoperative symptom duration will have less favorable outcome following surgery for LDH.

Design
Longitudinal Cohort

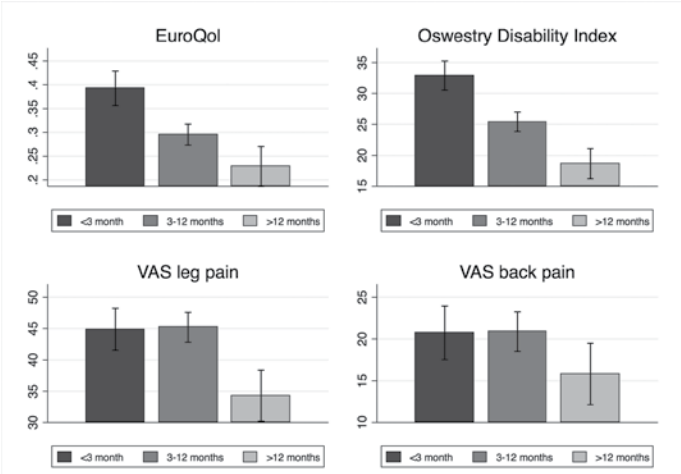
Introduction
Lumbar disc herniation (LDH) is associated with great morbidity and significant socio-economic impact in many parts of the world. Studies have shown that most LDH can be treated effectively with non-operative management. However, for some patients where pain and disability is unacceptable, surgical intervention provides effective clinical relief. Currently there is little consensus in the medical community on the timing of surgery for patients suffering from radicular pain due to LDH. Multiple studies suggest that prolonged symptom duration adversely affects clinical outcome.

Methods
Patients with first episode LDH were included in a single-center study. Data were prospectively collected in DaneSpine, the Danish National Spine Registry. Subjects were divided into three groups based on their self-reported duration of leg pain prior to enrollment into the registry: <3-months, 3-12 months and >12-months. Associations between patient-reported outcomes (PROs), perioperative complications and duration of symptoms were evaluated.

Results
1,834 patients were included in the study, with complete one-year follow-up on 1,448 patients (79%) and an overall reoperation rate of 8.4%. Incidence of surgical complications, specifically dural tears, was higher with increasing duration of leg pain, however, this did not reach statistical significance (p=0.028). Prolonged preoperative symptoms adversely influenced all PROs (EQ-5D, ODI, VAS) one year after surgery (p=0.001). Furthermore, reoperation rates increased with longer duration of preoperative symptoms. A statistically significant trend (p=0.009) of increasing incidence of reoperation was found with increasing length of symptom duration.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Conclusion
Delayed surgical intervention results in inferior clinical outcomes and increased reoperation rates. Patients who had surgery within the first 3 months of leg pain achieved the best outcome one year after surgery.



.

75. Lumbar Interbody Fusion Rates In 3D Printed Lamellar Titanium Cages Using a Silicate Substituted Calcium Phosphate Bone Graft

Robert Lee, MBBS, FRCS; Michael Mokawem, FRCS; Clare Harman, CNS

Summary
The success of lumbar interbody cages is dependent on patients achieving a solid fusion. The latter is dependent not only on cage material but also upon cage design, the bone graft used as well as surgical technique. We present a case series of 78 patients who had a combination of either transforaminal or lateral interbody 3D printed lamellar titanium cages packed with silicate substituted calcium phosphate bone graft. CT assessed fusion rate was 99% at 12 months.

Hypothesis
The use of 3D printed lamellar titanium cages packed with silicate substituted calcium phosphate bone graft, even over multiple levels,. leads to high fusion rates and good patient outcome scores

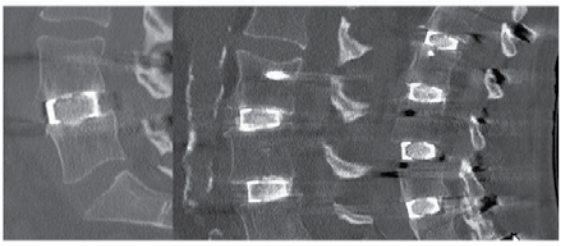
Design
Review of prospectively collected data from a single surgeon consecutive case series. CT based assessment of fusion rates.

Introduction
Lumbar interbody fusion rates are influenced by cage material, cage design, the bone graft used as well as surgical technique. Moreover, it is harder to achieve fusion in multilevel surgery. The aim of this paper is to demonstrate the fusion rates with 3D printed lamellar titanium cages packed with silicate substituted calcium phosphate bone graft.

Methods
This study is a review of prospectively collected data from a single surgeon consecutive case series of 78 adult patients who underwent either Transforaminal (TLIF) or Lateral Interbody Fusions (LLIFs), using 3D printed lamellar titanium cages. All patients had posterior instrumentation or a lateral plate. Outcome measures were collected at 6 weeks, 6 months and 1 year. All patients had CT scans at 12 months to assess fusion (reported by a consultant musculoskeletal radiologist and independently reviewed by the authors).

Results
Case mix included 25 single level TLIFs, 14 two level TLIFs, 39 LLIF cases with 79 cages (12 patients had two cages inserted and 10 patients had 3 or more cages). CT scans showed solid fusion in all bar one case with good integration of the cage at the vertebral body interface and no evidence of screw loosening. Average 12 month TLIF outcome scores were: VAS back 6.8 to 2.3, VAS leg 7.3 to 2, EQ-5D 0.338 to 0.889, EQ-5D VAS 51.8 to 78.4, ODI 55.4 to 25.4. Average 12 month LLIF outcome scores were: VAS back 7.2 to 2, VAS leg 7.8 to 1.5, EQ-5D 0.286 to 0.943, EQ-5D VAS 44.0 to 82.3, ODI 57.1 to 18.

Conclusion
Our study demonstrates a 99 % fusion rate at 12 months with the use of 3D printed lamellar titanium cages even where multilevel interbody cages are used. We believe that the excellent fusion rates contribute to the improvement in patient reported outcomes.



.

76. MRI Radiological Predictors of Requiring Microscopic Lumbar Discectomy after Lumbar Disc Herniation

Christopher Varlotta, BS; David Ge, BA; Nicholas Stekas, BS; Nicholas Frangella, BS; Jordan Manning, BA; Leah Steinmetz, BA; Dennis Vasquez-Montes, MS; Thomas Errico, MD; John A. Bendo, MD; Yong Kim, MD; Jonathan Stieber, MD; Gerard Varlotta, MD; Charla Fischer, MD; Themistocles Protopsaltis, MD; Peter Passias, MD; Aaron Buckland, MBBS, FRACS

Summary
This study analyzes the radiographic MRI characteristics of lumbar disc herniations (HNP) more likely to require microscopic lumbar discectomy (MLD) surgery versus non-operative treatment. Devising a proper classification system for MRI radiographic characteristics of HNPs helps inform patients as to their likelihood of requiring surgery. Patients who required operative treatment demonstrated greater axial HNP area (>70.52mm²), more likely to have caudal migration, greater

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

cephalad/caudal migration (>6.8mm), and grey HNP signal on T2 images.

Hypothesis
Lumbar HNPs in patients receiving MLD differ radiographically than lumbar HNPs in patients treated non-operatively.

Design
Retrospective analysis of patients treated at a single office with a lumbar HNP from 2011-2017.

Introduction
HNPs are common spinal pathologies, yet there is no conventional way to predict the likelihood of these patients requiring surgery via MLD. This study explores several radiographic metrics that can be useful for determining the likelihood of patients requiring MLD.

Methods
Patients who received HNP treatment were separated into operative (MLD) and non-operative treatment groups. HNP measurements included axial HNP area, axial spinal canal area, HNP:canal area ratio, cephalad/caudal migration, and HNP MRI signal (black, grey or mixed). MLD and non-op groups were compared with Chi-squared and t-tests. Binary logistic regression and decision tree analyses yielded odd's ratios and risk factor cutoff values.

Results
285 patients with a treated HNP were included (78 MLD, 207 non-operative). Independent risk factors for requiring MLD were larger axial HNP area (p<.01, OR=1.01 [1.00, 1.01]), higher caudal migration frequency (p<.05, OR=1.90 [1.02, 3.53]), larger cephalad/caudal migration (p<.01, OR=1.14 [1.05, 1.25]), and grey HNP MRI signal (p<.01, OR=5.42 [3.58, 8.20]). Cutoff values for independent risks included: axial HNP area (70.52mm², OR=2.66 [1.55, 4.57]), HNP:canal area (0.199 OR=3.29 [1.76, 6.16]), and cephalad/caudal migration (6.8mm, OR=2.43 [1.40, 4.20]). MLD risk for those with grey HNP MRI signal (67.6% alone) increased when combined with axial HNP area (75.5%, p=.01) and HNP:canal ratio (71.1%, p=.052) cutoffs. MLD risk in patients with cephalad/caudal migration>6.8mm (40.5% alone) increased when combined with axial HNP area and HNP:canal ratio (52.4%, 50%; p<.01).

Conclusion
Patients requiring MLD treatment had significantly higher axial HNP area, caudal migration frequency, cephalad/caudal migration magnitude, and grey HNP MRI signal compared to non-operative patients. This suggests that a meticulous radiographic analysis of HNPs should be utilized to effectively counsel patients about their likelihood of requiring surgery.

Patient Characteristics				Regression			Decision Tree Analysis			
Variable	MLD (n=78)	Non-MLD (n=207)	Sig (p-value)	Odd's Ratios	Sig (p-value)	95% CI	Cutoff Values	Odd's Ratios	Sig (p-value)	95% CI
	Mean	Mean								
Age	48.54 ± 16.40	49.41 ± 16.11	0.665							
Gender	M: 46.2%	M: 51.7%	0.428							
	F: 53.8%	F: 48.3%								
BMI	26.91 ± 5.20	27.65 ± 5.40	0.342							
HNP Area (mm^2)	95.35 ± 55.55	75.08 ± 48.26	**0.005**	1.01	**0.00**	1.00 - 1.01	70.52	2.66	**0.00**	1.55 - 4.57
Canal Area (mm^2)	282.4 ± 100.4	291.6 ± 103.5	0.497	1.00	0.50	1.00 - 1.00				
HNP Canal Compromise	34% ± 15.8%	29.0% ± 26.2%	0.116	2.23	0.13	0.78 - 6.37	20.0%	3.29	**0.00**	1.76 - 6.16
Cephalad Migration	20.51%	32.85%	**0.042**	1.90	**0.04**	1.02 - 3.53				
Caudal Migration	79.49%	67.15%								
Magnitude of Migration (mm)	6.74 ± 3.24	5.59 ± 2.61	**0.006**	1.14	**0.00**	1.05 - 1.25	6.80	2.43	**0.00**	1.40 - 4.20
Black Disc Signal	11.54%	61.84%								
Mixed Disc Signal	29.49%	27.54%	**0.00**	5.42	**0.00**	3.58 - 8.20				
Grey Disc Signal	58.97%	10.63%								

Decision Tree With Compounded Variable Analysis									
			Compounded Cutoff Variables						
Variable Groups	Cutoffs	% MLD Patients Above Cutoff	HNP Area > 70.52 mm	%	p-value	HNP Canal Compromise > 20%	%	p-value
Grey Disc Signal	Grey	67.6%	75.5%	7.9%	**0.010**	71.1%	4.1%	0.052
Magnitude of Migration (mm)	6.80	40.5%	52.4%	11.9%	**0.004**	50.0%	9.5%	**0.008**
Grey or Mixed Disc Signal	Grey or Mixed	46.8%				51.8%	5.2%	**0.022**

.

77. ASA Status is Associated with Cost and Length of Stay in Lumbar Laminectomy and Fusion: Results from an Institutional Database

Rachel Bronheim, BS; Jeremy Steinberger, MD; Samuel Hunter, MD; Sean Neifert, BS; Brian Deutsch, BS; Jonathan Gal, MD, FASA; John M. Caridi, MD

Summary
Spinal fusion accounts for the highest hospital costs of any surgical procedure performed in the US, and there is a paucity of literature that directly addresses the influence of ASA status on cost and length of stay following lumbar laminectomy and fusion. An institutional database was utilized to answer this question. ASA status was found to be a predictor of hospital length of stay, ICU length of stay, and direct cost.

Hypothesis
ASA status will be a predictor of increased cost and length of stay following lumbar laminectomy and fusion (LLF).

Design
Retrospective cohort study.

Introduction
LLF is a commonly performed spine procedure used to treat degenerative spine disorders and deformities by decompressing and stabilizing the lumbar spine. American Society of Anesthesiologists (ASA) physical status classification system was developed to estimate preoperative health, and is indicative of a patient's medical complexity. Spinal fusion accounts for the highest hospital costs of any surgical procedure performed in the US, and ASA status has been shown to be a risk factor for cost and length of stay in the orthopedic literature. There is a paucity of literature that directly addresses the

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

influence of ASA status on cost and length of stay following lumbar laminectomy and fusion.

Methods
An institutional database was utilized to identify patients undergoing lumbar laminectomy and fusion between 2006 and 2016. Univariate comparisons between groups were made using chi-squared tests for categorical variables and t-tests for continuous variables. Multivariate linear regression was utilized to estimate regression coefficients, and to determine whether ASA status is an independent risk factor for cost and length of stay following LLF.

Results
1,849 patients met inclusion criteria. For every one-point increase in ASA score, ICU length of stay increased by 0.518 days (CI: 0.391-0.646, P<0.001), and hospital length of stay increased by 1.93 days (CI: 1.56-2.29, P<0.001). For every one-point increase in ASA score, direct cost increased by $7,474.62 (CI: 5,861.31-9,087.92, P<0.001) (Table 1).

Conclusion
ASA status was a predictor of hospital length of stay, ICU length of stay, and direct cost. Consideration of the ways in which ASA status contributes to increased cost and prolonged length of stay can allow for more accurate reimbursement adjustment as well as more precise targeting of efficiency and cost effectiveness initiatives in the future.

Table 1- Linear Regression for Influence of ASA Status on Cost and Length of Stay

	Regression Coefficient	95% CI		P-value
ICU Length of Stay	.518	.391	.646	<0.001
Hospital Length of Stay	1.93	1.56	2.29	<0.001
Direct Cost	7,474.62	5,861.31	9,087.92	<0.001

78. Implementation of a Standardized Multimodal Analgesia Protocol Reduces Pain Scores, Opioid Consumption, Opioid-related Adverse Events, and Length of Hospital Stay after Posterior Lumbar Fusion

Corey Walker, MD; Virginia Prendergast, PhD, NP-C; Jakub Godzik, MD; Udaya Kakarla, MD; Juan S. Uribe, MD; Jay Turner, MD, PhD

Summary
We evaluated the impact of a standardized, evidence-based pain protocol on clinical outcomes after elective posterior lumbar fusion. Implementation of the pain protocol led to a reduction in pain scores, opioid consumption, opioid-related adverse events, and length of hospital stay.

Hypothesis
Implementation of a multimodal pain treatment protocol improves pain scores and post-operative outcomes after lumbar spinal fusion.

Design
Retrospective comparative cohort study

Introduction
Optimal postoperative pain control after spinal fusion surgery may lead to an improvement in clinical outcomes. An evidence-based, multidisciplinary quality improvement initiative was implemented to standardize pain treatment following neurosurgical procedures at our institution with the goal of improving clinical outcomes and patient satisfaction.

Methods
A retrospective chart review was conducted to evaluate pain-related outcomes after posterior lumbar fusion procedures at a single institution. We compared patients treated six months preceding and the six months following the implementation of the standardized pain protocol.

Results
A total of 115 pre- and 126 post- implementation patients were identified. The cohorts were well-matched with no differences in sex, age, surgical duration, number of segments fused, pre-operative pain level or baseline physical status (all p>0.05). Average patient-reported pain scores significantly improved in the first 24 hours post-operatively (5.8 versus 4.6, p<0.001) and 24 to 72 hours post-operatively (4.9 versus 4.0, p<0.001) following use of the pain protocols. Likewise, maximum pain scores during these periods, as well as time to achieving appropriate pain control were also significantly improved (p<0.05). Opioid consumption significantly decreased during the first 72 hours (128 versus 97 morphine milligram equivalents, p<0.001). Patients in the post-implementation cohort had a significantly decreased length of hospital stay (4.7 versus 3.9 days, p<0.001). Of opioid-related adverse events, there was a reduction in the incidence of constipation (58% versus 44%, p<0.001).

Conclusion
Implementation of an evidence-based, standardized multi-modal pain protocol led to a reduction in pain scores, opioid consumption, opioid-related adverse events, and length of hospital stay after posterior lumbar fusion.

Post-operative Pain-Related Outcomes	Pre-Protocol	Post-Protocol	p-value
Pain Metrics			
Average Pain Score in First 24 hours (mean (sd))	5.8 (1.7)	4.5 (1.7)	< 0.001
Highest Pain Score in First 24 hours (mean (sd))	8.7 (1.7)	8.1 (1.8)	0.017
Average Pain Score between24 to 72 hours (mean (sd))	4.9 (1.6)	4.0 (1.7)	< 0.001
Highest Pain Score between24 to 72 hours (mean (sd))	8.4 (1.8)	7.5 (2.0)	< 0.001
Average Time Until Pain Controlled (hours, mean (sd))	11.5 (11.3)	8.6 (7.1)	< 0.01
Peri-operative Outcomes			
Opioid Consumption in 72 hours Post-op (MME, mean (sd))	128 (104)	97 (78)	< 0.001
Hospital Length of Stay Post-op (days, mean (sd))	4.7 (2.1)	3.9 (2.0)	0.018
Opioid-related Adverse Events (ODAE, %)			
Total Events (mean number/patient)	1.08	0.69	<0.05
Oversedation / Respiratory Failure Requiring Naloxone	0	0	1.00
Delirium	9.3	6.3	0.76
Constipation	57.6	34.9	< 0.01
Ileus	5.1	4	0.86
Nausea / Vomiting	13.6	10.3	0.86
Urinary Retention	16.1	12.7	0.90

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

79. WITHDRAWN

80. WITHDRAWN

81. Complications and Revisions In Robotic vs. Fluoro-Guided Minimally Invasive Lumbar Fusions: Report From MIS ReFRESH

Samuel R. Schroerlucke, MD; Michael Y Wang, MD; Christopher Good, MD, FACS; Jae Y. Lim, MD; Victor Hsu, MD; Faissal Zahrawi, MD

Summary
We report interim results from the prospective MIS ReFRESH study designed to assess differences in outcomes in adult degenerative conditions, operated in a minimally invasive (MIS) approach in 1-to-3 level fusions. Nine sites enrolled 422 cases: 312 robot-guided and 110 fluoro-guided. The data show significantly higher complication and revision rates (3.1-fold and 14.7-fold higher, respectively) for fluoro-guided fusions compared to robotic-guided, and a 79% reduction in intraoperative fluoroscopy in the robotic-guided surgeries.

Hypothesis
Assess the impact of robotic-guidance on the incidence of clinical complications and revisions in MIS short lumbar fusions.

Design
Prospective, multi-center

Introduction
We report interim results from MIS ReFRESH, a prospective, comparative, multi-center study designed to assess differences in outcomes in adult degenerative conditions, operated in a minimally invasive (MIS) approach in 1-to-3 level fusions.

Methods
Data were prospectively collected. A single site randomized patients between arms, one enrolled control patients and the rest enrolled only robotic-guided cases.

