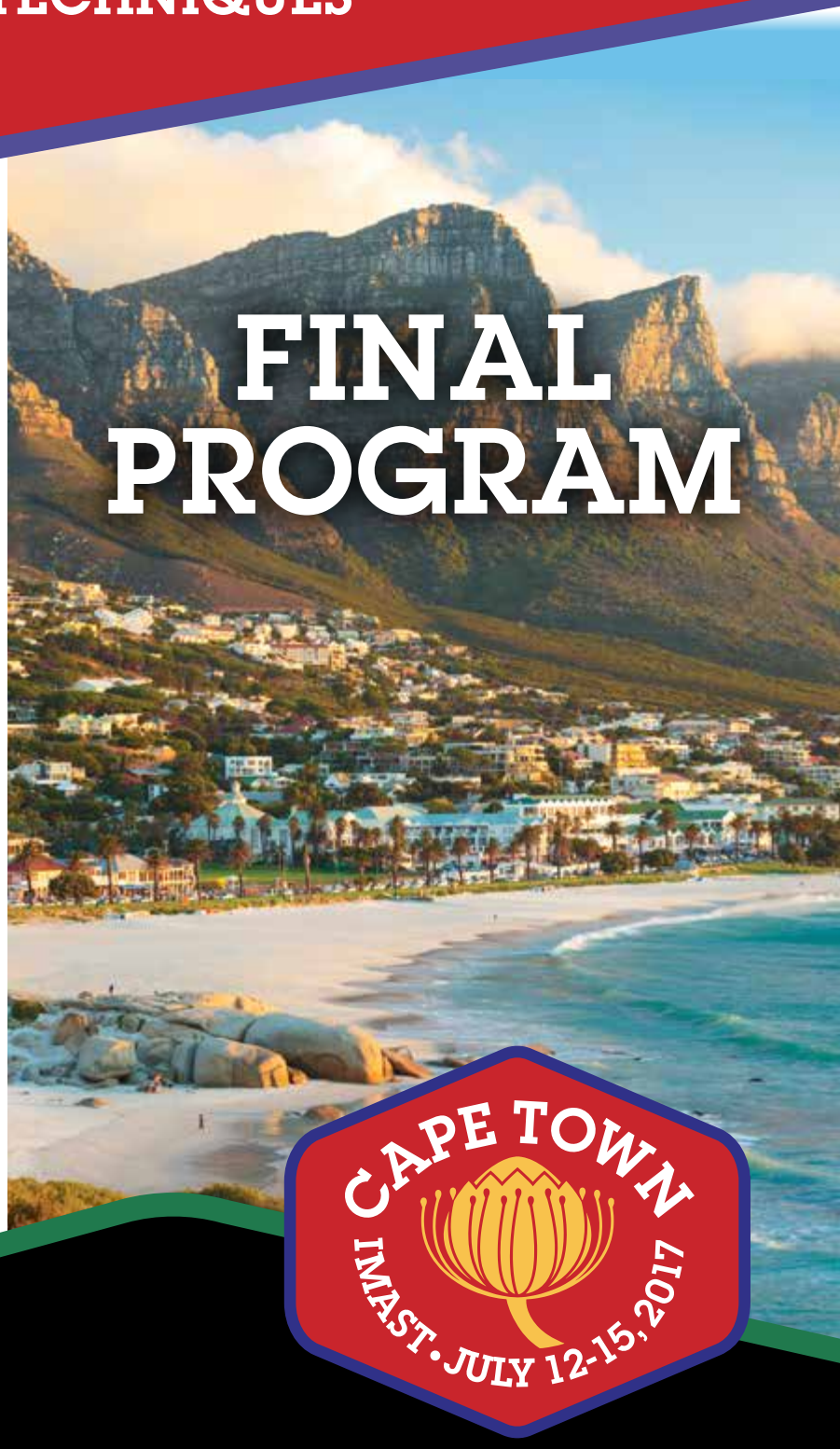
SCOLIOSIS RESEARCH SOCIETY presents

24th IMAST

INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES



FINAL PROGRAM

JULY 12-15, 2017

SOUTH AFRICA

CAPE TOWN INTERNATIONAL CONVENTION CENTRE

IMAST Committee

Ronald A. Lehman, Jr., MD, Chair
Henry F.H. Halm, MD, Co-Chair
Andrew H. Jea, MD
Dean Chou, MD
D. Kojo Hamilton, MD
Mun Keong Kwan, MBBS, MS Orth
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Juan S. Uribe, MD
Jeffrey Dean Coe, MD
Yong Hai, MD
David H. Clements, III, MD
Hossein Mehdian, MD, FRCS(Ed)
Stefan Parent, MD, PhD

CAPE TOWN
IMAST • JULY 12-15, 2017

www.srs.org/imast2017

CORPORATE SUPPORT

We are pleased to acknowledge and thank those companies that provided financial support to SRS in 2017.

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

Double Diamond Level Support

DePuy Synthes
Globus Medical
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NuVasive

Diamond Level Support

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EOS Imaging
Medicrea
Misonix
PainSol
Paradigm Spine
Philips
RSC Bracing, South Africa
Telefield Medical Imaging

GENERAL INFORMATION

The Scoliosis Research Society
gratefully acknowledges

DEPUY SYNTHES

for their overall Support of IMAST.

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24th IMAST Venue

Cape Town International Convention Centre (CTICC)
Convention Square, 1 Lower Long St, Cape Town, 8001, South Africa

Future Educational Events

52nd Annual Meeting & Course
September 6-9, 2017 • Philadelphia, Pennsylvania, USA

9th Spine Deformity Solutions: A Hands-On Course
October 20-22, 2017 • Bangkok, Thailand

25th International Meeting on Advanced Spine Techniques
July 11-14, 2018 • Los Angeles, CA, USA

SRS Regional Courses

Current Concepts in Spine Deformity, an SRS Course, in cooperation with the Chinese Scoliosis Research Society
October 13-15, 2017 • Shenzhen, People's Republic of China

CHAIRS' MESSAGE

Dear Participant,

We would like to personally welcome you to Cape Town, South Africa 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 24th 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, reducing the number of concurrent sessions to three. We also standardized the program, scheduling scientific abstract sessions in the mornings followed by didactic, faculty driven sessions in the afternoons. New this year, select scientific sessions will feature a mix of traditional 4-minute abstract presentations and a lightning round of 2-minute point presentations to conclude the session.

We will continue to offer Special Symposia sessions on Wednesday, July 12 from 15:00-16:45. The symposia topics will be "Redefining Sagittal Imbalance: Achieving Lordosis in Degenerative to Deformed Spines" and "Perioperative Safety and Quality: Why Aren't We All Doing the Same Thing?" After the symposia 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 roundtable case discussions; all led by an international and multidisciplinary faculty. We encourage all delegates to come and experience the interactive and innovative program we have planned.

Along with the exciting program, Cape Town is a must-see city with fascinating sites highlighting both the natural wonders of South Africa and historic and cultural sites, including: Table Mountain, the Winelands, safaris, Robben Island, and much more. When you have time in your schedule, we invite you to take advantage of these opportunities and see what this great city has to offer!

We are both honored to serve as your IMAST Chair and Co-Chair again this year. I want to thank those whose leadership and diligent efforts have created such a successful meeting, including; Kenneth M.C. Cheung, MD; Todd J. Albert, MD; Peter O. Newton, MD; David W. Polly, Jr., 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 24th IMAST. The app is designed to provide all the information about IMAST and Cape Town in one convenient location and can be accessed from any smart phone or tablet with an internet connection.

To download the 24th IMAST Mobile App: **1. Search for IMAST2017 in the App Store or Google Play and install**
2. Open the downloaded app to begin using the app right away!

Download all abstracts and the final program right from the app!

- Once downloaded, delegates can access all static content, including the agenda, speaker listing and info booth, on the app without an internet connection.
- A detailed IMAST agenda allows delegates to create a personalized schedule.
- Exhibitor information includes exhibit floor plan, company descriptions and the Hands-On Workshop schedule.
- An "information booth" features everything you need to know about IMAST, and its host city of Cape Town, South Africa, including scientific and social program details, housing information, as well as Cape Town dining and attractions.
- Maps of the Cape Town International Convention Centre (CTICC)
- An alert system for real-time updates from SRS – program changes, tour and social event notifications, and breaking news as it happens.
- A complete list of IMAST faculty and podium presenters, including presentation titles, times, dates and locations.
- Evaluations for individual sessions and the overall meeting.

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

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, papers and posters on current research, roundtable case discussions, debates, complication series and instructional course lectures, all lead by an international and multidisciplinary faculty. IMAST is presented by the Scoliosis Research Society (SRS).

Learning Objectives

Upon completion of IMAST, participants should be able to:

- Assess recent advances in surgical techniques for the treatment of spinal disorders, compare them with traditional and regional treatments and determine if and/or when to use them for optimal patient care.
- Analyze indications and potential complications for various procedures and approaches related to spinal surgery and apply that analysis to treatment decisions.
- Evaluate and apply principles of minimally invasive surgery (MIS) in the treatment of degenerative and deformed spines.
- Determine how to diagnose, treat and manage patients with cervical degenerative conditions, spinal cord injuries and cervical deformity.
- Identify how attention to safety issues facilitates risk-stratification.

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 16.25 *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 insure 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.

Language

Presentations and course materials will be provided in English.

No Smoking Policy

Smoking is not permitted during any IMAST activity or event.

GENERAL MEETING INFORMATION

CME Information

CME certificates will be available to pre-registered delegates upon the opening of the meeting at www.srs.org/imast2017/. Delegates who registered on-site may access their certificates after August 1, 2017. 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 the IMAST registration confirmation form and delegate meeting 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, 2017.

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 registration desk 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/imast2017/ and on the IMAST mobile app..

Session Information

Instructional Course Lectures (ICLs)

There will be four (4) 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 two (2) 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. 35.

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. 34 and p. 42.

Two-Minute Point Presentations

Two-Minute Point Presentations will continue in the abstract portion of the program this year. The sessions will follow a similar format to the traditional podium presentations, however, with a limited number of slides and time. These Two-Minute Point Presentation lightning rounds will be at the end of selected abstract sessions. Two-Minute Point presentations will also be available for review on the Two-Minute Point kiosks located in the Exhibit Hall room on Level 1 of the CTICC.

Special Symposia

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

Special Symposia – 15:00-16:45 (sessions run concurrently)

1A. Redefining Sagittal Imbalance: Achieving Lordosis in Degenerative to Deformed Spines

1B. Special Symposium: Perioperative Safety and Quality: Why Aren't We All Doing the Same Thing?

Each symposium will cover new and innovative topics featuring five different lectures from world-class faculty.

After the symposia we encourage delegates to take part in the Hands-On Workshops (HOWs) from 17:00-19:00 which will be followed by the Welcome Reception in the Exhibit Hall from 19:00-21:00.

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 CTICC, as badges will be used to control access to sessions and activist. 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.

Attire

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

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 Cape Town International Convention Centre (CTICC) 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.

GENERAL MEETING INFORMATION

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 Cape Town International Convention Centre (CTICC).

To log on select…
Network = IMAST2017
Password = spine2017

Note: Internet cookies must be enabled to connect

Two-Minute Point Presentation Kiosks

In addition to the lighting round presentations during the abstract sessions, the Two-Minute Point presentations will also be available for review on the Two-Minute Point kiosks located in the Exhibit Hall room on Level 1 of the CTICC.

Charging Station

Delegates are welcome to use the complimentary charging station inside the Exhibit Hall to recharge smartphones and small tablets.

The charging station is supported, in part, by a grant from NuVasive.

Presentation Upload Area

Location: Auditorium I Foyer

Presenters may upload their PowerPoint presentations in the Speaker Ready Area located in the Auditorium I Foyer, down the hall from the registration desks on level 1 of the CTICC.

Hours:

Wednesday, July 12	14:00-21:00 (during the Welcome Reception)
Thursday, July 13	7:30-18:30
Friday, July 14	7:30-18:00
Saturday, July 15	7:45-12:00

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

Registration Desk Hours

Location: Ballroom Gallery – Level 1 - CTICC

Wednesday, July 12	14:00-21:00 (during the Welcome Reception)
Thursday, July 13	7:45-17:00
Friday, July 14	7:45-16:00
Saturday, July 15	8:30-12:00

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.

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

Instant 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!

SOCIAL EVENTS

WELCOME RECEPTION

All registered delegates and registered guests are invited to pick up their registration materials and to attend the IMAST Welcome Reception on Wednesday, July 12 from 19:00-21:00. The reception will be hosted in the Exhibit Hall in the Ballroom at the Cape Town International Convention Centre (CTICC) on Level 1, where beverages and light hors d' oeuvres will be served. There is no charge for registered delegates, though a ticket must be requested at the time of registration. 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 12.

15:00-16:45
** Special Symposia**
1. Redefining Sagittal Imbalance: Achieving Lordosis in Degenerative to Deformed Spines
2. Perioperative Safety and Quality: Why Aren't We All Doing the Same Thing?

17:00-19:00 Hands-On Workshops with Beverages & Snacks

19:00-21:00 Welcome Reception

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

COURSE RECEPTION

IMAST delegates and registered guests are invited to take part in a closing reception at the Clivia & Jasminum Conservatory on the ground level of the CTICC on Friday, July 14 from 19:00 – 22:00. Join us in this beautiful setting for a night of networking and delicious cuisine. Tickets are $25 USD each for registered delegates and registered guests and must be purchased at the time of registration. A limited number of tickets may be available onsite, but organizers strongly encourage delegates to purchase tickets in advance. Business Casual or Cocktail attire is appropriate for the Course Reception.

MEMEBERSHIP INFO SESSION

Prospective members and new candidate members are invited to attend a membership information session Friday, July 14 from 17:00 – 17:30 in Meeting Room 2.4 - don't miss the opportunity to learn more about the SRS!

OPTIONAL TOURS

Please visit the Dekon Congress & Tourism table next to the registration desks, for information on the incredible attractions and tours available for you during your visit to Cape Town, South Africa.

Stay up to date with SRS during IMAST and share your experiences. #SRSIMAST17

@srs_org

Scoliosis Research Society

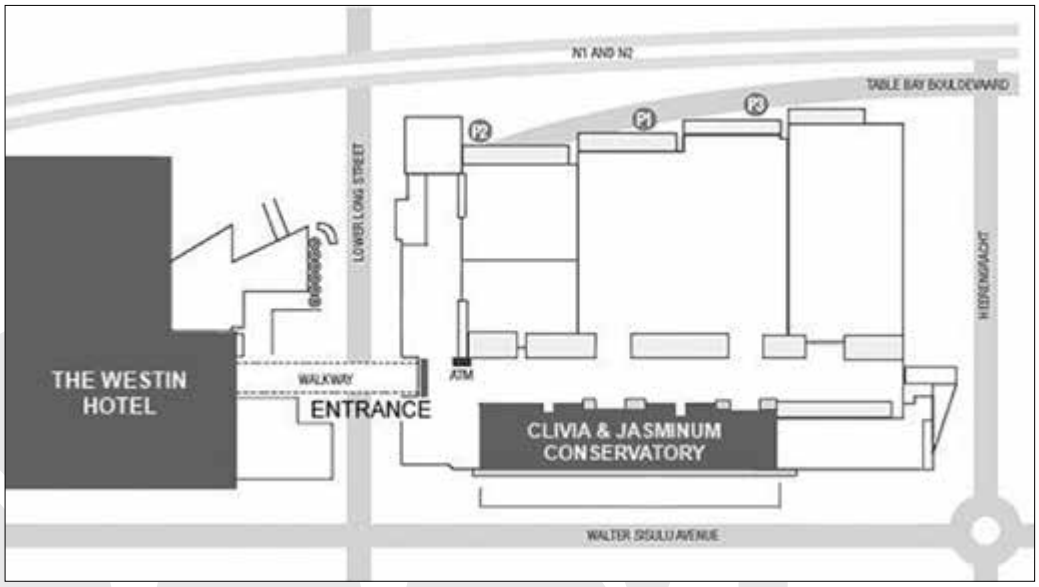
MEETING OVERVIEW

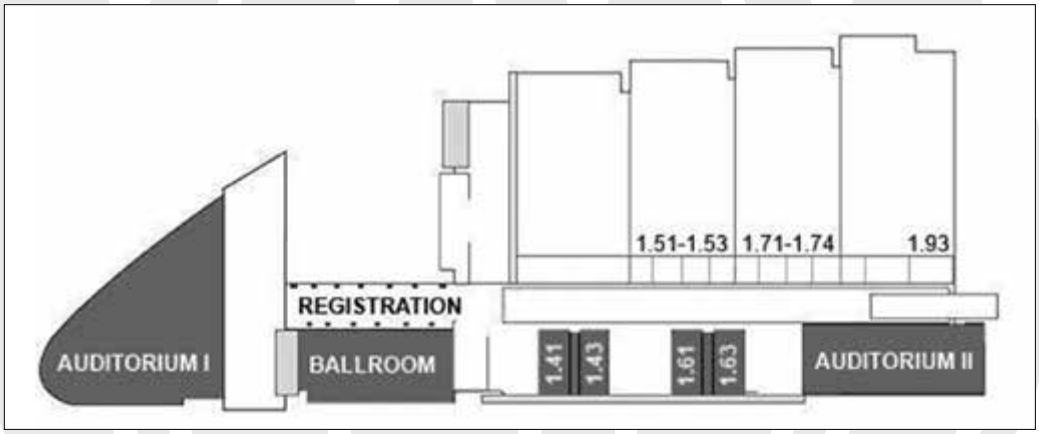
	Tuesday, July 11	Wednesday, July 12	Thursday, July 13	Friday, July 14	Saturday, July 15
Morning	8:00-17:00 Exhibit Setup	8:00-12:00 Exhibit Setup/ Exhibitor Registration Open Board of Directors Meeting	*7:45-8:45 Hands-On Workshops with Breakfast 7:45-17:00 Delegate Registration Open 8:00-8:45 Exhibit Viewing & Breakfast 9:00-10:35 General Session: Whitecloud Clinical Award Nominees & Presidential Address 10:35-11:05 Refreshment Break & Exhibit Viewing 11:05-12:30 Concurrent Abstract Sessions	*7:45-8:45 Hands-On Workshops with Breakfast 7:45-16:00 Delegate Registration Open 8:00-8:45 Breakfast & Exhibit Viewing 9:00-10:00 Concurrent Abstract Sessions 10:00-10:30 Refreshment Break & Exhibit Viewing 10:30-12:00 Concurrent Abstract Sessions	8:30-12:00 Delegate Registration Open 8:30- 9:00 Breakfast/Exhibits Closed 9:00-10:00 Concurrent ICLs 10:00-10:15 Walking Break 10:15-11:15 General Session 11:15-11:45 Walking Break & Lunch Buffet
Afternoon		12:00-14:00 Exhibit Setup Board of Directors Meeting 14:00-21:00 Delegate Registration Opens 15:00-16:45 Symposium A Symposium B 16:45-17:00 Walking Break	*12:30-13:30 Lunch Exhibit Viewing Hands-On Workshops 13:30-13:45 Walking Break 13:45-14:45 Concurrent ICLs 14:45-15:00 Walking Break 15:00-15:40 Concurrent Roundtable Sessions 15:40-16:10 Refreshment Break & Exhibit Viewing 16:10-17:10 Debates & Complications Sessions 17:10-17:15 Passing Break	*12:00-13:10 Lunch Exhibit Viewing Hands-On Workshops 13:10-14:10 Case Presentations 14:10-14:30 Walking Break & Exhibit Viewing 14:30-15:30 Concurrent Abstract Sessions & ICLs 15:30-15:45 Walking Break 15:45-16:45 Concurrent ICLs	11:45-13:00 Lunch with the Experts 13:00 Adjourn
Evening		*17:00-19:00 Hands-On Workshops with Beverages & Snacks *19:00-21:00 Welcome Reception in Exhibit Hall	*17:15-18:15 Hands-On Workshops with Beverages & Snacks Free Evening	*19:00-22:00 Course Reception	

**Denotes Non-CME Session*

CAPE TOWN INTERNATIONAL CONVENTIONS CENTRE (CTICC) FLOORPLANS

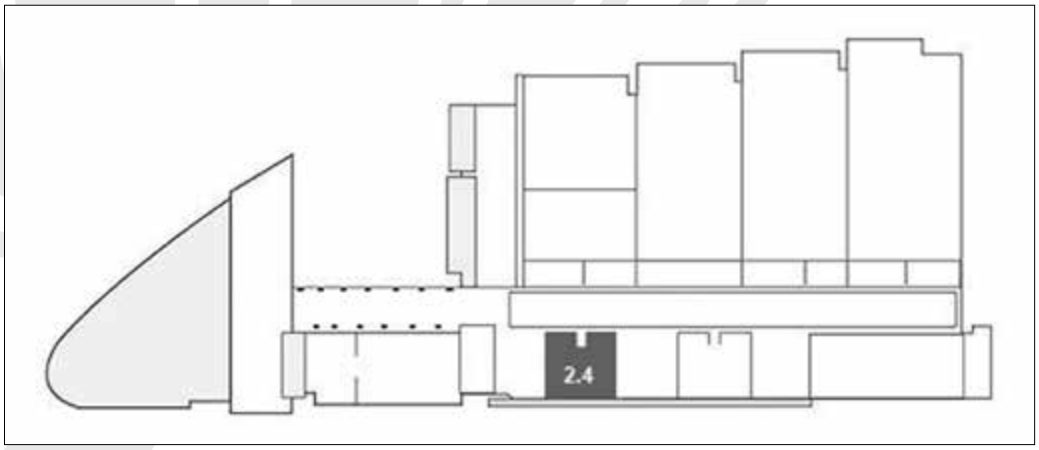
Level 0
- Entrance
- Course Reception – Clivia & Jasminum Conservatory





Level 1
- Registration – Ballroom Gallery
- Exhibits, Breakfast, Lunch, Breaks, Welcome Reception – Ballroom
- Presenter Upload Area – Auditorium I Foyer
- General and Concurrent Sessions – Auditorium I
- Concurrent Sessions – Auditorium II
- Hands-On Workshops (HOWs) – Meeting Rooms 1.41, 1.43, 1.61, 1.63

Level 2
- Concurrent Sessions – Meeting Room 2.4



AUTHOR DISCLOSURES

The Scoliosis Research Society
gratefully acknowledges

GLOBUS MEDICAL

for their overall Support of IMAST.

AUTHOR DISCLOSURES

Board of Directors

Todd J. Albert, MD	United States	AOA (e); ASIP (c); Biometrix (c); Breakaway Imaging (c); Crosstree (c); DePuy Synthes (b, g); Facetlink (c); Gentis (c); In Vivo Therapeutics (e, c); Invuity (c); Jaypee Brothers Medical Publisher (g); JBJS (g); Paradigm Spine (c); PMIG (c); Saunders/Mosby-Elsevier (g); Spine (g); Spine Deformity (g); Spinicity (c); Thieme Publishing (g); United Healthcare (g); Vertech (c); Zimmer Biomet (g)
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Samuel K. Cho, MD	United States	DePuy Synthes (b); Globus Medical (b); Medtronic (b); Zimmer Biomet (b, a)
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Stuart H. Hershman, MD	United States	No Relationships
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The Scoliosis Research Society
gratefully acknowledges

K2M

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and directional signage.

MEETING AGENDA

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

Wednesday, July 12, 2017

14:00 - 21:00 Registration Open

BALLROOM GALLERY – CTICC LEVEL 1

15:00 - 16:45 Concurrent Sessions 1A-B: Special Symposia

1A. Redefining Sagittal Imbalance: Achieving Lordosis in Degenerative to Deformed Spines

AUDITORIUM I

Moderators: Ronald A. Lehman, Jr., MD & David W. Polly, Jr., MD

15:00 - 15:20 **Level Degenerative Conditions: Why Aren't We Getting Lordosis and Tips to Achieve it?**
John R. Dimar II, MD

15:20 - 15:40 **Revision 3-4 Level Case: How to Avoid a 3 Column Osteotomy**
Lawrence G. Lenke, MD

15:40 - 16:00 **When and How to Employ Novel Techniques to Achieve Lordosis (ACR/OLIF/MIS/TLIF)**
Juan S. Uribe, MD

16:00 - 16:20 **What Guidelines Do We Have to Determine How Much Lordosis We Need and How Do We Then Achieve It?**
Frank J. Schwab, MD

16:20 - 16:45 **Discussion**

1B. Special Symposium: Perioperative Safety and Quality: Why Aren't We All Doing the Same Thing?

AUDITORIUM II

Moderators: Todd J. Albert, MD & Kenneth MC Cheung, MD

15:00 - 15:20 **Best Practice Guidelines for AIS: How Do We Do It Better, Decrease LOS and Return them to Play?**
Peter O. Newton, MD

15:20 - 15:40 **Risk Stratification for Adult Deformity: Metrics, Decision Making, Preoperative Indicators for a Successful Outcome**
Christopher P. Ames, MD

15:40 - 16:00 **Where Does Value and Quality Play a Role: Can We Do It Safer, Faster and Cheaper?**
Sigurd H. Berven, MD

16:00 - 16:20 **From Peds to Adults: Complication Avoidance for the Complex Patient - Red Flags for Concern**
Henry F. H. Halm, MD

16:20 - 16:45 Discussion

16:45 - 17:00 Walking Break

17:00 - 19:00 Hands-On Workshops (Non-CME)

MEETING ROOMS 1.41, 1.43, 1.61
(See the Exhibits and Hands-On Workshop (HOW) section on page 121 for more information)

19:00 - 21:00 Welcome Reception in the Exhibit Hall

BALLROOM

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Thursday, July 13, 2017

07:45 - 17:00 **Registration Open**

BALLROOM GALLERY – CTICC LEVEL 1

07:45 - 08:45 **Hands-On Workshops with Breakfast (Non-CME)**

MEETING ROOM 1.41
(See the Exhibits and Hands-On Workshop (HOW) section on page 121 for more information)

08:00 - 17:00 **Exhibits Open**

BALLROOM

08:00 - 08:45 **Exhibit Viewing & Breakfast**

BALLROOM

09:00 - 10:35 **General Session and Whitecloud Clinical Award Nominees**

AUDITORIUM I
Moderators: Henry F.H. Halm, MD & Ronald A. Lehman, Jr., MD

09:00 - 09:05 **Welcome Address**
Ronald A. Lehman, Jr., MD
IMAST Committee Chair

09:05 - 09:09 **Paper 1 Patient Reported SRS-24 Outcomes Scores after Surgery for Adolescent Idiopathic Scoliosis Have Improved Since the New Millennium†**
Tracey P. Bastrom; Peter O. Newton, MD; Harms Study Group

09:09 - 09:13 **Paper 2 Using The Lower Lumbar Touched Vertebra To Select The Lowest Instrumented Vertebra In Lenke Type 3 & 4 Curves At A Minimum 5 Yr Follow-Up†**
Lawrence G. Lenke, MD; Michael P Kelly, MD; Ronald A. Lehman, MD; Michael Vitale, MD, MPH; Baron S. Lonner, MD; Thomas J. Errico, MD; Randal R. Betz, MD; Suken A. Shah, MD; Harry L. Shufflebarger, MD; Peter O. Newton, MD; Kathleen M. Blanke, RN; Harms Study Group

09:13 - 09:17 **Paper 3 Disc Degeneration in Unfused Caudal Motion Segments Ten Years Following Surgery for Adolescent Idiopathic Scoliosis†**
Baron S. Lonner, MD; Yuan Ren, PhD; Michelle Claire Marks, PT, MA; Peter O. Newton, MD; Randal R. Betz, MD; Amer F. Samdani, MD; Harry L. Shufflebarger, MD; Suken A. Shah, MD; Daniel Lefton, MD; Hussein Nasser, MD; Colin Dabrowski; Karen S Chen, MD

09:17 - 09:26 **Discussion**

09:26 - 09:30 **Paper 4 Touched Vertebra (TV) on Standing Xray is a Good Predictor for LIV. TV on Prone Xray is Better†**
Vishal Sarwahi, MD; Stephen F Wendolowski, BS; Jesse Galina, BS; Beverly Thornhill, MD; Yungtai Lo, MD; Kathleen Maguire, MD; Terry D. Amaral, MD

09:30 - 09:34 **Paper 5 Rod Fracture in Adult Spinal Deformity Surgery Incidence, Risk Factors and Impact on Health Related Quality of Life in 526 Patients†**
Thamrong Lertudomphonwanit, MD; Munish C. Gupta, MD; Keith H. Bridwell, MD; Lawrence G. Lenke, MD; Prachya Punyarat, MD; Timothy Bryan; Brenda Sides, MA; Jacob M. Buchowski, MD, MS; Michael P. Kelly, MD; Lukas P. Zebala, MD

09:34 - 09:38 **Paper 6 2-Year Outcomes of Spinal Growth Tethering vs. Posterior Spinal Fusion for Scoliosis Flexibility vs. Reliability†**
Peter O. Newton, MD; Dylan G Kluck, MD; Wataru Saito, MD, PhD; Burt Yaszay, MD; Carrie E. Bartley, MA; Tracey P. Bastrom

09:38 - 09:47 **Discussion**

09:47 - 09:51 **Paper 7 Does Local Intraoperative Corticosteroids Delivered in a Gel-Matrix Minimize Dysphagia following Anterior Discectomy and Fusion (ACDF)? A Preliminary Analysis of a Double Blinded Randomize Controlled Trial (RCT)†**
Daniel Stein, BS; Han Jo Kim, MD; Darren R. Lebl, MD; Russel Huang, MD; Shari T Jawetz, MD; Okezie K. Aguwa, MD; Virginie LaFage, PhD; Todd J. Albert, MD

MEETING AGENDA

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Thursday, July 13, 2017

09:51 - 09:55 **Paper 8 Closed Reduction of Cervical Facet Dislocations a New Take on an Old Technique†**
Johannes H. Davis, MMed(Orth), FCOrth (SA); De La Rey HS Badenhorst; Moosa Ahmed Farouk Mohideen; Maarten Potgieter

09:55 - 09:59 **Paper 9 Safety of a High-Dose Tranexamic Acid Protocol in Complex Adult Spinal Deformity Analysis of 100 Consecutive Cases†**
James D Lin, MD; Lawrence G. Lenke, MD; Jamal Shillingford, MD; Joseph Lawrence Laratta, MD; Lee A Tan; Charla R. Fischer, MD; Ronald A. Lehman, MD