Results
Nine sites enrolled 422 cases: 312 in the robot-guided arm (RG), and 110 in the fluoro-guided arm (FG). Mean age of RG patients was 58.7 years vs. 62.5 for FG ($p=0.007$), there were 57.4% females in RG and 62.7% in FG ($p=0.468$), and BMI was 31.2 vs. 28.0, respectively ($p<0.001$). Charlson Comorbidity Index (CCI) was greater than 0 in 33.7% of patients in RG vs. 23.6% in FG ($p=0.051$). There were 4.8±1.2 pedicle screws per case in RG vs. 4.3±0.9 screws in FG ($p<0.001$). In RG 33% of cases were 2-levels and 5% 3-levels, while in FG 18% were 2-level fusions, and 1% were 3-level fusions. Use of fluoroscopy for the instrumentation phase was 3.7±4.0 seconds/screw in RG vs. 17.8±9.3 in FG ($p<0.001$). Average follow up was 1.3±0.7 years in RG and 0.8±0.6 in FG. Within the first year of follow up there were 43 (13.8%) complications in RG vs. 35 (31.8%) in FG, and 5 (1.6%) revisions in RG vs. 5 (4.5%) in FG. A Cox logistic regression model with age, gender, BMI, CCI and number of executed screws, found a Hazard Ratio (HR) for a complication 3.1-fold higher in FG compared to RG (95% Confidence Interval (CI): 2.0-4.9., $p<0.001$) and HR for a revision surgery 14.7-fold in FG (95% CI 2.8-76.8, $p=0.001$).

Conclusion
Interim results from MIS ReFRESH study demonstrate significantly higher complication and revision rates in fluoro-guided short MIS fusions when compared to robotic-guided surgeries, as well as a 79% reduction in intraoperative fluoroscopy, or almost a minute, helping offset the patients' exposure during the pre-operative CT scan required for planning the robotic procedure.

82. Restoration of Normal Pelvic Balance from Surgical Reduction of High-Grade Spondylolisthesis

Abdulmajeed Alzakri, MD, MS; Hubert Labelle, MD, FRCS(C); Michael T. Hresko, MD; *Stefan Parent, MD, PhD;* Daniel J. Sucato, MD, MS; Lawrence G. Lenke, MD; Michelle Claire Marks, MS, PT; Jean-Marc Mac-Thiong, MD, PhD

Summary
We reviewed 53 patients from 4 institutions who underwent surgery for high-grade spondylolisthesis. Thirteen patients remained with a high-grade slip postoperatively (in situ group) while 40 patients were reduced to a low-grade slip (reduction group). The likelihood for improving from unbalanced pelvis preoperatively to balanced pelvis postoperatively was significantly improved in the reduction group. Surgical reduction of high-grade spondylolisthesis to a low-grade slip is recommended in the presence of an unbalanced pelvis (high pelvic tilt and low sacral slope).

Hypothesis
Surgical reduction of high-grade spondylolisthesis is effective in maintaining or restoring a normal pelvic balance.

Design
Retrospective analysis of a prospective multicenter database

Introduction
It has been proposed that surgical reduction of high-grade spondylolisthesis can improve sagittal balance but the evidence supporting this concept remains limited. The objective of this study is to assess the impact of surgical reduction on pelvic balance in high-grade spondylolisthesis.

Methods
We reviewed a prospective cohort of 53 patients (17 males, 36 females) aged 14.1±3.3 years who underwent surgery for high-grade spondylolisthesis in one of 4 institutions, and were followed for a minimum of 2 years after surgery. Patients with a residual high-grade slip following surgery (in situ group) were compared to patients with a residual low-grade slip (reduction group). Pelvic balance was assessed from pelvic tilt and sacral slope, in order to identify patients with a balanced pelvis (high sacral slope and low pelvic tilt) or unbalanced pelvis (high pelvic tilt and low sacral slope).

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Results
There were 13 patients in the in situ group and 40 patients in the reduction group (Table). The 2 groups were similar preoperatively in terms of pelvic tilt and sacral slope. Lumbosacral angle improved from 59.3±9.8° to 75.7±8.5° in the in situ group and from 72.7±16.0 to 89.6±13.0 in the reduction group. 57% of patients in the in situ group and 75% of patients in the reduction group with a preoperative balanced pelvis maintained a balanced pelvis postoperatively. None of the patients in the in situ group and 45% of patients in the reduction group improved from an unbalanced pelvis preoperatively to a balanced pelvis postoperatively.

Conclusion
Surgical reduction of high-grade spondylolisthesis to a low-grade slip is more effective in maintaining and restoring a normal pelvic balance postoperatively. Surgical reduction to a low-grade spondylolisthesis is particularly recommended in the presence of an unbalanced pelvis. However, the impact of surgical reduction can vary, and further work is needed to assess the effectiveness of the different surgical techniques that are currently used.

Pelvic balance	In situ group (n=13)	Reduction group (n=40)	P value
Balanced pelvis preoperatively	7	20	
To balanced pelvis postoperatively	4	15	0.4
To unbalanced pelvis postoperatively	3	5	
Unbalanced pelvis preoperatively	6	20	
To balanced pelvis postoperatively	0	9	0.04*
To unbalanced pelvis postoperatively	6	11	

.

83. Patient-Reported Outcomes Using ODI, VAS Back and Leg Pain, and PROMIS in Low-Grade Degenerative Lumbar Spondylolisthesis Patients with High Versus Low Pelvic Incidence

Pablo Diaz-Collado, MD; Taleef Khan, BA; Chase Woodward, MD; Colleen Peters, MA; pooria salari, MD; Michael P. Kelly, MD, MS; Jacob Buchowski, MD, MS; Munish Gupta, MD; Keith Bridwell, MD; Lukas P. Zebala, MD

Summary
We aimed to determine if there is an association between Patient-Reported Outcomes (PROs) and Pelvic Incidence (PI) in low-grade Degenerative Lumbar Spondylolisthesis (DLS) patients undergoing 1-2 level decompression and fusion. We did a retrospective cohort study comparing PROs in patients with high PI (> 55 deg) versus low PI (< 55 deg). We found that PI does not make a significant difference in PROs in the low-grade DLS population.

Hypothesis
There is no difference in PROs for patients with low versus high PI undergoing 1-2 level decompression and fusion for low-grade DLS.

Design
Retrospective cohort study

Introduction
Few studies have looked at the association between PROs and Spino-Pelvic Parameters (SPPs) in the low-grade DLS population.

Methods
All Myerding grade 1 or 2 DLS patients who underwent 1-2 level decompression and fusion with at least 1-year of follow-up at our institution from August 2015 to October 2017 were retrospectively identified. Patients with high PI (>55 deg) and low PI (< 55 deg) were compared in terms of demographics, comorbidities, surgical factors, post-operative complications, fusion status, PI-LL mismatch, and PRO measures. ODI, VAS Back and Leg Pain, and PROMIS Computer Adaptive Tests (CAT) for Physical Function (PF), Pain, Depression and Anxiety were obtained at baseline, initial, 6-month and 1-year follow-up. Pre and post-operative SPPs and fusion status at 1-year were independently measured on standing lumbar radiographs by two spine surgeons.

Results
59 patients were included with 44 (74.6%) high PI and 15 (25.4%) low PI. Demographics, comorbidities, surgical factors, post-operative complications, fusion status, PI-LL mismatch, and PRO measures were not significantly different ($p > 0.05$) between the groups. In high PI patients, all PRO measures significantly improved ($p \leq 0.05$) after surgery compared to baseline at each follow-up (See Table). In low PI patients, VAS Back and Leg Pain and PROMIS PF and Pain significantly improved at initial follow-up, PROMIS Pain significantly improved at 6-month follow-up, and ODI, VAS Leg Pain and PROMIS PF and Pain significantly improved at 1-year follow-up.

Conclusion
PI does not make a significant difference in PROs in low-grade DLS patients undergoing 1-2 level decompression and fusion. High PI patients significantly improved in all PRO measures after surgery. Low PI patients either significantly improved or trended towards improvement in all PRO measures after surgery.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Patient Reported Outcomes in High vs Low PI Patients at Baseline, Initial, 6-Month and 1-Year Follow-Up and Comparison between Baseline vs 1-Year Follow-Up for High and Low PI Patients

High vs Low PI

		High PI (N=44)		Low PI (N=15)		
		Mean	Std Dev	Mean	Std Dev	P value
ODI	Baseline	47.8	13.9	37.0	18.3	0.059
	Initial F/U	30.7	16.2	22.7	22.1	0.313
	6 mo F/U	22.9	16.7	27.4	22.7	0.635
	1 yr F/U	22.0	22.1	16.7	21.0	0.573
VAS Back Pain	Baseline	6.1	2.3	6.4	1.9	0.724
	Initial F/U	2.3	1.7	3.1	3.1	0.481
	6 mo F/U	2.4	2.4	2.5	2.9	0.956
	1 yr F/U	1.9	2.7	2.6	2.7	0.560
VAS Leg Pain	Baseline	6.3	2.4	6.8	3.0	0.579
	Initial F/U	1.9	2.4	3.2	3.2	0.276
	6 mo F/U	3.0	4.4	4.1	3.1	0.445
	1 yr F/U	1.6	2.4	1.7	3.2	0.937
PROMIS PF	Baseline	32.9	5.9	32.9	5.2	0.985
	Initial F/U	36.1	7.5	40.3	7.7	0.153
	6 mo F/U	39.4	7.7	39.7	7.7	0.906
	1 yr F/U	43.0	8.9	43.8	9.7	0.842
PROMIS Pain	Baseline	66.8	5.8	66.7	5.4	0.947
	Initial F/U	58.3	5.4	55.7	10.2	0.460
	6 mo F/U	55.8	10.1	59.4	6.5	0.228
	1 yr F/U	54.6	10.1	52.1	12.4	0.606
PROMIS Depression	Baseline	50.5	9.1	52.8	10.3	0.453
	Initial F/U	46.4	10.2	50.7	12.9	0.349
	6 mo F/U	46.2	11.3	48.8	9.7	0.539
	1 yr F/U	45.3	10.2	45.5	11.7	0.968
PROMIS Anxiety	Baseline	55.0	6.9	53.9	10.3	0.798
	Initial F/U	47.0	10.2	48.5	13.7	0.801
	6 mo F/U	48.5	12.7	53.0	12.1	0.382
	1 yr F/U	47.4	11.8	49.0	13.4	0.763

Baseline vs 1-Year Follow-Up

	High PI (N=44)					Low PI (N=15)				
	Baseline		1-Year F/U			Baseline		1-Year F/U		
	Mean	Std Dev	Mean	Std Dev	P value	Mean	Std Dev	Mean	Std Dev	P value
ODI	47.8	13.9	22.0	22.1	**<0.001**	37.0	18.3	16.7	21.0	**0.043**
VAS Back Pain	6.1	2.3	1.9	2.7	**<0.001**	6.4	1.9	2.6	2.7	0.082
VAS Leg Pain	6.3	2.4	1.6	2.4	**<0.001**	6.8	3.0	1.7	3.2	**0.023**
PROMIS PF	32.9	5.9	43.0	8.9	**<0.001**	32.9	5.2	43.8	9.7	**0.016**
PROMIS Pain	66.8	5.8	54.6	10.1	**<0.001**	66.7	5.4	52.1	12.4	**0.013**
PROMIS Depression	50.5	9.1	45.3	10.2	**<0.001**	52.8	10.3	45.5	11.7	0.061
PROMIS Anxiety	55.0	6.9	47.4	11.8	**0.011**	53.9	10.3	49.1	13.4	0.147

.

84. Surgeon's Neck Syndrome: Postural Analysis of Surgeons Neck during Lumbar Spine Surgeries

Naresh-Babu J, MD; Arun Kumar Viswanadha, MBBS, MS

Summary

If prolonged work is performed with neck in flexion, pain associated with fatigue is the common symptom. The angle of neck flexion in a surgeon that is observed when performing spine surgery is causing a severe load on the surgeon's spine. Surgeon neck syndrome needs to get a word in the literature for its raising concern among surgeons as the chronicity of this condition may lead to early degenerative change.

Hypothesis

We hypothesize that in long term, a spine surgeon is at risk of developing an ailment proposed as "Surgeon Neck Syndrome" based on the observations of the present study.

Design

Prospective Study

Introduction

The effect of operating posture on the surgeon's neck is largely unknown. From the studies conducted on usage of smartphones, abnormal neck postures especially the Forward Head posture (FHP) was found to adversely affect the cervical spine of individuals. We analyzed the time spent by the surgeons in these abnormal neck postures while performing lumbar spinal surgeries.

Methods

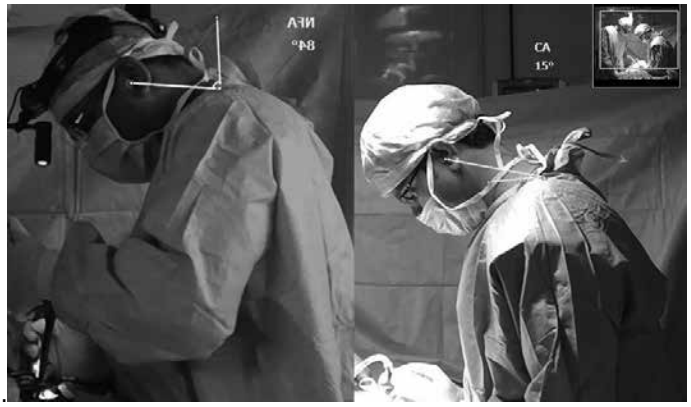
A Prospective study of 60 recorded surgeries performed by three spine surgeons was analyzed. Video recordings of 25 Transforaminal Lumbar Interbody Fusions (TLIF) and 35 Lumbar decompression procedures (15 with headlight and 20 with operating microscope) formed the study material. Running videos of the surgeries were recorded concentrating on the surgeons with reflective markers taped to their surface landmarks corresponding to C7, tragus of the ear and outer canthus of the eye. Snapshots from the video were obtained whenever the surgeon changes the position. Head flexion angle (HFA), Neck flexion angle (NFA), Cervical angle (CA), and Forward Head Posture (FHP) were measured and analyzed.

Results

All the measured angles are found to be highly abnormal and adversely affecting the cervical spine. HFA and NFA were significantly higher during the phases of decompression and fusion when compared with other phases (exposure, closure and instrumentation). Usage of microscope was found to be beneficial by avoiding the abnormal neck posture angles when compared to the usage of headlight. Average cervical angle of all surgeons was significantly lower thereby adversely affecting the cervical spine. (p value - <0.001).

Conclusion

When the neck stays in such a position on a daily basis, there is a huge pressure on the surgeon's neck making it highly vulnerable for early degeneration. Based on the results of the study we propose an entity called "Surgeon neck syndrome"affecting the spine surgeons who are at risk of aggravating the degenerative pathology over the years.



.

85. Prospective Assessment Mid-Term Radiological Outcomes Following Sublaminar Band Placement for Prevention of Proximal Junctional Kyphosis

Vibhu Krishnan Viswanathan, MBBS; Amy Minnema, MS; Stephanus Viljoen, MD; *H Francis Farhadi, MD, PhD, FRCS(C)*

Summary

Proximal junctional kyphosis (PJK) and proximal junctional failure (PJF) represent early complications following multisegment instrumented arthrodesis. We prospectively assessed mid-term radiological outcomes following UIV+1 sublaminar band insertion. Three procedure-related complications were noted, including two intraoperative CSF leaks and one transient neurologic deficit. Four

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

patients (10%) developed radiologic PJK while there were no cases of PJF. UIV+1 sublaminar band placement during long segment thoracolumbar instrumented arthrodesis is relatively safe and is not associated with an increased rate of PJK or PJF.

Hypothesis
Sublaminar band insertion at the upper instrumented vertebra (UIV)+1 level potentially reduces the incidence of PJK and PJF following ASD surgery.

Design
Prospective, consecutive, non-comparative cohort

Introduction
Proximal junctional kyphosis (PJK) can progress to proximal junctional failure (PJF) following treatment of adult spinal deformity (ASD). Sublaminar band (SLB) placement has been suggested as a possible technique to prevent PJK/PJF but carries the theoretical concern of a paradoxical increase in these complications secondary to the required muscle dissection and posterior ligamentous disruption.

Methods
Between August 2015 and February 2017, 40 consecutive patients underwent either upper (T2-T4) or lower (T8-T10) thoracic SLB placement at the UIV+1 level. Outcome measures were prospectively collected in a REDCap database designed specifically to include clinical and radiologic data (ClinicalTrials.gov NCT02411799).

Results
Forty patients (60% female) were included in this study. Patients with a minimum of either 1-year (n=29) or 2-year (n=11) follow-up were included in this analysis. Three procedure-related complications were noted, including two intraoperative cerebrospinal spinal fluid leaks and one transient neurologic deficit. Sagittal vertical axis (preoperatively: 9.0 cm, IQR 3.8-11.6 cm; final follow-up: 5.1 cm, IQR 2.2-7.6 cm, $p<0.01$), pelvic incidence-lumbar lordosis mismatch (25.6°, IQR 11.2°-33.1°; 8.9°, IQR 0.0°-18.9°, $p<0.01$) and pelvic tilt (29.4°, IQR 20.4°-34.3°; 18.1°, IQR 11.9°-26.0°, $p<0.01$) were all improved on final follow-up. While proximal junctional (PJ) Cobb angles increased overall (preoperatively: 4.2°, IQR 2.0°-7.4°; final follow-up 7.6°, IQR 5.5°-10.0°, $p<0.01$), the significant increase was primarily noted starting at the immediate postoperative time point (7.9°, IQR 5.0°-11.8°, $p<0.01$) and not beyond. Four patients (10%) developed radiologic PJK (mean ΔPJ Cobb 15.8°) while there were no cases of PJF.

Conclusion
UIV+1 SLB placement is relatively safe and is not associated with an increased rate of PJK. No subjects developed PJF in our series.

86. Proximal Junctional Kyphosis Prevention with Strap Stabilization Technique on Supra-Adjacent Level of Posterior Spinal Fusion

Francisco Rodriguez-Fontan, MD; Bradley Reeves, MS-II; Andriy Noshchenko, PhD; David Ou-Yang, MD; Christopher Kleck, MD; Christopher Cain, MD, PhD; Evalina Burger, MD; *Vikas Patel, MD, BS, MA*

Summary
Strap-stabilization with polyester fiber suture-tape of upper instrumented vertebrae (UIV) and supra-adjacent level might prevent proximal junctional kyphosis (PJK). This study compared the outcomes of 80 pts who underwent posterior instrumented fusion (PIF) surgeries for adult spinal deformity (ASD). Two groups were assessed for risk of PJK in a 2-year follow-up: MT versus no MT. PJK was defined as progression of postoperative junctional sagittal Cobb angle (SCA) at UIV≥10°. Results show that MT decreases the risk of PJK.

Hypothesis
Strap stabilization of UIV to one supra-adjacent level might prevent PJK in PIF surgeries.

Design
Retrospective cohort study.

Introduction
The use of PIF with pedicle screws is a standard approach for surgical correction of ASD. A change in biomechanical properties secondary to increased loading of UIV may lead to PJK, a complication of variable incidence (5.6 - 41%) following PIF surgery. It has been shown to progress, and increase the risk of neurological injury; hence revision surgery is required in up to 47% of the pts.

Methods
Pts who underwent PIF for ASD between 2006 and 2016 were analyzed. Inclusion criteria: ≥18 yrs-old; PIF with or without osteotomy, ≥3 levels fusion; use of pedicle screws; use of MT (cases) or not (controls). Controls were matched to cases by demographic and clinical characteristics. Radiographic SCA, lumbar lordosis, pelvic tilt, sacral slope and pelvic incidence were measured pre- and post-operatively in a 2-yr follow-up period, using a deformity measuring software program on lateral view spine X-rays. PJK was defined as progression of post-operative SCA at UIV≥10°. Statistical analysis included ANOVA, logistic regression, odds ratio, and survival analysis. P≤0.05 was considered as statistical significant.

Results
Eighty pts were included, encompassing 20 cases and 60 controls. The mean age was 63.2 ± 10.8 and 62.1 ± 11.2 yrs old in the case and control group, respectively (P=0.69). The overall incidence of PJK was 32.5%. The cumulative rate of PJK≥10° at 2-yr follow-up was 15% in cases versus 38% of controls (OR=0.28, P=0.04) with a higher latent period in cases, P=0.05 (Figure 1). MT significantly decreased risk of PJK in the following conditions: age, ≥55 yrs-old (OR=0.19, P=0.02); number of levels fused, 7-15 (OR=0.13, P=0.05); and UIV, T1-T12

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

(OR=0.13, P=0.05). Borderline significance was revealed in BMI ≥27 kg/m², osteoporosis, and having no sacroiliac fusion.