09:59 - 10:09 **Discussion**

10:09 - 10:14 **Introduction of the President**
Todd J. Albert, MD

10:14 - 10:29 **Presidential Keynote Address**
Kenneth MC Cheung, MD

10:29 - 10:35 **Preview of the 52nd Annual Meeting and 25th IMAST**
52nd Annual Meeting – Philadelphia, PA, USA
25th IMAST - Los Angeles, CA, USA

10:35 - 11:05 **Refreshment Break & Exhibit Viewing**

Case Presentations in Exhibit Hall

11:05 - 12:30 **Concurrent Sessions 2A-C: Abstract Sessions**

11:05 - 12:30 **2A. Whitecloud Basic Science Nominees and Top-Scoring Abstracts**
AUDITORIUM I
Moderators: Kenneth MC Cheung, MD & Justin S. Smith, MD, PhD

11:05 - 11:09 **Paper 10 Improved Clinical Outcomes of Intraoperative Lumbar Nerve Root Monitoring Changes Using Motor Evoked Potentials During Thoracolumbar Spinal Surgery***
Earl D. Thuet, B.S., CNIM; Lee Tan; Anil Mendiratta, MD; Moosa Ahmed Farouk Mohideen; Paul,F Kent, MD, PhD; Ronald A. Lehman, MD; Yongjung J. Kim, MD; Charla R. Fischer, MD; Mark Weidenbaum, MD; Lawrence G. Lenke, MD

11:09 - 11:13 **Paper 11 Changes in Cervical Facets Orientation During Child Growth***
Sebastien Pesenti; Renaud Lafage; Benjamin Blondel; Emilie Peltier, MD; Elie Choufani, MD; Jean-Luc Jouve, MD, PhD

11:13 - 11:17 **Paper 12 Locally Applied Simvastatin as an Adjunct to Promote Spinal Fusion in Rats***
Sravisht Iyer, MD; Patrick, E Donnelly, PhD; George Spaniel BS; Matthew E. Cunningham, MD, PhD

11:17 - 11:26 **Discussion**

11:26 - 11:30 **Paper 13 Widening of the Safe Trajectory Range During Subaxial Cervical Pedicle Screw Placement: Advantages of a Curved Pedicle Probe and Laterally Located Starting Point without Creating a Funnel-Shaped Hole**
Jin Hoon Park; Subum Lee

11:30 - 11:34 **Paper 14 Neurologic Deficits and MRI Characteristics of Syrinx in Idiopathic Syringomyelia Related Scoliosis***
Haining Tan; Fan Feng; Youxi Lin, MD; Xingye Li, MD; Chong Chen, MD; Jianxiong Shen, MD

11:34 - 11:38 **Paper 15 Impact of Type of Screw on Kyphotic Deformity Correction after Spine Fracture Fixation- Cannulated versus Solid Pedicle Screw***
Abduljabbar Alhammoud, MD; Mahmood Arbash; Ashik, M Parambathkandi; Ohmed Khilji; Abdul Moeen Baco

11:38 - 11:47 **Discussion**

11:47 - 11:51 **Paper 16 A 20-Year Analysis of AIS Patient Incidence of Critical Changes and Predictive Factors to Define Patients at Risk**
Daniel J. Sucato, MD, MS; Kiley Poppino, BS; Alec, S Thoveson; Ali Parsa; Steven, P Sparagana, MD; Patricia Rampy, MS, CNIM

MEETING AGENDA

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Thursday, July 13, 2017

11:51 - 11:55 **Paper 17 Rate of Instrumentation and Fusion-related Complications after Surgical Treatment for Severe Pediatric Spinal Deformity within 2 years: A Prospective Multi-center Cohort Study.**
Munish C. Gupta, MD; Lawrence G. Lenke, MD; Jahangir K. Asghar, MD; Oheneba Boachie-Adjei, MD; Patrick J. Cahill, MD; Mark A. Erickson, MD; Sumeet Garg, MD; Peter O. Newton, MD; Amer F. Samdani, MD; Suken A. Shah, MD; Harry L. Shufflebarger, MD; Brenda Sides, MA; Paul D. Sponseller, MD, MBA; Daniel J. Sucato, MD, MS; Michael P Kelly, MD

11:55 - 11:59 **Paper 18 Failure to Validate the Age-Adjusted Alignment Thresholds Concept in an Adult Spinal Deformity Database**
Caglar Yilgor, MD; Nuray Sogunmez, MSc; Yasemin Yavuz, PhD; Ibrahim Obeid, MD; Frank S. Kleinstueck, MD; Emre R. Acaroglu, MD; Francisco Javier Sanchez Perez-Grueso, MD; Anne F. Mannion, PhD; Ferran Pellisé,MD, PhD; Ahmet Alanay, MD; European Spine Study Group

11:59 - 12:08 **Discussion**

12:08 - 12:12 **Paper 19 Does Thoracoplasty Affect Pulmonary Function in Thoracic AIS Surgery Treated by Posteromedial Translation?**
Cedric Duray; Emmanuelle Ferrero, MD, MS; Brice Ilharreborde, MD, PhD

12:12 - 12:16 **Paper 20 3D Analysis of Spinal Deformity Progression following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis**
Vidyadhar V. Upasani, MD; Madeline Cross, MPH; Megan Jeffords, MS; Carrie E. Bartley, MA; Tracey P. Bastrom; Burt Yaszay, MD; Peter O. Newton, MD

12:16 - 12:20 **Paper 21 Natural History of Post-Operative Adding-On in AIS: What's the Risk Factors for Progressive Adding-On?**
ZeZhang Zhu, MD PhD; Xiao-dong Qin, PhD; Weixiang Sun, MD; Lei-lei Xu, MD; Yong Qiu, MD

12:20 - 12:30 **Discussion**

11:05 - 12:30 **2B. Early Onset Scoliosis Abstracts**
MEETING ROOM 2.4
Moderators: Khaled M. Kebaish, MD & Muharrem Yazici, MD

11:05 - 11:09 **Paper 22 The Evolution of Sagittal Spinal Profile in EOS: Is There A Difference Between Rib-Based and Spine-Based Growth Friendly Instrumentation?**
Xu Sun, MD, PhD; Zhonghui Chen, MD, PhD; Yong Qiu, MD; ZeZhang Zhu, MD, PhD; Xi Chen, MD; PhD; Changzhi Du, MD, PhD; Song Li, MD

11:09 - 11:13 **Paper 23 Cost Effectiveness of Magnetically Controlled Growing Rods: Who Really Benefits?**
Matthew E. Oetgen, MD; Allison Matthews, MSCR

11:13 - 11:17 **Paper 24 Proximal Junctional Kyphosis in Posterior Spinal Fusion in Early Onset Scoliosis**
Mariano Augusto Noel, MD; Lucas Piantoni, MD; Carlos A. Tello, MD, PhD; Ida Alejandra Francheri Wilson, MD; Eduardo Galaretto, MD; Rodrigo G. Remondino, MD; Ernesto S. Bersusky, MD

11:17 - 11:26 **Discussion**

11:26 - 11:30 **Paper 25 Graduation Protocol after Growing Rod Treatment: Is Removal of Hardware without New Instrumentation a Realistic Approach?**
Ismail Aykut Kocyigit, MD; Z. Deniz Olgun; Gokhan Demirkiran, MD; Mehmet Ayvaz; Muharrem Yazici, MD

11:30 - 11:34 **Paper 26 Traditional Growing Rod Graduates with Various Diagnoses Have Similar Clinical and Radiographic Outcomes**
Behrooz A. Akbarnia, MD; Jeff Pawelek; Pooria Hosseini, MD; Pooria Salari Salari, MD; David S. Marks, FRCS; Suken A. Shah, MD; David L. Skaggs, MD, MMM; John B. Emans, MD; Paul D. Sponseller, MD, MBA; George H. Thompson, MD; Growing Spine Study Group

11:34 - 11:38 **Paper 27 Magnetically-Controlled Growing Rod Patients Have Better HRQOL Measures Compared to Traditional Growing Rod Patients A Multicenter Pilot Study**
David L. Skaggs, MD, MMM; Behrooz A. Akbarnia, MD; Jeff Pawelek; Hiroko Matsumoto; Tricia St. Hilaire, MPH; Peter F. Sturm, MD; Francisco Javier Sanchez Perez-Grueso, MD; Scott John Luhmann, MD; Paul D. Sponseller, MD, MBA; John T. Smith, MD; Klane K. White, MD, MSc; Michael Vitale, MD, MPH; Children's Spine Study Group; Growing Spine Study Group

Thursday, July 13, 2017

11:38 - 11:47 **Discussion**

11:47 - 11:51 **Paper 28 Health-Related Quality of Life in Early-Onset Scoliosis Patients Treated Surgically EOSQ Scores in Traditional Growing Rod vs. Magnetically-Controlled Growing Rods**
Michael, E. Doany, MS3; Z. Deniz Olgun; Gizem Irem Kinikli; Senol Bekmez; Ismail Aykut Kocyigit, MD; Gokhan Demirkiran, MD; Muharrem Yazici, MD

11:51 - 11:55 **Paper 29 What is the Influence of Pedicle Screw Instrumentation for Vertebral Body and Spinal Canal in Children Younger than 5 Years Old: A More than 5 Years Follow-up**
Jianguo Zhang, MD; Yan Bin Zhang, MD

11:55 - 11:59 **Paper 30 Comparison of Ponte Osteotomies, Hemivertebrectomy and Vertebral Column Resection in the Treatment of Congenital Spinal Deformity**
Priscella S. Chan, MS; Lindsay M. Andras, MD; Ted Sousa, MD ;Elizabeth Joiner; Paul D. Choi, MD; Vernon Tolo, MD; David L. Skaggs, MD, MMM

11:59 - 12:08 **Discussion**

12:08 - 12:10 **Paper 31 Is There Still a Place for Convex Hemiepiphysiodesis in Congenital Scoliosis in Young Children? A Long Term Follow-up.**
Maroun Rizkallah, MD; Gaby Kreichati, Prof; Amer Sebaaly; Khalil Emile Kharrat, MD

12:10 - 12:12 **Paper 32 Incidence and Risk Factors of Neurological Complications of Thoracic PVCR for Severe Rigid Congenital Spinal Deformities**
Hui-Ren Tao, MD, PhD; Bo-bo Zhang, MD; Michael S. Chang, MD

12:12 - 12:14 **Paper 33 3D Assessment of Spine Growth in Early Onset Scoliosis During Growing Rod Lengthening**
Burt Yaszay, MD; Naveed Nabizadeh, MD; Megan Jeffords, MS; Fredrick Reighar;, Joshua Doan, Meng; Jeff Pawelek, Christine L. Farnsworth, MS; Gregory M. Mundis, MD; Behrooz A. Akbarnia

12:14 - 12:16 **Paper 34 Neuromuscular Scoliosis Complication Rates are Significantly Decreased from a Decade Ago: A Report from the SRS M&M Database**
Steven W. Hwang, MD; Amer F. Samdani, MD; Heather M Keeny, PA; Darrell S. Hanson, MD; Kathleen M. Blanke, RN; Joshua M. Pahys, MD

12:16 - 12:18 **Paper 35 Proximal Rib-Based Constructs in Early Onset Scoliosis Survivorship at or near Skeletal Maturity**
Alexandra Kondratyeva, DO; Nicholas Feinberg; Zachary Bloom; Chun Wai Hung, MEng; Hiroko Matsumoto; John T. Smith, MD; Joshua M. Pahys, MD; Sumeet Garg, MD ;David Price Roye, MD; Amer F. Samdani, MD; Michael Vitale, MD, MPH; Children's Spine Study Group

12:18 - 12:30 **Discussion**

11:05 - 12:30 **2C. Adult Deformity Abstracts**

AUDITORIUM II

Moderators: Mario Di Silvestre, MD & Sébastien Charosky, MD

11:05 - 11:09 **Paper 36 Unilateral vs. Bilateral Iliac Screw Fixation in Adult Deformity Surgery Long-Term Outcomes and Complications**
Michael S. Chang, MD; Dennis G. Crandall, MD; Jan Revella, RN; Yu-Hui H. Chang, MPH, PhD

11:09 - 11:13 **Paper 37 Early versus Delayed Rod Fracture in Adult Spinal Deformity Surgery Differ in Presentation and Revision Rates**
Thamrong Lertudomphonwanit, MD; Munish C. Gupta, MD; Keith H. Bridwell, MD; Lawrence G. Lenke, MD; Brenda Sides, MA; Prachya Punyarat, MD; Jacob M. Buchowski, MD, MS; Michael P Kelly, MD; Lukas P. Zebala, MD

11:13 - 11:17 **Paper 38 Sacropelvic Fixation Using S2 Alar-Iliac (S2AI) Technique in Adult Spinal Deformity Patients Fused to the Sacrum The Fate of the SI Joint at Five Years**
Tina Raman, MD; Khaled Kebaish, MD; Micheal Raad, MD

11:17 - 11:26 **Discussion**

11:26 - 11:30 **Paper 39 Towards the Development of a Core Outcome Set for Adult Spinal Deformity Surgery**
Sayf S.A. Faraj, BSc: Miranda L. Van Hooff, MS; Tsjitske M. Haanstra, PhD; Roderick Maurits Holewijn, BS; David W. Polly, MD; Marinus De Kleuver, MD, PhD

MEETING AGENDA

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Thursday, July 13, 2017

11:30 - 11:34	**Paper 40 Radiographic Sagittal Alignment in the Asymptomatic Elderly: What is Normal for Age?** *David McConda, MD; Susan Odum, PhD; Todd M Chapman Jr, MD; P Bradley Segebarth, MD*
11:34 - 11:38	**Paper 41 No Relation between Lumbopelvic Mismatch and Poor Outcome in Thoracic Hyperkyphosis Corrections** *Daniel, ACF Wong-Chung, MD, MSc; Miranda L. Van Hooff, MS; Marinus De Kleuver, MD, PhD; Harm Graat, MD, PhD; Roel Hoogendoorn, J.; Sayf S.A. Faraj, BSc*
11:38 - 11:47	**Discussion**
11:47 - 11:51	**Paper 42 Flexibility of Thoracic Kyphosis (TK) impacts postoperative Sagittal Alignment in Adult Spinal Deformity Patients** *Sebastian Decker, MD; Michael Mayer, MD, PhD; Axel Hempfing, MD; Lukas Ernstbrunner, MD; Heiko Koller*
11:51 - 11:55	**Paper 43 Low Bone Mineral Density is the Significant Risk for Developing PJF In Surgically Treated Patient with ASD** *Mitsuru Yagi, MD, PhD;N obuyuki Fujita, MD, PhD; Osahiko Tsuji, MD, PhD; Narihito Nagoshi, MD, PhD; Takashi Asazuma, MD, PhD; Ken Ishii, MD; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD; Kota Watanabe, MD, PhD; Keio Spine Research Group, (KSRG)*
11:55 - 11:59	**Paper 44 Should Targets for Adult Spinal Deformity Correction Depend on Pelvic Incidence?** *Themistocles S. Protopsaltis, MD; Alex Soroceanu, MD, MPH; Jared C Tishelman, BA; Aaron J. Buckland, MBBS, FRACS; Gregory M. Mundis, MD; Justin S. Smith, MD, PhD; Alan H. Daniels, MD; Lawrence G. Lenke, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; Christopher P. Ames, MD; Robert A. Hart, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Frank J. Schwab, MD; Virginie LaFage, PhD; International Spine Study Group, ISSG*
11:59 - 12:08	**Discussion**
12:08 - 12:10	**Paper 45 Risk Factor Analysis for PJK After Adult Spinal Deformity Surgery: A New Simple Scoring System** *Renaud Lafage, MS; Frank J. Schwab, MD; Eric O. Klineberg, MD; Douglas C. Burton, MD; Shay Bess, MD ;Han Jo Kim, MD; Justin S. Smith, MD, PhD; Christopher P. Ames, MD; Richard Hostin, MD; Christopher I. Shaffrey, MD; Gregory M. Mundis, MD; Virginie LaFage, PhD; International Spine Study Group, ISSG*
12:10 - 12:12	**Paper 46 Nutritional Insufficiency as a Predictor for Adverse Outcomes in Adult Spinal Deformity Cases** *John, F Di Capua, MHS, BS; Nathan J. Lee, BS; Sulaiman Somani, BS; Deepak, A Kaji; Jun S Kim, MD; Parth Kothari; Rachel S. Bronheim, BA; Samuel K. Cho, MD*
12:12 - 12:14	**Paper 47 Post-Tumor Spinal Deformity: Non-Operative versus Operative Management** *Nikita Zaborovskii, MD; Dmitrii Ptashnikov, MD, PhD; Dmitrii Mikhailov; Sergei Masevnin; Oleg Smekalenkov, MD; Olga Lapaeva, MD; Zabioulah Mooraby, MD; Yang Le, MD*
12:14 - 12:16	**Paper 48 Impact of Lumbar Lordosis Correction on Surgical Outcome Is Dependent on Age Decade in Elderly Adult Spinal Deformity Surgery** *Yu Yamato; Tomohiko Hasegawa, MD PhD; Sho Kobayashi, MD, PhD; Daisuke Togawa; Go Yoshida; Shin Oe, MD; Tomohiro Banno; Yuki Mihara, MD; Tatsuya Yasuda; Yukihiro Matsuyama, MD, PhD*
12:16 - 12:18	**Paper 49 Comparison between Unilateral and Bilateral Pelvic Fixation Using the S2AI Technique and the Incidence of Sacro-iliac Joint (SIJ) Pain** *Mostafa H. El Dafrawy; Paul D. Sponseller, MD; Micheal Raad; Khaled Kebaish, MD*
12:18 - 12:30	**Discussion**
12:30 -13:30	**Hands-On Workshops with Lunch (Non-CME)** MEETING ROOMS 1.41, 1.43, 1.61, 1.63 *(See the Exhibits and Hands-On Workshop (HOW) section on page 121 for more information)*
12:30 - 13:30	**Exhibit Viewing & Lunch** BALLROOM
13:30 - 13:45	**Walking Break**

MEETING AGENDA

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Thursday, July 13, 2017

13:45 - 14:45 Concurrent Sessions 3A-C: Instructional Course Lectures

13:45 - 14:45 **3A: The Latest in Spine Tumor Treatment**
MEETING ROOM 2.4
Moderators: Dean Chou, MD & Peter Rose, MD

- 13:45 - 13:55 **Metastatic Spine Disease: How Do We Classify and Determine Who Needs Surgery?**
  Peter Rose, MD
- 13:55 - 14:05 **Innovative Treatments for Spinal Tumors (MIS, Technologies, etc)**
  Daniel M. Sciubba, MD
- 14:05 - 14:15 **En Bloc Spondylectomy for Primary Malignant Tumors. Technique, Tips and Tricks.**
  Ulf R. Liljenqvist, MD
- 14:15 - 14:25 **Cervical Tumors: Special Considerations and Treatment**
  Christopher P. Ames, MD
- 14:25 - 14:45 **Discussion**

13:45 - 14:45 **3B: Cervical Spondylotic Myelopathy / Radiculopathy: Anterior, Posterior or Both**
AUDITORIUM II
Moderators: Michael G. Fehlings, MD, PhD, FRCSC, FACS & Vincent C. Traynelis, MD

- 13:45 - 13:55 **Use of ACDF and Corpectomy for the Treatment of SCM: When I Use Each**
  Todd J. Albert, MD
- 13:55 - 14:05 **Motion Preserving Techniques (Laminectomy, Laminoplasty and Foraminotomies)**
  Praveen V. Mummaneni, MD
- 14:05 - 14:15 **Posterior Decompression and Fusion Considerations**
  Martin Gehrchen, MD, PhD
- 14:15 - 14:25 **When to Use Anterior and Posterior Approaches to Ensure Success**
  BangPing Qian, MD
- 14:25 - 14:45 **Discussion**

13:45 - 14:45 **3C: Adolescent Idiopathic Scoliosis: Surgical Pearls to Achieve Success for Each Lenke Curve Type: The "Rule Book"**
AUDITORIUM I
Moderators: Andre Luis Fernandes Andujar, MD & Lawrence G. Lenke, MD

- 13:45 - 13:55 **Lenke 1; LIV Selection, Shoulder Balance, Derotation Maneuvers, Inducing Thoracic Kyphosis**
  Suken A. Shah, MD
- 13:55 - 14:05 **Lenke 3's, What Age to Offer Surgery, When to Perform Selective Thoracic Fusion in a 3C, Stopping at L3 vs L4**
  Amer F. Samdani, MD
- 14:05 - 14:15 **Lenke 5 C: Anterior vs Posterior, UIV and LIV Selection, LIV = L3 vs L4**
  Daniel J. Sucato, MD, MS
- 14:15 - 14:25 **Lenke 2, 4 and 6's: Special Considerations for These Curves**
  Ian J. Harding, BA, FRCS (Orth)
- 14:25 - 14:45 **Discussion**

14:45 - 15:00 Walking Break

MEETING AGENDA

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Thursday, July 13, 2017

15:00 - 15:40 Concurrent Sessions 4A-C: Concurrent Roundtable Sessions

15:00 - 15:40 4A: Growing Spine: When to Address and Which Treatment to Employ
MEETING ROOM 2.4
Moderators: Kenneth MC Cheung, MD & Muharrem Yazici, MD

- 15:00 - 15:10 **Case Presenter #1** *Stefan Parent, MD, PhD*
- 15:10 - 15:20 **Case Presenter #2** *Daniel J. Sucato, MD, MS*
- 15:20 - 15:30 **Case Presenter #3** *Amer F. Samdani, MD*
- 15:30 - 15:40 **Case Presenter #4** *John Dormans, MD*

15:00 - 15:40 4B: Adult Deformity: Advances on Treatment
AUDITORIUM I
Moderators: Sigurd H. Berven, MD & Yong Qiu, MD

- 15:00 - 15:10 **Case Presenter #1** *Frank J. Schwab, MD*
- 15:10 - 15:20 **Case Presenter #2** *Sébastien Charosky, MD*
- 15:20 - 15:30 **Case Presenter #3** *Saumyajit Basu, MD*
- 15:30 - 15:40 **Case Presenter #4** *Neel Anand, MD*

15:00 - 15:40 4C: Lumbar Degenerative Conditions: How to Address the Everyday Problem
AUDITORIUM II
Moderators: Robert Dunn, FCS (SA) Orth & Vincent C. Traynelis, MD

- 15:00 - 15:10 **Case Presenter #1** *Hani H. Mhadli, MD, PhD*
- 15:10 - 15:20 **Case Presenter #2** *John R. Dimar, II, MD*
- 15:20 - 15:30 **Case Presenter #3** *Mario Di Silvestre, MD*
- 15:30 - 15:40 **Case Presenter #4** *Jeffrey D. Coe, MD*

15:40 - 16:10 Refreshment Break & Exhibit Viewing
BALLROOM

MEETING AGENDA

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Thursday, July 13, 2017

16:10 - 17:10 Concurrent Sessions 5A-C: Debates, Worst Complication

16:10 - 17:10 5A: Debate Session #1 MISS: Is it a Hit or a Miss?
AUDITORIUM I
Moderators: Martin Gehrchen, MD & David W. Polly, Jr., MD

- 16:10 - 16:40 **Debate 1: Which Laterally Based Procedure is Best?**
- 16:10 - 16:20 **Transpoas is the Only Way!**
  Robert Lee, BSc, MBBS, MRCS, FRCS
- 16:20 - 16:30 **Join the Revolution: Antepsoas Works Best**
  Ronald A. Lehman, Jr., MD
- 16:30 - 16:40 **Discussion**
- 16:40 - 17:10 **Debate 2: Open or Shut Case: Can We Really use MISS to Treat Adult Deformity?**
- 16:40 - 16:50 **I Can Do it Better with Less Morbidity: Role of MIS**
  Neel Anand, MD
- 16:50 - 17:00 **If You are Doing a Surgery, Use One that Works: Open is Best**
  Khaled M. Kebaish, MD
- 17:00 - 17:10 **Discussion**

16:10 - 17:10 5B: Debate Session #2 The Growing Spine: When to Intervene and How
AUDITORIUM II
Moderators: John Dormans, MD & Cristina Sacramento Dominguez, MD, PhD

- 16:10 - 16:40 **Debate 1: Early Intervention is Best for Early Onset Scoliosis (EOS)**
- 16:10 - 16:20 **Early Surgery is Best**
  Muharrem Yazici, MD
- 16:20 - 16:30 **Bracing and Casting are Best for the Young Child**
  Kota Watanabe, MD, PhD
- 16:30 - 16:40 **Discussion**
- 16:40 - 17:10 **Debate 2: Tether vs Magnetic Growing Construct**
- 16:40 - 16:50 **Everyone Should Get Tethered**
  Amer F. Samdani, MD
- 16:50 - 17:00 **Posteriorly Based Technology is Best**
  Peter Newton
- 17:00 - 17:10 **Discussion**

16:10 - 17:10 5C: My Worst Complications: Strategies to Prevent/Manage
MEETING ROOM 2.4
Moderators: Praveen V. Mummaneni, MD & Daniel M. Sciubba, MD

- 16:10 - 16:30 **Adult Deformity Complication**
  Christopher I. Shaffrey, MD
- 16:30 - 16:50 **Neuromonitoring Loss during Pediatric Deformity: Why It Happens, What to Do, and What to Expect**
  Suken A. Shah, MD
- 16:50 - 17:10 **Severe Deformity in the Neglected Patient**
  Robert Dunn, FCS (SA) Orth

MEETING AGENDA

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Thursday, July 13, 2017

17:10 - 17:15 **Passing Break**

17:15 - 18:15 **Afternoon Hands-On Workshops with Beverages and Snacks (Non-CME)**

MEETING ROOM 1.41, 1.43, 1.61, 1.63
(See the Exhibits and Hands-On Workshop (HOW) section on page 121 for more information)

Friday, July 14, 2017

07:45 - 16:00 **Registration Open**

BALLROOM GALLERY – CTICC LEVEL 1

07:45 - 08:45 **Hands-On Workshops with Breakfast (Non-CME)**

MEETING ROOMS 1.41, 1.43
(See the Exhibits and Hands-On Workshop (HOW) section on page 121 for more information)

08:00 - 16:00 **Exhibits Open**

BALLROOM

08:00 - 08:45 **Exhibit Viewing & Breakfast**

BALLROOM

09:00 - 10:00 **Concurrent Sessions 6A-C: Abstract Sessions**

09:00 - 10:00 6A: Adolescent Idiopathic Scoliosis Abstracts

AUDITORIUM I

Moderators: Ferran Pellisé, MD, PhD & Peter O. Newton, MD

09:00 - 09:04 **Paper 50 Interpreting 2-Dimensional and 3-Dimensional Alignment in Adolescent Idiopathic Scoliosis: How Should Thoracic Kyphosis Be Defined?**
Subaraman Ramchandran, MD; Akhila Suré; John Moon, BS; Peter L Zhou, BA; Thomas J. Errico, MD; Aaron J. Buckland, MBBS, FRACS; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD

Paper 51 WITHDRAWN

09:04 - 09:08 **Paper 52 Causes for Early Readmission in AIS Surgery**
Steven W. Hwang, MD; Amer F. Samdani, MD; Tracey P. Bastrom; Peter O. Newton, MD; Harry L. Shufflebarger, MD; Baron Stuart Lonner, MD; Paul D. Sponseller, MD, MBA; Joshua M. Pahys, MD

09:08 - 09:12 **Paper 53 Lenke 1C AIS Curves: When do Experienced Surgeons Incorporate the Lumbar Curve?**
Akhil A Tawari, MD; Jahangir K. Asghar, MD; Stephen G. George, MD; Tracey P. Bastrom; Harms Study Group; Harry L. Shufflebarger, MD

09:12 - 09:24 **Discussion**

09:24 - 09:28 **Paper 54 Distal Adding-On Improves Residual Lumbar Curve in Lenke Type 1B and 1C Curves**
Takeshi Fujii, MD; Kenshi Daimon, MD; Nobuyuki Fujita, MD, PhD; Mitsuru Yagi, MD, PhD; Naobumi Hosogane, MD; Narihito Nagoshi, MD, PhD; Osahiko Tsuji, MD, PhD; Ken Ishii, MD; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD; Kota Watanabe, MD, PhD

09:28 - 09:32 **Paper 55 Anterior Vertebral Body Tethering for the Treatment of Idiopathic Scoliosis Feasibility, Outcomes, and Complications**
Firoz Miyanji, MD, FRCSC; Luigi Aurelio Nasto, MD, PhD; Eva Habib, BSc; Andrea M. Simmonds, MD, FRCSC

09:32 - 09:40 **Discussion**

09:40 - 09:44 **Paper 56 Pelvic Obliquity in Adolescent Idiopathic Scoliosis (AIS). An Analysis of 311 Lower Limb Radiographs.**
Chris Yin Wei Chan, MS Orth; Soe Naing Kyaw, MD; Chee Kidd Chiu, MBBS, MS Orth; Siti Mariam Mohamad, BSc, MSc; Mun Keong Kwan, MBBS, MS Orth

MEETING AGENDA

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09:44 - 09:48 **Paper 57 Pregnancy and Childbirth after Spinal Fusion for Adolescent Idiopathic Scoliosis**
Michelle Ho, BS;John M. Flynn, MD; Joshua M. Pahys, MD; Suken A. Shah, MD; Baron Stuart Lonner, MD; Burt Yaszay, MD; Harms Study Group, Patrick J. Cahill, MD

09:48 - 09:52 **Paper 58 Non-Contact Sports Participation in Adolescent Idiopathic Scoliosis Effects on Parent and Patient Reported Outcomes**
Frank A. Segreto, BS; James Messina; James, P Doran, MD; Alex Aylyarov, MD; Patrick J. Mixa; Kwaku Opare-Sem, Mr; Harleen Kaur; Louis M. Day; Barrett Torre; Douglas A Hollern, MD; Karen Paltoo; Qais Naziri, MD; Carl B. Paulino, MD; William P. Urban, MD; Bassel G. Diebo, MD

09:52 - 10:00 **Discussion**

09:00 - 10:00 **6B: Kyphosis/Congenital/Neuromuscular Deformity Abstracts**
AUDITORIUM II
Moderators: Hani H. Mhadli, MD, PhD & Stefan Parent, MD, PhD

09:00 - 09:04 **Paper 59 Restoration of Thoracic Kyphosis in AIS Patients with Thoracic Hypokyposis or Lordoscoliosis Using Multiple Ponte Osteotomies With or Without Additional Bilateral Rib Osteotomies**
Selhan Karadereler, MD; Alim Can Baymurat, MD; Cem Sever, MD; Gokce Feride Inan, MD; Isik Karalok, MD; Ayhan Mutlu, MD; Yesim Erol, BSc; Tunay Sanli, MA; Sinan Kahraman, MD; Meric Enercan, MD; Azmi Hamzaoglu, MD