Conclusion

MT at UIV and adjacent levels decrease the risk of PJK during 2 postoperative years diminishing the negative impact of different risk factors. Future research in greater sample size is needed to explore these PJK related factors.

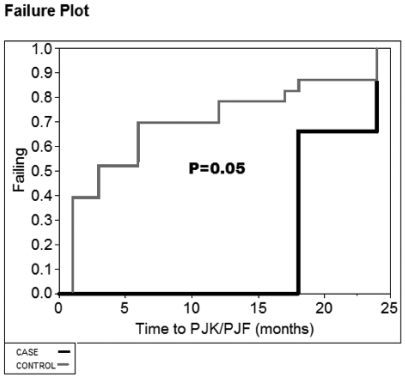


Figure 1: The Kaplan-Maier curves reflect the difference in rising of the cumulative PJK risk during 2 post-operative years for both groups: case (MT) and control (no MT).

.

87. Prophylactic Vertebral Cement Augmentation at the Uppermost Instrumented Vertebra and Rostral Adjacent Vertebra for the Prevention of Proximal Junctional Failure Following Long Segment Fusion for Adult Spinal Deformity

Joseph P. Gjolaj, MD; George Ghobrial, MD; Barth A. Green, MD; Nathan Lebwohl, MD

Summary

Proximal junctional kyphosis (PJK) and proximal junctional failure (PJF) are common problems after long-segment (>5 levels) thoracolumbar instrumented fusions in the treatment of adult spinal deformity (ASD). No specific surgical strategy has definitively been shown to lower the risk of PJK. Our study finds that use of prophylactic vertebral cement augmentation at the UIV and rostral adjacent vertebral segment at the time of deformity correction appears to be preventative in the development of proximal junctional kyphosis and failure.

Hypothesis

To assess the incidence of PJK and PJF in patients treated with prophylactic polymethylmethacrylate (PMMA) cement augmentation at the uppermost instrumented vertebrae (UIV) and rostral adjacent vertebrae (UIV+1).

Design

Retrospective cohort-matched surgical case series at a single academic institutional setting.

Introduction

Proximal junctional kyphosis (PJK) and proximal junctional failure (PJF) are common problems after long-segment (>5 levels) thoracolumbar instrumented fusions in the treatment of adult spinal deformity (ASD). No specific surgical strategy has definitively been shown to lower the risk of PJK as the result of a multifactorial etiology.

Methods

The impact of adjunctive PMMA use in long-segment (≥5 levels) fusion for ASD was assessed in adult patients aged 18 and older. Patients were included with at least one of the following: lumbar scoliosis >20°, pelvic tilt >25°, sagittal vertical axis >5 cm, central sacral vertical line >2 cm, and thoracic kyphosis >60°. The frequency of PJF and the magnitude of PJK were measured radiographically preoperatively, postoperatively, and at maximum follow-up in controls (Group A) and PMMA at the UIV and UIV+1 (Group B).

Results

Eighty-five patients (64±11.1 years) with ASD were identified: 47 control patients (58±10.6) and 38 patients (71±6.8) treated with PMMA at the UIV and UIV+1. The mean follow-up was 27.9 and 24.2 months in Groups A and B, respectively (p=.10). Preoperative radiographic parameters were not significantly different. The incidence of PJK was 36% (n=17) and 23.7% (n=9) in Groups A and B, respectively (p=.020). The odds ratio of PJK with vertebroplasty was 0.548 (95% confidence interval=0.211 to 1.424). Proximal junctional kyphosis was observed in 6 (12.8%) controls only (p=.031). The UIV+1 angle, a measure of PJK, was significantly greater in

Conclusion

The use of prophylactic vertebral cement augmentation at the UIV and rostral adjacent vertebral segment at the time of deformity correction appears to be preventative in the development of proximal junctional kyphosis and failure.

Table 3. Comparison of Radiographic Parameters

	No vertebroplasty(n=47)	Vertebroplasty (n=38)	p-value
Mean Preoperative Spinopelvic Parameters			
Sagittal Vertical Axis, cm(SD)	6.8 (± 5.9)	7.2 (± 5.6)	0.798
Lumbar Lordosis, degrees(SD)	26.8 (± 18.5)	27.3 (± 19.6)	0.922
Thoracic Kyphosis, degrees(SD)	28.9 (± 16.6)	29.6 (± 17.8)	0.853
Central Vertical Sacral Line, cm(SD)	2.0 (± 2.5)	2.0 (± 2.7)	0.977
Main Structural Curve, deg(SD)	34.1 (± 23.5)	27.2 (± 20.9)	0.160
Non-Structural Curve, degrees(SD)	21.1 (± 24.4)	11.1 (± 15.5)	0.030
Pelvic Tilt, degrees(SD)	26.6 (± 10.2)	31.4 (± 10.1)	0.032
Pelvic Incidence, degrees(SD)	55.1 (± 12.6)	60.7 (± 14.1)	0.059
Sacral Slope, degrees(SD)	30.0 (± 13.2)	29.1 (± 10.5)	0.745
Lumbopelvic mismatch, degrees(SD)	28.3 (± 19.7)	33.4 (±20.0)	0.237
UIV Angle, degrees (SD)	1.9 (± 1.5)	2.4 (± 1.6)	0.137
UIV +1 Angle, degrees (SD)	3.8 (± 2.8)	4.2 (± 2.3)	0.528
UIV CT Imaging Density, Hounsfield Units(SD)	147.3 (± 61.6)	153.9 (± 49.4)	0.561
Mean Interim Postoperative Spinopelvic Parameters			
Mean Interim Duration, days(SD)	387.3 (± 497.0)	262.1 (± 298.2)	0.172
Sagittal Vertical Axis, cm(SD)	2.5 (± 2.8)	4.0 (± 2.8)	0.018
Lumbar Lordosis, degrees(SD)	45.2 (± 12.7)	42.3 (± 13.9)	0.308
Thoracic Kyphosis, degrees(SD)	40.2 (± 15.1)	40.2 (± 16.8)	0.995
Main Fractional Curve, degrees(SD)	13.2 (± 13.7)	9.4 (± 12.5)	0.190
Non-Structural Curve, degrees(SD)	8.3 (± 16.0)	6.4 (± 10.6)	0.524

.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

88. Minimally-Invasive Posterior Cervical Foraminotomy (mis-PCF) with Tubes Prevents Undesired Fusion with Long-term Follow-up

Conor Dunn, MD; Jeffrey Moore, MD; Nikhil Sahai, MD; Kimona Issa, MD; Michael J. Faloon, MD, MS; Kumar G Sinha, MD; Ki Hwang, MD; Arash Emami, MD

Summary
We compared similar patients treated with mis-PCF and ACDF for cervical radiculopathy without myelopathy refractory to conservative therapy with mean follow-up of nearly 43 months in the mis-PCF cohort and found no difference in revision proportions, rates or functional outcome scores between cohorts. Future studies need to reevaluate these findings at 5 and 10 year f/u.

Hypothesis
mis-PCF will maintain similar revision rates and functional outcome scores with respect to ACDF when directly compared with long-term follow-up.

Design
Retrospective cohort study

Introduction
mis-PCF has proven effective in addressing symptoms radiculopathy in appropriately indicated patients. Few studies have compared the revision rates and outcome scores of the procedure directly to ACDF however, and all have been limited to 2-year f/u. Additionally, none of these studies have utilized a minimally-invasive technique with tubular decompression.

Methods
From 2009-2014, 210 consecutive patients underwent ACDF and 49 underwent mis-PCF for radiculopathy without myelopathy refractory to conservative treatment and a minimum of 2-year follow-up were compared in separate cohorts. mis-PCF patients had a mean follow-up was 42.9 months while ACDF patients had 44.9 months. Demographic variables, revision and complications were compared. Functional outcomes were assessed with NDI and VAS-a and VAS-n measurements preoperatively and at each follow-up visit then compared.

Results
There was no difference found in proportion of revisions between mis-PCF and ACDF cohorts (4 of 29, 8.2% vs 12 of 210, 5.7%, p=0.514, respectively). There was no difference found in revision rate per level per year (3.1 vs 1.7, p=0.464). Likewise, there was no difference found in revision rate per level per year at the index level (1.8 vs 0.7, p=0.466) or at an adjacent level (1.3 vs 1.1, p=0.906). No difference was found between cohorts in regards to change from pre-op to final post-op functional outcome scores (NDI, VAS-a and VAS-n). There was 1 (2.7%) complication in the mis-PCF cohort (post-operative hematoma) and 7 (3.3%) complications in the ACDF.

Conclusion
mis-PCF compared directly to ACDF, with a mean follow-up of nearly 43 months, has demonstrated similar revision proportions, rates, and functional outcome scores. Future studies with minimum 5 and 10 years follow-up comparing the procedures are still warranted to conclusively determine the utility of the mis-PCF technique with tubular decompression and its ability to prevent unwanted fusions.

89. Does the Sagittal Alignment of the Cervical Spine Have an Impact on Disc Degeneration? 20-Year Follow-Up of Asymptomatic Volunteers

Eijiro Okada, MD, PhD; Kenshi Daimon, MD; Hirokazu Fujiwara, MD, PhD; Yuji Nishiwaki, MD, PhD, MS; Kenya Nojiri, MD; Masahiko Watanabe, MD, PhD; Hiroyuki Katoh, MD, PhD; Kentaro Shimizu, MD, PhD; Hiroko Ishihama, MD; Nobuyuki Fujita, MD; Takashi Tsuji, MD, PhD; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD, PhD; Kota Watanabe, MD, PhD

Summary
To longitudinally evaluate the association between sagittal alignment of the cervical spine and progression of degenerative changes of intervertebral discs and development of clinical symptoms in healthy subjects. The present 20-year follow up study showed that non-lordotic cervical alignment may be related to progression of disc degeneration. However, cervical alignment had no impact on development of the clinical symptom in healthy subjects.

Hypothesis
Sagittal alignment of the cervical spine have an impact on disc degeneration in the asymptomatic subject for 20-years.

Design
A Longitudinal prospective study for 20-years.

Introduction
Few studies have investigated and clarified the association between sagittal alignment of the cervical spine and progression of degenerative changes of intervertebral discs. The purpose of this study was to longitudinally evaluate the association between sagittal alignment of the cervical spine and progression of degenerative changes of intervertebral discs and development of clinical symptoms in healthy subjects.

Methods
90 volunteers (30 males and 60 females) who had undergone MRI and plain radiography of the cervical spine between 1994 and 1996 and had been originally asymptomatic were enrolled in this 20-year follow-up study. All subjects underwent second MRI at an average of 21.6 years after the initial study. The mean age at the time of the initial study was 35.5 ± 13.4 years (11-65 years). The items assessed on MRI were 1) decrease in signal intensity of the intervertebral discs, 2) posterior disc protrusion, and 3) disc space narrowing from C2-3 to C7-T1. The subjects were divided into groups according to the age

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

and sagittal alignment of the spine at baseline, lordosis type or the non-lordosis type of sagittal alignment of the cervical spine.

Results
During the 20-year period, progression of decrease in signal intensity of the disc, posterior disc protrusion, and disc space narrowing were observed in 84.4 %, 86.7% and 17.8% of the subjects, respectively. Progression of the degenerative change at C7-T1 was significantly more frequent in the non-lordosis over 40 years group (90.9%) than those in older the lordosis group (54.2%) (p=0.032). No significant differences were observed between sagittal alignment and the onset of clinical symptom at follow-up.

Conclusion
The present 20-year follow up study showed that non-lordotic cervical alignment may be related to progression of disc degeneration. However, cervical alignment had no impact on development of the clinical symptom in healthy subjects.

90. Cervical and Cervicothoracic Sagittal Alignment By Roussouly Thoracolumbar Subtypes in Asymptomatic Volunteers

Alekos Theologis, MD; Sravisht Iyer, MD; Han Jo Kim, MD; Lawrence G. Lenke, MD; Michael P. Kelly, MD, MS

Summary
In Asymptomatic adult volunteers, sagittal alignment parameters of the axial, subaxial, cervicothoracic and Thoracic Spine were surprisingly no different despite the marked differences in lumbar, lumbopelvic and pelvic parameters according to the 4 Roussouly types. These important normative data should help direct appropriate cervicothoracic sagittal realignment, ensuring horizontal gaze and hopefully lessen PJK in patients undergoing major spinal reconstructions.

Hypothesis
Cervical alignment varies based on different lumbopelvic morphologies in asymptomatic individuals.

Design
Cross-sectional cohort

Introduction
Appropriate sagittal spinal alignment are dictated by a harmonious relationship between the cervical, thoracic, and lumbar spines. Comprehension of cervicothoracic alignment with respect to variations in thoracolumbar alignment is limited. This study aims to compare radiographic sagittal cervical alignment parameters of asymptomatic volunteers based on Roussouly's thoracolumbar sagittal alignment subtypes.

Methods
87 asymptomatic adults were recruited. Radiographic measurements: PI, PT, SS, LL, orbital tilt, orbital slope, occipital slope, occipital incidence, occiput-C2 lordosis, C2-7 lordosis, CBVA, T1 slope, cervicothoracic alignment, T2-5 kyphosis, and C2-C7 SVA. Each patient was classified into one of four Roussouly types. Cervical alignment parameters were analyzed and compared between groups.

Results
Presented in Table 1. 87 individuals [male-23; female-64; avg age 49±16 years (22-77 years)] were included for analysis. The four groups were similar for age, gender, and BMI. The four groups were significantly different for lumbopelvic parameters (PI, SS, PT, LL). Average values for all patients included: O-C2 lordosis (-28±90), CBVA (-1±90), C2-7 lordosis (-11±140), C2-7 SVA (21±9mm), T1 slope (25±90), C6-T4 angle (5±80), T2-5 angle (16±70), thoracic kyphosis (47±130). All sagittal radiographic alignment measurements of the cervical spine and cervicothoracic junction were similar between groups.

Conclusion
In asymptomatic volunteers, sagittal alignment parameters of the axial and subaxial cervical spine, cervicothoracic junction, and thoracic spine based on variations in thoracolumbar sagittal alignment were not different when sagittal profiles were classified as proposed by Roussouly. These data may guide surgical correction of cervical and cervicothoracic deformities to ensure horizontal gaze and good overall sagittal plane alignment.

Table 1.

	All	Roussouly Type				*p*
		I	II	III	IV	
N	87	8	47	19	13	
Gender Male Female	23 64	4 4	14 33	3 16	2 11	0.21
Age (yrs)	49 ± 16 (22-77)	37 ± 12 (23-60)	47 ± 17 (22-76)	52 ± 15 (28-77)	55 ± 16 (28-76)	0.07
BMI	27 ± 6 (19-45)	26 ± 6 (19-38)	27 ± 5 (19-45)	28 ± 6 (20-38)	27 ± 8 (20-41)	0.86
Thoracolumbar Parameters						
PI	49 ± 12 (22-88)	35 ± 8 (22-43)	44 ± 6 (31-54)	60 ± 4 (55-67)	64 ± 9 (56-88)	<0.01
SS	34 ± 8 (18-65)	22 ± 3 (18-25)	31 ± 4 (25-43)	38 ± 4 (26-43)	46 ± 9 (22-65)	<0.01
PT	15 ± 7 (-2-35)	13 ± 8.2 (-2-22)	12 ± 6 (0-27)	22 ± 5 (15-30)	18 ± 7 (11-35)	<0.01
LL	-58 ± 11 (-81- -32)	-52 ± 14 (-79- -39)	-55 ± 10 (-75- -32)	-61 ± 11 (-74- -36)	-67 ± 11 (-81- -43)	<0.01
TK	47 ± 13 (11-77)	45 ± 14 (23-68)	45 ± 12 (11-67)	50 ± 12 (35-70)	49 ± 15 (15-77)	0.45
Cervical/Cervicothoracic Parameters						
Orbital Tilt (deg)	68 ± 9 (43-96)	67 ± 8.1 (56-78)	70 ± 10 (44-99)	69 ± 7 (49-77)	68 ± 8 (55-84)	0.71
Occipital Slope (deg)	10 ± 9 (-11-30)	12 ± 6 (4-22)	8 ± 9 (-11 - 26)	11 ± 9 (-4-30)	13 ± 10 (-3-29)	0.21
Occipital Incidence (deg)	81 ± 8 (61-101)	84 ± 7 (73-100)	80 ± 9 (61-99)	82 ± 8 (72-101)	82 ± 8 (68-95)	0.38
Orbital Slope (deg)	19 ± 8 (-9-46)	18 ± 6 (12-28)	18 ± 9 (-9 – 46)	19 ± 7 (10-41)	21 ± 7 (11-35)	0.77
O-C2 (deg)	-28 ± 9 (-52- -6)	-32 ± 4.6 (-36 - -21)	-27 ± 9 (-52- -6)	-28 ± 9 (-42 - -8)	-31 ± 6 (-43- -22)	0.23
CBVA (deg)	-1 ± 9 (-28-33)	2 ± 8 (-10-14)	-2 ± 10 (-28 – 33)	-2 ± 6 (-10-12)	-1 ± 8 (-19-10)	0.73
C2-7 lordosis (deg)	-11 ± 14 (-43-21)	-12 ± 13 (-23 -18)	-9 ± 14 (-41 - 21)	-14 ± 13 (-32 - 16)	-15 ± 16 (-43-13)	0.33
C2-7 SVA (mm)	21 ± 9 (-2-49)	18 ± 7.1 (12-31)	21 ± 10 (-2 – 49)	21 ± 9 (8-40)	20 ± 9 (8-40)	0.84
T1 slope (deg)	25 ± 9 (0-52)	23 ± 7 (10-30)	23 ± 9 (0-52)	27 ± 7 (15-39)	26 ± 11 (8-44)	0.40

.

91. Magnetically Controlled Growing Rods: Sagittal Plane Analysis and the Risk of Proximal Junctional Kyphosis

Purnendu Gupta, MD; Jennifer Schottler, MPT; Alicia January, PhD; Felix Brassard, MD; Kevin Morash, MD; Ron El-Hawary, MD, MS; Benjamin Roye, MD, MPH; Jeffrey Sawyer, MD; Kim W. Hammerberg, MD; Children's Spine Study Group

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Summary
Magnetically controlled growing rod (MCGR) insertion in patients with early onset scoliosis (EOS) resulted in significant improvement of scoliosis and improvement of T1-T12 length, avoiding multiple anaesthetics. However, there was a significant change in T1 tilt, increased risk of proximal junctional kyphosis (PJK), and significant complication rate.

Hypothesis
MCGR insertion increases risk of PJK due to actuator geometry.

Design
Multi-center registry data

Introduction
MCGR can reduce the number of surgical procedures requiring anaesthesia in patients with EOS, however, there are challenges in sagittal contouring due to actuator geometry. The purpose of this study is to evaluate our initial experience using MCGR with analysis of sagittal plane parameters to determine the risk of PJK.

Methods
52 patients age 2-12 years, 50% male and 50% female, mean age 7.9 (±2.7) years, pre-op curves measuring an average of 72.1±15.8 degrees underwent MCGR insertion and subsequently 373 lengthenings (M=7.17 lengthenings per patient). 24 had idiopathic, 17 had neuromuscular, 7 had syndromic, and 4 had congenital scoliosis. Radiographic analysis was conducted at pre-op, post-op and at 24 months.

Results
Scoliosis improved significantly from 72.1±15.8 degrees pre-op to 40.2±14.8 post initial surgery (p<.001) and 44.7±16.2 at 24-month follow-up (p<.001). Initial subgroup analysis of available data demonstrates a significant mean increase in T1–T12 length from 17.7cm±3.2 pre-op to 20.2cm±3.3 post-op (p<.001), and 20.2cm±6.3 at 24-month follow-up (p<.001). T1 slope changed significantly from pre-op to initial post-op (18.0±15.5 vs 22.9±16.2; p=.022) as well as pre-op to 24-month follow-up (15.9±13.4 vs 21.2±16.7; p =.039). No significant changes in thoracic kyphosis (TK) at post-op (25.4vs 26.2, p=.799) or 24-months post-surgery (23.7vs 28.6, p=.072). Lumbar lordosis (LL) also did not change significantly from pre-op to immediate post-op (-52.5±20.1 vs -44.6±11.6, p=.065) or from pre-op to 24 months (-48.4±19.3 vs -52.5±18.1, p=.268). At 24-month evaluation, PJK developed in 4 of 33(12%) patients. Over the course of the study period, 46 complications occurred in 27(52%) patients.

Conclusion
MCGR insertion in patients with EOS resulted in significant improvement of scoliosis and improvement of T1-T12 length, avoiding multiple anaesthetics. However, there was significant change in T1 tilt and increased risk of PJK. Further study is needed to understand the benefits and long-term outcome of MCGR insertion.

92. Recovery Kinetics following Spinal Deformity Correction: A Comparison of Isolated Cervical, Thoracolumbar, and Combined Deformity Morphometries

Peter Passias, MD; Frank Segreto, BS; Renaud Lafage, MS; Virginie Lafage, PhD; Justin Smith, MD, PhD; Breton G. Line, BS; Justin Scheer, MD; Gregory Mundis, MD; D. Kojo Hamilton, MD; Han Jo Kim, MD; Bassel Diebo, MD; Munish Gupta, MD; Eric O. Klineberg, MD; Douglas C. Burton, MD; Robert A. Hart, MD; Frank J. Schwab, MD; Christopher Shaffrey, MD; Christopher Ames, MD; Shay Bess, MD; International Spine Study Group

Summary
Clear, objective benchmarks are needed to quantitatively define a 'good postoperative recover' across multiple follow-up (f/u) visits and varying deformity types. Our analysis found cervical deformity (C) patients to exhibit quicker rates of immediate postoperative recovery, despite exhibiting less Integrated Health State ODI-NDI improvements compared to thoracolumbar (T) and combined deformity (CT) morphometries. This study is a step towards creating objective recovery benchmarks for multiple deformity morphometries over a 2-Year follow-up interval.

Hypothesis
Spinal deformity patients have unique postoperative recovery profiles, depending on deformity morphometry.

Design
Retrospective review of two prospective spinal deformity databases.

Introduction
Postoperative recovery profiles of C, T, and CT patients, relative to one another, are poorly understood. Objective benchmarks are needed to define a good postoperative recovery.

Methods
Operative deformity patients >18y/o, with baseline(BL) to 2-Year HRQLs (EQ5D, ODI, NDI) were included. Patients were stratified by C only (C2-C7 Cobb>10°, CL>10°, cSVA>4cm, or CBVA>25°), T only (coronal scoliosis≥20°, SVA ≥5cm, PT≥25°, or TK≥60°), and CT. A novel method of area-under-the-curve (AUC) normalization generated normalized HRQL scores at BL and all f/u intervals(6wk, 3M, 6M, 1y, 2yr). Normalized scores were plotted against f/u time interval. AUC was calculated for each f/u interval, and total area was divided by cumulative f/u length, determining overall, time-adjusted HRQL recovery (Integrated Health State-IHS).

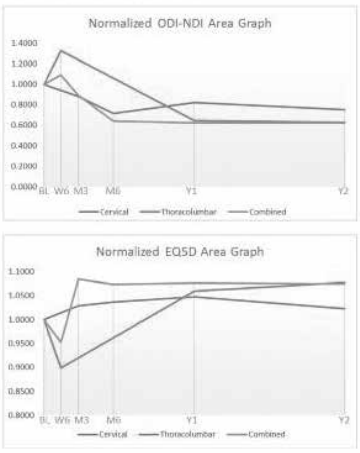
Results
170 patients were included (27 C, 27 T, 116 CT). Mean age: 61.99 (p=0.852); 73.5% Female. C had higher BMIs (C 45.5, T: 27.90, CT 32.51), T had the highest CCI (C 0.696, T 1.815, CT 1.699). Posterior approaches were most common (62.9%) followed by combined (28.8%) and anterior (6.5%). At BL, all groups had similar ODI-NDI and EQ5D scores (p>0.05). Standard analysis found no differences among groups regarding HRQL scores and recovery rates. After HRQL normalization, CT exhibited a higher ODI-NDI recovery rate (IHS)

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

compared to C (C: 0.23 vs T: 0.41 vs CT: 0.48, p=0.027). Despite trending towards immediate faster postoperative recovery, C had less patients meeting ODI-NDI MCID at 1Y postop (34.6% vs 53.8% vs 58.7%, p<0.05), although this difference diminished at 2Y postop (p>0.05).

Conclusion
Cervical deformity patients exhibited quicker rates of immediate postoperative recovery, despite a lower Integrated Health State ODI-NDI recovery. This study is a step towards objective recovery benchmarks for multiple deformity morphometries over a 2-year f/u interval.

Figure 1: Normalized Recovery Profiles for Operative Cervical, Thoracolumbar, and Combined Spinal Deformity Morphometries.



93. Cervical Pedicle Screw Placement with Use of a Navigated High-speed Drill

Kotaro Satake, MD; Tokumi Kanemura, MD, PhD; Hiroaki Nakashima, MD, PhD; Yoshimoto Ishikawa, PhD; Naoki Segi, MD; Jun Ouchida, MD

Summary
A navigated high-speed drill (ND) has a role to reduce the rate of lateral wall perforation in cervical pedicle screw (CPS) placement.

Hypothesis
Lateral pedicle wall perforation is still frequent even in navigated CPS placement. It may be caused by the forced vertebral rotation during the manual probing. Gentle probing using a ND may has a potential to reduce the vertebral rotation and the consequent lateral perforation.

Design
A retrospective study.

Introduction
Among the complications of CPS placement, lateral screw perforation involves a potential risk of vertebral artery injury. It is still difficult to avoid completely due to the wider transverse angle and the thinner lateral cortex of cervical pedicles. We have used a ND for initial probing to improve the accuracy of CPS placement. This study was performed to evaluate the accuracy of CPS placement with use of ND and to compare it with a conventional navigated manual probe (MP).

Methods
35 consecutive patients (20 males and 15 females, 66.5 [33 - 87] years) were enrolled in this study. They underwent a posterior cervical fixation using CPSs at C2 - C7 under an intraoperative 3D - CT based navigation system (total 159 CPSs). For initial probing, ND with 2-mm steel burr was used since Apr. 2017 (Group ND; 79 CPSs) and MP was used earlier (Group MP; 80 CPSs). There were no other different procedures in terms of CPS placement between the two groups. The accuracy of CPS placement was graded as defined by Neo et al. with postoperative axial images of CT and compared between the two groups. The direction of the pedicle perforation (lateral or medial) was compared as well.

Results
There was no significant difference of total perforation rate between Groups ND and MP (15.2 % vs. 13.8 %, p = 0.83). There were no symptomatic complications related to screw perforation in either groups. The lateral perforation rate was significantly reduced in Group ND compared to Group MP (33.3 % vs. 90.1 %, p = 0.01).

Conclusion
Although ND did not decrease the total perforation rate, it reduced the incidence of lateral perforation. ND is likely to make initial probing easier without a forcible manipulation which might cause the vertebral rotation and a consequent lateral perforation of pedicle wall.

94. Effect of Race, Age and Gender on Lumbar Muscle Volume and Fat Infiltration in the Degenerative Spine

Tetsuro Hida, MD; Robert K. Eastlack, MD; Tokumi Kanemura, MD, PhD; Gregory Mundis, MD; Shiro Imagama, MD, PhD; Behrooz Akbarnia, MD

Summary
Multi-center cross-sectional study of 140 patients with degenerative lumbar disease from US and Japan. Caucasian patients had larger cross sectional areas of lumbar muscle in MRI. Asian subjects had more fatty degeneration of posterior lumbar muscles. Female gender had an independent effect with increased fatty degeneration regardless of race. Lumbar muscle area became smaller and fat degeneration progressed with to aging.

Hypothesis
Lumbar muscle volume decreases in older patients and muscle degeneration increases with age, but gender and race have no effect.

Design
Multi-center cross-sectional study.

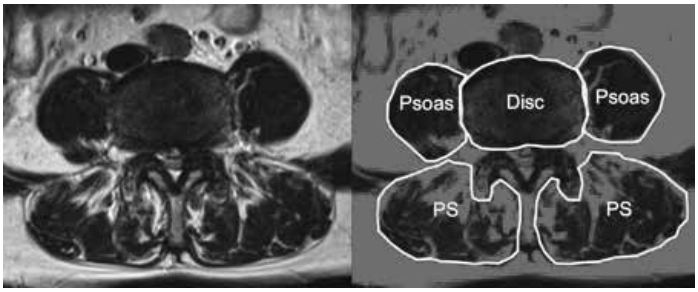
Introduction
Paraspinal (PS) and psoas muscles play an important role in low back pain, truncal stability , limb motion. The effect of age, gender, and race on muscle volume and fatty degeneration are not well understood.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Methods
Consecutive patients from 2 centers in Japan and US undergoing L4-5 single level lumbar fusion were enrolled. Using preop axial T2 MRI at L4-5 disc level, the cross sectional area of the psoas, multifidus and erector spinae muscles was measured. Fat infiltration was measured with the threshold method and calculated % fat area (%FA) in each muscle. The muscle/disc area ratio (MDAR) was used to control for size difference per patient. Age, gender, and race were used for comparison between groups with unpaired T test. Pearson's and partial correlation analysis with control for gender and race were performed to identify age-specific effects.

Results
140 patients(53 males, 87 females) were analyzed. Age was similar in Caucasian(Ca) and Asian(As) (M 68.1 vs 71.2 yrs, p=0.25; F 67.8 vs 69.4 yrs, p=0.45). MDARs were larger in Ca for PS (M, 2.07 vs 1.77, p<0.05; F, 2.24 vs 1.83, p<0.001) and psoas (M, 1.29 vs 1.15, p=0.074; F, 1.01 vs 0.83, p< 0.005). %FA of psoas was similar in Ca and As (M, 5.8% vs 4.6%, p=0.31; F, 7.7% vs 6.9%, p=0.41), but greater in PS muscles in As (M, 15.0% vs 19.6%, p<0.05; F, 20.65 vs 25.1%, p<0.01). There were significant negative correlations between age and MDAR in all muscles in both genders, and positive correlations between age and %FA in females, but not males. After controlling for race and gender, age was negatively correlated with MDAR (psoas, R = -0.39, p<0.001; PS, R = -0.60, p<0.001) and positively with %FA (psoas, R = 0.18, p<0.001; PS, R = 0.33, p<0.001).

Conclusion
Lumbar PS muscle size and fatty degeneration in those muscles vary relative to race for Asian and Caucasian individuals, and gender. Erector spinae and mulifidi muscle cross-sectional areas decrease with age, and fat degeneration in those same muscles progresses with age.



.

95. Lumbar Spine Degeneration and Flatback Deformity Alter Sitting-Standing Spinopelvic Mechanics - A Detailed Analysis of Segmental Spinal Alignment Change

Aaron Buckland, MBBS, FRACS; Peter Zhou, BS; Leah Steinmetz, BA; Nicholas Frangella, BS; Nicholas Stekas, BS; David Ge, BA; Christopher Varlotta, BS; Dennis Vasquez-Montes, MS; Virginie Lafage, PhD; Renaud Lafage, MS; Peter Passias, MD; Themistocles Protopsaltis, MD; Jonathan Vigdorchik, MD

Summary
Standing spinal alignment has been the center of focus recently, particularly in the setting of adult spinal deformity. Humans spend approximately half of their waking life in a seated position. This study demonstrates that there are significant changes in lumbopelvic alignment from standing to sitting. The predominant changes are seen in the L4-S1 segments and Pelvic Tilt. With lumbar spine degeneration and flatback deformity, relatively more alignment change occurs at the upper lumbar spine and thoracolumbar junction.

Hypothesis
Sitting and standing segmental spinal alignment are altered with lumbar degeneration (DEGEN) and flatback deformity (DEFORMITY) compared to patients with normal lumbar spines.

Design
Retrospective postural radiographic review

Introduction
Lumbopelvic sagittal alignment has been shown to adapt from standing to sitting posture, however segmental vertebral alignment of the entire spine is not yet fully understood, nor the effects of DEGEN or DEFORMITY. Segmental spinal alignment between sitting and standing and the effects of degeneration and deformity was analyzed.

Methods
Patients with full body sitting and standing stereoradiographs at a single institution were included. Exclusion criteria included lumbar fusion/ankylosis, hip arthroplasty, and transitional lumbosacral anatomy. Lumbar spines were then classified as NORMAL, DEGEN (at least one level of disc height loss >50%, facet arthropathy, or spondylolisthesis), or DEFORMITY (PI-LL mismatch>10°). Independent samples t-tests analyzed segmental alignment between sitting and standing within groups. ANOVA assessed differences between spine pathology groups.

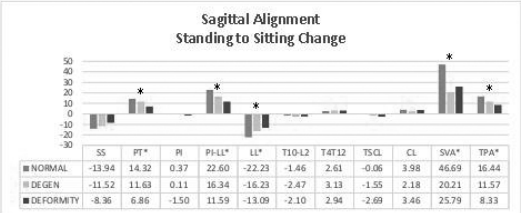
Results
There were 183 NORMAL, 216 DEGEN and 92 DEFORMITY patients with significant differences in age, gender, and hip OA grades. After propensity matching for these factors, there were 56 patients in each group (age 63±14, 58% female). Significant differences were noted between spinal pathology groups with regard to changes from standing to sitting alignment with regard to NORMAL vs DEGEN vs DEFORMITY groups in PT (14.3° vs 11.6° vs 6.9°, p=0.024), LL (22.2° vs 16.2° vs 13.1°, p=0.002), and PI-LL (22.6° vs 16.3° vs 11.6°, p<0.001) (Figure 1a). NORMAL patients had overall greater mobility in the lower lumbar spine from standing to sitting compared to DEGEN and DEFORMITY patients. L4-L5 (-6.3° vs -3.3° and -3.2°, p<0.001) and L5-S1 (-5.3° vs -3.5° and -1.7°, p=0.003) (Figure 1b).

Conclusion
The lower lumbar spine provides the greatest sitting to standing change in lumbopelvic alignment in normal patients. Degeneration

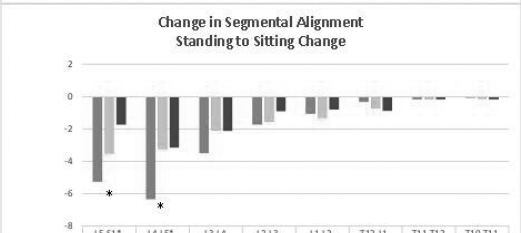
Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

and deformity of the spine significantly reduces the mobility of the lower lumbar spine and PT.

Figures 1a &1b: Changes in sagittal spinal alignment occur with changing posture from standing to sitting. Note the reduction in the relative contribution of the lower lumbar segments and pelvic tilt in the DEGEN and DEFORMITY groups with when compared to the normal group (* significant differences at p<0.05).



	SS	PT*	PI	PI-LL*	LL*	T10-L2	T4T12	TSCL	CL	SVA*	TPA*
NORMAL	-13.94	14.32	0.37	22.60	-22.23	-1.46	2.61	-0.06	3.98	46.69	16.44
DEGEN	-11.52	11.63	0.11	16.34	-16.23	-2.47	3.13	-1.55	2.18	20.21	11.57
DEFORMITY	-8.36	6.86	-1.50	11.59	-13.09	-2.10	2.94	-2.69	3.46	25.79	8.33



	L5-S1*	L4-L5*	L3-L4	L2-L3	L1-L2	T12-L1	T11-T12	T10-T11
NORMAL	-5.25	-6.32	-3.49	-1.71	-1.06	-0.32	-0.15	-0.07
DEGEN	-3.52	-3.25	-2.10	-1.56	-1.33	-0.74	-0.16	-0.14
DEFORMITY	-1.72	-3.15	-2.12	-0.90	-0.79	-0.87	-0.15	-0.16

.

96. Efficacy of Retroperitoneal Approached Interbody Fusion Surgery on the Sagittal Balance in the Degenerative Spinal Deformity

Seung Heon Yang, MD; Chi Heon Kim, MD, PhD; *Chun Kee Chung, MD, PhD*

Summary
Clinical improvement and restoration of a decent amount of regional lordosis and global alignment can be achieved with retroperitoneal approached interbody fusion surgery.

Hypothesis
Achieved segmental and regional lordosis through retroperitoneal approached interbody fusion surgery can be transferred to global sagittal imbalance.

Design
Case series

Introduction
Retroperitoneally approached interbody fusion surgery has gained its popularity for several reasons. It is generally accepted idea that lateral interbody fusion is effective in restoration of coronal, segmental and regional angle, but not in global sagittal alignment. Since 2005, we routinely performed retroperitoneally approached interbody fusion surgery with percutaneous pedicle screw fixation for any lumbar interbody fusion. Therefore, we retrospectively assessed clinical and radiological outcomes of the patients with degenerative spine deformity.

Methods
Among the patient who underwent anterior or lateral lumbar interbody fusion surgery since 2005, every patient who met sagittal modifier criteria of SRS-Schwab adult deformity classification system and who fulfilled 2-year follow-up was enrolled. Clinical and radiological 2-year outcomes were assessed. Using minimum clinically important difference (MCID) of ODI (>12.5), patients were divided into good and suboptimal outcome groups and risk factors including sagittal modifier of SRS-Schwab classification were assessed.

Results
A total of 149 segments were operated in 77 patients. One level surgery was done in 28 patients, 2-level in 32, and 3-level or more in 17. Mean ODI score changed from 52.9 to 29.1. Mean achieved segmental lordosis without osteotomy was 11.3° at a mean 1.81 level of fused segments per patient. A mean lumbar lordosis increased by 13.9°, and SVA decreased by 3.6cm. In case of additional SPO, a mean achieved segmental lordosis was 13.3° per level. A total 17 patients (22.1%) reported suboptimal outcomes. Pre- and postoperative global alignment ($p<0.01$) and postoperative 'PI-LL' ($p<0.05$) turned out to be risk factors.

Conclusion
Retroperitoneal approached interbody fusion surgery is effective in restoration of lordosis, and those seem to be successfully translated to improved global sagittal balance, which seems the most important parameter related to better clinical outcome.

97. Obesity is Associated with Increased OR Time, Hospital Stay, and Postoperative Wound Complications in Lumbar Fusion Surgery: Analysis of 1,196 Cases at a Single Institution

Amit Jain, MD; Sandra Hobson, MD; Eric Yoon ; Scott D. Boden, MD; John Heller, MD; John M. Rhee, MD; S. Tim Yoon, MD, PhD

Summary
Higher BMI is associated with increased OR time, length of stay, total hospital charges, and postoperative surgical I&Ds in patients treated with spinal fusion surgery for degenerative conditions.

Hypothesis
We hypothesize that obesity is associated with longer operative time and length of stay, and greater wound complications in patients treated with spinal fusion surgery for degenerative conditions.