09:04 - 09:08 **Paper 60 Changes in Body Shape Following Surgical Correction in AIS Surface Topography Changes Are Associated With Improvements in Health-Related Quality of Life**
Baron Stuart Lonner, MD; Yuan Ren, PhD; Gabrielle Kassin, BS

09:08 - 09:12 **Paper 61 Selection of the Optimal Distal Fusion Level for Correction of Scheuermanns Hyperkyphosis with Posterior All Pedicle Screw Instrumentation and Fusion**
Weiguo Zhu, MD, PhD; Xu Sun, MD, PhD; Xinxin Yuan, MD; Shifu Sha, MD, PhD; Lei-lei Xu, MD; Zhen Liu, MD, PhD;Y ong Qiu, MD; ZeZhang Zhu, MD PhD

09:12 - 09:20 **Discussion**

09:20 - 09:24 **Paper 62 Does Thoracolumbar Kyphosis Correction Change the Acetabular Cup Anteversion in Ankylosing Spondylitis Patients with a Previous Total Hip Replacement?**
Bangping Qian, MD; Jun Hu, MD, PhD; Mu Qiao, MD; Ji-chen Huang, MD; Bin Wang, MD; Yang Yu, MD; ZeZhang Zhu, MD PhD; Yong Qiu, MD

09:24 - 09:28 **Paper 63 Risk Factors for Proximal Junction Kyphosis (PJK) in Scheuermann's Kyphosis (SK)**
Jesse Galina, BS; Darren, F. Lui; Haiming Yu, MD; Adam Benton, BA BMBS; Sara Khoyratty, MD; Stephen F Wendolowski, BS; Vishal Sarwahi, MD; Sean Molloy, MBBS,FRCS(Orth),MSc

09:28 - 09:32 **Paper 64 Surgeon Operated Trans-Cranial Motor Evoked Potentials (tcMEP) in Spinal Deformity Surgery - A Viable Option in Resourced Challenged Environments?**
Robert Dunn, FCS (SA) Orth

09:32 - 09:40 **Discussion**

09:40 - 09:44 **Paper 65 Minimally Invasive Surgery in Neuromuscular Scoliosis A Superior Approach for Severely Impaired Patients**
Vishal Sarwahi, MD; Jesse Galina, BS; Stephen F Wendolowski, BS; Francisco Javier Laplaza, MD; Terry D. Amaral, MD

09:44 - 09:48 **Paper 66 Surgical Treatment of Segmental Spinal Dysgenesis: Selection of An Optimal Type of Fusion**
Olga Pavlova, Dr; Alexander Gubin, MD, PhD; Sergey Ryabykh, MD, PhD

09:48 -09:52 **Paper 67 The Effect of Pre-Operative Halo Gravity Traction (HGT) for Severe Spinal Deformities on the Neck Disability Index. Is Long term HGT harmful to the neck?**
Kwadwo Poku Yankey MD, MD; Cristina Sacramento Dominguez, MD, PhD; Henry Ofori Duah, RN; Henry Osei Tutu; Rufai Mahmud MD, MD; Beke Kwakou Ekpe, PT; Samuel Ayim Aboah, PT; Irene Wulff, MD; Harry Akoto, MD; Oheneba Boachie-Adjei, MD; FOCOS Spine Research Group

09:52 - 10:00 **Discussion**

MEETING AGENDA

† = Whitecloud Award Nominee – Best Clinical Paper
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Friday, July 14, 2017

09:00 - 10:00 **6C: Trauma & Tumor Abstracts**
MEETING ROOM 2.4
Moderators: Dean Chou. MD & Ian Harding, BA, FRCS (Orth)

09:00 - 09:04 **Paper 68 Minimally Invasive Percutaneous Screw Osteosynthesis for Hangmans Fracture**
Shuhei Osaki, MD, PhD; Yasuo Ito, MD, PhD

Paper 69 WITHDRAWN

09:04 - 09:08 **Paper 70 Paediatric Spinal Tuberculosis - Surgical Options and Outcomes**
Robert Dunn, FCS (SA) Orth;

09:08 - 09:18 **Discussion**

09:18 - 09:22 **Paper 71 The Spine Oncology Study Group Outcome Questionnaire (SOSGOQ) Analysis of Validity and Test-Retest Reliability**
Anne Versteeg, MD; Arjun Sahgal, MD; Laurence, D Rhines, MD; Daniel M. Sciubba, MD; James Schuster, MD; Michael Weber, MD, PhD; Michael G. Fehlings, MD, PhD, FRCSC FACS; Michelle Clarke, MD; Paul Arnold, MD; Ziya L. Gokaslan, MD; Charles Gregory Fisher, MD, MHSc, FRCSC; AOSpine Knowledge Forum Tumor

09:22 - 09:26 **Paper 72 Metastatic Spine Tumour Surgery: Does Perioperative Allogenic or Salvage Blood Transfusion Influence the Survival and Cancer Progression?**
Aye Sandar Zaw, MBBS, MPH; Shashidhar Bangalore Kantharajanna, Dr; Aditya Parkash Singla; Naresh Kumar, FRCS (Ortho), DM

09:26 - 09:30 **Paper 73 Evaluating PROMIS in Spine Tumor Patients**
David N. Bernstein, MBA, MA; Owen Papuga; Emmanuel N. Menga, MD; Paul T. Rubery, MD; Addisu Mesfin, MD

09:30 - 09:40 **Discussion**

09:40 - 09:44 **Paper 74 Predictive Factors for Survival in Surgical Series of Symptomatic Metastatic Epidural Spinal Cord Compression: A Prospective North American Multicenter Study in 142 Patients**
Anick Nater, Resident; Lindsay Tetreault; Branko Kopjar, MD, PhD, MS; Paul Arnold, MD; Mark B. Dekutoski, MD; Charles Gregory Fisher, MD, MHSc, FRCSC; John C. France, MD; Ziya L. Gokaslan, MD; Laurence, D Rhines, MD; Arjun Sahgal, MD; James Schuster, MD; Alexander R. Vaccaro, MD, PhD; Michael G. Fehlings, MD, PhD, FRCSC FACS

09:44 - 09:48 **Paper 75 Intermediate Screw in Thoracolumbar Fracture fixation -Does it Maintain the Correction?**
Abduljabbar Alhammoud, MD; Osama Aldhamasheh; Mahmood Arbash; Ashik, M Parambathkandi; Abdul Moeen Baco

Paper 76 WITHDRAWN

09:48 - 10:00 **Discussion**

10:00 - 10:30 **Refreshment Break & Exhibit Viewing**

Case Presentations in Exhibit Hall
BALLROOM

10:30 - 12:00 **Concurrent Sessions 7A-C: Abstract Sessions**

10:30 - 12:00 **7A: Lumbar Degenerative/Spondylolisthesis Abstracts**
AUDITORIUM II
Moderators: Michael Fehlings, MD, PhD, FRCSC FACS & BangPing Qian, MD

10:30 - 10:34 **Paper 77 Multicenter Evaluation of the Incidence of Pre- and Postoperative Malalignment in Degenerative Spinal Fusions**
Arash Emami, MD; Jean-Christophe A. Leveque, MD; Samuel R. Schroerlucke, MD; Nitin Khanna, MD; P. Bradley Segebarth, MD; Jim A. Youssef, MD; John Pollina, Md, FACS; Isaac O. Karikari, MD; Nikhil Sahai; Ioannis D Siasios, MD; Juan S. Uribe, MD

10:34 - 10:38 **Paper 78 The Effect of Symptom Duration on Outcomes after Fusion for Spondylolisthesis**
John Fleming, MD; Steven D. Glassman, MD; Adam Miller, BS; John R. Dimar, MD; Mladen Djurasovic, MD; Leah Yacat Carreon, MD, MSc

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10:38 - 10:42 **Paper 79 The Effect of Tranexamic Acid on Operative Time, Bleeding and Complications in Lumbar Spine Surgery, a Double Blind RCT.**
Signe Elmose, BS; Mikkel Andersen, MD; Else Bay Andresen, MD; Leah Yacat Carreon, MD, MSc

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

10:50 - 10:54 **Paper 80 Prognostic Factors for Satisfaction after Decompression Surgery for Lumbar Spinal Stenosis**
Rune Tendal Paulsen, MD; Jamal Bech Bouknaitir; Sren Fruensgaard; Signe Elmose, BS; Leah Yacat Carreon, MD, MSc; Mikkel Østerheden Andersen, MD

10:54 - 10:58 **Paper 81 Back Pain Improves Significantly Following Discectomy for Treatment Of Lumbar Disc Herniation**
Kirk Owens, MD; Leah Yacat Carreon, MD, MSc; Erica Bisson, MD, MPH; Mohamad Bydon, MD; Eric Potts, MD; Steven D. Glassman, MD

10:58 - 11:02 **Paper 82 The Feasibility and Efficacy of Robotic Assisted Pedicle Screw Placement**
Joseph M. Lombardi, MD; Joseph Lawrence Laratta, MD; Melvin, C Makhni, MD, MBA; Jamal Shillingford, MD; Ronald A. Lehman, MD

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

11:10 - 11:14 **Paper 83 The Effect of 1- or 2-level Posterior Lumbar Interbody Fusion on Global Sagittal Balance**
Jaehwan Cho, MD; Chang Ju Hwang, MD, PhD; Dong-Ho Lee, MD PhD; Choon Sung Lee, MD, PhD

11:14 - 11:18 **Paper 84 Lumbar Fusion Surgery versus Laminectomy for Spondylolisthesis Readmission, Reoperation, and Patient Reported Outcomes for 491 Patients from the QOD Registry**
Erica Bisson, MD, MPH; Mohamad Bydon, MD; Steven D. Glassman, MD; Kevin Foley, MD; Silky Chotai, MD; Eric Potts, MD; Christopher I. Shaffrey, MD; Paul Park, MD; Kai-Ming Gregory Fu, MD, PhD; Anthony L. Asher, MD; Michael Virk, MD, PhD; Jonathan R. Slotkin MD; Panagiotis Kerezoudis, MD; Andrew K. Chan, MD; Anthony M DiGiorgio, DO; Praveen V. Mummaneni, MD

11:18 - 11:22 **Paper 85 Patient Profiling Can Identify Spondylolisthesis Patients at Risk for Conversion from Nonoperative to Surgical Treatment**
Peter G. Passias, MD; Gregory W Poorman, BA; Samantha R. Horn, BA; Thomas J. Errico, MD; Michael Gerling

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

11:30 - 11:34 **Paper 86 Dynamic Stabilization of the Lumbar Spine in Patients with Degenerative Spondylolisthesis and Lumbar Spine Instability. 5 Years Follow-Up.**
Sergey Kolesov, MD, PhD; Arkadii Kazmin, MD; Igor Basankin, PhD; Artem Krivoshein, MD, PhD; Dmitry Kolbovskiy; Andrey Panteleyev, MD

11:34 - 11:38 **Paper 87 Obesity Worsens Patient Reported Outcomes Following Surgery for Degenerative Lumbar Spondylolisthesis: An Analysis of the Quality Outcomes Database**
Andrew K. Chan, MD; Erica Bisson, MD, MPH; Mohamad Bydon, MD , Steven D. Glassman, MD; Kevin Foley, MD; Eric Potts, MD; Christopher I. Shaffrey, MD; Paul Park, MD; Kai-Ming Gregory Fu, MD, PhD; Anthony L. Asher, MD; Jonathan R. Slotkin, MD; Michael Virk, MD, PhD; Silky Chotai, MD; Panagiotis Kerezoudis, MD; Praveen V. Mummaneni, MD

11:38 - 11:48 **Discussion**

11:48 - 11:50 **Paper 88 Clinical Relevance of a New Classification System for Degenerative Spondylolisthesis of the Lumbar Spine**
Soufiane Ghailane, MD; Houssam Bouloussa, MD, MS; Claudio Vergari, PhD; Simon Mazas, MD; Vincent Challier, MD; Jean-Marc Vital, MD, PhD; Pierre Coudert, MD; Olivier Gille, MD, PhD

11:50 - 11:52 **Paper 89 Radiographic Evaluation of Intervertebral Cage Subsidence in Lateral Retroperitoneal Transpsoas Lumbar Interbody Fusion**
Ryohei Kagotani; Shunji Tsutsui, MD, PhD; Hiroshi Yamada, MD; Hiroshi Hashizume, MD; Yasutsugu Yukawa, MD; Akihito Minamide, MD; Yukihiro Nakagawa, MD; Hiroshi Iwasaki, MD; Masanari Takami, MD, PhD; Shinichi Nakao, MD; Munehito Yoshida

11:52 - 11:54 **Paper 90 Monosegmental Circumferential Reduction and Fusion for High Grade Spondylolisthesis in Adolescents.**
Andrew G. King, MB,ChB, FRACS,FACS. FAOA; Pouya Alijanipour, MD; Michael Heffernan, MD

11:54 - 12:00 **Discussion**

MEETING AGENDA

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10:30 - 12:00 **7B: Cervical Spine Abstracts**

MEETING ROOM 2.4

Moderators: John Dormans, MD & Juan S. Uribe, MD

10:30 - 10:34 **Paper 91 The Association of Frailty with Chin-Brow Vertebral Angle Compensatory Ability in 122 Cervical Deformity Patients and with Global Sagittal Vertebral Angle in 813 Global Deformity Patients**
Emily K. Miller, MD; Brian J. Neuman, MD; Daniel M. Sciubba, MD; Justin K. Scheer; Justin S. Smith, MD, PhD; Tamir T. Ailon, MD, MPH; Khaled Kebaish, MD; Shay Bess, MD; Virginie LaFage, PhD; Breton G. Line, BSME; Christopher I. Shaffrey, MD; Frank J. Schwab, MD; Eric O. Klineberg, MD; Christopher P. Ames, MD; International Spine Study Group, ISSG

10:34 - 10:38 **Paper 92 Comparative Analysis of Changes in Spinal Canal Dimension and Myelopathy Improvement Between Patients with and without Cervical Deformity**
Peter G. Passias, MD; Charles Wang, BS; Gregory W Poorman, BA; Shaleen Vira, MD; Cyrus Jalai, BA; Bassel G. Diebo, MD; Samantha R. Horn, BA; Renaud Lafage; Jared C Tishelman, BA; Virginie LaFage, PhD

10:38 - 10:42 **Paper 93 The Effect of Prolonged Pre-Operative Halo Gravity Traction for Severe Spinal Deformities on the Cervical Spine Radiographs**
Kwadwo Poku Yankey MD, MD; Henry Ofori Duah, RN; Cristina Sacramento Dominguez, MD, PhD; Henry Osei Tutu; Rufai Mahmud MD, MD; Irene Wulff, MD; Harry Akoto, MD; Oheneba Boachie-Adjei, MD; FOCOS Spine Research Group

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

10:50 - 10:54 **Paper 94 The Cervical Spine Realignment after Kyphosis Correction of the Old Atlantoaxial Anterior Dislocation**
Yiwei Chen, MD; Junlong Zhong, MD; Zhiyun Li, MD; Zhimin Pan, MD; Zhaoxun Zeng, MD; Kai Cao, MD, PhD

10:54 - 10:58 **Paper 95 Effect of Cervical Decompression Surgery on Gait in Adult Cervical Spondylotic Myelopathy Patients**
Ram Haddas, PhD; Kevin Ju, MD; Theodore A Belanger, MD: Isador H. Lieberman, MD, MBA, FRCSC

10:58 - 11:02 **Paper 96 Outcomes of Complex Craniovertebral Anomalies in Children after Preoperative Planning with Surgeon Directed Multiplanar Reconstruction CT**
Arjun Dhawale, MD; Kshitij Chaudhary, MD; Avi Shah, MS; Abhay Nene, MD

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

11:10 - 11:14 **Paper 97 En Bloc Cervical Laminoplasty Using Translaminar Screws (T-laminoplasty)**
Tae-Ahn Jahng, MD PhD; Soo-Eon Lee, Dr

11:14 - 11:18 **Paper 98 Neurological Complications Following Minimally Invasive Direct Lateral Approach for Lumbar Interbody Fusion Using a Novel Retractor System without a Posterior Blade**
Robert S. Lee, FRCS; Fady S. Sedra, FRCS; Lester F. Wilson, FRCS Eng

11:18 - 11:22 **Paper 99 Minimally Invasive Midline Posterior Interbody Fusion with Cortical Screws Decreases Blood Loss and Surgical Time Compared to Open Transforaminal Lumbar Interbody Fusion**
Charles H. Crawford, MD; Kirk Owens, MD; Mladen Djurasovic, MD; Jeffrey L. Gum, MD; John R. Dimar, MD; Leah Yacat Carreon, MD, MSc

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

11:30 - 11:34 **Paper 100 Human versus Robot A Propensity-Matched Analysis of the Accuracy of Free Hand versus Robotic Guidance for Placement of S2 Alar-Iliac (S2AI) Screws**
Jamal Shillingford, MD; Joseph Lawrence Laratta, MD; Joseph M. Lombardi, MD; Alexander Tuchman, MD; Paul, J Park, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

11:34 - 11:38 **Paper 101 Does The Plate Maintain a Sagittal Plane Correction after Anterior Cervical Discectomy and Fusion Compared to a Stand Alone Cage?**
Abduljabbar Alhammoud, MD; Mohanad Aboulebda,; Mohamed Fahd Faleh, MD; Ohmed Khilji, MD; Abdul Moeen Baco

11:38 - 11:48 **Discussion**

11:48 - 11:50 **Paper 102 In Vivo Analysis of Kambins Triangle and the Clinical and Radiographic Results Following the Use of 14mm Extra Wide 3D Porous Lamellar Titanium TLIF Cages**
Robert S. Lee, FRCS ;Lester F. Wilson, FRCS Eng

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11:50 - 11:52 **Paper 103 Is It Surgical Volume, Surgeons Experience, Or The Number of Surgeons That Determine Safety, Efficacy, and Efficiency?**
Vishal Sarwahi, MD; Jesse Galina, BS; Stephen F Wendolowski, BS; Jon-paul Dimauro, MD; Yungtai Lo, PhD; Terry D. Amaral, MD

11:52 - 11:54 **Paper 104 Minimally Invasive Surgery in Patients with Adolescent Idiopathic Scoliosis is Safer, Cost Efficient with Similar Curve Correction and SRS-30 Outcomes as Standard PSF**
Vishal Sarwahi, MD; Rachel Gecelter, MS1; Stephen F Wendolowski, BS; Chhavi Katyal, MD; Jesse Galina, BS; Terry D. Amaral, MD

11:54 - 12:00 **Discussion**

10:30 - 12:00 **7C: Complications/Infections Abstracts**
AUDITORIUM I
Moderators: Andre Luis Fernandes Andujar, MD & Jeffrey D. Coe, MD

10:30 - 10:34 **Paper 105 One-Stage Spine-Shortening by Using Posterior Vertebral Column Resection for Severe Spinal Deformity Associated with Symptomatic or Asymptomatic Spinal Cord Malformations: It May Be a Choice to Leave Cord Malformations Untreated**
Yang Junlin, PhD; Huang Zifang, MD PhD

Paper 106 WITHDRAWN

10:34 - 10:38 **Paper 107 Major Complications following Surgical Correction of Spine Deformity in 253 Patients with Cerebral Palsy**
Burt Yaszay, MD; Carrie E. Bartley, MA; Paul D. Sponseller, MD, MBA; Patrick J. Cahill, MD; Suken A. Shah, MD; Firoz Miyanji, MD, FRCSC; Amer F. Samdani, MD; Mark F. Abel, MD; Jahangir K. Asghar, MD; Peter O. Newton, MD

10:38 - 10:46 **Discussion**

10:46 - 10:50 **Paper 108 Artificial Intelligence (AI) Can Predict Complications Better Than Traditional Statistical Testing Following Posterior Cervical Fusion (PCF)**
Jun S Kim, MD; Varun Arvind; Deepak, A Kaji, MD; John M. Caridi, MD; Samuel K. Cho, MD

10:50 - 10:54 **Paper 109 Hip Flexion Weakness Following Lateral Transpsoas Interbody Fusion**
Joes Nogueira-Neto, Mr.; Luis Marchi; Rafael Aquaroli, Mr; Elder Camacho, Mr; Rodrigo A. Amaral, MD; Leonardo A. Oliveira, Mr; Etevaldo Coutinho, MD; Luiz Henrique Pimenta, MD, PhD

10:54 - 10:58 **Paper 110 The Relationship of Older Age on Perioperative Outcomes Following Thoracolumbar Three-Column Osteotomy for Adult Spinal Deformity an Analysis of 300 Consecutive Cases**
Darryl Lau; Vedat Deviren, MD; Christopher P. Ames, MD

10:58 - 11:08 **Discussion**

11:08 - 11:12 **Paper 111 MRSA Swab Results Did Not Change Treatment or Outcome in Spinal Fusion Patients**
Ena Nielsen, BA; Lindsay M. Andras, MD; Liam R. Harris, BS; David L. Skaggs, MD, MMM

11:12 - 11:16 **Paper 112 Meta-Analysis of Risk Factors Associated with Surgical Site Infection after Spinal Arthrodesis**
Sebastien Pesenti; Tejbir Pannu; Jessica Andres-Bergos; Justin S. Smith, MD, PhD; Steven D. Glassman, MD; Ferran Pellisé MD, PhD ;Marinus De Kleuver, MD, PhD; Daniel M. Sciubba, MD; Virginie LaFage, PhD; Frank J. Schwab, MD

11:16 - 11:20 **Paper 113 Deep Infections Differ Following Spinal Fusion for Idiopathic, Syndromic and Neuromuscular Deformity**
Brian T. Sullivan, BS; Oussama Abousamra, MD; Varun Puvanesarajah; Amit Jain, MD; Matthew J Hadad; Paul D. Sponseller, MD, MBA

11:20 - 11:30 **Discussion**

11:30 - 11:34 **Paper 114 Revision Spine Surgery in Patients without Clinical Signs of Infection: How Often are There Occult Infections in Removed Hardware?**
Isador H. Lieberman, MD, MBA, FRCSC; Xiaobang Hu, PhD, CCRP

11:34 - 11:38 **Paper 115 Does the Presence of an Intraspinal Anomaly Increase Neurologic Complications and Lessen the Correction Rate in Severe Pediatric Spinal Deformity?**
Amer F. Samdani, MD; Lawrence G. Lenke, MD; Paul D. Sponseller, MD, MBA; Baron Stuart Lonner, MD; Munish C. Gupta, MD; Sumeet Garg, MD; Jane Park; Oheneba Boachie-Adjei, MD; Joshua M. Pahys, MD; Steven W. Hwang, MD

MEETING AGENDA

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11:38 - 11:42 **Paper 116 Comorbid Psychiatric Diagnoses are Associated with Poor Outcomes of Adult Spinal Deformity Surgery at 2 Year Follow Up**
Bassel G. Diebo, MD; Joshua, D. Lavian; George, A Beyer; Frank A. Segreto, BS; Lee Bloom, MD; Dennis Vasquez-Montes, MS; Louis M. Day; Douglas A Hollern, MD; Samantha R. Horn, BA; Ashish Patel, MD; Daniel Cukor, Dr.; Peter G. Passias, MD; Qais Naziri, MD; William P. Urban, MD; Carl B. Paulino, MD

11:42 - 11:50 **Discussion**

11:50- 11:52 **Paper 117 Unplanned Immediate Return to Operating Room after Spine Surgery Significance of Immediate Postoperative Radiographs**
Dennis Chen, MD; Francis H. Shen, MD; Adam, L Shimer, MD; Brian Urbani, Researcher; Anuj Singla, MD; Keith Bachmann, MD

11:52 - 11:54 **Paper 118 End Vertebra vs Apical Vertebra Where Are We More Likely to Misplace?**
Vishal Sarwahi, MD; Stephen F Wendolowski, BS; Jesse Galina, BS; Beverly Thornhill, MD; Yungtai Lo, PhD; Terry D. Amaral, MD; Rachel Gecelter, MS1

11:54 - 12:00 **Discussion**

12:00 -13:00 **Hands-On Workshops with Lunch (Non-CME)**

MEETING ROOMS 1.41, 1.43, 1.61
(See the Exhibits and Hands-On Workshop (HOW) section on page 121 for more information)

12:00 - 13:10 **Exhibit Viewing & Lunch**

BALLROOM

13:10 - 14:10 **Concurrent Sessions 8A-C: Case Presentations**

13:10 - 14:10 **8A: Cervical Deformity: Which Approach, How, and Why**

MEETING ROOM 2.4
Moderators: Sigurd H. Berven, MD & Frank J. Schwab, MD

13:10 - 13:25 **Case Presenter #1**
Christopher P. Ames, MD

13:25 - 13:40 **Case Presenter #2**
Yong Qiu, MD

13:40 - 13:55 **Case Presenter #3**
John Dormans, MD

13:55 - 14:10 **Case Presenter #4**
Juan S. Uribe, MD

13:10 - 14:10 **8B: Spine Trauma: Diagnosis and Treatment**

AUDITORIUM II
Moderators: Todd J. Albert, MD & Robert S. Lee, BSc, MBBS, MRCS, FRCS

13:10 - 13:25 **Case Presenter #1**
Justin S. Smith, MD, PhD

13:25 - 13:40 **Case Presenter #2**
Ian J. Harding, BA, FRCS (Orth)

13:40 - 13:55 **Case Presenter #3**
Neel Anand, MD

13:55 - 14:10 **Case Presenter #4**
Jeffrey D. Coe, MD

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13:10 - 14:10 **8C: Adolescent Idiopathic Scoliosis: Surgical Treatment**
AUDITORIUM I
Moderators: Saumyajit Basu, MD & Stefan Parent, MD, PhD

13:10 - 13:25 **Case Presenter #1**
Daniel J. Sucato, MD, MS

13:25 - 13:40 **Case Presenter #2**
Kota Watanabe, MD, PhD

13:40 - 13:55 **Case Presenter #3**
Cristina Sacramento Dominguez, MD, PhD

13:55 - 14:10 **Case Presenter #4**
Muharrem Yazici, MD

14:10 - 14:30 **Walking Break & Exhibit Viewing**
BALLROOM

14:30 - 15:30 **Concurrent Sessions 9A-C: Abstract Session and Instructional Course Lectures**

14:30 - 15:30 **9A: Innovative and Diagnostic Methods**
AUDITORIUM I
Moderators: Saumyajit Basu, MD & Hani H. Mhadli, MD, PhD

14:30 - 14:34 **Paper 119 Natural History of Lumbar Degenerative Kyphosis with Conservative Treatment - Do Clinical Symptoms and Radiological Parameters Progress?**
Whoan Jeang Kim, MD; Kun Young Park, MD; Shann Haw Chang, MD; Jae Won Lee

14:34 - 14:38 **Paper 120 Adult Spinal Surgery in Patients with Previous THA Should We Do the Spine First?**
Bassel G. Diebo, MD; George, A Beyer; Qais Naziri, MD; Jonathan Charles Elysée BS; Frank A. Segreto, BS; Steven, A. Burekhovich; Roby Abraham, MD; Sarah, E Walker, MD; Westley Hayes, MS; Barrett Torre; Louis M. Day; Peter G. Passias, MD; William P. Urban, MD; Carl B. Paulino, MD

14:38 - 14:42 **Paper 121 Which Sagittal Modifiers Significantly Deteriorate Health Related Quality of Life Investigated in Elderly Volunteers Four Year Follow-up Study**
Daisuke Togawa; Shin Oe, MD; Tomohiko Hasegawa, MD PhD; Yu Yamato; Go Yoshida; Sho Kobayashi, MD, PhD; Tatsuya Yasuda; Tomohiro Banno; Yuki Mihara, MD; Yukihiro Matsuyama, MD, PhD

14:42 - 14:50 **Discussion**

14:50 - 14:54 **Paper 122 Global Alignment and Proportion (GAP) Score Better Correlates to HRQoL Scores and Better Predicts Mechanical Complications Compared to SRS-Schwab Sagittal Modifiers**
Caglar Yilgor, MD.; Nuray Sogunmez, MSc; Yasemin Yavuz, PhD; Berk Baris Ozmen; Ibrahim Obeid, MD; Frank S. Kleinstueck, MD; Emre R. Acaroglu, MD; Francisco Javier Sanchez Perez-Grueso, MD; Anne F. Mannion, PhD; Ferran Pellisé, MD, PhD; Ahmet Alanay, MD; European Spine Study Group

14:54 - 14:58 **Paper 123 Ligament Augmentation Reduces Proximal Junctional Kyphosis and Proximal Junctional Failure in Adult Spinal Deformity**
Michael Safaee, MD; Vedat Deviren, MD; Justin K. Scheer; Darryl Lau, MD; Joseph Osorio, MD; Fred H. Nicholls, MD, MA, FRCSC; Christopher P. Ames, MD

14:58 - 15:02 **Paper 124 Use of Prophylactic Techniques to Prevent Proximal Junctional Failure (PJF) Following Adult Spinal Deformity (ASD) Surgery Does Not Prevent PJF, However Prophylaxis Might Reduce Need for Revision Surgery**
Shay Bess, MD; Breton G. Line, BSME; Virginie LaFage, PhD; Renaud Lafage, MS; Christopher P. Ames, MD; Douglas C. Burton, MD; Robert A. Hart, MD; Richard Hostin, MD; Michael F. O'Brien, MD; Gregory M. Mundis, MD ;Munish C. Gupta, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; Khaled Kebaish, MD; Themistocles S. Protopsaltis, MD; Peter G. Passias, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; International Spine Study Group

15:02 - 15:10 **Discussion**

MEETING AGENDA

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15:10 - 15:12 **Paper 125 Lumbar Total Disc Replacement by the Lateral Approach up to 10-year Follow-Up**
Luiz Henrique Pimenta, MD, PhD; Luis Marchi; Joes Nogueira-Neto, Mr.; Leonardo A. Oliveira, Mr; Etevaldo Coutinho, MD; Rodrigo A. Amaral, MD

15:12 - 15:14 **Paper 126 Pedicle Screw Impinging the Aorta A Diagnostic Dilemma Resolved on Prone CT Scan**
Vishal Sarwahi, MD; Beverly Thornhill, MD; Adam L. Wollowick, MD; Stephen F Wendolowski, BS; Rachel Gecelter, MS1; Jesse Galina, BS; Terry D. Amaral, MD

15:14 - 15:16 **Paper 127 Mechanical Loading of the Upper-most Instrumented Vertebra Normative Values and Impact on Proximal Junctional Kyphosis in Adult Spinal Deformity Surgery**
Tejbir Pannu; Renaud Lafage, MS; Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Gregory M. Mundis, MD; Richard Hostin, MD; Christopher P. Ames, MD; Lawrence G. Lenke, MD; Munish C. Gupta, MD; Han Jo Kim, MD; Shay Bess, MD; Jeffrey L. Gum, MD; Frank J. Schwab, MD; Virginie LaFage, PhD; International Spine Study Group

15:16 - 15:18 **Paper 128 Long-Term Clinical and Radiologic Outcomes of Lumbar Total Disc Replacements (More Than 10 Years Follow-up)**
Onur Levent Ulusoy, MD; Sezgi Burcin Barlas, MD: Gokce Feride Inan, MD; Ayhan Mutlu, MD; Alim Can Baymurat, MD; Cem Sever, MD; Sinan Kahraman, MD; Tunay Sanli, MA; Meric Enercan, MD; Azmi Hamzaoglu, MD

15:18 - 15:20 **Paper 129 Return of Shoulder Function Following Posterior Spinal Fusion**
Gabriela A. Villamor, BA; David L. Skaggs, MD, MMM; Paul D. Choi, MD; Vernon Tolo,MD; Priscella S. Chan, MS; Joshua Yang, BA; Lindsay M. Andras, MD

15:20 - 15:30 **Discussion**

14:30 - 15:30 **9B: Neuromuscular Scoliosis: What the Current Thought Leaders are Doing**
AUDITORIUM II
Moderators: Ulf R. Liljenqvist, MD & Luis Munhoz Da Rocha, MD

14:30 - 14:40 **Indication for Long Fusion to S1 and Tips for Sacral Fixation**
Luis Munhoz Da Rocha, MD

14:40 - 14:50 **In Which Cases Can We Stop Short of the Sacrum?**
Peter O. Newton, MD

14:50 - 15:00 **Indications for Combined Anterior and Posterior Correction and Fusion with Special Regard to Pelvic Obliquity**
Ulf R. Liljenqvist, MD

15:00 - 15:10 **Tips and Tricks to Correct Pelvic Obliquity from Posterior Only**
Andre Luis Fernandes Andujar, MD

15:10 - 15:30 **Discussion**

14:30 - 15:30 **9C: Anterior Surgery: Is it Making a Comeback?**
MEETING ROOM 2.4
Moderators: David W. Polly, Jr., MD & Kota Watanabe, MD, PhD

14:30 - 14:40 **Open Anterior Approaches to Lenke 1 and 5 Curve - with Surgical Video**
Henry F.H. Halm, MD

14:40 - 14:50 **Open Posterior Approaches to Lenke 1 and 5 Curve - with Surgical Video**
Ferran Pellisé, MD, PhD

14:50 - 15:00 **ALIF for Degenerative Lumbar Disease**
Christopher I. Shaffrey, MD

15:00 - 15:10 **Anterior Appoaches for Tumor/Trauma/Infection: Better Access and Better Resection**
Peter S. Rose, MD

15:10 - 15:30 **Discussion**

15:30 - 15:45 **Walking Break**

MEETING AGENDA

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

Friday, July 14, 2017

15:45 - 16:45 Concurrent 10A-C: Instructional Course Lectures

15:45 - 16:45 10A. Degenerative Conditions of the Spine: Tips and Pearls for Treatment
AUDITORIUM II
Moderators: Dean Chou, MD & Khaled M. Kebaish, MD

- 15:45 - 15:55 **Spondylolisthesis: When to Operate and How Best to Treat**
  Shane Burch, MD, FRCS(C)
- 15:55 - 16:05 **Spinal Stenosis: Decompression or Decompression and Fusion**
  Ian J. Harding, BA, FRCS (Orth)
- 16:05 - 16:15 **De Novo Scoliosis: Decompress, Decompress and Fuse or Deformity Correction**
  Justin S. Smith, MD, PhD
- 16:15 - 16:25 **Degenerative Disc Disease: Should We Treat, When to Treat, How to Treat**
  Vincent C. Traynelis, MD
- 16:25 - 16:45 **Discussion**

15:45 - 16:45 10B. Special Considerations When Resources are Limited
MEETING ROOM 2.4
Moderators: Saumyajit Basu & Robert N. Dunn, FCS (SA) Orth

- 15:45 - 15:55 **Severe Spinal Deformity**
  Amer F. Samdani, MD
- 15:55 - 16:05 **Spine Trauma: Spinal Cord Injury and Neglected Trauma**
  Michael G. Fehlings, MD, PhD, FRCSC, FACS
- 16:05 - 16:15 **Infections and Tumors**
  Peter S. Rose, MD
- 16:15 - 16:25 **Strategies to be Effective and Safe**
  Ferran Pellisé, MD, PhD
- 16:25 - 16:45 **Discussion**

15:45 - 16:45 10C. Surgical Techniques: A Step by Step Guidebook - Video Supplement
AUDITORIUM I
Moderators: Sigurd H. Berven, MD & Mario Di Silvestre, MD

- 15:45 - 15:55 **Three Column Osteotomy for Sagittal Correction**
  Christopher I. Shaffrey, MD
- 15:55 - 16:05 **Step by Step TLIF for Achieving Lordosis**
  Henry F.H. Halm, MD
- 16:05 - 16:15 **Coronal Plane Correction from a Posterior Approach: Recipe for Success**
  Ronald A. Lehman, Jr., MD
- 16:15 - 16:25 **Cervical Osteotomy for Correction of Cervical Deformity**
  Christopher P. Ames, MD
- 16:25 - 16:45 **Discussion**

19:00 - 22:30 Course Reception
CLIVIA & JASMINUM CONSERVATORY – CTICC LEVEL 0

MEETING AGENDA

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Saturday, July 15, 2017

08:30 - 12:00 Registration Open

BALLROOM GALLERY – CTICC LEVEL 1

08:30 - 09:00 Breakfast/ Exhibits Closed

09:00 - 10:00 Concurrent Sessions 11A-C: Instructional Course Lectures

09:00 - 10:00 11A: Topic Surgical and Perioperative Planning for Adult Deformity

AUDITORIUM I

Moderators: David W. Polly, Jr., MD & Yong Qiu, MD

09:00 - 09:10 **Preoperative Assessments to Ensure Success**
Daniel M. Sciubba, MD

09:10 - 09:20 **Radiographic and Templating to Determine Correction: How Much is Really Needed?**
Shane Burch, MD, FRCS(C)

09:20 - 09:30 **Surgical Execution for Coronal Plan Deformity: Step by Step**
BangPing Qian, MD

09:30 - 09:40 **Surgical Correction for Sagittal Plane Deformity: Step by Step**
Sébastien Charosky, MD

09:40 - 10:00 **Discussion**

09:00 - 10:00 11B: Value and Safety in Spine Care: How are we doing?

MEETING ROOM 2.4

Moderators: Todd J. Albert, MD & Luis Munhoz Da Rocha, MD

09:00 - 09:10 **How to Risk Stratify the Deformity Patient**
Sigurd H. Berven, MD

09:10 - 09:20 **Perioperative Complications and the Scoli-Risk Data**
Kenneth MC Cheung, MD

09:20 - 09:30 **QALYs and PROs - Do We Fully Understand What We are Reporting?**
Praveen V. Mummaneni, MD

09:30 - 09:40 **How to Make MISS Safe and Effective**
Juan S. Uribe, MD

09:40 - 10:00 **Discussion**

09:00 - 10:00 11C: What's New in Degenerative Spine Surgery

AUDITORIUM II

Moderators: Saumyajit Basu, MD & Robert N. Dunn, FCS (SA) Orth

09:00 - 09:10 **Every Lumbar Fusion Should be Treated like a Deformity Operation**
Martin Gehrchen, MD, PhD

09:10 - 09:20 **Cervical Fusion vs Cervical Arthroplasty: What Should I Do?**
Vincent C. Traynelis, MD

09:20 - 09:30 **How to Determine when a Decompression will Suffice vs a Decompression and Fusion for the Lumbar Spine**
Neel Anand, MD

09:30 - 09:40 **Hyperlordotic or Expandable Cages: Which Should I Use?**
Jeffrey Coe, MD

09:40 - 10:00 **Discussion**

10:00 - 10:15 Walking Break

MEETING AGENDA

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Saturday, July 15, 2017

10:15 - 11:15 — Session 12: What's New in Spine Trauma

AUDITORIUM I
Moderators: Ulf R. Liljenqvist, MD & Daniel M. Sciubba, MD

10:15 - 10:22	What to Do when a Patient with a Spinal Cord Injury Presents Acutely to Your Hospital: Principles and Timing of Treatment *Michael G. Fehlings, MD, PhD, FRCSC, FACS*
10:22 - 10:30	Discussion
10:30 - 10:37	What's New in Thoracolumbar Trauma *Justin S. Smith, MD, PhD*
10:37 - 10:45	Discussion
10:45 - 10:52	How to Use MISS to Treat Thoracolumbar Trauma: Steps to Decrease the Learning Curve *Robert Lee, BSc, MBBS, MRCS,FRCS*
10:52 - 11:00	Discussion
11:00 - 11:07	What's New in Pediatric Spine Trauma *Suken A. Shah, MD*
11:07-11:15	Discussion

11:15 - 11:45 — Walking Break & Lunch Buffet

11:45 - 13:00 — Session 13: Lunch with the Experts

AUDITORIUM I
Moderators: Ronald A. Lehman, MD & Kenneth MC Cheung, MD

11:45 - 11:52	State of the Art: How to Correct AIS in the Sagittal and Axial Plane: How to Derotate and Kyphose the Thoracic Spine *Peter O. Newton, MD*
11:52 - 12:00	Discussion
12:00 - 12:07	Alternatives to VCR in Severe Spinal Deformities *Kenneth MC Cheung, MD*
12:07 - 12:15	Discussion
12:15 - 12:22	What to Do when Things Start to Go Badly in the Operating Room *Christopher I. Shaffrey, MD*
12:22 - 12:30	Discussion
12:30 - 12:37	How Spinal Navigation Has Changed My Practice *David W. Polly, Jr., MD*
12:37 - 12:45	Discussion
12:45 - 12:52	My Learning Curve for 3 Column Osteotomies (3CO): What I Learned to Make is Safe and Efficient *Lawrence G. Lenke, MD*
12:52 - 13:00	Discussion

13:00 **Adjourn**

NOTES

PAPER ABSTRACTS

The Scoliosis Research Society
gratefully acknowledges

MEDTRONIC

for their support of the IMAST Welcome
Reception, Breakfasts, Beverage Breaks,
and Newsletter.

PAPER ABSTRACTS

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1. Patient Reported SRS-24 Outcomes Scores after Surgery for Adolescent Idiopathic Scoliosis Have Improved Since the New Millennium†

Tracey P. Bastrom; *Peter O. Newton, MD;* Harms Study Group

Summary
Techniques for surgical correction of scoliosis have evolved. This study of a 13 year period found that the percentage of patients with positive post-operative Scoliosis Research Society outcome instrument (SRS-24) scores in 3 domains has increased in the modern era, providing some suggestion that newer surgical techniques are enhancing patient outcomes. However, recent patients were more afflicted with negative self-image scores prior to surgery.

Hypothesis
Evolving surgical techniques will result in improved patient reported outcomes following correction of adolescent idiopathic scoliosis (AIS).

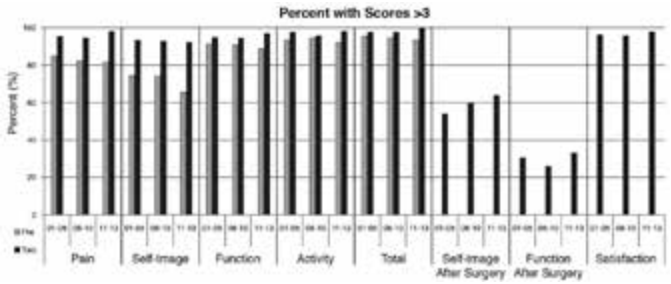
Design
Longitudinal prospective study

Introduction
Techniques for correction of scoliosis have evolved, in theory for the better. The goal of this study was to examine changes in patient reported 2 year post-op outcomes via the SRS-24 Outcomes Instrument from 2001 to 2013.

Methods
AIS patients with pre and 2 year post-op SRS scores from a prospective multicenter registry were divided into 3 groups based on year of surgery ('01-'05, '06-'10, and '11-'13). Due to the ordinal scale (1-5) and bipolar nature of the response sets (positive/negative responses to statements) for the SRS-24, domain/ total scores were categorized as ≤3 (predominantly negative) or >3 (predominantly positive). The distribution of scores for each year group were compared with chi-square test (alpha $p<0.05$).

Results
1284 patients were analyzed; 260 ('01-'05), 645 ('06-'10), and 379 ('11-'13). Average age was 14.7±2yrs, average primary Cobb was 54±12° and the group was primarily female (81%). The percentage of predominantly positive responses (>3) can be seen in the figure. There was no significant difference in pain pre-op, however at 2 years the '11-'13 group showed the highest rate of positive (pain free) scores, (98%, p=0.03). Pre-op self-image showed significant differences with the '11-'13 group having the lowest rate of positive scores (66%, p=0.007) yet no differences post-op (p>0.05). However, "self-image after surgery" was significantly improved (p=0.04). At 2 years, there was a significant difference for the 3 time periods for SRS-24 total score (p=0.02). There was no difference in function, activity, or satisfaction.

Conclusion
The percentage of patients with positive post-op SRS scores in 3 domains has increased in the modern era, providing some suggestion that newer surgical techniques could be resulting in improved patient outcomes. Interestingly, recent patients were more afflicted with negative self-image (lower scores) prior to surgery. Understanding if that is an effect of societal change or worsening scoliosis severity is yet to be determined.



2. Using the Lower Lumbar Touched Vertebra To Select the Lowest Instrumented Vertebra in Lenke Type 3 & 4 Curves At A Minimum 5 Yr Follow-Up†

Lawrence G. Lenke, MD; Michael P. Kelly, MD; Ronald A. Lehman, MD; Michael Vitale, MD, MPH; Baron S. Lonner, MD; Thomas J. Errico, MD; Randal R. Betz, MD; Suken A. Shah, MD; Harry L. Shufflebarger, MD; Peter O. Newton, MD; Kathleen M. Blanke, RN; Harms Study Group

Summary
Using the TV to select the LIV for Type 3 & Type 4 AIS curves when the lumbar curve is included in the fusion produces excellent LIV centering on the CSVL with minimal disc angulation. Fusing 1 level above the TV produces slightly inferior LIV alignment but still overall good coronal balance at ≥5 yr FU.

Hypothesis
Selecting the Touched Vertebra (TV) in the lower lumbar spine for the lowest instrumented vertebra (LIV) in double (type 3) & triple (type 4) major AIS curves will produce optimal long term radiographic outcomes at ≥5 yr FU.

Design
Observational Cohort

Introduction
LIV selection for Lenke 3 & 4 curves with structural lumbar curves is controversial. We utilized the Touched Vertebra rule to assess radiographic results of LIV selection in these curves at ≥5 yr FU.

Methods
A multi-center prospective AIS database was queried for pts. with Lenke Type 3 & 4 curves who had a posterior-only fusion including the lumbar spine that were ≥5 yrs postop. Two examiners drew the center sacral vertical line (CSVL) & the TV was selected as the most cephalad vertebra below the lumbar apex "touched" by the CSVL. The TV was compared to the actual LIV as either TV 0 (TV=LIV) or TV-1 (LIV 1 level above the TV) with respect to LIV translation (LIV-CSVL distance), LIV disc angle, coronal balance (C7-CSVL distance) & LIV position on the CSVL at ≥5 yr FU.

Results
There were 42 pts identified with Lenke type 3 or 4 curves (Lumbar modifiers: A: 7, B: 3, C: 32.) Twenty pts. were in the TV 0 group (LIV=TV) & 22 were in the TV-1 group (LIV 1 level above the TV.) When comparing LIV radiographic parameters, the TV 0 vs the TV-1 group had a statistically improved LIV-CSVL translation (1.04 vs 1.78 cm; p=.002) & LIV disc angle (1.7° vs 2.7°; p=.019), but no difference in overall coronal balance (1.2 vs 1.1 cm; p=.72). Regarding LIV centering on the CSVL, all 20 TV 0 pts had the CSVL between the LIV pedicles at ≥5 yr FU. In the TV-1 pts, 16/22 had the CSVL centered between the pedicles, 5/22 had the CSVL touching the LIV pedicle & 1/22

had the CSVL lateral to the LIV body. The preop position of the CSVL on the TV (substantially touched or just touching the corner of the vertebra outside the pedicle) had no effect on the results. None of the pts. in this series had revision surgery at ≥5 yr FU.

Conclusion
Using the TV to select the LIV in Lenke Type 3 & 4 AIS curves when the lumbar curve is included in the fusion produces optimal results for LIV translation & disc angle. Fusing to TV-1 saves 1 lumbar level but LIV translation & disc angle will be slightly worse. Both groups had overall good balance & no pt. required revision surgery at ≥5 yr FU.

3. Disc Degeneration in Unfused Caudal Motion Segments Ten Years Following Surgery for Adolescent Idiopathic Scoliosis†

Baron S. Lonner, MD; Yuan Ren, PhD; Michelle Claire Marks, PT, MA; Peter O. Newton, MD; Randal R. Betz, MD; Amer F. Samdani, MD; Harry L. Shufflebarger, MD; Suken A. Shah, MD; Daniel Lefton, MD; Hussein Nasser, MD; Colin Dabrowski; Karen S. Chen, MD

Summary
Disc degeneration (DD) was assessed at 10 years following surgery for adolescent idiopathic scoliosis. We found that 7.3% of patients had radiographic markers of significant DD. >50% DD occurred at the 2nd and 3rd disc caudal to the LIV. LIV at L4 had the highest risk of developing significant DD. The rates of DD increased over time. Development of DD was not associated with # levels fused, surgical approach, or construct type and had no effect on SRS-22 outcomes.

Hypothesis
The frequency of disc degeneration (DD) in the distal mobile segments will increase over time following surgery for adolescent idiopathic scoliosis (AIS).

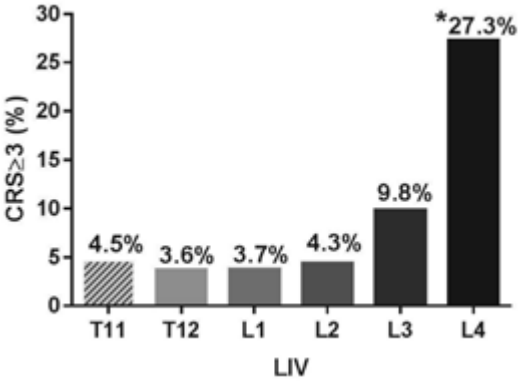
Design
Observational cohort study

Introduction
Durability of surgical outcomes is essential for maintenance of quality of life as well as for family decision-making and for assessment of the value of a healthcare intervention. We assessed disc degeneration (DD), its risk factors and association with HRQOL 10 years following AIS surgery.

Methods
Five radiographic indicators of disc degeneration, previously validated were evaluated at pre-operatively, 1 month, 2, 5 and 10 years postoperatively by a radiologist in operative AIS patients. A composite radiographic score (CRS) [0-10] was calculated using the sum of each of the DD indicators. The severity of CRS in relation to time point after surgery and various risk factors were assessed using linear regression or Pearson's Chi-2 test. CRS≥ 3 was chosen to indicate significant DD. Association of CRS with SRS-22 outcome was evaluated by linear regression.

Results
193 consecutive patients (mean age 14.4 years; 86% female) were assessed. Surgical approach included 102 posterior and 91 anterior fusions. Contributors to maximum CRS at 10 years were Schmorl's nodes (7.3% of patients), osteophytes (40.4%), sclerosis (29%), intradiscal calcification (1.6%) and irregular endplate (8.3%). CRS≥3 occurred in 1.6%, 0.54%, 3.7%, 6.8% and 7.3% of patients at the various time points, (r2=0.83, p=0.0313), respectively. More than 50% of DD occurred at the 2nd (35.5%) and 3rd (20%) disc caudal to the LIV. LIV of L4 compared to more cephalad LIV had the highest risk of developing significant DD (27.3%; p=0.0267) (Figure). Severity of DD was not associated with # levels fused (p=0.2131), surgical approach (p=0.8245), or construct type (p=0.2922). No significant association between 10-year CRS and SRS-22 scores was established.

Conclusion
In the first study of its kind, we found that 7.3% of patients had significant DD 10 years following surgical correction of AIS. Rates of DD increased over time. LIV at L4 had the highest risk of significant DD.



4. Touched Vertebra (TV) on Standing Xray is a Good Predictor for LIV. TV on Prone Xray is Better†

Vishal Sarwahi, MD; Stephen F. Wendolowski, BS; Jesse Galina, BS; Beverly Thornhill, MD; Yungtai Lo, PhD; Kathleen Maguire, MD; Terry D. Amaral, MD

Summary
Touched vertebra on prone xray is an effective and better way to determine the lowest instrumented vertebra. At 2-year follow up, this study did not find coronal decompensation.

Hypothesis
Using TVP to determine LIV saves fusion levels with good correction and coronal balance.

Design
Ambispective cohort study

Introduction
Minimizing the fusion levels in PSF for AIS is important. Previous studies have shown good results utilizing TV as the lowest instrumented vertebra (LIV). TV is the vertebra 'touched' by the central sacral vertical line on standing AP XRs (TVS). In our experience, we find that TV moves proximally on supine/ prone XRs. Thus utilizing TV on prone XRs (TVP) in LIV decision making may allow even shorter fusion.

Methods
There were three groups. Group I: patients where TVP was used to determine LIV. Group II: patients where TVS was used to determine LIV. Group III: non-operative AIS (Risser 4/5, Cobb <30) to determine 'acceptable' end vertebra tilt and disc wedging. Patients with only thoracic fusion were excluded. Chart and XR were reviewed. Radiographic parameters such as Cobb angle, coronal balance (cm), LIV tilt angle and translation (cm), and disc wedging were collected at preop and postop. Median values and interquartile were collected for the subsets. Wilcoxon and Kruskal-Wallis test were used.

Results
The control group had 100 patients with a median Cobb angle of 20°, age of 15.3 yrs, coronal balance 1.2 cm (0.5-1.8), disc wedging of 4° (3-6), and LIV tilt of 9° (6-11.5). In group I (n=83), median pre-op Cobb was 53.75° (47.55-61.9°), kyphosis was 32.2° (25.3-38.9°), and coronal balance was 1.6cm (1.0-3.0 cm). Post op median Cobb was 12.9° (7.0-19.7°), kyphosis was 37° (24.6-39.7°) and coronal balance was 1.4cm (0.3-2.45 cm). Compared to controls, group I patients had similar coronal balance (0.9 vs 1.2, p =0.18), but significantly lower disc wedging (1.2° vs 4, p>0.001), and LIV tilt (4.3° vs 9 p<0.001). Group I saved an average 1.05 (0-3) levels compared to TVS. In group II (n=27), median preop Cobb was 54.4° (50-66.6°, kyphosis was 26.8 (17-43.6) and coronal balance was 2.3cm (0.8-2.9 cm). Post op median cobb was 19.2° (12.5-27.3°), kyphosis was 24.6 (21.1-30.5) and coronal balance was 1.8 cm (1.2-2.9 cm). Group II patients could have saved an average 2.24 (1-4) levels, if fused to TVP.

Conclusion
In AIS, using TVP to determine LIV allows shorter fusion saving than TVS. Despite shorter fusion, coronal balance and correction is maintained, at final follow up with no adding on. LIV tilt and disc wedging is also within 'acceptable' levels determined on controls.

5. Rod Fracture in Adult Spinal Deformity Surgery: Incidence, Risk Factors and Impact on Health Related Quality of Life in 526 Patients†

Thamrong Lertudomphonwanit, MD; Munish C. Gupta, MD; Keith H. Bridwell, MD; Lawrence G. Lenke, MD; Prachya Punyarat, MD; Timothy Bryan, MD; Brenda Sides, MA; Jacob M. Buchowski, MD, MS; Michael P. Kelly, MD; Lukas P. Zebala, MD

Summary
The incidence of rod fracture (RF) from the largest single center study in adult spinal deformity (ASD) surgery was 18.4%. Risk factors included baseline demographics, pre-op radiographic parameters and surgical factors. RF still occurred up to 10 yrs after ASD surgery. RF had a negative impact on patient satisfaction and self-image improvement at latest F/U.

Hypothesis
The incidence of RF after ASD surgery is high.

Design
Retrospective cohort.

Introduction
Posterior long construct spinal fusion for ASD has high rates of implant failure. There is little detailed analysis of RF in a large population from one center. This study reports the incidence, risk factors and determines HRQOL changes associated with RF in ASD pts undergoing surgical treatment from one center with only 2 surgeons.

Methods
A database of consecutive ASD pts (age > 18 yo) undergoing ≥ 5 levels posterior fusion to sacrum by 2 senior surgeons from 2004-2014 were assessed. We reviewed demographics, radiographic, operative data, complications, outcomes and revision rates. A minimum 2-yr F/U was required for pts with no RF (NRF). Preop, 2-month postop and latest F/U radiographs were measured. RF events were based on review of each F/U radiograph and outpatient record. HRQOL outcomes were assessed at baseline, 1-yr and latest F/U. Statistical analysis included Cox proportional hazards regression and mixed model analytic approach.

Results
526 pts out of 657 pts (Avg.56.8 yo, 87% F) were included with mean F/U at 4.6 yrs. RF occurred in 97 (18.4%) pts at a mean of 39.6 months postop (range 5.6-121mo). Factors associated with higher risk of RF included age, weight, BMI, ASA scores, preop PT/TK/TL kyphosis/max coronal Cobb angle, rod material, rod diameter, # of instrumented levels, # of fused levels, interbody fusion approach, dose of BMP-2/level fused and use of allograft (all p<0.05, Table 1). RF postoperatively occurred in 51 (53%) pts in 3 yrs, 23 (24%) pts at 3-5 yrs and 22 (23%) pts at 5-10 yrs. Only 40 (7.6%) pts with RF had revision. RF and NRF pts had improvements in HRQOL as measured by ODI and SRS-30 (all p<0.0001). The overall improvement of ODI and SRS-30 compared to baseline was similar in both groups except SRS satisfaction (p=0.007) and self-image domain (p=0.01). From preop to latest F/U, RF pts had less improvement in SRS satisfaction and SRS self-image domain (all p<0.05, Table 1).

Conclusion
The incidence of RF after ASD surgery is 18.4%. Risk factors may be useful for pre-op counseling and surgical planning. RF impacts patient satisfaction and self-image improvement at latest F/U. Pts need F/U of at least 5-10 yrs to detect RF after ASD surgery.

Table 1: Risk Factors for Rod Fracture and HRQOL Change in ASD Pts With and Without Rod Fracture

Parameter	Non Rod Fracture (n=429)	Rod Fracture (n=97)	P Value*	HR (95% CI for HR)
Baseline Demographic				
Age (yrs)	56.3 ±10.7	59.0 ±9.2	0.003	1.37 (1.11-1.70)
Weight (kg)	69.7 ±14.5	75.2 ±16.5	0.003	1.10 (1.03-1.17)
BMI (kg/m²)	26.8 ±4.9	28.5 ±5.0	0.004	1.32 (1.09-1.59)
ASA			0.01	1.67 (1.12-2.50)
ASA 1	27 (6.3%)	0 (0%)		
ASA 2	328 (76.5%)	77 (79.4%)		
ASA 3	74 (17.2%)	20 (20.6%)		
Radiographic (degree)				
Pre-Op PT			0.005	>30 vs≤ 21: 1.64 (1.03-2.61)
≤ 21	145 (33.8%)	29 (29.9%)		>30 vs> 21-30: 2.24 (1.35-3.73)
> 21 - 30	149 (34.7%)	22 (22.7%)		
> 30	135 (31.5%)	46 (47.4%)		
Pre-Op TK (T5-T12)	29.1 ± 18.6	35.9 ± 20.5	0.001	1.02 (1.01-1.03)
Pre-Op TL Kyphosis (T10-L2)	13.1 ± 18.4	24.1 ± 23.3	<0.0001	1.02 (1.02-1.04)
Pre-Op Max coronal Cobb angle	47.6 ± 23.8	53.6 ± 27.1	0.02	1.01 (1.001-1.02)
Surgical Factor				
Rod Material			<0.0001	4.07 (2.59-6.40)
Cobalt Chromium	149 (35.1%)	47 (49.0%)		
Stainless Steel	276 (64.9%)	49 (51.0%)		
Rod Diameter (mm)			0.01	5.5 vs 6.35: 1.71 (1.04-2.79), 6 vs 6.35 : 7.74 (1.77-33.9)
5.5	277 (64.6%)	71 (74.7%)		
6.0	5 (1.2%)	2 (2.1%)		
6.35	128 (29.8%)	21 (22.1%)		
# of Instrumented Levels			0.002	2.21 (1.34-3.65)
≤ 10	160 (37.3%)	19 (19.6%)		
> 10	269 (62.7%)	78 (80.4%)		
# of Fused Levels			<0.0001	2.58 (1.70-3.91)
≤ 10	263 (61.3%)	36 (37.1%)		
> 10	166 (38.7%)	61 (62.9%)		
Interbody Fusion Approach			0.01	2.41 (1.23-4.72)
ALIF	60 (14.6%)	14 (22.2%)		
TLIF	184 (75.4%)	49 (77.8%)		
Dose of BMP-2/levels Fused (mg/level)	15 ± 10	11 ± 8	<0.0001	0.57 (0.43-0.75)
Use of Allograft	257 (59.9%)	66 (68.0%)	0.03	1.61 (1.05-2.48)
HRQOL Change				
SRS Satisfaction at 1 year	1.47	1.36	0.42	
SRS Satisfaction at latest F/U	1.31	0.86	0.002	
SRS Self Image at 1 year	1.14	1.08	0.33	
SRS Self Image at latest F/U	1.02	0.73	0.004	

*P values were tested by Cox proportional hazards regression for non HRQOL data and RM-ANOVA for HRQOL data. P < 0.05 was considered to be statistical significance. HR = Hazard ratio

PAPER ABSTRACTS

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

6. 2-Year Outcomes of Spinal Growth Tethering vs. Posterior Spinal Fusion for Scoliosis – Flexibility vs. Reliability†

Peter O. Newton, MD; Dylan G Kluck, MD; Wataru Saito, MD, PhD; Burt Yaszay, MD; Carrie E. Bartley, MA; Tracey P. Bastrom

Summary
17 patients who underwent anterior spinal growth tethering (ASGT) were compared to 14 patients of similar age and comparable curve type/magnitude and skeletal maturity who underwent posterior spinal fusion (PSF). PSF had a greater operative time and estimated blood loss (EBL). At 2-year follow-up, ASGT resulted in larger residual curves, but avoided PSF in the majority of patients. The tether cohort had a higher reoperation rate. SRS-22 scores were similar pre-op and at 2 years post-op.