Design
Retrospective

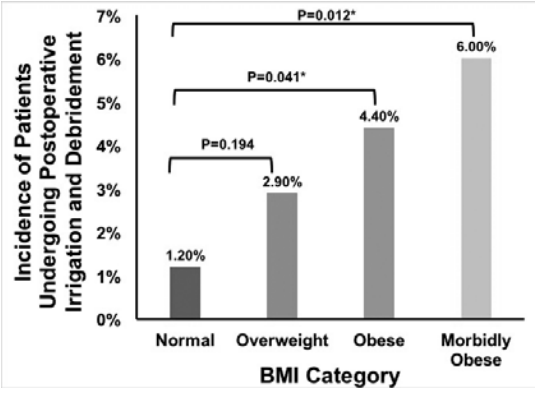
Introduction
The aim of our study was to determine the association of obesity with operating room time, length of stay, hospital charges, and postoperative irrigation and debridement surgeries (I&D) in patients treated with lumbar fusion surgery for degenerative pathologies.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Methods
A retrospective review of all lumbar surgeries for degenerative conditions was performed at a single orthopaedic hospital for a 4-year period from Sept 2011 through Aug 2015. Patients were stratified by their body mass index (BMI) into 4 categories: "Normal" (BMI 18.5-24.9): 21.8% patients, "Overweight" (BMI 25-29.9): 39.4%, "Obese" (BMI 30-34.9): 26.2%, and "Morbidly Obese" (BMI≥35): 12.6%. Multivariate linear regression analysis was performed and adjustments were made for patient age, comorbidities, levels fused, revision surgery status, and use of interbody device.

Results
There was no significant association between BMI and patient age (P=0.533) or sex (P=0.287). On multivariate analysis, compared to normal BMI patients, the adjusted mean operating room time was 25±6 mins longer in the overweight group, 40±7 mins longer in the obese group, and 50±8 mins longer in the morbidly obese group (P<0.001 each). Morbidly obese patients had significantly longer length of hospital stay compared to normal BMI patients (4.0 vs. 3.5 days, P=0.02). Multivariate analysis revealed that the mean adjusted hospital charges for the index surgery were significantly greater in each of the higher BMI categories. Multivariate logistic regression analysis revealed that obese patients had 3.6-fold odds (P=0.040), and morbidly obese patients had 5.7-fold odds (P=0.012), of undergoing postoperative surgical I&D compared to normal BMI patients.

Conclusion
Higher BMI is associated with increased OR time, length of stay, total hospital charges, and postop surgical I&Ds in spinal fusion surgery for degenerative conditions.



.

98. Risk Factors for Pseudarthrosis after a Surgical Site Infection of the Spine

Douglas Hollern, MD; Barrett Woods, MD; Neil Shah, MD, MS; Gregory Schroeder, MD; Christopher K. Kepler, MD; Mark Kurd, MD; David Kaye, MD; Paul Millhouse, MD, MBA; Bassel Diebo, MD; Carl Paulino, MD; Alan Hilibrand, MD; Alexander Vaccaro, MD, PhD; Kris Radcliff, MD

Summary
The effect of surgical site infection on the development of symptomatic pseudarthrosis after spinal fusion is still not clearly defined. Our study suggests that number of spinal levels fused (OR: 1.356 per level) and BMI (OR: 1.083) maybe independent predictors pseudarthrosis in patients who develop SSI following spinal fusion. This is the first known study to specifically identify risk factors for the development of symptomatic pseudarthrosis.

Hypothesis
There are likely specific factors that can be identified when pseudarthrosis is diagnosed first clinically and subsequently confirmed radiographically.

Design
Retrospective review of a prospectively-collected database

Introduction
Pseudarthrosis following spinal fusion is a complication that frequently requires revision surgery. Reported rates of pseudarthrosis after surgical site infection range from 30 to 85%, but few studies have identified infection as an independent risk factors for its development. This study sought to determine the incidence of clinically symptomatic pseudarthrosis in patients who developed SSI following lumbar fusion and identify factors associated with its development.

Methods
Patients who underwent spine surgery and developed a surgical site infection from Jan 2005-Mar 2015 were included. Patient-specific and procedural characteristics were recorded. Presence of pseudarthrosis was determined clinically by the treating surgeon and confirmed radiographically. All those in the pseudarthrosis group required a revision procedure after eradication of infection. Univariate and multivariate analyses were conducted as appropriate.

Results
416 patients were included. 21 of 416, or 5.0%, developed symptomatic pseudarthrosis following SSI. Multivariate regression analysis showed that in this cohort, age, CCI, male sex, and surgical approach were not significant predictors of pseudarthrosis formation. However, number of spinal levels fused was found to be the leading predictor for development of pseudarthrosis (OR 1.356 per level, 95% CI 1.15-1.54, p<0.001), followed by BMI (OR 1.083 per point, 95% CI 1.02-1.015, p<0.009) in this cohort. Removal of hardware was found to be a significant predictor of the number of levels fused (OR: 1.19 per level, 95% CI: 1.08-1.30, p<0.001). Of the 21 pseudarthrosis cases, 85.7% found Staphylococcal spp, of which 27.8% exhibited MRSA.

Conclusion
The effect of surgical site infection on development of symptomatic pseudarthrosis after spinal fusion is still not clearly defined. Our study suggests that number of spinal levels fused and BMI may be independent predictors pseudarthrosis in patients who develop SSI after spinal fusion.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

99. Postoperative Deep Wound Infections: Do The Implants Really Need To Be Removed?

Viral Patel, MD; John M. Dawson, PhD; Benjamin Mueller, MD, PhD; Amir Mehbod, MD; Manuel Pinto, MD; James Schwender, MD; Joseph H. Perra, MD; Timothy A. Garvey, MD

Summary
Spine surgery patients with SSI who underwent irrigation and debridement were retrospectively studied for recurrence of infection. The overall reinfection rate (RR) was 7%. The RR for retained implants is 8% and for removed implants is 0% (not statistically significant, p=0.68). The RR was not statistically different between patients with no/removed implants and patients. Implants do not need to be removed in acute infections to have successful outcomes.

Hypothesis
The reinfection rate after SSI is not related to retention or removal of implants.

Design
Retrospective chart review

Introduction
Spine surgery patients with a post-operative wound infection were studied to determine if retained instrumentation is associated with infection reoccurrence.

Methods
Spine surgery patients who underwent irrigation and debridement (I&D) between 2006-2015 were studied. Data included demographics, comorbidities, smoking, surgical details, implant type, I&D details, and infection treatment. Outcomes included ODI or NDI and VAS, implant status, pseudoarthrosis and recurrence of infection. Data were statistically analyzed using the Fisher's Exact Test.

Results
151 patients were identified; 47 were excluded for various reasons; 104 met inclusion criteria. 69 patients had instrumented fusions and 35 had uninstrumented fusion (6/35) or no fusion (29/35). There were 53 males and 51 females; age was 55±17 years; BMI was 32±9. Time from surgery to first I&D was 39±5 days. The overall RR was 7%. Implants were retained in 64/69 patients with a RR of 8%; among explanted patients (5) none had a recurrence (0%). The difference between retained and explanted patients was not statistically significant (p=0.7). Among patients with no/removed implants, RR was 5%. The RR was not statistically different between patients with no/removed implants and patients with retained implants (p=0.5). Among 76 fusion patients, 30% had radiographic evidence of pseudoarthrosis; 7% had a recurrent infection. Pseudoarthrosis and reinfection were unrelated (p=0.16). 94 patients provided some or all of their clinical outcomes preoperatively and a minimum of 6 months. 33% achieved a Minimum Clinically Important Difference (MCID) in ODI or NDI scores; 56% achieved MCID in VAS. The occurrence of a reinfection was not related to achieving MCID for functional outcome score (p=0.63) or pain (p=0.40).

Conclusion
Successful treatment of SSI after I&D and antibiotic treatment was not related to retention or removal of implants. SSI with successful treatment did not impact clinical outcomes after spine surgery. Implants do not need to be removed in acute infections to have successful outcomes.

Implant \ Reinfection	Yes(7)	No(97)
Yes(64)	5(8%)	59(92%)
No(40)	2(5%)	38(95%)

100. Complications Associated with Minimally Invasive Anterior to the Psoas (ATP) Fusion of the Lumbosacral Spine: A Review of 909 Patients

Tony Tannoury, MD; *Harish Kempegowda, MD;* Kaveh Haddadi, MD; Chadi Tannoury, MD

Summary
During last two decades, various innovative MIS fusion techniques have evolved. It is very important for surgeons to evaluate feasibility and safety of new techniques before adapting into practice. The current study was performed with goals to report on feasibility and complications of a novel ATP approach to perform lumbosacral fusion. A single center study of 909 patients with 2373 levels of fusion revealed peri-operative complications in 61 patients (6%) which seems similar or better than many newer fusion techniques.

Hypothesis
Anterior to the psoas approach is a safe approach to perform anterior fusion from T12-S1.

Design
Retrospective analysis

Introduction
A recent cadaveric study reported on safe surgical corridor owed to Minimally Invasive Anterior to the Psoas approach (MIS-ATP) enabling anterior lumbar interbody fusion (ALIF) from L1 to S1. However, strong clinical supportive studies are still lacking & many surgeons believe ATP approach is not feasible at L5-S1 level. Current study reports complications associated with ATP approach for lumbosacral fusion including approach related & medical issues

Methods
A detailed retrospective chart review of 909 patients who had underwent MIS ALIF single or multi levels through ATP approach between T12-S1 was performed. Available electronic data (ED) from surgeries performed between January 2008 and December 2016 by two fellowship trained orthopaedic spine surgeons was evaluated for patients treated for spondylolisthesis, spondylosis, stenosis, sagittal and/or coronal deformity by a single independent reviewer not involved in patient care for documented complications. A complication is defined as any adverse event related to the index spine procedure

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

for which patient required specific intervention or treatment. MIS ALIF was performed with patient in the lateral decubitus position, via either a left sided or right sided ATP discectomy, followed by placing PEEK cage filled with cortico-cancellous allograft. Generally this is followed by prone repositioning and posterior percutaneous pedicle screw fixation.

Results
A total of 2373 MIS ALIF performed during study period in 909 patients. Of the 909 patients, 61 patients (6%) sustained one or more complications during peri-operative period, of which 19 % were surgical and 81 % were medical complications. (Table. 1)

Conclusion
MIS ATP approach provides a safe access to ALIF between T12-S1 and it does not require neuromonitoring, and warrant minimal to no psoas muscle retraction thereby less postoperative thigh pain and lumbar plexus injuries. Additionally, clear visualization of the major and minor blood vessels reduces risk of inadvertent vascular injuries.

Patient characteristics (n=909) Age (y) Mean: 58.5; Range: 22-90 Gender (n) Males: 400; Females: 509 Total number of patients sustained one or more peri-operative complications: **61 (6%),**			**Level of fusion (n)** One-level (243) Two-level (277) Three-level (143) Four-level (125) Five-level L1-L5 to L5-S1 (79) Six-level T12-L1 to L5-S1(42)	
Comp-lications	**Major(n, %)**	**Interventions**	**Minor (n, %)**	**Interventions**
Medical Peri-operative	Hospital Acquired pneumonia (2, 0.2) Pulmonary Embolism (5, 0.5) Acute Renal Failure (1,0.1%) Deep Vein Thrombosis (4, 0.4%) Acute Coronary Syndrome (2, 0.2%) Congestive Heart Failure (2, 0.2%) Pneumothorax	Antibiotics + Supportive Heparin drip Dialysis Heparin Cardiac intensive care Cardiac intensive care Chest tube placement	Anemia (26 2.8%) Ileus (8, 0.8%) Ileus-Ogilvie syndrome (1, 0.1%) Urinary infection (3, 0.32%) Urinary Retention (3, 0.32%) Transient hypoxia (3, 0.32%) Arrhythmias (3, 0.32%) Delirium and confusion (2, 0.2%) Acute Tubular Necrosis (9, 0.98%)	Blood transfusion NG Tube placement NG Tube placement Treated with antibiotics Discharged with Foley catheter Supportive management Antiarrythmics Supportive management Supportive management
Surgical Peri-operative	Superior mesentric artery syndrome(1) Retroperitoneal Hematoma (1, 0.1%) Posterior Deep wound infection (1) Foot Drop (4, 0.4%) Misplaced screws (4, 0.4%)	Colectomy Exploration Debridement AFO brace Revision surgery	Vascular injury of Segmental vessels (3, 0.3%) Posterior Superficial wound infection (2, 0.2%) CSF Leakage (5, 0.5%)	Intraoperative control by Spine Surgeon Local wound care and Ora antibiotics Sealant
Discharge to 3 months post-op	Deep wound Infection-Posterior (3, 0.3% Deep wound Infection-Anterior (1,0.3%)	I & D, Deep Wound Vac I & D, Hardware removal	Thigh pain (12, 1.33%) Posterior wound infection (4, 0.5%) Wound Dehiscence (5, 0.6%) Leg pain and dysesthesia (4, 0.5%	Conservative managemer Local wound care and Ora antibiotics Local wound care Conservative managemer
3 months-1 year	Hardware failure (2, 0.2%) Proximal Junctional kyphosis (1, 0.1% Adjacent segment disease (2, 0.2%) Retrograde ejaculation (2, 0.2%)	Revision surgery Revision surgery Revision surgery Observation	Thigh pain (5, 0.5%) leg pain and dysesthesia (24, 2.6%) Screw pullout (2, 0.2%)	Conservative managemer Conservative managemer Conservative managemer

101. The Influence of Pedicle Screws on Nonunion of Lateral Lumbar Interbody Fusion

Kotaro Satake, MD; Tokumi Kanemura, MD, PhD; Hiroaki Nakashima, MD, PhD; Yoshimoto Ishikawa, PhD; Naoki Segi, MD; Jun Ouchida, MD

Summary
Larger convergent angle (> 27°) of pedicle screws (PSs) and larger mismatch of screw diameter to the pedicle (> 3 mm) are risk factors for nonunion of lateral lumbar interbody fusion supplemented with PSs.

Hypothesis
PS size or positioning may influence the stabilizing effect of the LLIF segment and consequent fusion status.

Design
A retrospective study.

Introduction
PS is the common supplemental fixation for lateral lumbar interbody fusion (LLIF). This study was performed to evaluate the influence of PS position on LLIF nonunion at 2 years postoperative.

Methods
51 patients (20 males and 31 females, 69.1 years, 81 segments) who underwent a transpsoas LLIF with bilateral PSs (minimum 2-years follow-up) were enrolled. PSs were intended to be placed parallel to the superior endplates of the vertebrae. 18-mm width PEEK cages packed with allogenic bone were applied. No posterior bone graft was added. For each segment, nonunion segments were identified by CT 2 years postoperative and they were classified into nonunion inside the cage (NC), in the facet joints (NF), and both (NB). The convergent angle (CA), the shortest distance from anterior vertebral wall to the screw tip (dWS), and the difference of pedicle- and screw diameters (dPS) of each PS were measured by CT as well. For each LLIF segment, the averaged CA, dWS, and dPS of 4 surrounding PSs were calculated. Age, sex, body mass index, smoking status, bone mineral density, previous vertebral fractures, the numbers of posterior fixed segments, intraoperative endplate injury, and the approach of PS (open or percutaneous) were investigated and entered into the analyses as well. The risk factors for NC, NF, and NB were identified by uni- and multivariate analyses. ROC curve analysis was used for each risk factor to determine the cutoff value.

Results
NC was 34 (42 %), NF was 30 (37 %), and NB was 16 (19.8 %). CA was determined as a risk factor for NC (OR: 1.18, 95% CI: 1.08 – 1.29, p = 0.00) and dPS was a risk for NB (OR: 1.43, 95% CI: 1.08 – 1.9, p = 0.01). The cutoff value of CA for the best prediction of NC was 27 ° (sensitivity 83 %, specificity of 35.3 %), and dPS for NB was 3.1 mm (sensitivity 75 %, specificity of 44.6 %).

Conclusion
We should be aware of PS convergent angle and the screw diameter matched to the pedicle size to reduce nonunion of LLIF.

102. Survival of Multiple-Rod Constructs Across 3-Column Osteotomies in Long Fusions to the Sacrum for Adult Spinal Deformity

Jun Yang, MD; Rongping Zhou, MD; Suomao Yuan, MD; Meghan Cerpa, BS, MPH; Lawrence G. Lenke, MD

Summary
Three-column osteotomies (3CO) are often used to treat adult spinal deformities (ASD), typically with a standard 2-rod construct (RC) across a highly unstable osteotomy site. Due to the increased instability across osteotomy sites we propose that multiple-rod constructs should be implemented in place of a 2-RC. Patients fused with 2-RC to the pelvis have a higher incidence of implant failure and pseudarthrosis than those fused with multiple-rod constructs.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Hypothesis
Use of multiple rod constructs can reduce implant related complications and maintain correction postoperatively with long fusions to the sacrum in adult spinal deformity surgery.

Design
Single-center cohort

Introduction
Rod breakage secondary to pseudarthrosis is one of the most common implant related complications after corrective surgery for ASD. Fusions extending to the sacrum have a higher incidence of pseudarthrosis with rod fracture, which most frequently occurs around the lumbosacral junction. Similar to employing multiple rod constructs for 3CO in order to avoid rod fracture and pseudarthrosis, we have been using multi-rod constructs in primary and revision ASD cases undergoing long fusions to the sacrum/ilium.

Methods
45 consecutive ASD patients who underwent long fusions to the sacrum/pelvis were analyzed. Patients with a 3CO by a single surgeon were matched for age/diagnosis/vertebrae levels fused, and curve magnitude. Inclusion criteria was set for >10 levels, primary fusion or revision for pseudarthrosis, and minimum 1yr f/u. 19 patients undergoing revision surgery (RS) were matched to 26 consecutive patients undergoing primary surgery (PS) with a multiple-RC across the 3CO site.

Results
No statistical differences in mean age at surgery, vertebrae resected, levels fused, bone morphogenetic protein used, or average preoperative Cobb magnitude were seen. There was significant correction in coronal balance and pelvic incidence for the PS vs. RS group. Patients fused with a 2-RC had a significantly higher incidence of implant failure and revision surgery for pseudarthrosis at the 3CO site than those fused with multiple-RC, especially in fusions to the sacrum/pelvis ($p = 0.004$). There were 2 rod breakages in the primary group, and 1 patient had unilateral S2AI screw breakage without symptomatic pseudarthrosis.

Conclusion
The use of a multi-RC is a safe and effective method to provide increased stability across 3CO sites and significantly prevent implant failure and/or symptomatic pseudarthrosis. We recommend using a multi-RC to stabilize 3CO of the thoracic and lumbar spine especially for revision surgery extending to the sacrum/pelvis.

103. "Reconstruction of the Basement" Rather than "Adding a Storey" is More Effective in Preventing Re-PJK in Adult Spinal Deformity Patients

Caglar Yilgor, MD; Suna Lahut, PhD; Kadir Abul, MD; Yasemin Yavuz, PhD; Firat Gulagaci; Ibrahim Obeid, MD, MS; Frank S. Kleinstueck, MD; Francisco Javier Perez-Grueso, MD; Emre Acaroglu, MD; Ferran Pellisé, MD; Ahmet Alanay, MD; European Spine Study Group

Summary
In an analysis of 47 adult spinal deformity patients, that had undergone PJK revision surgery, re-PJK rates were found to be significantly lower in patient that had "Reconstruction of the Basement" (i.e., spinopelvic realignment surgery) rather than "Adding a Storey" only (i.e., extension of fusion to higher segments). Patients that reached ideal individualized sagittal plane shape and alignment had the lowest re-PJK rates.

Hypothesis
Reconstruction of spinopelvic alignment is more effective in preventing re-PJK than extension of fusion to upper segments.

Design
Retrospective analysis of a prospectively collected data of adult spinal deformity pts.