Hypothesis
ASGT will lead to similar scoliosis correction with comparable revision rates vs PSF at 2yrs.

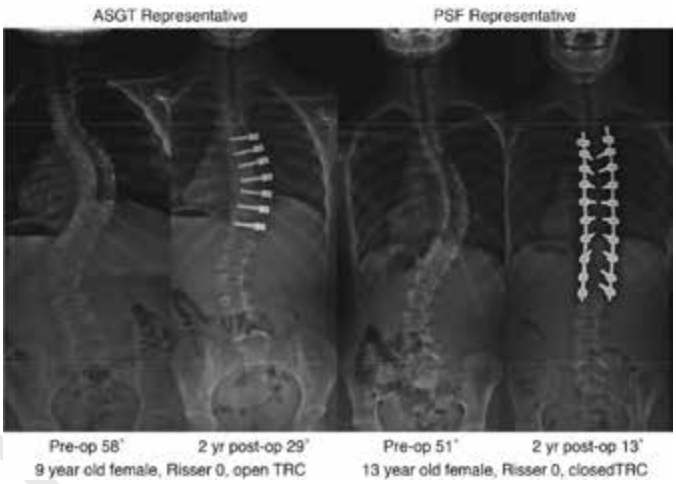
Design
Retrospective cohort study

Introduction
ASGT has been shown to alter spinal growth with the potential to correct scoliosis while maintaining spine flexibility. Clinical experience with ASGT is limited, and there are no studies comparing 2yr outcomes between ASGT and PSF.

Methods
From 2011-2013, 17 patients with thoracic major scoliosis underwent thoracoscopic ASGT. 14 patients with PSF during a similar time period with comparable age, curve type/magnitude and skeletal maturity were retrospectively identified. Pre-op and 2-year post-op parameters and SRS-22 scores were analyzed.

Results
All patients had Lenke 1 or 2 curve types and most were idiopathic. Age at tether was 11y (range 9-14y) vs 12y (range 11-14y) for PSF (p=0.04). Tether patients were Risser 0 and PSF patients were Risser ≤1. Pre-op Cobb was 52±10° in tether vs 54±7° in PSF (p=0.6). Operative time in ASGT was 194±35min, EBL 84ml (range 30-100ml) vs 278±68min, EBL 939ml (range 300-2000ml) in PSF (p=0.001, p<0.001). ASGT had 5.8±0.5 vertebrae tethered with a 5.5±1.4 day hospital stay vs 10±1 levels fused and a 5.5±1d stay in PSF (p<0.001, p=0.9). 2-year post-op Cobb after ASGT was 27±18° with 61% correction (range 5-173%) vs 14±8° with 73% correction (range 38-90%) in PSF (p=0.02, p=0.3). Revision surgery was performed in 7 tethers (4 removals due to complete/over correction, 1 lumbar added, 1 replaced, 1 PSF). PSF was indicated in 3 additional patients due to progression. There were no revisions after PSF. SRS-22 total score at 2 years post-op was 4.7±0.2 in tether (n=5) vs 4.6±0.3 in PSF (n=12) (p=0.3).

Conclusion
Although most patients still had some remaining skeletal growth, ASGT resulted in a large range of percent curve correction compared to PSF at 2 years post-op. Operative time and EBL were greater with PSF, but reoperation rates were higher with ASGT. SRS-22 scores were similar. It is clear that the tether affects spinal growth and, importantly, avoided fusion for most patients at 2 year follow-up.



7. Does Local Intraoperative Corticosteroids Delivered in a Gel-Matrix Minimize Dysphagia following Anterior Discectomy and Fusion (ACDF)? A Preliminary Analysis of a Double Blinded Randomize Controlled Trial (RCT)†

Daniel Stein, BS; Han Jo Kim, MD; Darren R. Lebl, MD; Russel Huang, MD; Shari T Jawetz, MD; Okezie K. Aguwa, MD; Virginie LaFage, PhD; Todd J. Albert, MD

Summary
The aim of this double blind RCT is to determine if the application of local intraoperative corticosteroids (LIC), during ACDF surgery, impacts post-op dysphagia severity. This interim analysis revealed that patients treated with LIC showed smaller pre-post op decrease in several dysphagia specific PRO domain scores, compared to a control group.

Hypothesis
LIC application has no effect on early Post op dysphagia severity.

Design
Double Blinded Randomized Clinical Trial – preliminary results, ongoing enrollment

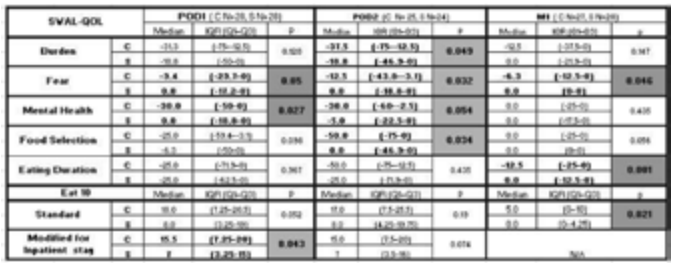
Introduction
Dysphagia is a common complication in the setting of ACDF surgery. There is controversy in the literature regarding the effectiveness of Local Intraoperative Corticosteroids in reducing post-operative dysphagia. This study aims to evaluate the effectiveness of LIC in decreasing the severity of swallowing difficulty following ACDF.

Methods
Adult patients undergoing primary multi-level ACDF (2-4 levels) were enrolled at a single institution, and randomized (double blinded) to two arms. Arm S (Steroid) received 1ml (40mg) of methylprednisolone delivered with an absorbable gel matrix (vehicle) to the retro-esophageal space prior to closure. The control arm (C) only received the LIC prior to closure. Dysphagia specific PROs (Swal-QOL, Eat-10, Bazaz) were collected pre-operatively, and at day-1 (POD1), day-2 (POD2), and 1 month (M1) post-operatively. A Mann-Whitney U test was performed to compare the median change in the PRO scores (S vs C) from baseline to each post-op time point.

Results
A total of 59 patients were enrolled: 30 patients in the S Arm (37% with >2

level fusion; 57% male), and 29 patients in the C Arm (52% with >2 level fusion, 2 Corpectomy; 66% male). The C arm had a higher BMI (31.7±6 vs 28.4±5.6, p=.03), longer OR time (158±42 vs 132.6±40, p=.02), and rated their baseline neck (5.9±2.5 vs 3.77±2.8, p<0.01) and right arm (3.82±3.2 vs 1.48±2.2, p=.002) pain higher on visual pain scales. At baseline, patients in the S and C arm had similar dysphagia outcome scores. Pre-Post op comparison of the SWAL-QOL domains found that patients in group C had a worsening of Burden sub-score at POD2, Fear at POD1 & 2 and M1, Mental Health at POD1, Food selection at POD2, Eating Duration at M1; they also had a larger increase in a modified inpatient Eat-10 score at POD1, and total Eat-10 score at M1. There was no difference between groups on the Bazaz -Dysphagia score at any time point.

Conclusion
Our study shows a promising potential for the application of LIC with this delivery method to prophylactically reduce dysphagia following ACDFs.



8. Closed Reduction of Cervical Facet Dislocations – A New Take on an Old Technique†

Johannes H. Davis, MMed(Orth), FCOrth (SA); De La Rey HS Badenhorst; Moosa Ahmed Farouk Mohideen; Maarten Potgieter

Summary
Cervical facet dislocations require urgent intervention, especially when associated with spinal cord compromise. A recent ruling in the South African Constitutional court mandates reduction within 4 hours. Historical data shows limited success and lengthy delays using standard techniques (weights and pulley). This prompted development of a controlled, closed-system traction table to assist with reduction of cervical facet dislocations. This retrospective review compares outcomes of closed reduction of cervical facet dislocations using the purpose built traction table to the standard technique.

Hypothesis
Improved success rate and decreased time to perform closed reduction of cervical facet dislocation when comparing the closed system traction table to the traditional reduction method.

Design
Retrospective review

Introduction
The traditional method for cervical reduction (weight and pulley) is cumbersome with variable success. Cervical dislocation injuries requires urgent reduction. Delays in successful reduction are multifactorial, but contribute to poorer outcomes.

Methods
This study reviewed the closed reduction of cervical dislocation injuries at Tygerberg Hospital between November 2008 and March 2016. Patients presenting before March 2015 were treated using the traditional method of reduction (weight and pulley) whereas patients presenting after March 2015 were treated using a novel closed system traction table. Patient clinical and demographic data was extracted from clinical notes and a preliminary comparison was made of (i) reduction success rate and (ii) time to reduction using the different approaches.

Results
Sixty nine patients with cervical spine dislocations presented at the hospital during the study period, of which 47 were treated using the traditional method (39 men, 8 women, mean age 38 years, range 16-65 years), 14 were treated with the traction table (12 men, 2 women, mean age 38 years, range 23-54 years) and 8 did not receive a reduction attempt. The rate of successful reduction was 74% (n=35/47) using the traditional method and 100% (n=14/14) using the traction table. Median time to successful reduction was 54 min (range 10-300 min) using the traditional method and 45 min (range 12-87 min) using the traction table.

Conclusion
The current findings suggest that use of a purpose-built closed traction table is an effective means of reducing cervical dislocation injuries. Furthermore, our preliminary comparison suggests that this method may improve reduction success rate and decrease time to reduction when compared to the traditional reduction method.

9. Safety of a High-Dose Tranexamic Acid Protocol in Complex Adult Spinal Deformity: Analysis of 100 Consecutive Cases†

James D. Lin, MD; Lawrence G. Lenke, MD; Jamal Shillingford, MD; Joseph L. Laratta, MD; Lee Tan, MD; Charla R. Fischer, MD; Ronald A. Lehman, MD

Summary
There have been very few reports of high-dose TXA (>=50mg/kg loading dose) usage in adult spinal deformity (ASD). This study shows that high-dose TXA is safe and effective in reducing intraoperative blood loss as compared to previously published series.

Hypothesis
We hypothesize that a high-dose TXA protocol (loading dose of 50 mg/kg followed by 5 mg/kg/hr infusion until skin closure) is safe and effective in reducing intraoperative blood loss in ASD.

Design
Retrospective review of high-dose TXA use in consecutive ASD patients.

Introduction
Spinal deformity surgery may involve significant amounts of blood loss, especially when various osteotomy techniques are utilized. Antifibrinolytic agents such as TXA have been used to reduce intraoperative blood loss. However, there is no universally accepted dosing protocol for its use. There have been very few reports of high-dose TXA (>=50mg/kg loading dose) usage in ASD.

Methods
Consecutive patients undergoing spinal deformity correction by a single surgeon over a 14-month period at a single institution were identified. Inclusion criteria were adults (age >= 18 years) who underwent posterior spinal fusion of at least 5 levels and use of our standard TXA protocol of 50 mg/kg intravenous

loading dose followed by a 5 mg/kg/hr infusion until skin closure. Patient demographics, estimated blood loss (EBL), operative time, transfusion rates, complications and other procedure specific information were recorded.

Results

A total of 100 adult patients were included. All operative procedures were performed by the senior surgeon. The mean age was 47.3 years, and 71% of patients were female. Average BMI was 24.9. The average fusion length was 14 levels; 33/100 patients had fusion constructs 17 levels or more. Pedicle subtraction osteotomy (PSO) was performed in 9 patients and vertebral column resections (VCRs) were performed in 14 patients. There were 45/100 patients who had a primary procedure, while the rest were revisions. Mean EBL was 1336 mL (98 mL/level, 31% EBV). There were three thromboembolic complications including one PE and two DVTs, which were all treated successfully with anticoagulation. There were no MIs, seizures, strokes, or renal complications.

Conclusion

High dose TXA is safe and effective in reducing intraoperative blood loss in ASD surgery as compared to prior published series, and is safe to use in well-selected adult spinal deformity patients.

Table 1. Demographic Information, Blood Loss, and Transfusions

Variable	Total	No 3CO	3CO	p
Patients	100	78	22	
Age	47.3+- 19.4 (18-75)	49.0 +- 19.0	41.3 +- 20.1	0.101
Gender (F)	71 (71%)	58 (74%)	13 (59%)	0.163
BMI	24.9 +- 5.7 (15.1-43.7)	24.7 +- 5.2	25.5 +- 7.2	0.577
Levels	14.0 +- 4.5 (5-24)	13.7 +- 4.6	15.2 +- 4.2	0.186
OR time	472.2 +- 138.6 (179-853)	444.4 +- 131.0	569.6 +- 121.9	**<0.001**
Primary	45 (45%)	39 (50%)	6 (27%)	0.058
Revision	55 (55%)	39 (50%)	16 (73%)	0.058
VCR cases	14 (14%)	0 (0%)	14 (100%)	--
PSO cases	9 (9%)	0 (0%)	9 (100%)	--
Pelvis Fixation	63 (63%)	51 (65%)	12 (54%)	0.352
TLIF	54 (54%)	45 (58%)	9 (41%)	0.163
Intraop BL	1336 +- 754 (100-4000)	1198 +- 638	1825 +- 931	<0.001
Intraop BL (%EBV)	30.8 +- 17.2 (2.4-81.0)	28.1 +- 16.1	40.6 +- 17.4	0.002
Intraop BL / Level	98 +- 63 (13-500)	88 +- 43	135 +- 100	0.041
Intraop Transfusion	391 +- 454 (0-1400)	332 +- 425	601 +- 499	0.013
% Intraop transfusion	52 (52%)	35 (45%)	17 (77%)	0.007
Cellsaver	411 +- 296 (0-1500)	364 +- 245	578+- 395	0.023
Total Transfusion	815 +- 691 (0-2450)	709 +- 660	1190 +- 681	0.006
% total transfusion	73 (73%)	53 (68%)	20 (91%)	0.032

10. Improved Clinical Outcomes of Intraoperative Lumbar Nerve Root Monitoring Changes Using Motor Evoked Potentials During Thoracolumbar Spinal Surgery*

Earl D. Thuet, BS, CNIM; Lee Tan, MD; Anil Mendiratta, MD; Moosa Ahmed Farouk Mohideen; Paul F Kent, MD, PhD; Ronald A. Lehman, MD; Yongjung J. Kim, MD; Charla R. Fischer, MD; Mark Weidenbaum, MD; Lawrence G. Lenke, MD

Summary

Clinical outcomes of using motor evoked potential to monitor lumbar nerve roots during 337 consecutive thoracolumbar spinal surgeries found that 14 patients(4%) met warning criteria for MEP nerve root monitoring, 12/14 had nerve root compression identified at the appropriate level, and 11/12(92%) had improvement of the MEP nerve root data. None of the patients with improved responses had a residual neurologic postop deficit.

Hypothesis

MEP monitoring will provide early identification of changes in lumbar nerve root function. This information will improve clinical outcomes.

Design

Retrospective analysis of monitored spinal procedures.

Introduction

Somatosensory evoked potentials (SSEPs) and motor evoked potentials (MEPs) can detect intraoperative spinal cord dysfunction with good reliability. However, the reliability of lumbar nerve root monitoring remains controversial. We report the clinical outcome of patients with intraoperative MEP nerve root monitoring changes using a unique warning criteria.

Methods

Patients from a single center undergoing thoracolumbar spinal surgery with multimodality monitoring over a 12-month period (Aug 2015 – Aug 2016) were reviewed. Patient demographics, indexed procedure, intraoperative monitoring data, interventions, findings, and postoperative neurological status were analyzed.

Results

There were 337 consecutive patients that underwent thoracolumbar spinal surgery over the study period. A total of 14 patients (4%) had MEP nerve root monitoring changes that met our warning criteria. There were 12/14 (86%) patients with nerve root compression identified at the corresponding levels. Intraoperative nerve root decompression resulted in improvement of MEP signals in 11/12 (92%) patients in the true positive group; all these patients had either no postoperative deficits or only had transient deficits that completely recovered at follow-up visit. The MEP signal failed to improve despite nerve root decompression in one patient (8.3%), who also had a persistent neurological deficit at the follow-up visit. There were only 2/14 (14.3%) patients who had MEP nerve root monitoring changes but did not have any nerve root compression identified intraoperatively. Neither patient had a postoperative neurologic deficit. In 7/14 (50%) cases, MEP responses were the only positive indicator of change in nerve root function.

Conclusion

Intraoperative MEP nerve root monitoring changes highly correlated with nerve root compression. We have found MEP nerve root monitoring to be an effective tool for intraoperative identification of nerve root compression and should be considered to optimize surgical outcome.

11. Changes in Cervical Facets Orientation During Child Growth*

Sebastien Pesenti, MD; Renaud Lafage, MS; Benjamin Blondel; Emilie Peltier, MD; Elie Choufani, MD; Jean-Luc Jouve, MD, PhD

Summary

During growth, the orientation of articular facets of the cervical spine increases progressively. The inclination of the cervical joints reinforces cervical spine stability, acting as a mechanical brake. To date, changes in facets orientation has never been clearly proved. Based on sagittal slices of cervical MRI of 90 children aged from 4 months to 18 years old, the facets orientation at each

cervical vertebra was measured and confirmed the positive correlation between age and facets orientation.

Hypothesis
There is an increase in cervical facets orientation during growth

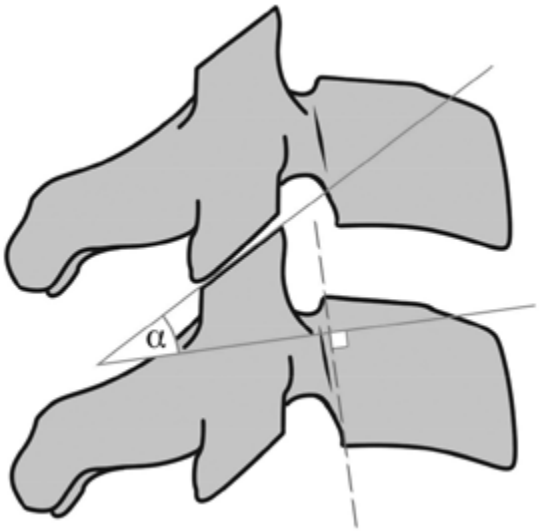
Design
Single-center retrospective cohort study

Introduction
During growth, the orientation of articular facets of the cervical spine increases progressively. The inclination of the cervical joints reinforces cervical spine stability, acting as a mechanical brake. To date, changes in facets orientation has never been clearly proved. Due to the mainly cartilaginous composition of the vertebrae in young children, the assessment of vertebral landmarks is challenging and can be misleading. The aim of this study was to demonstrate the increase of cervical facets orientation during growth based on an MRI study.

Methods
Based on sagittal slices of cervical MRI of 90 children aged from 4 months to 18 years old, the facets orientation at each cervical vertebra was measured. This angle was defined as the angle between the superior facet and a perpendicular line to the posterior wall of the vertebral body.

Results
For each level from C3 to C7, there was a positive correlation between facets orientation and age (R=0.497, IC95% [0.4142; 0.5712], p<0.001). The orientation angles were higher for C3 and C7 compared to other levels (43.5° and 47.8°, respectively). In the other hand, the orientation angle of C5 was the lower.

Conclusion
This study confirms the correlation between age and increase of the cervical facets orientation. Differences were visible according to vertebral level. At each end of the cervical spine, the higher values correspond to smaller mobility areas. The lower orientation at C5 corresponds to the maximum range of cervical flexion-extension. This particularity persists at adult age and can explain the frequency of trauma and degenerative diseases at this level.



12. Locally Applied Simvastatin as an Adjunct to Promote Spinal Fusion in Rats*

Sravisht Iyer, MD; Patrick E. Donnelly, PhD; George Spaniel, BS; *Matthew E. Cunningham, MD, PhD*

Summary
We were able to successfully validate that sustained release of Simvastatin (SIM) via a PLGA nano particle (NP) SimNP was able to induce an increase in mineralization as well as an increase in markers of bone formation. Rats treated with SimNP had more bone formation on X-ray (XR) and were significantly more likely to achieve fusion. Our findings highlight the potential of simvastatin as a safe, cost-effective bone anabolic agent for use in spinal fusion surgery.

Hypothesis
Sustained, local delivery of SIM would assist with spinal fusion in a rat animal model

Design
Animal study

Introduction
Despite data showing the bone-anabolic properties of statins in fracture healing, no studies that have evaluated the impact of locally delivered statins on spinal fusion.

Methods
Blank PLGA (BlankNP) and SIM-loaded PLGA (SimNP) nanoparticles were created by adapting established techniques. SimNP, ranging from 217ug/mL to 883ug/mL, was placed in 15mL of PBS at 37°C with agitation. SIM release was measured for 15d using an UV spectrophotometer. In vitro validation was performed using MC3T3-E1 osteoblast precursor cells were cultured in complete (COMP) or mineralizing (MIN) media. A posterior spinal fusion model was utilized in 40 male 12wk old outbred Wistar rats. Rats were treated with BlankNP, SimNP (15 rats each) or SIM drug (10 rats). XR to assess bone formation were obtained at 4wks and 9wks after surgery. Spines were explanted at 9wks and a manual assessment of fusion (MAF) was performed by three blinded observers.

Results
SimNP successfully achieved sustained release over two weeks with ~50% occurring in the first day. Release efficiency averaged 74.1%. MC3T3 cells cultured with SimNP at 200ug/mL had higher expression of OCN and OPN at 1wk and 2wks. Cells cultured with SimNP showed more deposition of calcium as assessed by alizarin staining at 1wk and 3wks. Three animals (one from each group) were sacrificed due to post-operative complications (paralysis x2, infection). The remaining animals were analyzed. We found no significant differences between the BlankNP and SIM drug rats in XR scores or MAF. Compared to BlankNP, SimNP treated rats had significantly higher XR scores at 4wks (3.0 vs. 1.9, p=0.010) and 9wks (3.6 vs. 1.8, p<0.001) (Figure). Compared to SIM drug, SimNP rats had similar XR scores at 4wks but higher scores at 9wks (3.6 vs 2.1, p=0.005). MAF showed that SimNP had a significantly higher fusion rate than BlankNP (42.9% vs. 0%, p=0.006).

Conclusion
Rats treated with SimNP had significantly more bone formation on XR and were significantly more likely to achieve fusion judged by MAF compared to control animals (BlankNP).

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

13. Widening of the Safe Trajectory Range During Subaxial Cervical Pedicle Screw Placement: Advantages of a Curved Pedicle Probe and Laterally Located Starting Point without Creating a Funnel-Shaped Hole

Jin Hoon Park; Subum Lee

Summary
An entry point medial shifting yield a wider ranged safer trajectory during CPS without creating a funnel-shaped hole. The entry point shifting also led us to perform safe CPS even with the achievement of smaller medial angle which is easier than that of anatomical cervical pedicle angle. The absence of a funnel-shaped hole creation allows us to use a longer screw, have a longer bone and screw engagement, reduce surgical time, and convert into lateral mass screw.

Hypothesis
A small-diameter curved pedicle probe give us an entry point medial shift and safer trajectory widning during CP

Design
Retrospective Cohort study

Introduction
The small diameter of cervical pedicles and a large transverse cervical pedicle angle are challenges for spinal surgeons, which have led them to find how they could achieve a wider safety trajectory and reduce the insertion angle during cervical pedicle screw (CPS) placement. Here, the authors suggest the advantages of a curved pedicle probe and a laterally located entry point for overcoming these challenges.

Methods
From March 2012 to May 2016, we performed posterior cervical fusions using CPS on 119 patients. The lateral mass screw conversion and the CPS breech rate were analyzed. Using preoperative CT scanning, we determined that the θat, is similar to the anatomical pedicle angle, and the θmed, is the minimally acceptable medial angle. The actual inserted medial angle (θins) was determined by postoperative CT scan. To identify how much of the medial angle on the θins could be reduced from the anatomical pedicle angle (θat), and how much closer to the θmed, we calculated (θins – θmed) / (θat – θmed). To verify the entry point shifting and trajectory widening, the mean df/Df (i.e. shifted fact point/planned facet point) values were analyzed.

Results
The total number of planed CPS was 759, the conversion rate was 4.61% (35/759), and the accuracy rate was 95.9% (694/724). We could calculate that θins could be expected near the 90, 80, 80, 80, and 110 % value of θat on C3, 4, 5, 6, and 7 levels with the (θins – θmed) / (θat – θmed) equation. The mean df/Df values were 0.64, 0.62, 0.63, 0.63, and 1.24 on the C3, C4, C5, C6, and C7 levels, respectively.

Conclusion
Through the use of a curved pedicle probe and a laterally located starting point, the planned and laterally located entry point medial shift was made during CPS. The entry point shift yielded a wider, safe trajectory and reduced the burden to make a large medial angle for safe CPS without creating a funnel-shaped hole which resulted in easy lateral mass screw conversion.

14. Neurologic Deficits and MRI Characteristics of Syrinx in Idiopathic Syringomyelia Related Scoliosis*

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

Summary
Fifty-five scoliosis patients secondary to idiopathic syringomyelia (IS) were identified after ruling out all other causes of syringomyelia and reviewed retrospectively. Results showed that the correlation between syrinx with either scoliosis curve or neurological deficit, which was published previously, has been controversy.

Hypothesis
Syrinx of IS is related with features of scoliosis or neurological deficits

Design
Retrospective study

Introduction
Limited studies have shown that syrinx deviation is correlated with both scoliosis curve convexity and neurological abnormality. This study aims to further demonstrate the relationship between neurologic deficits, scoliosis curve and syrinx features.

Methods
Fifty-five scoliosis patients secondary to IS were identified after ruling out all other causes of syringomyelia (Chiari malformation, spinal cord tumor, trauma, infection, tethered cord, etc.) and reviewed retrospectively. Patients with syrinx less than two vertebra levels or diameter less than 1mm also were excluded. Location, syrinx/cord ratio (S/C), length and morphological appearance of the syrinx were systematically assessed on MR images. Neurologic symptoms were recorded through detailed physical examination of nervous system. Three subgroups (none, minor and severe) were classified according to reflex, sensory and motor disturbance.

Results
The major curve Cobb was 69.8±25.2° (range 33-132°). The maximal S/C and length of the syrinx in IS averaged 0.58±0.20 (range 0.20–0.98) and 8.4±4.7 (range 2-19) vertebral levels. 36 (65.5%) patients had various neurological deficits, including tendon or superficial abdominal reflex abnormality (36, 65.5%), sensory and/or motor disturbances (22, 40.0%). The S/C, length and morphological features had no correlation with degree of neurological deficit and scoliosis curve parameters, such as Cobb, flexibility, and apex vertebra translation (AVT). The major curve convexity wasn't coincident with side of syrinx significantly (27.2% concordance rate, P=0.52) or neurologic deficit (16.3% concordance rate, P=0.21). Location of syrinx wasn't correlated with range of major curve.

Conclusion
None significant relationship is detected among neurologic deficits, scoliosis curve parameter and MRI features of syrinx. Correlation between syrinx of IS with either scoliosis curve or neurological deficit has been controversy.

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

Table 1 Correlation between major curve direction and the side of deviated syrinx

Major curve direction	Syrinx deviation	
	Left	Non-Left
Left	6	13
Right	8	28

Fisher exact test, P=0.52

Major curve direction	Syrinx deviation	
	Right	Non-Right
Right	9	27
Left	2	17

Fisher exact test, P=0.29

Table 2 Correlation between the side of neurologic deficit and syrinx deviation

Syrinx deviation	Neurologic deficit		
	Left	Both	Right
Left	3	3	3
Middle	6	7	5
Right	3	0	6

Fisher exact test, P=0.21

15. Impact of Type of Screw on Kyphotic Deformity Correction after Spine Fracture Fixation- Cannulated versus Solid Pedicle Screw*

Abduljabbar Alhammoud, MD; *Mahmood Arbash;* Ashik M. Parambathkandi; Ohmed Khilji; Abdul Moeen Baco

Summary
Retrospective case series of 172 patients with traumatic thoracolumbar fracture fixed by solid or cannulated screw to detect the impact of type of screw on kyphotic deformity correction

Hypothesis
Solid screws are superior to cannulated screws in the increased correction of kyphotic angle and the height of the fractured vertebra.

Design
Retrospective case series

Introduction
Spine fractures result from multiple causes particularly fall from heights and road traffic accidents. It is a major cause of disability if not treated properly. Many advocates are in favor of pedicle fixation method, considering it a comparatively safer procedure when compared to the riskier non-pedicle counterpart. Open spine surgery is known to have several limitations which include blood loss, elongated post-operative pain and disability risk. Minimal incision techniques were, therefore, a 'looked-for' advancement. Pedicle screw can be Polyaxial cannulated screw or Monoaxial solid screw. Our aim is to explore and find out if the screw design differences will affect the correction of the deformity after the fixation of unstable spine fractures

Methods
Retrospective case series of all pedicle screw fixation for traumatic thoracolumbar fractures (Open vs. MIS) in Hamad General Hospital, Doha, Qatar. The use of cannulated screws (CS) and solid core screws (SCS) during the two surgical modes named 'traditional open' (OPEN) and 'minimally invasive' (MISS) are considered for the study. The data comprised of patient details for five years from 2011 to 2015.

Results
172 cases with traumatic thoracolumbar fracture underwent pedicle screw fixation (Open vs MIS) either with CS or SCS. 142 males and 28 females, average age 36.1 ± 12.4 years, 100 open and 72 MIS, 76 solid and 96 cannulated screws. The average pre-operative, intra-operative and postoperative kyphotic angle of the fractured vertebra was respectively 18.9 ± 9.9 (range from 1 to 90), 7.4 ± 6.7 (range from 0 to 40) and 8.1 ± 6.5 (range from 0 to 40) degrees and an average 13.08 degree angle reduction was quantified with solid screws and 8.96 degrees with cannulated screws. Average height reduction in the pre-operative and post-operative stages showed a wide difference which indicated a successful height gain after surgery, and this is supported statistically while performing ANOVA ($p < 0.05$) in solid groups compared to cannulated screw procedure performed.

Conclusion
Solid screws are found to be superior in the increased correction of kyphotic angle and the height of the fractured vertebra comparing to cannulated ones.