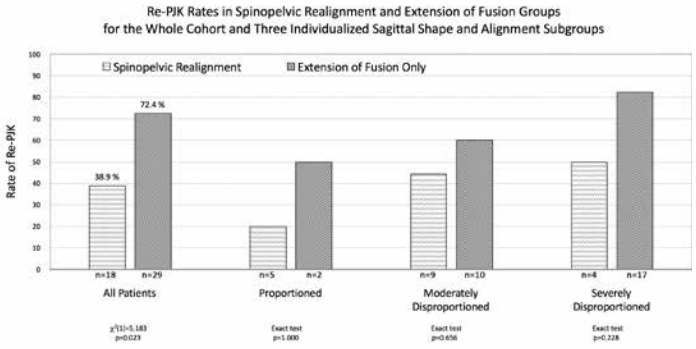
Introduction
Extension of fusion to upper segments is the mainstay of symptomatic PJK/PJF revision surgery. Although this procedure stands effective due to the reduction of stressors at the proximal junctional segments, it frequently results in re-PJK. A reason for this may be the ongoing spinopelvic misshape and malalignment. The aim was to compare the effects of two different surgical strategies (Spinopelvic realignment and extension of fusion (REALIGN) vs extension of fusion only (EXT)) on re-PJK rates.

Methods
Inclusion criteria: ≥4 levels fusion, ≥2y f/up and having revision surgery due to symptomatic PJK/PJF. Re-PJK/PJF was defined as UIV-UIV+2 angle ≥20° and ≥10° increase between early postop and f/up xrays and/or fracture of UIV/UIV+1 and implant complications at UIV. The Global Alignment and Proportion (GAP) score was used to postoperatively divide pts into 3 groups: Proportioned (GAP-P), Moderately Disproportioned (GAP-MD) and Severely Disproportioned (GAP-SD), indicating individualized sagittal shape and alignment. Re-PJK rates were compared using Chi-squared tests.

Results
47 pts (36F, 11M) were included. Mean age: 66.9±11(23-81) yrs. Mean f/up: 31±10.8(24-62) months. 29 had EXT and 18 had REALIGN surgery. Groups were similar according to age, BMI and gender ($p>0.05$). Overall, 28 (59.6%) had re-PJK. Re-PJK rates were different in treatment groups ($p=0.023$). In EXT, mean pre- and post-op GAP was 8 and 7, respectively. 72.4% of the pts had re-PJK. In REALIGN, mean pre- and post-op GAP was 10.7 and 4.5, respectively. 38.9% of the pts had re-PJK. Details are given in Fig 1.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Conclusion
Re-PJK occurred in more than half of the patients that had undergone PJK revision surgery. Re-PJK rates can significantly be reduced via performing spinopelvic realignment surgery in addition to extension of fusion. Lowest re-PJK rates were observed in patients that reached ideal individualized sagittal shape and alignment.



.

104. Long Satellite Rod Constructs Can Reduce the Incidence of Rod Fractures Following 3-Column Osteotomy

Yu Yamato, MD, PhD; Tomohiko Hasegawa, MD, PhD; Daisuke Togawa, MD, PhD; Go Yoshida, MD, PhD; Tomohiro Banno, MD, PhD; Shin Oe, MD; Hideyuki Arima, MD, PhD; Sho Kobayashi, MD, PhD; Tatsuya Yasuda, MD; Yuki Mihara, MD; Hiroki Ushirozako, MD; Yukihiro Matsuyama, MD, PhD

Summary
The effect of satellite rod (SR) constructs to prevent rod fractures (RF) in adult patients who underwent 3-column osteotomy was retrospectively investigated. Forty-eight patients (average age 67.6 years; follow-up rate: 90.6%) were included. The incidence of RF in patients with SRs (36%) was significantly lower than that of conventional 2-column rods (68%). Subanalysis showed a higher incidence of RF (64%) in patients with SRs covering only the osteotomy site. SRs covering the osteotomy site and lumbosacral junction reduced RF incidence.

Hypothesis
Satellite rod constructs reduce the incidence of rod fracture (RF) following 3-column osteotomy in patients with adult spinal deformity.

Design
A retrospective analysis of prospectively collected consecutive cases in a single center

Introduction
Rod fracture (RF) is a frequent implant-related complication following 3-column osteotomy (3-CO) surgery in patients with adult spinal deformity (ASD). Two types of satellite rod constructs were utilized to prevent RF. The objective was to verify the effect of satellite rods and to determine the optimal type of satellite rod to prevent RF.

Methods
We retrospectively evaluated consecutive patients who underwent 3-CO from 2013 to 2015 in patients with ASD. The inclusion criteria were patients with a fused pelvis and a minimum of 2-year follow-up. Patients were classified into two groups depending on rods constructs: conventional 2-rod (2R) and 2-rods with satellite rods (SRs). SRs were constructed on the inside from one or both side regular rods using 3 or 4 connectors. The satellite rod constructs were also stratified into two groups according to the location, they covered, only osteotomy site (Short SR) or osteotomy site and lumbosacral junction (Long SR). We analyzed the effect of the SR constructs and determined which model was the best to prevent RF via investigation of the incidence of RF.

Results
A total of 48 patients (average age 67.6 years; follow up rate: 90.6%) were included. Patients with 2R and SR constructs included 25 and 23 cases, respectively. No significant difference was observed in age (2R: 68.9, SR: 66.4), fusion levels (9.3, 9.4), operation time (437 min, 442 min), blood loss (2174 g, 1893 g), and rod composition except radiographic follow-up periods (45.9 months, 33.5 months; $p<0.05$). The incidence of RF in SR (9 cases, 36%) was significantly lower than that in 2R (17 cases, 68%). Comparing the SR constructs, RF occurred in 7 cases (64%) in short SR and 2 cases (17%) in long SR. RF occurred at the level below the SR construct in 6 of 7 RF cases with short SR.

Conclusion
Satellite rods covering the osteotomy site and lumbosacral junction reduced the incidence of RF following 3-CO surgery.

105. Effectiveness of Four-Rod Fixation in Pedicle Subtraction Osteotomy

Sergey Kolesov, MD, PhD; *Andrey Panteleyev, MD*

Summary
Study of the effectiveness of 4-rod fixation technique in the PSO zone in comparison with literature data on standard 2-rod fixation in terms of rod breakage incidence.

Hypothesis
Due to high stress on rods in PSO zone, 4-rod fixation should decrease the loads on each individual rod, decreasing rod breakage rate.

Design
Retrospective study of consecutive patients.

Introduction
Pedicle subtraction osteotomy is an effective, but radical technique for sagittal balance correction. Due to high stress on rods, the rod breakage rate in PSO zone is unacceptably high when 2-rod fixation is used. A 4-rod fixation technique can effectively reduce the loads on the rods, limiting the rod breakage rate.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Methods
37 consecutive patients (23 F, 14 M) with rigid spinal deformities and sagittal imbalance, were operated from 2011 to 2015. All patients underwent PSO at one level (most often at L3). Based on clinical and radiological data, assessment of sagittal balance, degree of deformity and its correction, and rate of complications in early and late postoperative periods was performed. The follow-up period was 2.5 to 6.5 years. The results were compared with literature data on rod fracture rate with 2-rod fixation in PSO zone.

Results
The average age of patients was 57.1 years. The average length of fixation was 9.4 segments. The average degree of segmental correction is 31°. In most cases, adequate LL, SVA, PT, T1 slope and LL / PI mismatch parameters were achieved. Among the serious complications of surgical intervention, proximal junctional kyphosis was observed in 8.1% (3) of cases, neurologic deficit in 10.8% (4) of cases, fractures of the rods in the osteotomy zone or at adjacent levels were not detected in any of the presented cases, while the frequency of fractures of the rods of the other localization was 10.8% (4).

Conclusion
Literature data on four-rod fixation at the site of PSO is very limited. When reviewing the literature on the complications of PSO, a high rate of rod fractures (up to 30%) is evident when using 2-rod fixation. Most of the fractures are observed in the PSO zone and adjacent levels (up to 90%). The results of our study indicate that the presence of short auxiliary rods reduces the angle of deformation of the main rods, reducing their load, which, in turn, leads to a significant decrease in the rate of rod fractures in the PSO zone in the long-term period.

106. Surgeon Specific Risk Stratification Model for Complex Adult Spinal Deformity Surgery

Lawrence G. Lenke, MD; Meghan Cerpa, BS, MPH; Xudong Li, MD, PhD; Alexander Tuchman, MD; *Lee Tan, MD;* Li Jin, PhD

Summary
There is a substantial amount of variability in spine deformity intervention and postoperative care. We sought to develop a risk stratification model based on one surgery center and one surgeon. Based on univariate and multivariate regression models to analyze various predictors and outcomes, we generated a surgeon and hospital specific model to more accurately predict a patient's individual risk. Using this risk stratification model can guide individual spine deformity surgeons for their decision making.

Hypothesis
One surgeon's operative technique and hospital specificities to develop a risk stratification model result in more accurate predictions of postoperative complications

Design
Single-center cohort

Introduction
Complications following complex spine deformity surgery remains a significant problem. The purposes of this study were to identify risk factors, to develop a data-driven surgeon-specific risk stratification model, and to predict the likelihood of 6-week postoperative complications.

Methods
124 adult deformity patients with >8 instrumented fusion levels at a single institution by a single surgeon were reviewed. Demographics, co-morbidities, and preoperative surgical plan, and complications were identified. Univariate and Logistic regression analysis (LRA) were performed. A formula was developed to provide a numeric probabilistic likelihood statistic.

Results
34(27%) complications were categorized into medical and/or surgical. The predictive model was significant ($\chi2=39.285$, $p<0.01$), Hosmer-Lemeshow test showed good fit ($\chi2=2.839$, $p=0.9$), and was calibrated by using area under the receiver operating characteristics curve analysis (AUROC=0.823, $p<0.05$). The model explained 39.3% of the variance in complication and correctly classified 83.1% cases. A 3-column osteotomy (3CO) and history of deep vein thrombosis (DVT) have 6 and 19 times higher overall complication rates. Patients with 3CO and BMI>30 are 24 and 11 times more likely to have a wound complication. A 3CO had a 10 times higher surgical complication rate. Patients with ASA>=2 had 6 times higher medical complication rate.

Conclusion
The newly established risk stratification model based on patient-specific demographic parameters and preoperative planning for a single experienced spinal deformity surgeon showed that performing a 3CO and a prior DVT markedly increased overall complication rates, having a 3CO with a BMI > 30 markedly increased wound complication rates, and patients >= ASA 2 had much higher medical complication rates.

107. Rapid Bodyweight Reduction Prior to Lumbar Fusion Surgery Associated with Poorer Post-operative Outcomes

Sandip Tarpada, BS; *Woojin Cho, MD, PhD;* Jayson Lian, BS; Julian Haimovich, BS

Summary
Here we perform a matched-pair nationwide analysis, using the NSQIP database, of 129 individuals that underwent lumbar fusion, with a greater than 10% bodyweight loss within 6 months prior to surgery. We find that rapid weight loss was associated with significantly longer length of hospital stay, more surgical site infections, more blood transfusions, and DVT occurrences.

Hypothesis
Individuals with greater than 10% weight loss 6 months prior to lumbar fusion will have higher postoperative complications and LOS.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

Design
Retrospective review

Introduction
It has been documented in several studies that the risks of numerous post-op complications following fusion are amplified in the obese patient. Recent evidence suggests that rapid weight loss in the form of bariatric surgery, may be associated with decreased bone mineral density and Vitamin D levels. It is unclear whether metabolic derangements in the setting of rapid weight loss affect post-op outcomes in patients undergoing lumbar fusion

Methods
All available lumbar fusion surgeries from the NSQIP datasets spanning 2005-2015 were included in the study. Patients were stratified into groups based on 10% weight loss within the past 6 months prior to surgery. Each patient in the weight loss (WL) group was matched with a randomized non-weight loss patient based on age, sex, smoking status, and BMI. Paired two-tailed T-tests were then used to compare surgical outcomes between the groups.

Results
39,742 patients underwent lumbar fusion surgery, and 129 (3.2%) of these patients met WL criteria. Compared the non-WL group, the WL group had a significantly longer LOS (9.7 vs. 4.0 days; $p<0.05$), WL group experienced 8.0 total SSIs vs. 3.0 among the non-WL group ($p<0.05$). Rhe number of transfusion occurrences and DVT were also significantly higher in the WL group compared to non-WL (40.0 and 5.0 vs. 20.0 and 0.00; $p<0.05$, respectively).

Conclusion
On a nationwide scale, rapid weight loss prior to lumbar spine fusion surgery is associated with worse post operative outcomes longer LOS.

108. Correlations between anterior malalignment and fat infiltration using a CT-scan based approach.

Jonathan Charles Elysée, BS; Renaud Lafage, MS; Jeffrey Varghese, BS; Eric Feuchtbaum, MD; Frank J. Schwab, MD; Han Jo Kim, MD; Virginie Lafage, PhD

Summary
Spinal alignment research has historically focused on radiographically visible bony structures, yet a significant proportion of the trunk is soft tissue. Just as bone quality can affect alignment, it is possible that soft tissue quality can also influence alignment. In fact, this study demonstrates the correlations between fat infiltrations in the upper thoracic, lower thoracic, and lumbar spine and the significant relationship between anterior malalignment and fat infiltration in the erector spinae muscles at T2, T10, and L3.

Hypothesis
Pre-operative spinal alignment and muscle fat infiltration are linked to each other.

Design
Retrospective review

Introduction
Sagittal malalignment triggers a chain of compensatory mechanisms spanning the full body. While most of these mechanisms have been extensively studied from a radiographic point of view, little is known on how muscle quality can impact spino-pelvic compensation. This study aims to analyze the relationship between sagittal alignment and muscular fat infiltration.

Methods
This study is a retrospective review of a single center, single surgeon registry of ASD patients with pre-operative CT-scans and full spine radiographs. With CT Multi Planar Reconstructions (MPR), muscle analysis was conducted at T2, T10, and L3 (3 slices per level) by evaluating the cross sectional area (CSA) of the erectors and the psoas (when applicable) as well the content of fat (defined as -100 to -50 Hounsfield Units). Correlations and linear regression analysis were conducted between demographic, alignments and muscle characteristic

Results
75 of 234 pts had pre-operative CTs available (57±18yo, 82%F, Mean BMI 26.4±6.7). Muscle data was available for 41 pts at T2, 25 pts at T10, and 53 pts at L3. The mean fat infiltration was: T2=9%±6, T10=7%±6, L3_Erector=12%±7, and L3_Psoas=7%±5). Fat infiltration correlated across levels (T2 vs T12 r=0.743; T12 vs L3_Erector r=0.631; L3_Erector vs Psoas r=0.540). Fat infiltration correlated significantly with demographic information; older pts had greater fat percentages and greater BMIs, both of which can increase muscular infiltration. In terms of spinal alignment, an increased fat infiltration was associated with an increased pelvic retroversion (PT), an increased global deformity (TPA) and an increased anterior malalignment (SVA), highlighting the relationship between global alignment of the spine and muscle quality

Conclusion
Anterior malalignment was associated with increased fat infiltration. However causality cannot be established between both phenomena as they happen simultaneously and add to each other. Further studies should investigate the effect of physical therapy on muscle quality and its impact on restoring alignment.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

	Upper Thoracic % (N=41)	Lower Thoracic % (N=25)	Posterior Lumbar % (N=44)	Anterior Lumbar % (N =53)
Upper Thoracic %	-	0.743 0.000	0.294 0.269	0.398 0.091
Lower Thoracic %		-	0.631 0.016	0.394 0.131
Posterior Lumbar %			-	0.540 0.000
Age	0.416 0.007	0.535 0.006	0.354 0.020	0.516 0.000
BMI	0.343 0.030	0.431 0.032	0.348 0.022	0.235 0.094
Weight	0.161 0.320	0.288 0.162	0.291 0.058	0.209 0.137
PT	0.425 0.006	0.591 0.002	0.399 0.007	0.232 0.095
TPA	0.530 0.000	0.455 0.022	0.405 0.006	0.298 0.030
SVA	0.552 0.000	0.305 0.139	0.316 0.037	0.312 0.023

Spearman correlations between percentage of fat within muscle group (fat infiltration) and other muscle fat infiltration percentage, demographic and pre-operative alignment parameters

.

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

NOTES

NOTES

NOTES

EXHIBITS & WORKSHOPS

The Scoliosis Research Society gratefully acknowledges OrthoPediatrics for their grant support of IMAST and the IMAST Announcement Board.

25th ANNIVERSARY OF THE INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

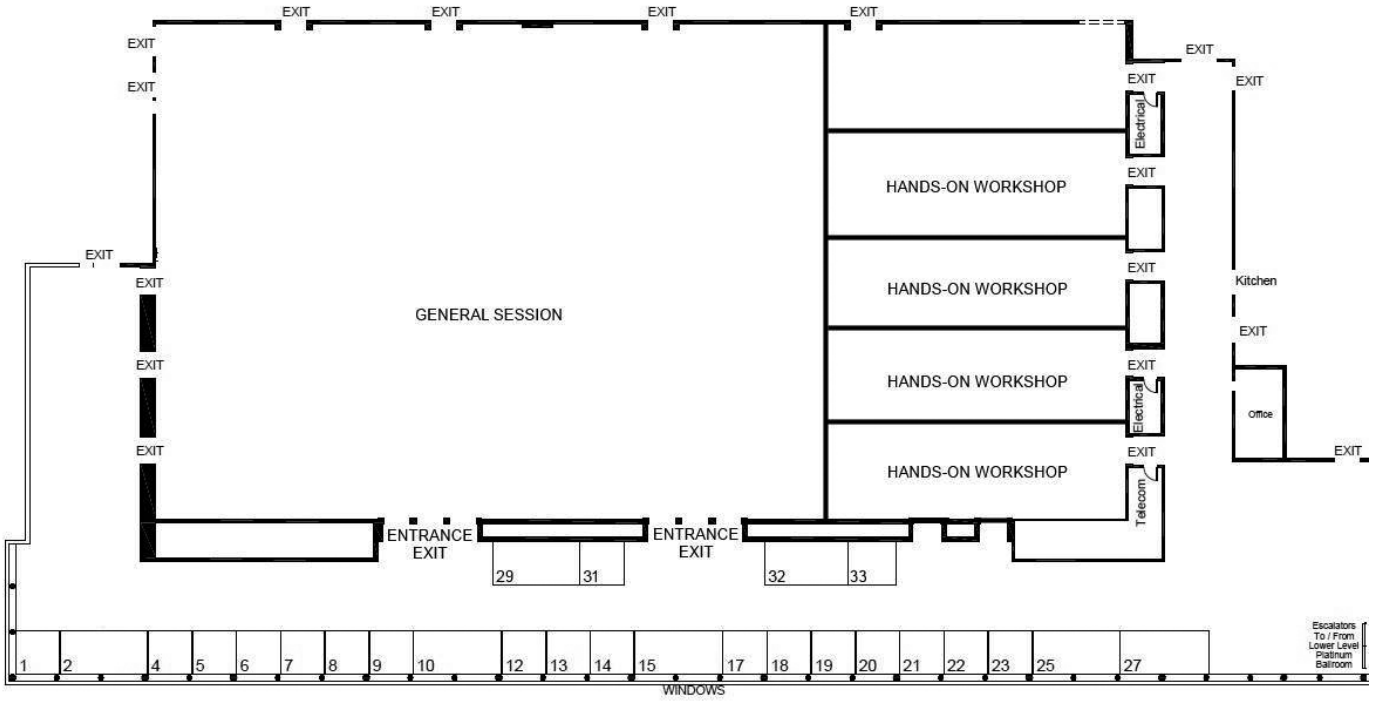
25th IMAST

July 11-14, 2018

LOS ANGELES, CA, USA

EXHIBITS & WORKSHOPS

EXHIBIT HALL FLOORPLAN



IMAST EXHIBIT HALL

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.

The IMAST Exhibit Hall is located in the Diamond Foyer.

Hours:

Wednesday, July 11	14:00-20:00 (*Welcome Reception – 18:00-20:00)*
Thursday, July 12	8:00-17:30
Friday, July 13	8:00-16:45
Saturday, July 14	Exhibits Closed

Make sure to visit the IMAST History Exhibit in Booth #2 to celebrate the 25th Anniversary of IMAST and learn about its history!

25th IMAST
July 11-14, 2018
LOS ANGELES, CA, USA

Company	Booth
Alphatec Spine	4
Biologica Technologies	6
DePuy Synthes	15
DIERS Medical Systems	21
EOS Imaging	17
Genoss Co., Ltd.	19
Globus Medical	27
IMAST History Exhibit	2
Implanet	7
K2M	29
Life Spine, Inc.	5
Medicrea	23
Medtronic	10

Company	Booth
Medyssey	12
Misonix, Inc.	31
NASS (North American Spine Society)	20
NuVasive	32
Orthofix	22
OrthoPediatrics	33
Paradigm Spine	14
Silony Medical	13
Spinal Balance	8
SRS Membership	1
Stryker	9
Titan Spine	18
Zimmer Biomet	25

EXHIBIT DESCRIPTIONS

ALPHATEC SPINE – BOOTH #4

5818 El Camino Real
Carlsbad, CA 92008
www.atecspine.com

Alphatec Spine, Inc., is a medical device company with a mission to improve patients' lives by architecting spine surgery solutions through their relentless pursuit of superior outcomes. ATEC markets products in the U.S. via independent sales agents and a direct sales force. Additional information can be found at www.ATECpine.com.

BIOLOGICA TECHNOLOGIES – BOOTH #6

800 Roosevelt Street
Carlsbad, CA 92008
www.biologicatechnologies.com

Biologica Technologies is a company focused on providing clinically relevant biologic solutions across the aesthetic and orthopaedic specialties. Biologica has developed innovative and ground breaking methods to access the naturally occurring growth factors found within allograft tissue. ProteiOS growth factor is our first product for the orthopaedic and neurosurgery markets.

DEPUY SYNTHES – BOOTH #15

325 Paramount Drive
Raynham, MA 02767
www.depuysynthes.com

DePuy Synthes has one of the largest and most diverse portfolios of products and services in spinal care and is a global leader in traditional and minimally invasive spine treatment. The company offers procedural solutions for the full spectrum of spinal disorders including adult and adolescent deformity, spinal stenosis, trauma and degenerative disc disease. DePuy Synthes, a Johnson & Johnson company, is the largest provider of Orthopaedic and neurological solutions in the world. For more information visit, www.depuysynthes.com.

DIERS MEDICAL SYSTEMS – BOOTH #21

1752 Capital Street
Suite 310
Elgin, IL 60124
www.diersmedical.com

DIERS Medical Systems is an innovative company offering a radiation-free system for assessment of the spine and trunk. Using surface topography, the DIERS formetric system can provide a 3-D reconstruction of the spine as a static measurement or while the spine is in motion. The addition of lower extremity video analysis and foot pressure measurements from the integrated treadmill turns the spine system into a fully functional gait lab.

The DIERS formetric system provides reliable outcomes data for clinicians who treat patients with scoliosis, kyphosis, neuromuscular disorders, gait abnormalities, adult degeneration, spinal fusions, and can even be used in patients with total joint replacement or sports medicine.

DIERS proudly supports the Spine and Surface Topography Study Group (SSTSG.org), consisting of top researchers interested in the use of surface topography to evaluate trunk and spine deformity in new and innovative ways.

Visit the company website at: www.diersmedical.com

EOS IMAGING – BOOTH #17

185 Alewife Brook Parkway
Suite 205
Cambridge, MA 02135
www.eos-imaging.com

EOS imaging designs, develops and markets advanced imaging and image-based solutions for musculoskeletal pathologies and orthopedic surgical care. A low dose or Micro Dose EOS exam provides full body, stereo-radiographic images in weight-bearing positions. The frontal and lateral images are acquired simultaneously in less than 20 seconds without magnification. The accompanying sterEOS workstation enables you to create patient-specific 3D models, calculate over 100 clinical parameters automatically and generate customizable patient reports. EOS also offers online 3D Services and cloud-based, 3D surgical planning software solutions for the spine, hip and knee. The EOS platform connects imaging to care by adding value along the entire patient care pathway from diagnosis to follow-up.

EXHIBIT DESCRIPTIONS

GENOSS CO., LTD. – BOOTH #19

209, Gyeonggi R&DB Center
105, Guanggyo-ro
Yeongtong-gu, Suwon-Si 16229
Republic of Korea
www.genoss.com

With a vision to grow into one of the world's leading enterprises in the field of medical device manufacturing, GENOSS Co., Ltd. has been ceaselessly developing in the spirit of respect for human life since its foundation.

Making investment of 30% of revenue in R&D every year, we have pushed ahead with staffing the company with outstanding research professionals from around the world and developing the world's best products. And every product we have developed meets such high global standards as FDA and CE, which means their quality is reliable in the global market. These values of ours are validated by a number of national projects in progress.

GENOSS 3d Cage™ is produced with Selective Laser Melting [SLM] technique and Rough elevated surface provides high primary stability. GENOSS 3d Cage™ produced that a wide variety of shape is available on upon request.

GLOBUS MEDICAL – BOOTH #27

2560 General Armistead Avenue
Audubon, PA 19403
www.globusmedical.com

Globus Medical, Inc. is a leading musculoskeletal solutions company and is driving significant technological advancements across a complete suite of products ranging from spinal and trauma therapies to robotics, navigation and imaging. Founded in 2003, Globus' single-minded focus on advancing spinal surgery has made it the fastest growing company in the history of orthopedics. Globus is driven to utilize superior engineering and technology to achieve pain free, active lives for all patients with spinal disorders.

IMPLANET – BOOTH #7

60 State Street
Suite 700
Boston, MA 02139
www.implanet.com

IMPLANET is a global company with a singular focus to provide novel solutions to complex spinal pathologies through the use of the JAZZ™ polyester band system.

The JAZZ Band & Frame hybrid approach for complex deformity correction has been shown to reduce implant volume, decrease surgical cost, and reduce blood loss and OR time while demonstrating significant improvement in Sagittal Balance.

JAZZ Lock is the first, and only, rodless band fixation device. JAZZ Lock allows for rapid posterior fixation of cervical spine fractures, is a low profile tension band for top-of-construct protection and provides additional fixation options in compromised bone.

More information available at www.implanet.com

K2M – BOOTH #29

600 Hope Parkway
Leesburg, VA 20175
www.k2m.com

K2M Group Holdings, Inc. is a global leader of complex spine and minimally invasive solutions focused on achieving three-dimensional Total Body Balance™. Since its inception, K2M has designed, developed and commercialized innovative complex spine and minimally invasive spine technologies and techniques used by spine surgeons to treat some of the most complicated spinal pathologies. K2M has leveraged these core competencies into Balance ACS™, a platform of products, services, and research to help surgeons achieve three-dimensional spinal balance across the axial, coronal and sagittal planes, with the goal of supporting the full continuum of care to facilitate quality patient outcomes. The Balance ACS platform, in combination with the Company's technologies, techniques and leadership in the 3D-printing of spinal devices, enable K2M to compete favorably in the global spinal surgery market.

LIFE SPINE, INC. – BOOTH #5

13951 S. Quality Drive
Huntley, IL 60142
https://lifespine.com/

Life Spine is a designer, developer and manufacturer of spinal implants and instrumentation. We focus on providing innovative solutions to address spinal pathology from the occiput to the sacrum. Our comprehensive product portfolio that centers around fusion and minimally invasive surgeries is driven by patient and surgeon needs.

MEDICREA – BOOTH #23

50 Greene Street
4th Floor
New York, NY 10013
www.medicrea.com

Through the lens of predictive medicine, Medicrea leads the design, integrated manufacture, and distribution of 30+ FDA approved spinal implant technologies that have been utilized in over 150,000 spinal surgeries to date. By leveraging its proprietary software analysis tools with big data and machine learning technologies and supported by an expansive collection of clinical and scientific data, Medicrea is well-placed to streamline the efficiency of spinal care, reduce procedural complications and limit time spent in the operating room.

EXHIBIT DESCRIPTIONS

MEDTRONIC – BOOTH #10

710 Medtronic Parkway
Minneapolis, MN 55432
www.medtronic.com

As a global leader in medical technology, services and solutions, Medtronic improves the health and lives of millions of people each year. We believe our deep clinical, therapeutic and economic expertise can help address the complex challenges — such as rising costs, aging populations and the burden of chronic disease — faced by families and healthcare systems today. But no one can do it alone. That's why we're committed to partnering in new ways and developing powerful solutions that deliver better patient outcomes. Founded in 1949 as a medical repair company, we're now among the world's largest medical technology, services and solutions companies, employing more than 85,000 people worldwide, serving physicians, hospitals and patients in more than 155 countries. Join us in our commitment to take healthcare Further, Together. Learn more at Medtronic.com.

MEDYSSEY USA, INC. – BOOTH #12

1550 E Higgins Road
Suite 123
Elk Grove Village, IL 60007
www.medyssey.com

Thank you for visiting with Medyssey USA, Inc.
Medyssey designs, develops, manufactures and markets products for the surgical treatment of spine disorders through novel instrumentation and advanced orthobiologic solutions designed to improve spinal fusion rates, preservation of mobility and clinical outcomes.

Brands: ILIAD & Zenius Spinal Fixation System, BN, Taurus & C7 Cage, Athena ACP, Poseidon OCT System, Medussa (Porous-structured Ti Cage by 3D Printer), Custom-fit Products

MISONIX, INC. – BOOTH #31

1938 New Highway
Farmingdale, NY 11735
www.misonix.com

Misonix is a world leader in developing ultrasonic surgical devices for hard and soft tissue removal. The Misonix BoneScalpel is a unique ultrasonic osteotome for tissue-selective bone dissection that encourages en-bloc bone removal and refined osteotomies while sparing elastic soft tissue structures. Many leading surgeons have praised the BoneScalpel to be one of the most important advancements to enter spine surgery this decade.

NASS (NORTH AMERICAN SPINE SOCIETY) – BOOTH #20

7075 Veterans Boulevard
Burr Ridge, IL 60527
www.spine.org

The NASS- North American Spine Society is a global multidisciplinary medical society that utilizes education, research and advocacy to foster the highest quality, ethical, value and evidence-based spine care for patients. Representing over 8,000 members from multiple specialties, NASS is your link to health care professionals invested in advancing spine care. New applicants may apply for a FREE 2018 MEMBERSHIP at www.spine.org/freemembership2018

NUVASIVE – BOOTH #32

7475 Lusk Boulevard
San Diego, CA 92121
www.nuvasive.com

NuVasive is a global medical device company focused on transforming spine surgery and beyond by empowering surgeons with technology to approach procedures in the least disruptive way possible and restore the vitality of life for those that suffer from debilitating spinal conditions. Through its minimally invasive, procedurally-integrated solutions, the Company is expanding the boundaries of modern healthcare with technologies and surgeon training designed to provide reproducible and clinically-proven surgical outcomes that are redefining the success factors of spine surgery like never before. Addressing a variety of pathologies up and down the spine, from complex spinal deformity to degenerative spinal conditions, NuVasive's highly differentiated solutions include access instruments, implantable hardware, biologics, software systems for surgical planning and imaging solutions, magnetically adjustable implant systems for spine and orthopedics, and intraoperative monitoring service offerings. NuVasive believes its integrated approach and expertise can fundamentally evolve spine care by delivering improved patient experiences, and better economics for healthcare systems. NuVasive has an approximate 2,400 person workforce in more than 40 countries serving surgeons, hospitals and patients. For more information, please visit www.nuvasive.com.

EXHIBIT DESCRIPTIONS

ORTHOFIX – BOOTH #22

3451 Plano Parkway
Lewisville, TX 75056
www.orthofix.com

Orthofix is a global medical device company focused on musculoskeletal healing products and value-added services. The Company's mission is to improve patients' lives by providing superior reconstruction and regenerative musculoskeletal solutions to physicians worldwide. Headquartered in Lewisville, Texas, the Company has four strategic business units: BioStim, Extremity Fixation, Spine Fixation, and Biologics. Orthofix products are widely distributed via the Company's sales representatives and distributors. Orthofix products are widely distributed via the Company's sales representatives and distributors

The Company began in Verona, Italy, from the work of orthopedic researcher Giovanni De Bastiani, of the University of Verona. Toward the end of the 1970s, De Bastiani proposed the concept of "dynamization," based on the natural ability of bone to repair itself. He developed a modular system of external axial frame devices that could be fitted to a bone, allowing micromovement at the fracture site to stimulate bone healing. Together with a group of surgeons and an industrial engineer, De Bastiani founded Orthofix in 1980 in order to continue the development of these devices and to bring them to market. By the 1990s, our products were sold in more than 70 countries.

Today our extremity fixation products are designed to address the lifelong bone-and-joint health needs of patients of all ages, helping them achieve a more active and mobile lifestyle. Our well-rounded product lines offer comprehensive solutions within both limb reconstruction and trauma specialties. The Company's orthopedic trauma products offer a simple approach and high performance in trauma settings. They are based on a philosophy of treatment that focuses not only on fractured bone, but also considers the long-term preservation of function and quality of life for the patient. Orthofix provides a wide range of solutions for specific anatomical areas taking into account each patients' needs. Our limb reconstruction and deformity correction products restore normal anatomy for patients with a physical deformity, either congenital or post-traumatic, as well as for patients needing limb lengthening. JuniOrtho™ is a range of products and resources created by Orthofix, dedicated to children and young adults with bone fractures and deformities.

For more information, please visit www.orthofix.com, www.limbhealing.com, or www.juniortho.club.

ORTHOPEDIATRICS – BOOTH #33

2850 Frontier Drive
Warsaw, IN 46582
www.orthopediatrics.com

Founded in 2006, OrthoPediatrics is an orthopedic company focused exclusively on providing a comprehensive product offering to the pediatric orthopedic market to improve the lives of children with orthopedic conditions. OrthoPediatrics currently markets 24 surgical systems that serve three of the largest categories within the pediatric orthopedic market. This offering spans trauma & deformity, scoliosis and sports medicine/other procedures. OrthoPediatrics' global sales organization is focused exclusively on pediatric orthopedics and distributes its products in the United States and 37 countries outside the United States.

PARADIGM SPINE, LLC – BOOTH #14

505 Park Avenue
14th Floor
New York, NY, 10022
www.paradigmspine.com

Paradigm Spine, LLC, founded in 2004, is a privately held company and remains focused on the design and development of solutions for the disease management of spinal stenosis. The Company's signature product is the coflex® Interlaminar Stabilization® device, the exclusive posterior lumbar motion preservation solution with proven long-term outcomes for moderate to severe spinal stenosis patients. The coflex device was first CE marked in 2005 for sale in Europe. In October 2012, the device was approved by the U.S. Food and Drug Administration for use in patients suffering from lumbar spinal stenosis at 1 or 2 contiguous levels. The technology was tested against pedicle screw fusion in the U.S., and further tested against decompression alone in Germany, where both studies produced Level I Evidence. The device is currently used in over 60 countries worldwide. coflex is the only lumbar spinal device that has produced Level I evidence in two separate prospective, randomized, controlled studies against two different control groups, changing the standard of care for lumbar spinal stenosis treatment. For additional information visit www.paradigmspine.com or www.coflexsolution.com.

EXHIBIT DESCRIPTIONS

SILONY MEDICAL – BOOTH #13

Bahnhofstr. 1
Bremen 28185 Germany
www.silony-medical.com

CLINICALLY DRIVEN
Silony Medical develops and produces implant and instrument systems that are precisely tailored to the needs of patients, doctors and hospital staff.

We believe a product should adapt to the user – and not the other way around. We wish our customers to consider us as a partner, not just a supplier. As such, we develop all of our products jointly with clinicians to ensure they are as practical as possible. We cooperate closely with some of world's most experienced surgeons, who contribute not only their requests and requirements but also offer valuable suggestions to help us realize and improve our systems and services. We believe that service is only worthy of the name if it remains flexible and transparent. We work together to find intelligent solutions to existing problems, guard against future obstacles and optimize proven solutions down to the highest standard.

Everyone at Silony is highly motivated and committed to delivering change in our industry. We all subscribe to a set of core values: commitment, integrity, teamwork and uncompromising quality.

SPINAL BALANCE – BOOTH #8

1510 N Westwood Avenue
Suite 2040
Toledo, OH 43607
www.spinalbalance.us

Spinal Balance, Inc. presents Libra®, a technically advanced pre-sterilized pedicle screw system with the ability to prevent cross contamination intra-operatively. Functionally our package guards the implant during handling and delivery, is easy to open and extremely intuitive to use. A major advantage of our package is its ability to act as a guide for loading the screwdriver, making that key step almost effortless.

Our innovative packaging is Clinically Effective, Economically Advantageous and Logistically Efficient. Using Libra saves time and money, eliminates direct handling of the implant and reduces the workload at SPD. Our Libra pedicle screw system benefits the patient, surgeon, facility and insurance provider.

STRYKER – BOOTH #9

2 Pearl Court
Allendale, NJ 07401
www.stryker.com

We are one of the world's leading medical technology companies and, together with our customers, we are driven to make healthcare better. We offer innovative products and services in Orthopaedics, Medical and Surgical, and Neurotechnology and Spine that help improve patient and hospital outcomes. At the Spine division, we offer a comprehensive portfolio for orthopaedic and neurosurgeons specializing in the surgical treatment of spinal pathologies. Our continually expanding portfolio features complete procedural solutions for the spine spanning from the occiput to the pelvis, including a full suite of LITe (Less Invasive Technology) procedures such as the LITe TLIF, LITe LIF and LITe ALIF. By teaming up with our sister divisions, we have been able to add navigation and power capabilities to many of our spinal fixation systems including Serrato, Xia 3, Xia 4.5 and ES2. We recently launched our first 3D printed porous titanium interbody devices, the Tritanium PL, TL and Tritanium C Cages. These cages are manufactured using our proprietary Tritanium In-Growth Technology, a novel highly porous titanium material designed for bone in-growth and biological fixation.1 We plan to expand the use of this unique technology over the next few years.

1. PROJ 43909 | Tritanium technology claim support memo

TITAN SPINE – BOOTH #18

6140 W Executive Drive
Suite A
Mequon, WI 53092
www.titanspine.com

Titan Spine, Inc. is a surface technology company focused on the design and manufacture of interbody fusion devices for the spine. The company is committed to advancing the science of surface engineering to enhance the treatment of various pathologies of the spine that require fusion. Titan Spine, located in Mequon, Wisconsin and Laichingen, Germany, markets a full line of Endoskeleton® interbody devices featuring its proprietary textured surface in the U.S., portions of Europe, and Australia through its sales force and a network of independent distributors. To learn more, visit www.titanspine.com.

ZIMMER BIOMET – BOOTH #25

10225 Westmoor Drive
Westminster, CO 80021
www.zimmerbiomet.com

Zimmer Biomet Spine is a leader in restoring mobility, alleviating pain, and improving the quality of life for patients around the world by delivering surgeons a comprehensive portfolio of quality spine technologies and procedural innovation, best-in-class training, and unparalleled service via a network of responsive team members and sales professionals.

EXHIBIT DESCRIPTIONS

25TH IMAST HISTORICAL BOOTH – BOOTH #2

Visit the IMAST historical booth, for a special exhibit celebrating the 25th Anniversary of the International Meeting on Advanced Spine Techniques (IMAST).

SCOLIOSIS RESEARCH SOCIETY – BOOTH #1

555 E Wells Street
Suite 1100
Milwaukee, WI 53202
www.srs.org

The Scoliosis Research Society (SRS) is an international society that was founded in 1966 with 35 members. It has gained recognition as one of the world's premier spine societies. The SRS has maintained a commitment to research and education in the field of spinal deformities. Strict membership criteria ensure that the individual Fellows support that commitment. Current membership includes more than 1,300 of the world's leading spine surgeons, researches, physician assistants and orthotists who are involved in research and treatment of spinal deformities.