16. A 20-Year Analysis of AIS Patient Incidence of Critical Changes and Predictive Factors to Define Patients at Risk

Daniel J. Sucato, MD, MS; Kiley Poppino, BS; Alec S. Thoveson; Ali Parsa; Steven P. Sparagana, MD; Patricia Rampy, MS, CNIM

Summary
The incidence of critical neuromonitoring changes in a consecutive series of 1605 patients was 2.24%, predominantly during deformity. Risk factors were older age, longer surgery, larger curves and ant/post surgery. The timely response by the surgical team resulted in no permanent neurologic event as long as blunt trauma to the cord was avoided. Modern IONM monitoring prevents permanent neurologic deficits with an incidence of 0.06%

Hypothesis
Multimodal use of intraoperative neuromonitoring is associated with a low incidence of permanent postoperative neurological deficits in AIS due to careful and rapid response to critical changes

Design
Retrospective chart review

Introduction
In AIS surgery, critical intraoperative neuromonitoring (IONM) changes are uncommon and permanent deficits are rare. Few studies identify risk factors for these changes or strategies to limit their occurrence.

Methods
A retrospective review of a consecutive series of AIS patients at a single institution undergoing a posterior surgery using SSEP, NMEP and TcMEP monitoring was performed over an 18year period. Risk factors, responses to changes and ultimate outcome were determined.

Results
There were 1605 patients who were 14.57 years at surgery with 80.9% female and a major preoperative Cobb of 60.8 . Critical IONM changes occurred in 36 (2.24%) patients- 28 girls/ 8 boys. The changes were motor (39%), sensory (11%), and motor/sensory (50%) and occurred during anchor placement (22%), corrective maneuvers (56%), anesthetic event (8.3%) and other (13.8%). Preoperative MRI was ordered in more patients in the

critical change group (66.7% vs 29.8%) (P<0.05). All normal in the critical group. Risk factors were older (14.6 vs 13.8 yrs), larger preop Cobb (71.5 vs 60.8°), longer surgery (323 vs 275 min), ant/post surgery (P<0.05). The surgical team's responses were: raising temperature (100%), raising MAP (68.1 to 85.1 mm Hg), steroids (30.6%), alteration of the implants and/or rod (41.67%). Surgery was aborted in 5 (13.9%) due persistence of abnormal monitoring. Transient neurologic deficits were seen in 7 patients (hyperesthesia, subjective weakness <48 hrs). One patient (0.06) (cord contusion) had a permanent neurologic deficit.

Conclusion
The incidence of intraoperative critical neuromonitoring changes during surgery for AIS is 2.24% primarily during rod placement and correction with older age, larger curves, ant/post surgery and longer surgery as risk factors. An appropriate response to these changes results in a very low incidence of permanent neurologic deficit (0.06%).

17. Rate of Instrumentation and Fusion-related Complications after Surgical Treatment for Severe Pediatric Spinal Deformity within 2 years: A Prospective Multi-center Cohort Study.

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Summary
There is a 12% risk of instrumentation related complications in the first 2 years in severe pediatric deformity patients (>100° or planned VCR). These patients require close continued follow-up.

Hypothesis
Pediatric patients with severe spinal deformities treated surgically have a high rate of revision surgery for instrument and fusion related complications.

Design
Prospective observational multi center cohort of pediatric patients having surgical treatment for severe spinal deformity (>100° or planned VCR).

Introduction
Severe pediatric deformity can be extremely challenging to treat due to difficulties with instrumentation placement in small patients, stress on implants due to correction of severe deformities, and use of three column osteotomies. This study analyzed the instrumentation and fusion related complications in complex spine deformity surgical cases.

Methods
176 patients with severe complex spinal deformity were included from a prospective database with a min. 2 year follow-up. Complications with or without revision due to pseudoarthrosis, instrumentation failure, infection requiring instrumentation removal and progression of deformity were all analyzed.

Results
176 patients out of 313 pts reached a minimum of 2 years follow up. 21 patients (12%) had complications associated with the instrumentation. 15 patients (9%) required 16 revision surgeries because of instrumentation failure. 6 patients (3%) had complications but did not require any revisions. The 16 revision surgeries included 7 (43%) with loss of fixation. The average time for the revision surgery was 13 months (0-28) after the index surgery. Only one patient had 2 revisions. 4 patients were revised for pseudarthrosis at an average of 23 months (17-35). 2 patients (13%) had revisions for prominent instrumentation (both at 27 mos post), 2 (13%) for infection (19 and 36 months respectively), and one patient had revision surgery for deformity progression at 2 months postoperatively. The patients that did not have revision surgeries included 2 with prominent implants both found at 18 months postop, 2 with progressive deformity/PJK at 18 months average (14-22), and 2 had loss of fixation at 6 months (0-12).

Conclusion
Pediatric patients with severe spinal deformity are high risk for revision surgeries at 12% rate within 2 years. The average time for revision surgery was 19 months postoperatively. These patients require close follow-up and will require continued follow-up after 2 years.

18. Failure to Validate the Age-Adjusted Alignment Thresholds Concept in an Adult Spinal Deformity Database

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Summary
This study, in an independent adult spinal deformity (ASD) database, failed to validate the age-adjustment thresholds concept that proposes to target ideal sagittal alignment goals according to age.

Hypothesis
Adjusting Schwab alignment thresholds according to age do not decrease mechanical complication rates nor improve clinical outcomes.

Design
Retrospective analysis of a prospectively collected data of ASD patients.

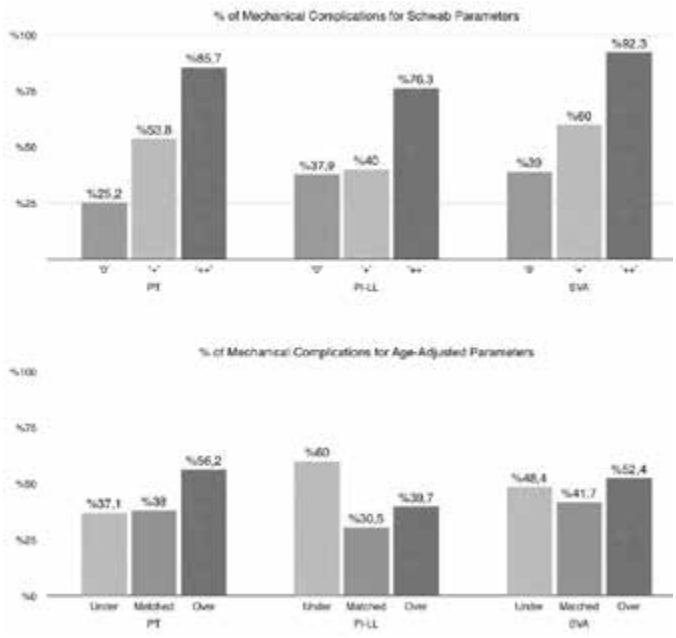
Introduction
Spinopelvic alignment is known to vary for age. Attempts have been made to adapt these changes to ASD realignment objectives. Formulae were proposed to calculate age-adjusted alignment thresholds. PT=(Age-55)/3+20. PI-LL=(Age-55)/2+3. SVA=2x(Age-55)+25. Thresholds for over and undercorrection was based on patient age +/- 10 years. Aim was to validate age-adjusted Schwab alignment thresholds on both HRQoL scores and mechanical complication rates.

Methods
Inclusion criteria were ≥4 levels fusion and ≥2y follow-up. Mechanical complications were PJK/PJF, DJK/DJF, rod breakage and implant-related complications. Patients were classified as Undercorrected, Matched or Overcorrected according to the proposed formulae. The Chi Squared test was performed to compare mechanical complication rates for PT, PI-LL and SVA groups and age-adjusted groups. Last f/up HRQoL scores were compared using ANCOVA eliminating the effect of pre-op HRQoL scores.

Results
222 pts (168F, 54M) met the inclusion criteria. Mean age was

52.2±19.3(18-84) years. Mean follow-up was 28.8±8.2(24-62) months. Mechanical complication rates were similar for PT matched and undercorrected (p>0.05), for PI-LL matched and overcorrected (p>0.05) and for all age-adjusted groups in SVA (p>0.05). ODI, SF-36 PCS and MCS were not different in age-adjusted groups (p=0.055, p=0.516 and p=0.381, respectively). SRS22 subtotal score was different in age-adjusted groups (p=0.019) with undercorrected group having the best results.

Conclusion
Reaching age-adjusted Schwab realignment goals in ASD surgery failed to improve, if not worsened, clinical outcomes and to prevent mechanical complications.



19. Does Thoracoplasty Affect Pulmonary Function in Thoracic AIS Surgery Treated by Posteromedial Translation?

Cedric Duray, MD; Emmanuelle Ferrero, MD, MS; Brice Ilharreborde, MD, PhD

Summary
Thoracoplasty can be proposed in addition to the main curve correction in adolescent idiopathic scoliosis (AIS) surgery for cosmetic demand. Its consequences on pulmonary function tests (PFTs) remain controversial in recent studies with direct vertebral derotation techniques. In the current study, thoracoplasty did not affect pulmonary function recovery at 2-year follow-up in patients operated for thoracic AIS with posteromedial translation.

Hypothesis
Thoracoplasty did not affect PFTs at 2-year follow-up in patients operated for thoracic AIS with posteromedial translation.

Design
Prospective study

Introduction
Cosmetic demand is a major source of motivation in adolescents undergoing idiopathic scoliosis surgery. Thoracoplasty can therefore be proposed in addition to the main curve correction, but its consequences on PFTs remain controversial. Most of the recent studies are limited to all-screw constructs and direct vertebral derotation techniques, and fail to draw clinically relevant conclusion. The aim of this study was to analyze the influence of thoracoplasty on PFTs, in AIS patients treated by posteromedial translation.

Methods
97 consecutive patients with thoracic AIS (Lenke 1 and 2) were prospectively included between 2013 and 2014. Thoracoplasty was systematically proposed in case of significant rib hump (> 2 cm). All patients underwent surgical correction using a combination of thoracic sublaminar bands and pedicle screws (hybrid construct) to improve sagittal correction. Pulmonary function tests and 3D low-dose stereoradiographs were performed preoperatively and at 2-year follow-up. The influence of thoracoplasty on complication rates and PFTs was analyzed.

Results
36 patients (37%) decided to undergo thoracoplasty. No significant difference was found between groups preoperatively regarding demographic data, radiological parameters and PFTs. Eighty patients had Lenke 1 curves and 17 had Lenke 2 with a mean preoperative Cobb angle of 55±12°. Mean correction rate of the main curve was 72% without difference between groups. PFT were back to preoperative values at 2-year follow-up in all patients. Pleural effusion was diagnosed in 71 patients (74%) in the early postoperative period, but they all resolved within 10 days. No difference was reported between groups regarding blood loss.

Conclusion
Thoracoplasty did not affect pulmonary function recovery at 2-year follow-up in patients operated for thoracic AIS with posteromedial translation. Pleural effusions can be expected, but they are usually asymptomatic and treated conservatively. Knowing the low risk of this procedure, the exact impact on patient's satisfaction needs to be further assessed.

20. 3D Analysis of Spinal Deformity Progression following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

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Summary
3D radiographic analysis of post-op AIS patients with DP and matched controls identified increased axial plane deformity in patients with progression in the coronal plane. These findings emphasize the need to better understand pre- and post-operative axial plane deformity in AIS patients and utilize surgical techniques, including selection of fusion levels that maximize and maintain 3D deformity correction.

Hypothesis
Post-operative deformity progression (DP) after posterior spinal fusion (PSF) occurs in adolescent idiopathic scoliosis (AIS) patients due to spinal growth and progressive axial plane deformity.

Design
Retrospective review of prospectively collected data

Introduction
Recent studies have reported DP in AIS after PSF with all pedicle screw constructs. It is unclear, however, if the DP occurs due to continued anterior spinal growth (crankshaft), adding-on of the structural curve, or both. The purpose of this study was to perform a comparative 3D radiographic analysis of patients who experienced DP after PSF compared to those who did not.

Methods
378 AIS patients with simultaneous biplanar radiographs and minimum 2yr post-operative follow-up were screened for DP following PSF. DP was identified in 43 patients (11%), and was defined as an increase in the coronal curve or disc angulation below the fusion of ≥10° from the 1st erect (FE) to 2yr time points. Patients with Lenke 1 and 2 curves were included in a 1:2 matched analysis with non-progressors based on Cobb angle, Lenke classification, and lowest instrumented vertebra (LIV). 7 patients with DP and 14 matched controls were included in this analysis. 3D reconstruction software was used to obtain segmental measurements in the plane of each individual vertebra and disc. Vertebral growth and rotation were compared between those who progressed (DP) and those who did not (controls) using repeated measures ANOVA.

Results
No significant differences existed pre-operatively between the two groups in terms of age, sex, Lenke type, and LIV (p>0.77). Comparative measurements are shown in Table 1. Thoracic and thoracolumbar Cobb angles increased significantly in DP patients compared to controls from FE to 2yr post-op, confirming DP. No significant differences were observed in the changes in anterior and posterior vertebral heights during the follow-up period. Torsion within the fused segment and axial rotation below the LIV increased significantly in DP patients compared to controls.

Conclusion
DP in the coronal plane was not associated with vertebral growth but was primarily due to increased axial plane deformity during the follow-up period.

	Group	Pre-operative	First Erect	2-Year Post-op	p-value
Thoracic Cobb	DP	55° ± 8°	16° ± 4°	22° ± 8°	0.05
	Control	54° ± 6°	9°± 7°	12° ± 6°	
Thoracolumbar Cobb	DP	32°± 8°	13° ± 6°	17° ± 6°	0.008
	Control	37° ± 8°	12° ± 11°	10° ± 10°	
Total Anterior Vert Ht (mm)	DP	310 ± 16	317 ± 16	336 ± 11	0.34
	Control	344 ± 32	348 ± 29	359 ± 30	
Total Posterior Vert Ht (mm)	DP	309 ± 17	323 ± 16	339 ± 9	0.32
	Control	337 ± 33	350 ± 29	357 ± 34	
Torsion of the Fused Segment	DP	11° ± 13°	0° ± 7°	7° ± 6°	0.04
	Control	14° ± 7°	0° ± 7°	0° ± 6°	
Axial Rotation Below LIV	DP	3° ± 5°	2° ± 5°	-4° ± 6°	<0.001
	Control	-1° ± 3°	1° ± 3°	2° ± 4°	

Table 1: Comparison of selected measurements between progressors (DP) and controls.

21. Natural History of Post-Operative Adding-On in AIS: What's the Risk Factors for Progressive Adding-On?

ZeZhang Zhu, MD, PhD; Xiao-dong Qin, PhD; Weixiang Sun, MD; Lei-Lei Xu, MD; Yong Qiu, MD

Summary
The distal adding-on phenomenon after surgical treatment of adolescent idiopathic scoliosis (AIS) may progress or keep stable. The risk factors for its progression remain unclear. In this study, we found several factors such as the skeletal maturity and selection of lowest instrumented vertebra (LIV) were associated with the progression of post-operative distal adding-on. Skeletally immature patients with short fusion level seemed more likely to have progressive adding-on.

Hypothesis
Factors such as the skeletal maturity and selection of LIV are associated with the progression of post-operative distal adding-on.

Design
A retrospective comparative study.

Introduction
Distal adding-on is often accompanied by unsatisfactory clinical outcome and high risk of revision surgery. Although several studies have investigated factors associated with adding-on, few studies have focused on the natural history of distal adding-on.

Methods
219 patients were included in the study with a minimum of 2-year follow-up after selective posterior thoracic instrumentation for Lenke 1A and 2A curve. Progressive adding-on was determined through comparison between the initial radiograph indicating the incidence of adding-on and the last follow-up radiograph, which was defined as 1) an increase of more than 5 mm in the deviation of the first vertebra below the instrumentation from the CSVL, or 2) an increase of more than 5° in the angulation of the first disc below the instrumentation. Non-progressive adding-on was defined as the deviation of the first vertebra and the angulation of the first disc below the instrumentation remained unchanged or decreased. Patients were assigned to the progressive and the non-progressive group.

Results
49 patients (22.4%) met the definition of distal adding-on, among whom, 19 (38.8%) patients were progressive and 11 (22.4%) patients were non-progressive. Lower Risser grade (P=0.005) and LIV proximal to substantially touching vertebra (P=0.016) were found to be significantly associated with the progressive adding-on. However, patients with progressive adding-on were found to have more obvious shoulder rebalancing during the follow-up (P=0.004). The mean self-image score of SRS-22 questionnaire at the last follow-up was significantly lower in the progressive group than that in the non-progressive group (p=0.03).

Conclusion
There is a relatively high incidence of progressive adding-on following surgical treatment of AIS patients. Skeletally immature patients with selective thoracic fusion are more likely to have progressive adding-on. Again, progressive distal adding-on may compensate for the shoulder imbalance during the follow-up.

22. The Evolution of Sagittal Spinal Profile in EOS: Is There A Difference Between Rib-Based and Spine-Based Growth Friendly Instrumentation?

Xu Sun, MD, PhD; Zhonghui Chen, MD, PhD; Yong Qiu, MD; *ZeZhang Zhu, MD, PhD;* Xi Chen, MD; PhD; Changzhi Du, MD, PhD; Song Li, MD

Summary
Although the growing rod instrumentation (GR) and vertical expandable prosthetic titanium rib encourage spinal growth via regular lengthening, they may create different results because of different fixation characteristics and mechanism in correcting scoliosis. This study demonstrates that prosthetic rib

had the similar results in coronal correction and spinal growth as GR. However, in the sagittal plane, the prosthetic rib was not as good as GR.

Hypothesis
GR and prosthetic rib may create different results

Design
Retrospective

Introduction
Although the growing rod instrumentation (GR) and vertical expandable prosthetic titanium rib encourage spinal growth via regular lengthening, they may create different results because of different fixation characteristics and mechanism in correcting scoliosis.

Methods
Thirty patients with GR and 9 with prosthetic rib were reviewed. All patients had more than 2 years' follow-up with more than 2 lengthenings. Radiographic measurements were performed before and after the index surgery and at the last follow-up. The complications were identified and compared.

Results
The mean age before surgery in the GR and prosthetic rib groups was 6.2 and 6.8 years, respectively. The GR and prosthetic rib groups had an average number of lengthenings of 5.6 and 7.3 with an average length of follow-up of 4.7 and 6.6 years, respectively. The mean lengthening intervals were 9.3and 9.9 months in the GR and prosthetic rib groups, respectively. In the GR group, thoracic kyphosis changed from 66.7° preoperatively to 36.2° at the last follow-up, indicating insignificant changes (P<0.001). In contrast, thoracic kyphosis in the prosthetic rib group notably decreased from 62.4° to 38.7° (P<0.001) after the index surgery and slightly increased to 46.7° (P=0.051) over time with subsequent distractions. Proximal junctional angle (PJA) in the prosthetic rib group was significantly greater than that in the GR group at each time point, but the increasing amount of PJA was not statistically significant (7.0° vs 8.7°, P=0.388). In both groups, the mean change in PI was not statistically significant (P>0.05). Similarly, mean SS and PT did not show any significant change during the 3 measurement periods (P>0.05). The overall complication rate was higher in the prosthetic rib group compared with in the GR group (88.9% vs 53.4%, P= 0.115).

Conclusion
Prosthetic rib had the similar results in coronal correction and spinal growth as GR. However, in the sagittal plane, the prosthetic rib was not as good as GR technique in control of thoracic kyphosis. Thus, for hyperkyphotic EOS patients, GR is more preferable than prosthetic rib.

23. Cost Effectiveness of Magnetically Controlled Growing Rods: Who Really Benefits?

Matthew E. Oetgen, MD; Allison Matthews, MSCR

Summary
Despite the purported cost savings with MCGR, our findings suggest healthcare institutions solely bear the cost of this new technology while payors gain the long-term financial benefit.

Hypothesis
The purpose of this study was to evaluate the cost difference between MCGR and TGR surgeries at initial implantation and determine the recipient of the reported long-term cost savings.

Design
Retrospective Case Control

Introduction
Treatment of early onset scoliosis is challenging. To control curve progression and allow thoracic development, growing rods (GR) have become standard of care. While effectively controlling deformity, traditional systems (TGR) require surgical lengthening bi-annually. Magnetic systems (MCGR), while more costly, control curve progression and eliminate repeat surgical lengthenings. Although initial implantation of MCGR is more expensive than TGR, cost analyses have suggested MCGR results in lower overall cost after 3 years compared to TGR due to the elimination of repeat surgeries. While MCGR appear to offer cost savings over time, the benefactor of these savings is unclear.

Methods
All patients who underwent implantation of GR from 05/2011-01/2016 at a single children's hospital were included for a total of 37 cases (16 MCGR, 21 TGR, 4 TGR to MCGR conversions). Financial information included insurance provider and amount billed to and reimbursed from the payor. Charges across the inpatient stay at the time of implantation were divided into service categories (surgery time, room/board, anesthesia, implant cost, lab, radiology, therapy, medications, neuromonitoring, OR materials, recovery room) and reimbursements converted into percentage of total charge. Variables were compared using T-tests to determine differences between charges and reimbursements.

Results
The average overall charge for MCGR implantation was 25% greater than TGR implementation, which was significantly more expensive (p=0.04). Average charges were statistically similar across all categories, except implant costs, which were significantly more expensive for MCGR cases (MCGR 2.8x greater vs. TGR, p<0.0001). Despite this charge difference, the average percent reimbursement of total charges was similar between systems (MCGR 43% vs. TGR 45%, p=0.66).

Conclusion
MCGR has a significantly higher initial charge than TGR which appears to be due to the higher expense of the MCGR implants. Despite this, total institutional reimbursement is similar between the two procedures. While MCGR have been shown to be "cost effective" after 3 years, our findings suggest healthcare institutions solely bear the cost of this new technology while payors gain the long-term financial benefit.

24. Proximal Junctional Kyphosis in Posterior Spinal Fusion in Early Onset Scoliosis

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Summary
Proximal junction kyphosis (PJK) rate in instrumented posterior spinal fusion (PSF) for early-onset scoliosis (EOS) is more common in younger children

although between 8 to 10 years of age the rates equalize. There is no sex difference and the rate is increased in syndromic, congenital disorders. Clinical and neurological evaluation of the patient is more important than the PJK diagnosis itself in the decision-making regarding a possible revision surgery.

Hypothesis
Higher rates of PJK in EOS with PSF are associated with syndromic and congenital etiologies and upper instrumented vertebra (UIV) in T6-T7 and not associated with sex and age.

Design
A retrospective study.

Introduction
EOS is defined as scoliosis developing in children younger than 10 years of age regardless of the etiology. Prevalence varies from 7 to 61%. The aim of this study was to evaluate the presence of PJK in our series of EOS with PSF and to identify factors that may be associated with the risk of developing PJK in the postoperative period (POP).

Methods
From a total of 448 spine surgeries, we evaluated 61 patients with EOS underwent PSF for scoliosis or kyphoscoliosis at a single center between 2013 and 2015. Inclusion criteria were: thoracic or thoracolumbar curves, instrumented PSF ≥6 levels, no previous history of surgery, no early POP complication, and at least 2 years follow up each. Patients with growth guidance or growing rods systems, three-column osteotomies, or a history of chest or abdominal surgery were excluded. Spinal X-rays were performed at 6, 18, and 24 months POP.

Results
Of 61 patients, 47 met the inclusion criteria. PJK was observed in 24 (51.1%). The curves were neuropathic in 4.2%, idiopathic in 8.4%, syndromic in 41.6%, and congenital in 45.8%. Twelve were female and 12 male with a mean age of 8yr+1m (1yr+1m to 10yr). PJK at 6m/18m/24m was 15.8°/17.7°/22.7°. The UIV with the highest PJK rate was T6-T7. The most distal instrumented vertebra (LIV) with the highest PJK rate was L2. Mean PJK rate in children <5y was 16.1° (6m POP) and 19.7° (24mPOP), while in those >5yr mean PJK rate was 15.6° (6m POP) and 23.3° (24m POP). Mean follow-up was 2yr+11m (2yr to 3yr+9m).

Conclusion
Even though PSF is rare in EOS, a low rate of revision surgery due to PJK was observed (4.2%). PJK rate was higher in congenital and syndromic etiologies. Patients <5yr of age started with a higher PJK rate but this rate equalized from 8 to 10yr. The UIV with the highest PJK rate were T6-T7 and the LIV with the highest PJK rate was L2. The PJK angle increased with the growth of the child.

25. Graduation Protocol After Growing Rod Treatment: Is Removal Of Hardware Without New Instrumentation A Realistic Approach?

Ismail Aykut Kocyigit, MD; Z. Deniz Olgun; Gokhan Demirkiran, MD; Mehmet Ayvaz, MD; *Muharrem Yazici, MD*

Summary
Results of a prospective treatment decision made at the outset of growth-friendly surgical treatment for EOS: remove implants, similar to discontinuing a brace.

Hypothesis
Growing rod treatment has been likened previously to an 'internal brace'. Braces are utilized during the period of growth to prevent worsening of deformities and discontinued when growth is concluded. In a similar manner, the authors asked the question of whether growing rod implants could be removed at the end of growth, and what would happen if they were.

Design
Prospective non-randomized.

Introduction
The growing rod (GR) remains an effective option in the treatment of early-onset scoliosis, and has previously been likened to an internal brace. While details of GR treatment have been largely agreed upon, its appropriate conclusion remains a matter of controversy. A prospective decision was made in 2004 at the beginning of GR treatment of the first patient of this institution: remove longitudinal instrumentation when the period of lengthening concluded and, analogous to discontinuing a brace, leave the spine free. This report summarizes the outcome of this decision.

Methods
From 2004, patients less than 10 years old at index surgery were enrolled in the prospective treatment pathway. For this report inclusion criteria were: completeness of records and radiographs, regular lengthenings, no unplanned surgery, minimum 2 years' follow-up after age 14. At age 14, patients were re-evaluated and one of three treatment routes taken: group-1)adequate correction and no requirement for extension of fusion: growing rods removed, group-2)inadequate correction/interval changes: removal of growing rod and instrumented fusion, and group-3)Risser sign 0 or otherwise immature: continued lengthenings.

Results
Twenty-six patients met criteria. Mean age at index operation was 82.6 months. There were 10 patients in group-1, 9 in group-2 and 7 in group-3. Of the 10 patients whose rods were removed without additional instrumentation, 9 had significant worsening of deformity and required re-implantation with fusion.

Conclusion
Despite senior surgeons' initial intentions to remove hardware, only 10 of the initial 26 patients met criteria to do so. In a vast majority, deformity worsened after removal, proving that prolonged GR treatment does not necessarily result in reliable autofusion. Removal of spinal hardware without new instrumentation is not a realistic graduation protocol following GR treatment, and implants present should be retained or, if extension required, another procedure undertaken.

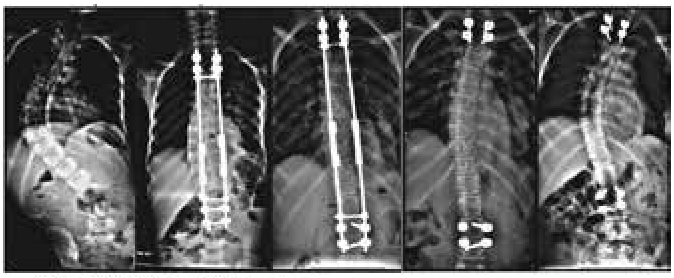

Table 1. Demographic information broken down into groups.

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Group 1 (n=10)	83	81-[illegible] (after removal)	12	61	25	35	34	56	35	36	0.2
Group 2 (n=9)	76	78-[illegible] (after fusion)	11	57	28	n/a	n/a	44	31	33	0.1
Group 3 (n=7)	87	83	12	48	23	n/a	n/a	n/a	n/a	29	None

All values are averages. Pre-graduation and post-graduation denote before and after removal of implants respectively. mo: months

26. Traditional Growing Rod Graduates with Various Diagnoses have Similar Clinical and Radiographic Outcomes

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Summary
Early-onset scoliosis patients of all etiologies have similar clinical and radiographic outcomes after completing traditional growing rod treatment.

Hypothesis
Early-onset scoliosis patients who complete traditional growing rod treatment will have varying degrees of clinical and radiographic outcomes.

Design
Multicenter retrospective review.

Introduction
Early-onset scoliosis (EOS) encompasses a diverse population of patients with multiple etiological diagnoses. Traditional growing rod (TGR) surgery has been described to be effective in treating specific underlying diagnoses within EOS (e.g. cerebral palsy, Marfan syndrome, congenital spine anomalies). However, no published literature has compared outcomes between the various etiologies in patients who completed TGR treatment. This study compared results between etiological categories in TGR graduates.

Methods
A retrospective review of a multicenter EOS database was performed. Patients were included if they had minimum 2-year follow up after index surgery, completion of TGR treatment, and post-graduation radiographs. 202 out of 232 TGR graduates met inclusion criteria. Patients were categorized by etiology per C-EOS: congenital, neuromuscular, syndromic, and idiopathic.

Results
There were 28 congenital, 65 neuromuscular, 57 syndromic, and 52 idiopathic patients. Age, gender, ethnicity, and BMI were similar between groups at time of index surgery; however, the neuromuscular group had a statistically significant higher percentage of non-ambulatory patients. Mean length of follow-up and number of lengthenings across groups were not significantly different. No differences were found from pre-index surgery to post-graduation between groups in major curve correction, increase in T1-S1 and T1-T12, implant related complications and surgical site infections (Table 1).

Conclusion
Coronal deformity correction and amount of spinal and thoracic height gain were similar across all etiologies after completion of TGR treatment. Incidence of implant and wound complications were also similar between etiologies. While EOS patients necessitate varying degrees of medical and surgical management based on their disease and health status, TGR graduates of all etiologies have similar clinical and radiographic outcomes.

	Congenital	Neuromuscular	Syndromic	Idiopathic	p
Female	57.1%	56.9%	61.4%	71.2%	0.416
Age at time of index surgery (years)	6.7	7.1	6.8	7.6	0.104
Ambulator at time of index surgery	94.7%	30.2%	82.9%	100.0%	<0.001*
Length of follow-up (years)	7.8	7.8	8.7	7.8	0.475
Mean No. of Lengthenings	7.4	5.5	6.4	6.3	0.246
BMI: Pre Index	16.1	16.8	16	17.7	0.546
BMI: 1st Post Graduation	18.6	21.9	17.6	20.3	0.082
BMI: 2 YR Post Graduation	22.1	22.5	22.1	19.9	0.342
Curve Correction: Pre Index to Post Index	40.9%	43.8%	37.3%	41.5%	0.292
Curve Correction: Pre Index to 1st Post Graduation	40.4%	43.5%	38.7%	48.9%	0.366
Curve Correction: Pre Index to 2 YR Post Graduation	12.0%	38.8%	32.8%	38.1%	0.485
T1-S1 Gain: Pre Index to 1st Post Graduation	34.2%	42.0%	35.2%	36.6%	0.388
T1-S1 Gain: Pre Index to 2 YR Post Graduation	43.8%	37.7%	38.5%	40.7%	0.967
T1-T12 Gain: Pre Index to 1st Post Graduation	28.5%	41.4%	28.2%	37.4%	0.822
T1-T12 Gain: Pre Index to 2 YR Post Graduation	36.9%	45.8%	37.9%	41.5%	0.927
Surgical site infection	25.00%	36.90%	35.10%	19.20%	0.147
Implant complication	53.60%	41.50%	57.90%	61.50%	0.139

*Statistical significance was set to p<0.05

27. Magnetically-Controlled Growing Rod Patients Have Better HRQOL Measures Compared to Traditional Growing Rod Patients: A Multicenter Pilot Study

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Summary
Despite having lower HRQoL domain scores pre-operatively, EOS patients treated with magnetically-controlled growing (MCGR) had significantly better Transfer, Daily Living and Emotion domain scores post-operatively compared to patients treated with traditional growing rods (TGR).

Hypothesis
MCGR patients have higher postoperative HRQoL scores compared to TGR patients.

Design
Multicenter retrospective cohort study.

Introduction
Since the introduction of magnetically-controlled growing rods (MCGR), patients with progressive early-onset scoliosis (EOS) have been afforded a reduction in the number of surgeries compared to the traditional growing rod (TGR) technique. However, little is known about whether there is an improvement in health-related quality of life (HRQoL) between these two surgical techniques.

Methods
We are reporting early HRQoL results of a multicenter retrospective cohort study that compared MCGR and TGR patients treated between August 2008 and November 2016. The EOSQ-24 questionnaire was used to measure HRQOL. The EOSQ-24 was administered at pre-op and 6-mo, 12-mo, 24-mo post-operative time points. A 10% difference in domain scores between the two groups was the minimal clinically important difference (MCID).

Results
Pre-operatively, the groups had similar gender distribution, age and major curve size. However, there were more neuromuscular patients in the MCGR group (44% vs. 29%) and more congenital patients in the TGR group (17% vs. 9%). Daily Living, Emotional, Transfer and Physical Function domain scores were lower in MCGR (n=119) compared to TGR (n=55) prior to index surgery. However, Transfer improved in MCGR at 6-mo and 12-mo. Daily Living remained lower for MCGR compared to TGR at 6-mo, however, improved in MCGR at 24-mo. Emotion was also better in MCGR at 24-mo.

Conclusion
Compared with TGR patients who underwent repetitive surgical lengthenings, MCGR patients had improved postoperative HRQOL scores in 3 of 10 domains. All other domains were similar between the groups.

28. Health-Related Quality of Life in Early-Onset Scoliosis Patients Treated Surgically: EOSQ scores in Traditional Growing Rod vs. Magnetically-Controlled Growing Rods

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Summary
This study aims to compare quality of life and caregiver burden in TGR and MCGR patients.

Hypothesis
MCGR increases HRQL compared to TGR

Design
Cross-sectional

Introduction
Traditional growing rods (TGR), the growth-preserving surgical treatment for early-onset scoliosis (EOS), causes repetitive stress on patients and requires a significant commitment of resources from their families. The magnetically controlled growing rod (MCGR) was developed in an attempt to decrease surgical sessions and achieve more natural growth with frequent non-invasive lengthenings. Although the clinical indications for these treatments have largely been agreed upon, there is a lack of understanding of their impact on patients' and their families' psychosocial status and health-related qualities of life.

Methods
Inclusion criteria: age less than 10 years and major curve more than 30° and minimum 2-year postoperative follow-up. The previously validated Turkish version of the Early Onset Scoliosis Questionnaire (EOSQ) was utilized to assess health-related quality of life. Paired-sample t tests were applied to test for significant differences in scores between TGR and MCGR patients. Statistical methods were utilized to control for length of follow-up to project scores in both groups.

Results
44 children, 19 treated with MCGR and 25 with TGR were included. TGR patients were significantly older at the time of questionnaire (8.7 vs 14.0y) and had longer follow-up (34.3 vs 101.3m); groups were similar in terms of gender and age at index surgery (6.7 vs 6.1y). Complications and unplanned surgeries were similar (p=.344).. EOSQ values current and projected are listed in Table. Scores of economic burden and overall satisfaction of children in MCGR group were significantly higher than those in TGR group by univariate analysis. When controlled for follow-up, some domain scores showed a trend toward being significant better in the MCGR group, some remained stable, and some became less significant.

Conclusion
HQRL data obtained from MCGR and TGR reveal superior outcomes in the financial burden and patient satisfaction, and, when controlled for length of follow-up possible superiority in general health, physical function and pain. However, the positive effect of MCGR in financial burden and satisfaction decreases when controlled for length of follow-up, and in all other domains, both treatments remain similar, indicating that the TGR is far from being obsolete as of yet.

Table: Questionnaire results, adjusted for follow-up.

	Questionnaire Results (mean)			Adjusted for follow-up (means; 95% confidence interval)		
Domain	MCGR	TGR	p	MCGR	TGR	p
General Health	59.9	58.0	0.703	66.6 (56.5-76.7)	52.9 (44.7-61.1)	0.084
Pain/Discomfort	71.1	77.0	0.642	86.0 (72.4-99.7)	65.6 (54.4-76.8)	0.059
Pulmonary Function	86.2	87.0	0.896	95.3 (82.6-107.9)	80.0 (69.7-90.5)	0.127
Transfer	65.8	51.0	0.160	54.3 (32.7-76.0)	59.7 (42.0-77.4)	0.749
Physical Function	72.4	57.0	0.075	78.0 (60.0-96.0)	52.7 (38.0-67.4)	0.075
Daily Living	50.0	61.5	0.287	55.0 (32.1-77.9)	57.7 (39.0-76.5)	0.877
Fatigue/Energy Level	71.1	77.0	0.421	76.1 (60.4-91.7)	73.2 (60.4-86.0)	0.812
Emotion	61.2	52.0	0.219	57.6 (41.8-73.4)	54.7 (41.8-67.6)	0.811
Parental Burden	53.4	46.0	0.308	51.3 (35.8-66.8)	47.6 (34.9-60.3)	0.758
Financial Burden	61.8	38.0	**0.002**	61.4 (45.6-77.2)	38.3 (25.4-51.2)	0.064
Overall Satisfaction	82.9	67.5	**0.010**	83.2 (70.7-95.8)	67.2 (57.0-77.6)	0.106
Average	66.9	61.1	0.194	69.6 (60.2-78.9)	59.1 (51.4-66.8)	0.155

29. What is the Influence of Pedicle Screw Instrumentation for Vertebral Body and Spinal Canal in Children Younger than 5 Years Old: A More than 5 Years Follow-Up

Jianguo Zhang, MD; Yan Bin Zhang, MD

Summary
Segmental pedicle screws instrumentation is the state-of-art treatment of scoliosis. It provide better correction rate than other techniques.The effect of pedicle screws instrumentation in pediatric patients needs to be illuminated.

Hypothesis
The application of this treatment in very young children may lead to the damage of neurocentral synchrondrosis and result in retardation of vertebra development.

Design
We set the maximal operation age to 5 years old as the growth rate of vertebrae reaches peak rate before 5 years old, and the minimal follow-up time to 5 years when the spine is almost completely developed, to investigate whether pedicle screws instrumentation at a very young age could have a negative impact on the development of spine.

Introduction
When compared to other spinal instrumentation techniques (i.e. hooks, wires, and hybrid constructs), pedicle screws instrumentation demonstrates considerably better curve correction, lower revision rate, shorter fusion length as well as less operation time. Recently this kind of technique has got extensive application in pediatric patients, especially in the treatment of congenital

scoliosis. Concern remains over the effect of pedicle screw insertion on the growth potential of vertebral body and spinal canal.

Methods
This study reviewed 13 patients with congenital scoliosis who underwent pedicle screws instrumentation under 60 months old with a follow-up of more than 60 months. All patients' CT images before operation and in the last follow-up were obtained. Measurements were performed in all instrumented and adjacent non-instrumented vertebrae (within 3 levels).

Results
A total 107 segments of vertebrae were measured. The growth values of instrumented and non-instrumented vertebrae were compared. Significant difference existed in vertebral body length, pedicle length, anteroposterior diameter of the spinal canal and area of the spinal canal between instrumented and non-instrumented vertebrae.

Conclusion
Pedicle screws instrumentation may have dual effect on the vertebral growth, promoting the growth of posterior vertebral elements and also inhibiting the growth of anterior vertebral elements.

30. Comparison of Ponte Osteotomies, Hemivertebrectomy and Vertebral Column Resection in the Treatment of Congenital Spinal Deformity

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Summary
Patients with congenital spinal deformity treated with multiple Ponte osteotomies achieved similar correction, and less neurologic risk than those treated with 3 column osteotomies.

Hypothesis
PO will provide the majority of the correction with less neurologic risk when compared to HV/VCR in the treatment of congenital spinal deformity.

Design
Retrospective review

Introduction
Congenital spinal deformity has traditionally been treated with 3 column osteotomies (hemivertebrectomy or vertebral column resection) to address rigid deformities. Alternatively, multiple Ponte osteotomies may provide correction while minimizing risk. Our purpose was to compare safety and outcomes of patients undergoing surgical treatment for congenital spinal deformity with these three procedures.

Methods
Retrospective review of congenital spinal deformity patients treated with posterior spinal fusion between 1996 to 2013. Patients treated with multiple Ponte osteotomies (PO group) were compared to those managed with 3 column osteotomies (HV/VCR group). Patients with previous instrumentation, isolated cervical deformity, growing spine instrumentation, or < 2 year follow-up were excluded. Deformity angular ratio (DAR) was calculated as curve magnitude divided by number of levels of the deformity.

Results
There were 49 patients (17 PO, 32 HV/VCR [26 HV, 6 VCR]). For the PO group, mean age was 14 years, and they had a mean of 4 pontes and an 11 level fusion. The PO group had a mean number of 1.8 congenital anomalies. The HV/VCR group had a mean age of 7 years and a 5 level fusion. The HV/VCR group had a mean total DAR of 28 and mean number of congenital anomalies was 2.1. Patients had a mean of 54.1% correction of coronal deformity in the PO group and 54.4% in the HV/VCR group (p=0.78). Signal changes were observed less frequently with PO (5.9%; 1/17) and HV (3.8%; 1/26) than with VCR (66.7%; 4/6), p=0.001. 1 patient in the VCR group had a permanent neurologic injury. Revision rates were 17.6% (3/17) in the PO group and 37.5% (12/32) in the HV/VCR group (p= 0.35). See Table 1.

Conclusion
Patients with congenital spinal deformity (DAR = 25) treated with multiple Ponte osteotomies and long fusions had correction comparable to the HV/VCR group (DAR=28). Vertebral column resection is the group at highest risk for signal changes and permanent neurological injury.

Table 1. Reasons for Revision.

Reasons for Reoperation	PO (n=17)	HV/VCR (n=32)
Total	3 (17.6%)	12 (37.5%)
Decompensation below LIV	0	1
Proximal junctional kyphosis	1	1
Broken implants	0	3
Implant migration	0	3
CSF leak and wound dehiscence	0	1
Pseudarthrosis	0	2
Wound drainage	1	1
Implant prominence	1	0
Progression of scoliosis	0	2

31. Is There Still a Place for Convex Hemiepiphysiodesis in Congenital Scoliosis in Young Children? A Long Term Follow-up.

Maroun Rizkallah, MD; Gaby Kreichati, MD; Amer Sebaaly; *Khalil Emile Kharrat, MD*

Summary
When it is performed in case of isolated HV, in curves less than 35° and in children younger than 3 years old, convex hemiepiphysiodesis yields it best results with 71% of correction of the congenital curve. It then spares the patient the risks of vertebral resection and instrumentation.

Hypothesis
The purpose of this study is to evaluate the long term results of anterior and posterior convex hemiepiphysiodesis used to treat congenital scoliosis with HV and to evaluate its effect on coronal deformity correction.

Design
This is a Retrospective descriptive study

Introduction
Nowadays, hemivertebra(HV) resection followed by limited fusion and instrumentation is the most used procedure in the treatment of congenital scoliosis in children with HV. This procedure has its well-known risks (particularly neurologic).

Methods
This study is performed on 30 children with 33 congenital scoliotic curves operated on using a one staged double approach (anterior+posterior) hemiephysiodesis by bone grafting of the convex side without instrumentation. We defined a "Limited Fusion" as the one centered on the HV and including the 2 adjacent levels. An "Extensive Fusion" is carried on more than one adjacent vertebra to the HV. Patient's mean age at surgery was 3 years, with an equal distribution of genders and a mean frontal Cobb angle of 42.5°. The mean follow up is 15 years (8 to 25 years). There were 23 isolated HV and 10 HV associated to a congenital bar(CB). Limited Fusion was performed on 21 curves with a mean angle of 37° while Extensive Fusion was performed on 12 curves with a mean angle of 50°.

Results
Overall results showed a frontal Cobb angle reduction from 42.5° to 29.5°. Twenty two curves had a mean correction of 47%, 8 curves were stabilized and 3 curves had a mean aggravation of 16% . Subgroup analysis took into account age at surgery, type of the malformation, and Cobb angle. It showed: - 57% correction in patients aged <3 years and 32% in patients aged >3 years. - 55% correction in curves with isolated HV compared to 26% correction in curves with HV and CB. - 65% correction in curves <35° compared to a 40% correction in curves >35°. The best correction with Limited Fusion (71%) occurred in case of an isolated HV, with a curve less than 35° and a surgery performed before age of 3.

Conclusion
A limited convex hemiepiphysiodesis still have a place in congenital scoliosis care, sparing the patient the risks of vertebral resection and instrumentation, fusing the same number of levels, when it is performed in case of isolated HV, in curves less than 35° and in children younger than 3 years old.

32. Incidence and Risk Factors of Neurological Complications of Thoracic PVCR for Severe Rigid Congenital Spinal Deformities

Hui-Ren Tao, MD, PhD; Bo-bo Zhang, MD; Michael S. Chang, MD

Summary
PVCR at thoracic spine carries high risk of neurological injury. Incidence and risk factors for neurological complications when treating spinal deformities by thoracic PVCR were investigated. Clinical records and radiographic data of 62 pts were retrospectively reviewed. Multi-factor logistic regression revealed the risk factors for neurological complications were age ≥ 18 years, pulmonary dysfunction, and EBL> 50%. And the pulmonary dysfunction can be regarded as the most valuable indicator to measure the severity

Hypothesis
New risk factors of neurological complications may be found in thoracic PVCR.

Design
Retrospective clinical study.

Introduction
By PVCR can achieve satisfactory results in treating severe rigid spinal deformities. However, neurological injury risk following thoracic osteotomy is probably high. And there were few studies have analyzed the neurological complications of thoracic PVCR. Accordingly, the present study evaluated the incidence and risk factors for neurological complications of thoracic PVCR in treating severe and rigid congenital spinal deformities at a single institution.

Methods
Between 2008 and 2013, there were 62 consecutive patients (34 female and 28 male patients; mean age: 16.3 years) treated with thoracic PVCR. We retrospectively reviewed the clinical records to obtain demographic and radiographic data, operative time, estimated blood loss (EBL, the ratio between circulating and lost blood), bleeding volume (the lost blood), intraoperative neuromonitoring data and so on. Multi-factor logistic regression was used to find the major risk factors for neurological complications.

Results
The average follow-up period was 46 months (range: 24–88 months); no patients were lost to follow-up. The average operative time was 524.8 ± 156.8 minutes (range: 165.0–880.0 minutes), the average bleeding volume was 2585 ± 2210 ml (100–9600 ml), and the average estimated blood loss was 75.8% (9%–278%). Ten patients (16.1%) developed postoperative neurological complications (9 transient (Figure 1) and 1 permanent). Multi-factor logistic regression revealed the risk factors for neurological complications were age ≥ 18 years, pulmonary dysfunction, and EBL> 50%).

Conclusion
Thoracic PVCR can lead to satisfactory outcomes in the treatment of severe spinal deformities. Risk factors for neurological complications include age over 18 years, presence of pulmonary dysfunction, and EBL greater than 50%. And the pulmonary dysfunction can be regarded as the most valuable indicator to measure the severity of the spine deformity.

Fig. 1 Radiographic findings of a 26-year-old woman who had congenital scoliosis associated with syringomyelia and severe restrictive ventilatory dysfunction. Neurological function was normal preoperatively, but after T8, 9 PVCR, the strength of the left leg was grade IV and sensation decreased. Neurological function recovered to normal within one week. The preoperative radiographs demonstrate a right curve of 144° (A) and kyphosis of 130° (B). The postoperative radiographs demonstrate a right curve of 45° (C) and kyphosis of 41° (D).

33. 3D Assessment of Spine Growth in Early Onset Scoliosis During Growing Rod Lengthening

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Summary
Measuring the true spine growth during growing rod (GR) lengthening is limited with 2D radiographs. With 3D imaging, this study demonstrates that during GR lengthening the spine lengthens and vertebra increase in size suggesting spinal growth that matches the relative increase in rod length during the distraction period.

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

Hypothesis
Early Onset Scoliosis treated with growing rods can be monitored in 3D

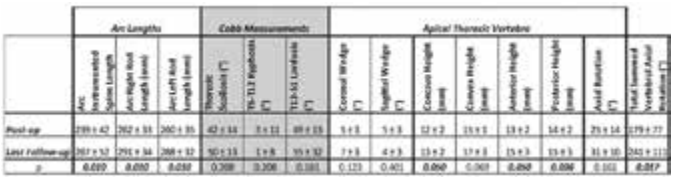
Design
3D analysis of retrospectively collected images

Introduction
Current methods of assessing spinal growth during growing rod (GR) treatment utilizing 2D radiographs are limited. 3D spinal contour and growth during GR lengthening in Early Onset Scoliosis (EOS) has not been reported. The purpose of this study is to analyze 3D spinal contour, rotation and growth in patients with EOS during GR lengthening.

Methods
Cohort: ≤10year olds with non-congenital EOS, monitored using simultaneous biplanar radiographs during the GR lengthening period (post-index surgery to last follow-up). 3D reconstructions were created. Arc lengths of the entire spine, instrumented spine, and rods were calculated. Thoracic scoliosis, kyphosis, lordosis and apical thoracic vertebra wedge angles and heights were measured relative to the local vertebral coordinate systems (vertebrae derotated). Local Cobb magnitudes were summed over the primary thoracic curve and sagittal measurements were summed from T5-T12 and T12-S1. Parameters from index procedure and last follow-up images were compared via nonparametric statistics (Wilcoxon Signed Rank test) due to the small cohort size. Significance was $p \leq 0.05$.

Results
Eight patients (4 M, 4 F), mean age of 7.6 (range 3.9-10.2) yrs at index surgery, were followed during lengthening at a mean of 31.2 months (range 17-49). Etiologies included idiopathic(2), tumor related(2), neuromuscular(2 Chiari, 1 tethered cord), syndromic(1). Scoliosis, Kyphosis and Lordosis were maintained throughout the treatment period (TABLE). The full spine arc length increased significantly (319±40 to 360±40mm, p=0.012), as did arc length of the instrumented spine, concave, anterior, posterior vertebral heights, demonstrating overall spinal growth as both rods lengthened significantly. Apical vertebral wedging (coronal or sagittal) did not change and rotation did not change significantly.

Conclusion
During the lengthening process, spine growth is obtained as measured in 3D by the changes in spine arc length and vertebral height. When compared to the changes in rod length (28-29mm) during this period, the instrumented spine demonstrates a matched response in growth (28mm). Future studies utilizing 3D radiographic analyses will better compare the effects of different treatments on spinal growth.



34. Neuromuscular Scoliosis Complication Rates are Significantly Decreased from a Decade Ago: A Report from the SRS M&M Database

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Summary
Neuromuscular (NM) scoliosis correction is associated with a high complication rate. We sought to determine if the rate of complications have decreased over the last decade. We retrospectively reviewed a self-reported complication database. All complication rates appear to have decreased from 11-16% down to approximately 4%.

Hypothesis
The incidence of complications in NM scoliosis surgery has decreased over the last decade.

Design
Retrospective review of registry

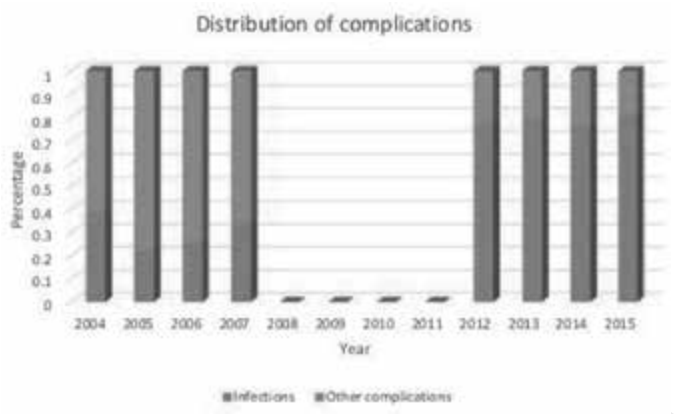
Introduction
Surgeons constantly try to minimize surgical complications, and NM scoliosis correction has some of the highest complication rates. We sought to query the SRS M&M registry to see how complications in NM scoliosis have changed over the last decade. We retrospectively reviewed complications reported in the database from 2004 to 2015.

Methods
We retrospectively reviewed complications reported in the SRS M&M database from 2004 to 2015.

Results
Overall incidence of complications was consistent between 2004-2008, varying from 11-16%, but appears to have decreased dramatically after 2008, nearing 4%. The most commonly reported complications were related to wound healing and infections. The absolute number of infections has decreased over time (Figure). Increased data were available from 2012-2015 and suggested that most infections occurred at 20.2 ± 1.4 days post-op, with the majority being deep infections (72.25%). The most common infections were consistently MSSA (27.2%), followed by E. Coli (13.8%), Pseudomonas (10.1%), MRSA (8.1%), and Staph Epidermidis (6.1%). There was also a decrease, albeit not statistically significant, in antibiotic administration (both IV and PO) from 2012-2015, decreasing from 48.5 ± 75.6 days to 33.1 ± 32.6 average days of IV antibiotics (p=0.11), and 91.1 ± 108.4 to 80.3 ± 72.5 average days of PO antibiotics (p=0.56). Risk of neurological injury ranged from 0.8-1.4% between 2004 and 2007 and then has decreased to a range of 0.4-0.7% since.

Conclusion
In NM scoliosis, reported complication rates appear stable over the last several years but may be lower than a decade ago. Although infections and wound healing have decreased, they continue to represent a significant portion of complications encountered in neuromuscular scoliosis surgery.

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



35. Proximal Rib-Based Constructs in Early Onset Scoliosis: Survivorship at or near Skeletal Maturity

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Summary
In the surgical treatment of patients with EOS using proximal rib-based constructs, complication risks and reoperations are often high. While modern day rib-based constructs offer additional proximal fixation options, patient risk factors identified in this study need to be considered during preoperative planning.

Hypothesis
We hypothesized that the majority of proximal rib-based construct revisions and failures will occur within 2 years of implantation.

Design
Multicenter retrospective cohort study

Introduction
Rib-based constructs are a commonly employed type of instrumentation for the treatment of early onset scoliosis (EOS). This study aims to examine the longevity of such constructs and to identify risk factors associated with revisions.

Methods
This study queried an EOS registry of 15 major institutions for patients who had implantation of traditional rib-based growing constructs between 2002 and 2011 with 4 or fewer proximal anchors and a minimum of 5 years of follow-up. This yielded a total of 206 EOS patients. Constructs requiring removal or revision were evaluated. Statistical analysis was performed to evaluate the relationship between revision/failures and the following factors: age, Cobb, kyphosis, gender, unilateral vs bilateral constructs, BMI, ambulatory status, and etiology.

Results
Mean age at implantation was 5.8±2.8years. Mean follow-up 6.6±2.4years. Of 206 total patients, 140 required construct revision or removal and 66 reached final fusion. Risk of revision/removal per each year was calculated as: 26% (year 1), 18%(2), 17% (3-4), 16% (5), 13% (6), 11% (7), 0% (8-14). 90% of all revisions and removals occurred in the first 4 years. Severity of Cobb ($P<0.006$), kyphosis>50 ($p<0.021$), age at implantation ≤6 years old ($p<0.001$), and distal anchor fixation to the pelvis ($p<0.02$) were all found to be significant risk factors. Factors such as BMI, gender, unilateral vs bilateral architecture, and etiology did not demonstrate statistical significance.

Conclusion
Proximal hardware complication failures and reoperations are high although modern day rib-based constructs offer additional options. While proximal hardware complications decrease over time, overall rates of revision are quite high after traditional rib-based constructs. High revision rates persist throughout 5 years subsequently, but it should be noted that this study describes a historical cohort of patients with rib-based constructs, so these results may not be applicable to modern day constructs.

36. Unilateral vs. Bilateral Iliac Screw Fixation in Adult Deformity Surgery: Long-Term Outcomes and Complications

Michael S. Chang, MD; Dennis G. Crandall, MD; Jan Revella, RN; Yu-Hui H. Chang, MPH, PhD

Summary
43 patients undergoing unilateral iliac screw fixation for adult spinal deformity were matched with 34 patients receiving bilateral fixation. At greater than 5 yrs follow-up, patients with unilateral iliac screw fixation had less pain with similar radiographic and HRQOL outcomes.

Hypothesis
Unilateral iliac screw fixation is as effective in adult deformity surgery as bilateral fixation without additional risk for decompensation or non-union.

Design
Retrospective analysis of prospective cohort

Introduction
Iliac screw fixation improves construct strength and stability but extends operative times and may require a separate procedure for removal due to irritation. Studies suggest that unilateral iliac screw placement may be as effective as bilateral over the course of 2-3 yrs, but no study to date has explored the long-term clinical and radiographic outcomes between these two methods, when problems such as non-union or progressive imbalance are more likely to occur.

Methods
77 pts with adult deformity underwent unilateral (n=43) or bilateral (n=34) iliac screw fixation as part of their thoracolumbar fusion at a single center. Minimum follow up was 5 yrs (mean 7.1 yrs) and all fusions were T11 to pelvis or longer. HRQOL data including VAS and ODI as well as radiographic outcomes were assessed at pre-op, 1 yr, 5 yrs, and latest follow-up. Residual symptoms after surgery and complications were also analyzed. Statistics included Chi-square and 2 sample t-test.

Results
While the two groups had similar HRQOL scores before and in the short-term after surgery, by 5 yrs the bilateral group had significantly worse VAS (4.6 vs 3.2, $P<0.01$) and ODI (0.38 vs 0.25, $P<0.001$). Posterior iliac pain counted for much of this discrepancy, with 35.3% of the bilateral group vs. 11.6% of the unilateral affected. Of the unilateral group, pain was more likely on the side of screw placement (9.3% vs. 2.3% contralateral). The uni group was also less likely to have a second surgery for iliac screw removal ($P=0.02$). Other complications between both groups were similar with no difference in

non-union rates or need for revision surgery other than iliac screw removal. All radiographic parameters, including alignment and balance, were similar between the groups at all time intervals.

Conclusion
Unilateral iliac screw fixation compares favorably to bilateral placement for adult deformities. Although initial HRQOL measures were similar between the two groups, over time the unilateral group had less posterior iliac pain and was less likely to need revision surgery for iliac screw removal. The overall rate of union, balance, and functional outcomes were not significantly different at 5 yrs.

37. Early versus Delayed Rod Fracture in Adult Spinal Deformity Surgery Differ in Presentation and Revision Rates

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Summary
Rod fracture (RF) in adult spinal deformity (ASD) surgery were divided into 2 groups, early RF (ERF) occurring within 4 yrs or delayed RF (DRF) beyond 4 yrs after surgery. We found different rates between ERF and DRF. ERF were more symptomatic and had a higher revision rate and slightly less HRQOL outcomes improvements at early postop period. Use of different rod sizes and material and dose of BMP-2 is associated with different time of onset of RF.

Hypothesis
ERF and DRF occur with different rates, clinical outcomes and revision rates.

Design
Retrospective analysis.

Introduction
The detailed data of the pts. correlated with the time of onset of RF after ASD surgery has not been described in the literature. We aimed to compare differences in incidence, contributing factors and clinical outcomes between ERF and DRF pts.

Methods
Pts were included if they were > 18 yo, ≥ 5 levels fused to sacrum from 2004-2014 and ≥ 2 yrs F/U. Pts were stratified according to onset of RF: ERF ≤ 4 yrs and DRF > 4 yrs after index surgery. We reviewed demographics, radiographic and operative data, outcomes, complications and revision rates. HRQOL outcomes were assessed at baseline, 1-yr and latest F/U. Analyses were performed using a t-test, ANOVA and $\chi 2$ test.

Results
524 pts out of 657 pts were included (Avg.56.8 yo, 87% F). 63 pts (12%) developed ERF and 32 pts (6.1%) DRF. Groups were similar in baseline demographic, preop/postop radiographic parameters and amount of correction. DRF had longer F/U (6.7 yr vs 4.6 yr) and survival time to RF (5.9 yr vs 2.1 yr), all p<0.01. ERF had more frequency of cobalt chromium (CC) rod use (58.8% vs 28.2%) and smaller diameter (5.5mm) rod use compared to 6.35mm rod (87.3% vs 62.5%), all p=0.01. ERF used lower dose of BMP-2 (106 mg vs 138 mg, p=0.04). There were no differences in # of rod use, # of fused levels, #/type of osteotomies, interbody fusion, pelvic fixation and use of allograft (all p>0.05, Table1). ERF had higher postop major complications including persistent pain, loss of correction and prominent rod (49% vs 28%), and higher revision (49% vs 28%), all p<0.05. ERF and DRF were similar in baseline, 1-yr and latest F/U HRQOL outcomes as measured by ODI and SRS-30. The overall improvement of ODI and SRS-30 compared to baseline was similar in both groups (all p>0.05), however ERF tended to have less improvement of ODI at 1-yr postop (17.3 vs 24.6, p=0.051).