Prospective members and new candidate members are invited to attend a membership information session Friday, July 13 from 17:00 – 17:30 in Platinum Salon A-C!

HANDS-ON WORKSHOPS

IMAST delegates are encouraged to attend the Hands-On Workshops (HOW) on Wednesday, and Thursday afternoons, at lunch on Thursday and Friday and during breakfast on Thursday and Friday mornings. Each workshop is programmed by a single- supporting company and will feature presentations on topics and technologies selected by the company.

*Please note: CME credits are not available for Hands-On Workshops.

HOWs are located in Diamond Salon Rooms 6, 7, 8, and 9.

SCHEDULE

	Wednesday, July 11	Thursday, July 12	Friday, July 13
MORNING		**7:45-8:45**	**7:45-8:45**
Diamond 6		Medtronic	Zimmer Biomet
Diamond 7		DePuy Synthes	Orthofix
Diamond 8		Mighty Oak Medical	
Diamond 9		Misonix, Inc.	
LUNCH		**12:30-13:30**	**12:00-13:00**
Diamond 6		K2M	K2M
Diamond 7		NuVasive	NuVasive
Diamond 8		Medtronic	DePuy Synthes
Diamond 9		Zimmer Biomet	Globus Medical
AFTERNOON	**16:00-18:00**	**17:15-18:15**	
Diamond 6	K2M	K2M	
Diamond 7	Zimmer Biomet	Silony Medical	

HOW INFORMATION

WEDNESDAY, JULY 11

K2M – Diamond Salon 6
Techniques for Correcting Cervical Spine Deformities
Faculty: Christopher Ames, MD; Steven Glassman, MD; Jeffery Gum, MD

Achieving total spinal balance is an important part of correcting cervical spine deformities. During this workshop, we will discuss techniques, issues, pearls, and pitfalls for correcting cervical spine deformities. The workshop will also highlight K2M's newest cervical solutions, YUKON™ Posterior Cervical Fusion System and OZARK™ Anterior Plating System, for achieving cervical fusion goals.

Zimmer Biomet – Diamond Salon 7
Vitality+Power – The benefits of power in the O.R.
Focus: Vitality®+ Power Instrument Kit
Learn and get hands on experience on the latest technology in pedicle screw based procedures. Dr. David Skaggs and Dr. Lindsay Andras will present their experiences on reducing surgeon fatigue in pedicle screw placement utilizing power to deliver safe, consistent, reproducible results.
Faculty: David L. Skaggs, MD and Lindsay M. Andras, MD

THURSDAY, JULY 12 – 7:45-8:45

Medtronic – Diamond Salon 6
TLIF or OLIF: Innovations in Anterior Column Support to Restore Lumbar Lordosis
Faculty: Ron A. Lehman, Jr., MD and Shane Burch, MD

This workshop will feature presentations on the principles of restoring lumbar alignment through the use of interbody devices and anterior column support. Discussion will compare and contrast the TLIF and OLIF procedures, including patient selection, radiographic assessment, surgical approach, and the application of the latest technologies to achieve optimal outcomes. Upon completion of the course, participants will be able to define which patients potentially benefit the most from each technique, and understand why it is important to know both procedures, including the advantages and limitations of each in the restoration of lumbar lordosis.

DePuy Synthes – Diamond Salon 7
Advance Techniques in the Management of Pediatric Spinal Deformity: Highlighting 3D planning, Neuromuscular and AIS
Faculty: Baron Lonner, MD; Stefan Parent, MD, PhD; Burt Yaszay, MD

Mighty Oak Medical – Diamond Salon 8
FIREFLY® Patient-Specific 3D Printed Navigation Guides in Complex Spine Surgery: Safety, Simplicity, Speed and Radiation Avoidance
Faculty: Rajiv K. Sethi, MD, George Frey, MD, and S. Samuel Bederman, MD, PhD, FRCSC

Navigation should be a menu of options -- so that surgeons can choose what is best based on the patient and the proposed surgical procedure. Come learn about an exciting new option for precise screw placement, and the disruptive role that 3D printing and concierge presurgical planning can play in navigation. This symposium will enable an assessment of FIREFLY® 3D printed patient-specific navigation guides for multi-level fusions, including the most complex spine pathologies. Experienced surgeons will discuss case-specific examples and present safety and efficacy data from their cases, demonstrating the ability of FIREFLY® to reduce screw placement time without compromising accuracy. They will share how they were able to "shed the lead" with FIREFLY® patient-specific guides that do not require any intraoperative radiation during screw placement. This symposium will be highly interactive and will allow for hands-on anatomical demonstrations of 3D printed spine models and guides with "tips and tricks" for use. FIREFLY® is FDA-cleared and compatible with all screw systems. We welcome international visitors to this workshop since FIREFLY® is expanding beyond the U.S. to various international markets.

Misonix, Inc. – Diamond Salon 9
Ultrasonic Bone Management in Complex Spine & Deformity
Ultrasonic Bone Management in Complex Spine & Deformity is a hands-on demonstration detailing the use of the Misonix BoneScalpel device in a variety of complex spine procedures.

THURSDAY, JULY 12 – 12:30-13:30

K2M – Diamond Salon 6
Using Spinopelvic Parameters to Optimize Correction in the Adult Patient
Faculty: Christopher Ames, MD; Shay Bess, MD; Robert Lee, BSc, FRCS

Spinal balance is a critical component of correction in adult deformity patients. This workshop will review spinal parameters and current techniques to optimize spinal balance, as well as future developments in predictive analytics and data management. Time will be allotted for case presentations, discussion, question and answer, and hands-on.

NuVasive – Diamond Salon 7
Protect yourself and your patients with LessRay®: A novel technology to reduce radiation and increase OR efficiency.
Faculty: Stephen I. Ryu, MD and Amer Samdani, MD

Medtronic – Diamond Salon 8
Global Alignment Planning: Matching Osteotomies and Instrumentation to the Deformity
Faculty: Lawrence G. Lenke, MD and Ahmet Alanay, MD

This workshop will feature presentations on the latest in pre-op planning, instrumentation, and techniques to achieve optimal global alignment in complex spinal surgery. Discussion will include patient selection, radiographic assessment, surgical approach, and the application of the latest technologies to achieve optimal outcomes. Upon completion of the course, participants will have a more clear appreciation of how pre-operative planning can affect post-op outcomes, when and how to use osteotomies, nuances in instrumentation techniques, and effective strategies for complication avoidance and management.

HOW INFORMATION

Zimmer Biomet – Diamond Salon 9
Utilizing Hyperlordotic Cages vs. PSO for Sagittal Correction
Focus: Hyperlordotic Cages vs. PSO
Dr. Han Jo Kim and Dr. Larry Khoo will discuss two alternative approaches to restoring sagittal balance with case discussions, rationale as to why they chose their approach, complications and successes in their approach.
Faculty: Han Jo Kim, MD and Larry Khoo, MD

THURSDAY, JULY 12 – 17:15-18:15

K2M – Diamond Salon 6
Alternative Fixation Using Band Technology
During this workshop, the faculty will review unique techniques for alternative fixation using Band Technology for adolescent and adult patients. We will look at case presentations showcasing successes and challenges with the NILE™ Alternative Fixation and NILE™ Proximal Fixation systems.
Faculty: Gregory Mundis, MD and Burt Yaszay, MD

Silony Medical – Diamond Salon 7
Optimal Strategies to Correct and Stabilize the Spine.
Results and complications in the treatment of adolescent idiopathic scoliosis retrospective review of prospectively collected data in 446 consecutive cases from 2010-2017
Faculty: Henry F.H. Halm, MD

Treatment of adolescent idiopathic double major curves and large curves >80°.
Faculty: Heiko Koller, MD

Sagittal balance control with TLIF. Surgical technique with video presentation
Faculty: Henry F.H. Halm, MD

Revision surgery in failed scoliosis surgery
Faculty: Heiko Koller, MD

FRIDAY, JULY 13 – 7:45-8:45

Zimmer Biomet – Diamond Salon 6
Polaris 4.75 - One of the Most Comprehensive Growth Systems Available
Focus: Polaris™ 4.75 Deformity System Growth Indications
Dr. David Skaggs will present his experiences utilizing the Polaris 4.75 Growth System and how this exciting new technology, including unique curved growth connectors and pelvic saddles benefits his patients.
Faculty: David L. Skaggs, MD

Orthofix – Diamond Salon 7
A Comprehensive Solution for Revision Deformity Procedures
Rajiv K. Sethi, MD

FRIDAY, JULY 13 – 12:00-13:00

K2M – Diamond Salon 6
Hybrid Approaches to Deformity Surgery
Faculty: Robert Lee, BSc, FRCS and Payam Moazzaz, MD

Technological breakthroughs are changing how we approach deformity surgery. During this workshop, we will review hybrid approaches to correcting spinal deformity, including combinations of lateral, anterior, and posterior approaches. The faculty will also discuss the importance of navigation and robotics to achieve surgical goals.

NuVasive – Diamond Salon 7
Leading. Expanding. Advancing. Insights to Lateral Procedural Solutions.
Faculty: Christopher R. Brown, MD and Jeff Lehmen, MD

DePuy Synthes – Diamond Salon 8
Advance Techniques in the Management of Complex Adult Spine: Highlighting Adult Deformity, MIS and Tumor
Faculty: Munish C. Gupta, MD; Steven Ludwig, MD and Daniel Sciubba, MD

Globus Medical – Diamond Salon 9
ExcelsiusGPS™ First Clinical Experience
Workshop Featured Technology: ExcelsiusGPS™
Faculty: Jeffery A. Goldstein, MD, FACS

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

AUTHOR INDEX

The Scoliosis Research Society gratefully acknowledges Zimmer Biomet for their grant support of the IMAST Charging Station.

25TH ANNIVERSARY OF THE INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

25th IMAST

July 11-14, 2018

LOS ANGELES, CA, USA

AUTHOR INDEX

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

AUTHOR INDEX

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

AUTHOR INDEX

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

AUTHOR INDEX

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

AUTHOR INDEX

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

AUTHOR INDEX

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

AUTHOR INDEX

Key: *1-108 = Paper Presentations; ICL = Instructional Course lecture; DB = Debate Series; CP = Case Presentations; CS = Complication Series; LE = Lunch with Experts; S = Special Symposium; VS = Video Based Session*

ABOUT SRS

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 37 orthopaedic surgeons to an international organization of more than 1,300 health care professionals.

MISSION STATEMENT

The purpose of the 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 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.

Senior Candidate Fellowship (membership) is limited to senior surgeons, neurosurgeons and to non-physicians members of allied specialties. This candidacy is a path to SRS Active Fellowship. Senior surgeons have the opportunity to become Active Fellows of SRS in two years and not 5 years like the regular Candidate Fellowship track. They must have 20 years of experience (time spent with fellowship and training does not count), be a full professor, head of spine unit or chief of spine division, and clinical practice which includes 20% spinal deformity. After two years, those who complete all requirements are eligible to apply for Active Fellowship in the Society. Senior Candidate Fellowship does not include the right to vote or hold office.

Visit www.srs.org/professionals/membership for membership requirement details.

SRS MEMBERSHIP INFORMATION SESSION

Prospective members and new candidate members are invited to attend a membership information session on **Friday, July 13 from 17:00 – 17:30 in Platinum Salon A-C.** Membership information will also be available at the SRS Membership Booth (booth #1) in the exhibit hall. Don't miss the opportunity to learn more about the SRS!

PROGRAMS AND ACTIVITIES

SRS is focused primarily on education and research that include the Annual Meeting, the International Meeting on Advanced Spine Techniques (IMAST), Worldwide Conferences, a Global Outreach Program, the Research Education Outreach (REO) Fund which provides grants for spine deformity research, and development of patient education materials.

WEBSITE INFORMATION

For the latest information on SRS meetings, programs, activities, and membership please visit www.srs.org. The SRS Website Committee works to ensure that the website 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, please visit the SRS website at www.srs.org.

SOCIAL MEDIA

Follow SRS online. Join the conversation online about the 25th IMAST. Share your experience and stay up-to-date with SRS during and after the meeting.

Share and search public posts with: #SRSIMAST18

@srs_org

@srs_org

@ScoliosisResearchSociety

/company/SRS_org

If you need assistance finding the SRS social media or using the hashtag (#SRSIMAST18), please see Shawn at the registration desk.

SOCIETY OFFICE STAFF

Tressa Goulding, CAE – Executive Director (tgoulding@srs.org)
Lily Atonio – Education and Program Manager (latonio@srs.org)
Alysha Chapman, CNP – Membership Manager (achapman@srs.org)
Ann D'Arienzo, CMP – Senior Meetings Manager (adarienzo@srs.org)
Jenifer Heller – Program Manager (jheller@srs.org)
Courtney Kissinger – Senior Education Manager (ckissinger@srs.org)
Lauren Kritter – Education Coordinator (lkritter@srs.org)
Ashtin Neuschaefer – Director of Administration (aneuschaefer@srs.org)
Shawn Storey – Website and Program Manager (sstorey@srs.org)

SCOLIOSIS RESEARCH SOCIETY

555 East Wells Street, Suite 1100
Milwaukee, WI 53202
Phone: 414-289-9107
Fax: 414-276-3349
www.srs.org

SAVE THE DATE

Scoliosis Research Society presents

IMAST 2019
amsterdam
THE NETHERLANDS

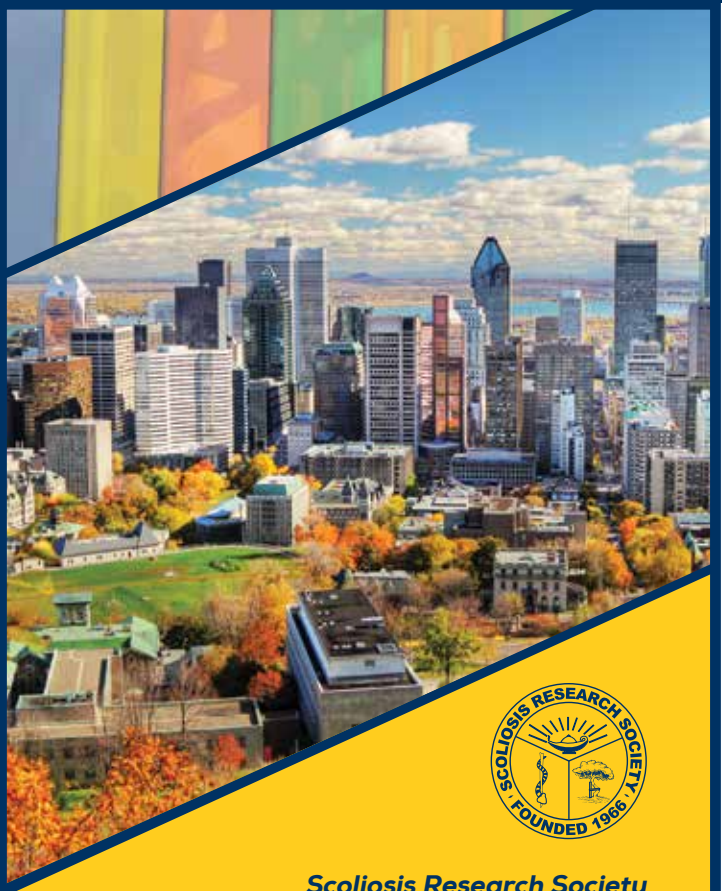
26th International Meeting on Advanced Spine Techniques

July 17-20, 2019 • Amsterdam, The Netherlands

ABSTRACT SUBMISSION OPEN
November 1, 2018

ABSTRACT DEADLINE
February 1, 2019

www.srs.org



Scoliosis Research Society

54th Annual Meeting & Course

SEPTEMBER 18-21, 2019

Montréal, Canada

Abstract submission open – November 1, 2018
Abstract deadline – February 1, 2019

www.srs.org

MEETING OVERVIEW

Wednesday, July 11, 2018		
13:00-19:00	Registration Open	Platinum Foyer
14:00-15:45	Special Symposium	Diamond Salon 1-5
16:00-18:00	*Hands-On Workshops	Diamond Salons 6 & 7
18:00-20:00	*Welcome Reception	Exhibit Hall – Diamond Foyer
Thursday, July 12, 2018		
7:45-17:00	Registration Open	Platinum Foyer
7:45-8:45	*Hands-On Workshops with Breakfast	Diamond Salons 6, 7, 8, & 9
8:00-8:55	Coffee & Exhibit Viewing	Exhibit Hall – Diamond Foyer
9:00-10:35	General Session	Diamond Salon 1-5
10:35-11:05	Refreshment Break & Exhibit Viewing	Exhibit Hall – Diamond Foyer
11:05-12:30	Concurrent Sessions 2A-C: Abstract Sessions	Diamond Salon 1-5; Platinum A-C; Platinum D-E
12:30-13:30	Lunch & Exhibit Viewing; *Hands-On Workshops	Exhibit Hall – Diamond Foyer; Diamond Salons 6, 7, 8, & 9
13:45-14:45	Concurrent Session 3A-B: Debates	Diamond Salon 1-5; Platinum D-E
14:45-15:00	Walking Break & Exhibit Viewing	Exhibit Hall – Diamond Foyer
15:00-15:40	Concurrent Sessions 4A-C: Case Presentations	Diamond Salon 1-5; Platinum A-C; Platinum D-E
15:40-16:10	Refreshment Break & Exhibit Viewing	Exhibit Hall – Diamond Foyer
16:10-17:10	Concurrent Sessions 5A-B: Complications Sessions	Diamond Salon 1-5; Platinum D-E
17:10-17:15	Passing Break	
17:15-18:15	*Hands-On Workshops with Beverages & Snacks	Diamond Salons 6 & 7
Friday, July 13, 2018		
7:45-16:00	Registration Open	Platinum Foyer
7:45-8:45	*Hands-On Workshops with Breakfast	Diamond Salons 6 & 7
8:00-8:55	Coffee & Exhibit Viewing	Exhibit Hall – Diamond Foyer
9:00-10:00	Concurrent Sessions 6A-C: Abstract Sessions	Diamond Salon 1-5; Platinum A-C; Platinum D-E
10:00-10:30	Refreshment Break & Exhibit Viewing	Exhibit Hall – Diamond Foyer
10:30-12:00	Concurrent Sessions 7A-C: Abstract Sessions	Diamond Salon 1-5; Platinum A-C; Platinum D-E
12:00-13:00	Lunch & Exhibit Viewing; *Hands-On Workshops	Exhibit Hall – Diamond Foyer; Diamond Salons 6, 7, 8, & 9
13:10-14:10	Concurrent Sessions 8A-C: Debates, Case Presentations, ICLs	Diamond Salon 1-5; Platinum A-C; Platinum D-E
14:10-14:15	Passing Break	
14:15-15:15	Concurrent Sessions 9A-B: ICLs	Diamond Salon 1-5; Platinum D-E
15:15-15:45	Refreshment Break & Exhibit Viewing	Exhibit Hall – Diamond Foyer
15:45-16:45	Concurrent Sessions 10A-C: Case Presentations	Diamond Salon 1-5; Platinum A-C; Platinum D-E
17:00-17:30	*SRS Member Info Session	Platinum A-C
Saturday, July 14, 2018		
8:30-11:00	Registration Open	Platinum Foyer
9:00-10:00	Concurrent Sessions 11A-B: ICLs	Diamond Salon 1-5; Platinum D-E
10:00-10:15	Walking Break	
10:15-11:15	Session 12: Surgical Video Session	Diamond Salon 1-5
11:15-11:45	Walking Break & Lunch Pick-up	Diamond Foyer
11:45-13:00	Session 13: Lunch with the Experts	Diamond Salon 1-5
13:00	Adjourn	
**Denotes Non-CME Session*		

SRS-0518-462

Wireless Internet: *Network* = **JW Marriott_CONFERENCE** *Password* = **IMAST2018**

#SRSIMAST18