Conclusion
There are distinct differences between ERF and DRF. Use of smaller rod diameter, CC material and lower dose of BMP-2 is associated with ERF. Compared to DRF, ERF have greater symptoms, higher revision rate and slightly less outcomes improvements at early time period.

Table 1: Comparison of Early and Delayed Rod Fracture Patients in Adult Spinal Deformity Surgery

	Early Rod Fracture (n=63)	Delayed Rod Fracture (n=32)	P Value
Preoperative Radiograph			
SVA (cm)	7.2	6.5	0.64
PT	30.0	26.8	0.19
PI-LL	22.3	19.7	0.63
TK (T5-T12)	37.9	32.1	0.20
TL Kyphosis (T10-L2)	27.1	18.7	0.10
Max coronal Cobb angle	53.7	55.0	0.82
Postoperative Radiograph			
SVA (cm)	2.6	2.0	0.53
PT	23.3	21.3	0.36
PI-LL	8.3	4.5	0.27
TK (T5-T12)	36.7	37.6	0.75
TL Kyphosis (T10-L2)	11.2	9.1	0.52
Max coronal Cobb angle	26.2	23.7	0.55
Surgical Factors			
Rod Material use Cobalt Chromium Stainless Steel	 37 (58.8%) 26 (41.3%)	 9 (28.2%) 22 (68.8%)	0.01*
Rod Diameter 5.5 mm 6.35 mm	 55 (87.3%) 8 (12.7%)	 20 (62.5%) 12 (37.5%)	0.01*
Number of Rods 2 3 4	 44 (69.8%) 13 (20.6%) 6 (9.5%)	 29 (90.6%) 3 (9.4%) 0 (0%)	0.054
# of Fused levels	11.8	11.6	0.84
Pedicle Subtraction Osteotomy	11 (17.5%)	7 (21.9%)	0.60
Three Column Osteotomy	14 (22.2%)	7 (21.9%)	0.97
Interbody Fusion	40 (63.5%)	22 (68.8%)	0.61
Pelvic Fixation	60 (95.2%)	32 (100%)	0.21
BMP-2 (mg)	105.5	138.4	0.04*
Use of Allograft	44 (69.8%)	20 (62.5%)	0.47
Outcomes Improvements			
ODI at 1 year	17.3	24.6	0.051
ODI at latest F/U	15.0	16.7	0.67
SRS: Average of Domain at 1 year	0.78	0.93	0.36
SRS: Average of Domain at latest F/U	0.78	0.76	0.998
SRS: Satisfaction Domain at 1 year	1.32	1.65	0.30
SRS: Satisfaction Domain at latest F/U	1.29	1.11	0.62
Survival time to Rod Fracture (yrs)	2.1	5.9	<0.01*
Revision rate	31 (49.2%)	9 (28.1%)	0.049*

*Statistically significant

38. Sacropelvic Fixation Using S2 Alar-Iliac (S2AI) Technique in Adult Spinal Deformity Patients Fused to the Sacrum: The Fate of the SI Joint at Five Years

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Summary
The S2-alar-iliac sacropelvic fixation technique described previously by our group minimizes implant prominence and tissue dissection, and has been shown to have a lower complication rate and need for revision compared with the traditional iliac screw technique. We sought to assess the long term effect of the S2AI technique on the sacroiliac joint in 103 patients, and found a 10.8% rate of buttock pain, and a 3.5% incidence of radiographic SI joint degeneration at five year follow up.

Hypothesis
There are no long term adverse effects on the SI joint after S2AI sacropelvic fixation.

PAPER ABSTRACTS

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

Design
Retrospective review of a prospective database.

Introduction
Reportedly, up to 34% of iliac screws may need to be removed for screw prominence and postoperative buttock pain. In this regard, we sought to assess the effect of the S2AI screw on SI joint pain and degeneration at 5 year follow up.

Methods
197 consecutive ASD patients who underwent sacropelvic fixation with S2AI technique 2007-2012 were eligible for 5 year follow up. After excluding patients with ankylosing spondylitis, and those with incomplete follow up data, the study population consisted of 103 patients (52.2%). Clinical outcomes assessed included buttock pain, symptomatic screw prominence, SI joint injection, and S2AI screw revision. The primary radiographic outcome was SI joint degeneration.

Results
Complications specific to the S2AI technique occurred in 4 patients (3.9%): 2 (1.0%) broken screws in 2 patients (1.9%), and 4 (2.0%) screws in 2 patients (1.9%) removed for persistent buttock pain. The prevalence of buttock pain at 5 years was 10.8% (10 patients). Two patients required an SI joint injection for buttock pain (1.9% of patients). New evidence of SI joint degeneration compared with preoperative radiographs was seen in 4 patients (3.5%). Patients who developed radiographic SI joint degeneration after S2AI technique were significant older at the time of surgery (75.5±5.8y) versus those who did not (59.5±11.4y) (p=0.006). There was a significant association between radiographic evidence of S2AI screw loosening and ipsilateral SI joint degeneration (p=0.011). SI joint degeneration was significantly associated with symptoms of SI joint/buttock pain (p=0.046).

Conclusion
This is the largest series demonstrating long term effects of the S2AI technique on the SI joint. Older patients may be more likely to develop SI joint degeneration after S2AI fixation. Interestingly, radiographic evidence of S2AI screw loosening may be associated with the incidence of SI joint degeneration.

39. Towards the Development of a Core Outcome Set for Adult Spinal Deformity Surgery

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Summary
A total of 29 outcome domains were identified in the Adult Spinal Deformity (ASD) literature. In the next phase, using a modified Delphi study, the list of outcome domains derived from the present study will serve as a foundation for the development of a core outcome set for ASD surgery for implementation in spine registries and future clinical trials.

Hypothesis
International formal consensus can be reached on which outcomes and contributing factors should be included in core outcome sets for adult spinal deformity surgery.

Design
Systematic review of the literature

Introduction
Adult Spinal Deformity causes severe functional disability, reduces overall quality of life, and results in a substantial societal burden of disease. As healthcare is becoming more value-based, and global benchmarking is required to improve outcomes, standardising patient-reported outcomes (PROs) is a key first step; however, this can only achieve its maximum benefit when the measures used are uniform, valid, reliable and risk-adjusted.

Methods
A systematic review of the literature to highlight current strengths, weaknesses and gaps in PROs used for assessment of ASD; to provide recommendations for future improvements; and to serve as a foundation for the process of seeking global consensus on standardising outcomes measures in future clinical trials and spine registries worldwide. PROs were extracted and linked to the outcome domains of WHO's International Classification of Function, Disability and Health (ICF) according to international linking rules.

Results
The systematic review identified 144 papers that met inclusion criteria, and nine frequently used PROs were identified. These covered 29 ICF outcome domains, which could be grouped into 3 of the 4 main ICF chapters: body function (n=7), activity and participation (n=19), and environmental factors (n=3). The three most reported outcome domains are: b280 Sensation of Pain, d850 Recreation and leisure, and d450 Walking.

Conclusion
A total of 29 outcome domains were identified. Outcome domains related to mobility and pain were well represented. We identified a gap in current outcome measures regarding neurological and pulmonary function. In the next phase, supported by an SRS directed research grant, using a modified Delphi study these results will serve as a foundation for the process of seeking international consensus on a standard set of outcome domains, accompanied PROs and contributing factors to be used in future clinical trials and spine registries. This will subsequently allow for global benchmarking of standardised risk-adjusted surgical outcomes and ultimately lead towards value-based care

Table 1. Top 10 identified outcome domains within PROs in 144 ASD publications.

Top 10 Most Frequent Measured Outcome Domains in Literature	Measured (%)	Top 10 Less Frequent Measured Outcome Domains in Literature	Measured (%)
Sensation of pain	83	Hand and arm use	7
Recreation and leisure	67	Work and employement, other specified and unspecified	12
Walking	62	Energy en drive functions	12
Informal social relationships	60	Intimate relationships	27
Remunerative employment	40	Basic interpersonal interactions	27
Doing housework	40	Moving around using equipment	27
Carrying out daily routine	40	Sexual function	27
Moving around	39	Sleep function	27
Experience of self and time functions	35	Temperament and personality functions	28
Emotional functions	34	Family relationships	28

40. Radiographic Sagittal Alignment in the Asymptomatic Elderly: What is Normal for Age?

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Summary
Given the high complication rate of deformity correction in the elderly, this study attempted to define "normal for age" in terms of sagittal alignment, however, the results of this study showed that asymptomatic elderly individuals maintained a relatively normal sagittal profile.

Hypothesis
Asymptomatic, elderly individuals will have an increasingly positive sagittal balance as determined by the sagittal vertical axis (SVA).

Design
Prospective Cohort

Introduction
Over the past several years, there has been an increasing awareness of the impact of positive sagittal alignment in the overall health related quality of life (HRQOL). However, attempts to restore normal spino-pelvic parameters in the elderly population can introduce challenges with risk factors inherent in this age group.

Methods
One hundred and thirty-five volunteers were recruited and divided into cohorts for age ranges of 60, 65, 70, 75 and 80 years. Subjects were asked to complete ODI (Oswestry Disability Index) and VR-12 (Veterans Rand 12) questionnaires as well as stand for a full lateral radiograph. The primary outcome measure was the SVA with other measurements including thoracic kyphosis (T4-T12), total lumbar lordosis (L1-S1), lumbar lordosis (L4-S1), pelvic tilt (PT), pelvic incidence (PI), pelvic incidence lumbar lordosis mismatch (PI-LL), sacral slope (SS), and T1 spino pelvic inclination (T1SPi). Statistical analysis was performed with significance set at ($p<0.05$).

Results
The mean SVA for the 60, 65, 70, 75 and 80 year age groups were (21.55,18.22, 27.68, 37.3, 39.04)mm respectively which, overall, were not significantly different and were in the normal range of < 40mm ($p = 0.1083$) . We did find significant differences between the age groups in L1-S1($p=0.0056$), and SS($p=0.0113$), with a positive correlation between age group and L1-S1 ($p=0.0006$) and a negative correlation between age group and SS ($p=0.0061$). The mean L1-S1 for the age groups were (57.32, 52.93, 53.4, 48.77, 45.39) degrees respectively with significant differences between the 60 year and 75 year age groups ($p=0.0382$), and the 60 year and 75 year age groups ($p=0.006$). The mean SS for the age groups were (39.18, 32.97, 34.33, 32.57, 32.17) degrees respectively with significant differences between the 60 year and 70 year age groups ($p=0.0354$), the 60 year and 75 year age groups ($p=0.0194$) and the 60 year and 80 year age groups ($p=0.0384$). The ODI and VR-12 scores were not significantly different between the age groups.

Conclusion
Asymptomatic elderly individuals maintained a relatively normal SVA; however, full body radiography may better demonstrate other compensatory mechanism accounting for this.

Table 1: Mean radiographic parameter values for each age group. * significantly different ($p < 0.05$)

	Age Group (Years)					
Parameter	60	65	70	75	80	ANOVA P-Value
SVA (mm)	21.55	18.22	27.68	37.30	39.04	0.1083
PI(°)	55.61	50.79	52.70	50.17	51.33	0.4372
PT(°)	17.00	18.31	19.07	18.13	19.72	0.7738
SS(°)	39.18	32.97	34.33	32.57	32.17	*0.0113
PI_LL(°)	-1.71	-2.17	-0.60	1.30	6.11	0.1079
L4_S1(°)	-43.79	-41.90	-43.57	-40.13	-41.11	0.5322
LL(°)	-57.32	-52.93	-53.40	-48.77	-45.39	*0.0056
T1_Spi(°)	-3.25	-4.34	-3.30	-2.27	-2.39	0.147
T4_T12(°)	38.61	44.19	47.47	42.73	38.33	*0.0116

41. No Relation between Lumbopelvic Mismatch and Poor Outcome in Thoracic Hyperkyphosis Corrections

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Summary
In Scheuermann's patients no predictable realignment of the pelvis and lumbar spine was observed 14-21 year after thoracic fusion corrections and no relationship was found between lumbopelvic mismatch and clinical outcome.

Hypothesis
Lumbopelvic mismatch do not relate to clinical outcome after thoracic hyperkyphosis corrections.

Design
Retrospective consecutive cohort study

Introduction
In adult spinal deformity, when planning sagittal deformity correction, postoperative lumbopelvic mismatch (LPM; Lumbar Lordosis (LL) minus Pelvic Incidence (PI) > ±10°) has been described to predict failure and functional outcome after lumbar fusion corrections. However, for selective thoracic kyphosis (TK) correction in patients with Scheuermann's kyphosis (SK) the relation between these lumbopelvic parameters and functional outcome is unknown.

Methods
For 28 of the 33 patients (85%) in a cohort of surgically treated Scheuermann's patients (mean age 26.5 years) full spine radiographic assessments at preoperative (PO), 3-months postoperative (FU1) and 14-21 years follow-up (FU2) were available as well as functional outcome (Oswestry Disability Index; ODI) at FU2. Spinopelvic parameters and multiple sagittal spine parameters were analyzed. Correlations between lumbopelvic mismatch and ODI at FU2 were determined.

Results
The mean ODI at FU2 was 20 (SD 18). At PO average TK was 82°, LL was 75° and PT was 8°. At FU1 average TK was 61° (correction 26%), LL was 64°, PT was 6° and LPM occurred in 17/18 patients. At FU2 average TK changed to 68° (correction 17%), LL to 60°, PT to 11° and LPM occurred in 19/28 patients. Average PI was 44°. No strong correlations were observed in sagittal realignment between any of the parameters measured. Moreover, patients with similar changes in LL could show paradoxical changes in PT (i.e. increase/decrease). Chi-square test between LPM and dichotomized functional outcome (ODI≤22 = success) was 0.146 ($p=0.70$).

Conclusion
In this unique cohort of patients with thoracic SK and very long follow-up no radiographic spinopelvic parameters could reliably predict realignment of the pelvis and lumbar spine 14-21 years after thoracic fusion correction. Despite lumbopelvic mismatch in many patients, the average functional outcome was good, and no relationship was found between LPM and clinical outcome. We speculate that preoperative planning based on conventional static radiographic parameters are flawed in Scheuermann's patients and do not relate with long term outcome. In these patients with relatively young flexible lumbar spines, other mechanisms also play an important role in realignment such as hamstrings shortening, aging and individual neuromuscular control.

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

42. Flexibility of Thoracic Kyphosis (TK) impacts postoperative Sagittal Alignment in Adult Spinal Deformity Patients

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Summary
The authors analyzed preop TK-flexibility as a predictive parameter for postop sagittal alignment and PJK in ASD pts. In ASD pts with fusions maintaining a mobile thoracic spine, evolution of postop TK and PJK did also depend on TK-flexibility. Revision rates were increased with decreased TK-flexibility.

Hypothesis
TK-flexibility is a supportive parameter to predict postop TK.

Design
Retrospective analysis of patient data of an ASD database.

Introduction
Current prediction models struggle with accurate classification of sagittal balance and postop TK.

Methods
Pts with ≥2yr F/U or pertinent PJK after ASD surgery, ≥4 level fusion, and with UIV at ≤T10 were included. TK-flexibility was expressed as the difference between preop TK in standing and TK in supine position. A flexible TK was defined as a >10° difference and pts classified as TK-flexible (F-Group) and non-flexible (NF-Group).

Results
65 pts fulfilled inclusion criteria. Age was Ø66 yrs, 74% were female. A sig. correlation existed between TK-flexibility, preop TK (r=.5, p<.01) and the difference of preop and postop TK (r=.4, p<.01). An increase of the preop PJK-angle correlated with postop TK and F/U TK (r=.4/.44, p<.01) as well as the difference btw. preop and postop TK (r=0.4, p<.01). In 20 (31%) pts with a flexible TK (F-Group) the PJK rate was 0%, preop TK was larger (p<.01), the difference btw. preop and postop TK was neg. (-5° vs. 4°, p<.01) and TK progression ≥5° preop to postop (15% vs. 85%, p=.01) as well as postop to F/U (30% vs. 70%, p>.05) occurred less often than in the NF-Group. In the F-Group, postop stable TK or improvement by ≥1° (70% vs. 30%, p<.01) and by ≥5° (55% vs. 45%, p<.01) was more likely. The postop TK matched the TK-supine ≤10° more often than in the NF-Group (68% vs. 32%, p=.03). 32% of pts needed revision surgery and had a larger PJK-angle at F/U (p=.01), larger preop TK (p=.01), TK-supine (p<.01), postop TK (p=.01) and F/U TK (p=.03). 4 pts suffered from PJK and had less TK-flexibility (p=.04).

Conclusion
This is the first study analyzing the predictive value of TK-flexibility for postop TK. TK-Flexibility is a parameter to be included in future prediction models for global spinal balancing.

43. Low Bone Mineral Density is the Significant Risk for Developing PJF in Surgically Treated Patient with ASD

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Summary
Prevention of PJF is urgent issue in scoliosis surgery. Propensity match comparisons of the incidence of PJF between surgically treated ASD patient who have low BMD and those who have normal BMD was conducted from the multi-centered database. Low BMD (T-score<-1.5) was identified and confirmed as a significant risk factor for developing PJF in this propensity matched cohort (Odds ratio 6.4). Prophylactic treatment should be considered when performing correcting spine surgery for ASD with low BMD.

Hypothesis
Low BMD is a significant risk factor for developing PJF in matched patient cohort.

Design
Propensity match comparisons of the risk of PJF in surgically treated ASDs.

Introduction
Symptomatic PJK (PJF) is one of the most devastating complications in the surgical treatment for adult spinal deformity (ASD). Once PJF is developed, following PJF commonly occurred. Therefore, prevention of PJF is urgent issue to be address. Most of the previous studies for the risk assessment of PJF were designed as retrospective study and due to the presence of the selection bias for the surgical strategies, to identify true modifiable risk factor for PJF was difficult. The purpose of this study was to identify the true modifiable risk factor for developing PJF in a propensity matched patient cohort.

Methods
113 surgically treated ASD who reached 2 yrs follow-up were selected from multicenter database. Patients were categorized low BMD group (L group; T-score<-1.5) or normal BMD group (N group; T-scoreΘ1.5) and were propensity matched by age, gender, BMI, level involved, UIV and LIV level, anchor type, primary of revision, PSO, Schwab-SRS type and sub types. PJF was defined as an increase from baseline of proximal junctional angle ≥ 20° with concomitant deterioration of at least 1 SRS-Schwab sagittal modifier grade from immediate post-op or PJK requiring revision.

Results
Among 113 patients, 48 patients were propensity matched (N group vs L group; age 62.2±11.2 vs 62.2±8.y/o, BMI22.1±3.9 vs 21.1±3.2kg/m2, level involved 9.9±2.4 vs 9.9±2.1, C7SVA8.1±5.8 vs 8.1±5.9cm, PI-LL34.6±23.2 vs 36.0±23.5deg, SRS-Schwab type N;4T;8D;12L;0 vs N;4T;8D;12;L0). The incidence of PJF was significantly high in L group in a propensity matched ASD population and the odds ratio was 6.4 (PJF; 33% vs 8%, p<0.01, 95% CI: 1.1-32.4).

Conclusion
Low BMD was identified and confirmed as a significant risk factor for developing PJF in this propensity matched cohort. The odds ratio of low BMD (T-score<1.5) for PJF following corrective spine surgery was 6.4. Prophylactic treatment should be considered when performing correcting spine surgery for ASD with low BMD.

44. Should Targets for Adult Spinal Deformity Correction Depend on Pelvic Incidence?

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Summary
Age specific alignment has recently been recognized in adult spinal deformity (ASD) surgery. This study demonstrates that normative spinal alignment differs based on age and PI. Using age specific US normative SF36-PCS, alignment targets in ASD should differ based on pelvic incidence (PI) and age. Alignment targets do not need to be as rigorous for patients with high PI.

Hypothesis
Spinal alignment targets in ASD should depend on age and pelvic incidence.

Design
Retrospective review of a prospectively collected database.

Introduction
Targets for deformity correction have been reported: SVA<5cm, PT<20°, PI-LL<9°. The T1-Pelvic Angle (TPA) has gained in applications for ASD surgical planning since it directly measures the spinal alignment separate from pelvic and lower extremity compensation. Recent studies have demonstrated that ASD corrections should be age specific. This study investigates whether deformity corrections should vary by PI with an analysis in normative and ASD patients.

Methods
A prospective database of consecutive ASD patients was analyzed in conjunction with a normative spine database. Inclusion criteria: ASD, age>18, and any of the following: coronal Cobb angle >20°, SVA>5cm, thoracic kyphosis>60°, and PT>25°. Clinical measures of disability included ODI, and SF36 PCS. Baseline relationships between TPA, Age, PI and HRQL were analyzed in the ASD patients and a database of normative subjects. Age specific ODI thresholds were established through correlation to the US normative PCS values. Linear regression modeling was used to determine alignment targets based on PI and age-specific ODI.

Results
903 ASD patients (mean age 53.7) and 111 normative subjects (mean age 50.7y) were included. Patients were subanalyzed by PI: low, medium, high (<40, 40-75, >75); and age: elderly (>65y, n=375) middle age (MA 45-65y n=387) and young (18-45y, n=141). TPA correlated with age and PI in ASD and normative subjects (r>.42, p<.0001). ODI correlated with PCS (r=.71, p<.0001). Linear regression analysis using normative age-specific ODI values demonstrated that ideal spinopelvic alignment increases with increasing PI and age, Table 1. For low PI patients, TPA targets for young, middle aged and elderly were 8.4, 10.0 and 12.3; for medium PI, they were 17.2, 18.6 and 21.1; for high PI they were 28.3, 29.9 and 32.1.

Conclusion
Targets for ASD correction should vary by age and PI. This is demonstrated in both asymptomatic and ASD subjects. Using US normative HRQL values, TPA alignment targets are described for different age and PI categories (Table 1). The high PI patients do not require as rigorous realignments to attain age specific normative levels of health status.

Table 1 : T1 Pelvic Angle alignment targets correlated to US Normative age-specific ODI and TPA alignment targets as determined by mild and moderate ODI disability stratified by pelvic incidence magnitude

	TPA Goal for US Age-Specific ODI Thresholds			Disability thresholds	
	Age < 45	Age 45 - 65	Age > 65	ODI 20	ODI 40
PI<40	8.41	10.0	12.3	9.22	14.0
PI 40 - 75	17.2	18.6	21.1	18.0	22.8
PI > 75	28.3	29.9	32.1	29.1	33.9

45. Risk Factor Analysis for PJK After Adult Spinal Deformity Surgery: A New Simple Scoring System

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Summary
While numerous risk factors for proximal junctional kyphosis have been reported, a simple pragmatic system is still missing. Using patient characteristics and surgically controllable parameters, this study established a 5-point scoring system. At 2 years post index surgery, the PJK rate ranged from 17% for patients with 1 point to 69% for patients with 5 points. Findings from this study will enhance shared decision making and pre-operative patient counseling.

Hypothesis
A simple pragmatic scoring system, created through literature review, can predict the risk of PJK in the after adult spinal deformity (ASD)

Design
Retrospective analysis, prospective multicenter ASD database

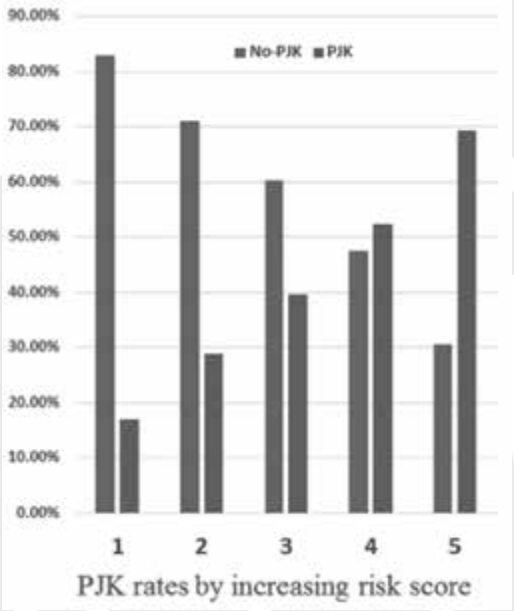
Introduction
Junctional failure following ASD correction has gained much attention recently. While realignment goals have been published, there are concerns that dramatic spinal realignment surgery poses elevated risks of proximal junctional kyphosis (PJK) and failure. Several studies have established independent risk factors for PJK but a pragmatic scoring system remains elusive.

Methods
417 surgical ASD patients (80% female, 57.8 yo) with 2yr follow up were included. PJK was identified when a >10° kyphotic angulation existed between the upper instrumented vertebra (UIV) and the vertebrae two levels above it. Based on a literature review, the following point score was attributed for parameters likely to impact PJK development: Age > 55 (1pt), fusion to S1/ilium (1pt), UIV in the upper thoracic spine (1pt), UIV in the lower thoracic region (2pts), flattening of the kyphosis vs. lordosis (i.e. $\theta_{LL} - \theta_{PJK}$) greater than 10° (1pt)

Results
At 2 years, the PJK rate was 43%. The odds ratio for each risk factor were: Age > 55 (2.52), fusion to S1/ilium (5.17), UIV in the upper thoracic spine (6.63), UIV in the lower thoracic region (8.24), and a >10° surgical reduction in kyphosis across fused segments (1.59). Analysis by risk factor revealed a significant impact on PJK (no pjk vs. pjk): Age >55 (28% vs 51% p < 0.001), LIV S1/ilium (16.3% vs 51.4% p<0.001), UIV in lower thoracic spine (12.0%

vs 52.9% p<0.001), and a >10° surgical reduction in kyphosis vs. LL increase (40.0% vs 51.5% p < 0.025). The PJK rate by point score was: 1=17%, 2=29%, 3=40%, 4=53%, and 5=69%

Conclusion
This study confirms the impact of published factors linked to PJK. A pragmatic scoring system was developed that is tied to the increasing risk of proximal junctional kyphosis. These findings will permit enhanced shared decision making and patient counseling pre-operatively. Additionally, based upon the results of this investigation, surgeons may consider varying their surgical strategy to mitigate the post-operative development of PJK.



46. Nutritional Insufficiency as a Predictor for Adverse Outcomes in Adult Spinal Deformity Cases

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Summary
Nutritional status has not been thoroughly investigated as a risk factor for complications following elective adult spinal deformity surgery. The present analysis, using the ACS-NSQIP database identified patients with poor preoperative nutritional status to be at risk for 30-day mortality, increased length of stay, all complications, pulmonary complications, renal complications peripheral nerve injuries and transfusions.

Hypothesis
Patients with poor preoperative nutritional status will experience a higher rate of postoperative complications.

Design
Retrospective cohort study.

Introduction
Adult spinal deformity (ASD) is one of the most complex spinal disorders and includes a wide variety of spinal disease. Considering the aging population, the number of patients who will likely require spinal deformity surgery will greatly increase. Nutritional insufficiency is an important and significant factor that can predispose patients to adverse postoperative outcomes. The relationship between nutritional status and outcomes has not been previously explored in adult spinal deformity cases.

Methods
This was a retrospective analysis of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database between 2010 and 2014 for patients undergoing ASD surgery. Patients were included based on CPT codes. Patients were categorized per preoperative nutritional status. Nutritionally insufficient patients were defined as having any of the following: serum albumin <3.5g/dL, BMI <18.5kg/m2 and weight loss ≥10% 6 months prior to surgery. The two groups were compared using chi-square test and multivariate logistic regression models were employed to determine the effect of nutritional status on postoperative outcomes.

Results
2,236 (38.4%) cases met the inclusion criteria for the study. 192 (8.6%) of patients were categorized as nutritionally insufficient. Multivariate logistic regression (Table 1) revealed nutritional insufficiently to be a risk factor for mortality (OR=15.67, 6.01-40.84), length of stay (OR=2.22, 1.61-3.06), any complication (OR=1.82, 1.31-2.51), pulmonary complication (OR=2.29, 1.29-4.06, p-value=0.0046), renal complication (OR=2.71, 1.05-7.00, p-value=0.0395), peripheral nerve injury (OR=19.21, 1.74-212.68, p-value=0.0160) and transfusion (OR=1.52, 1.08-2.12, p-value=0.0148). P-value<0.001 unless otherwise noted.

Conclusion
Nutritional insufficiency is significantly and independently associated with 30-day mortality, length of stay, all complications, pulmonary complications, renal complications peripheral nerve injuries and transfusions for patients undergoing elective ASD procedures.

Table 1: Nutritional Insufficiency as a Risk Factor for Complications Following Elective ASD Surgery (N=2,236)

Outcome	Odds Ratio	Lower Confidence Limit	Upper Confidence Limit	P-value
Mortality	15.67	6.01	40.84	<0.0001
Length of Stay ≥5 days	2.22	1.61	3.06	<0.0001
All Complications	1.82	1.31	2.51	0.0003
Pulmonary Complications	2.29	1.29	4.06	0.0046
Renal Complications	2.71	1.05	7.00	0.0395
Peripheral Nerve Injury	19.21	1.74	212.68	0.0160
Intra/Postoperative RBC Transfusion	1.52	1.08	2.12	0.0148

47. Post-Tumor Spinal Deformity: Non-Operative versus Operative Management

Nikita Zaborovskii, MD; *Dmitrii Ptashnikov, MD, PhD;* Dmitrii Mikhailov; Sergei Masevnin; Oleg Smekalenkov, MD, PhD; Olga Lapaeva, MD; Zabioulah Mooraby, MD; Yang Le, MD

Summary
The study describes outcome and health-related quality of life (HRQOL) parameters in patients with post-tumor spinal deformity after non-operative or operative management. We found that surgical correction of post-tumor deformity is a promising treatment option.

Hypothesis
Correction of post-tumor spinal deformity improve quality of life.

Design
A retrospective study.

Introduction
The purpose of our research is evaluation of patients with post-tumor spinal deformity.

Methods
Data were collected for 44 patients with spinal deformity (SRS-Schwab sagittal modifiers: 2 grade and more) and confirmed spinal oncology by biopsy. All patients have had oncology remission with a 3-year minimum follow-up. Spinal deformity was developed in the period between 1 and 6 years after chemotherapy or radiotherapy of tumor. Patients were divided into three groups. The first non-operative group (NOP) included 18 patients (plasmacytoma (n=12), multiple myeloma (n=6)) who underwent nonoperative management (non-steroid anti-inflammatory medication, muscle relaxants, pain medication, muscle exercises, steroid blocks, brace). The second operative group with selected spinal fusion and correction of regional deformity (SOP) consisted of 12 patients (plasmacytoma (n=10), multiple myeloma (n=2)). The third operative group with long spinal fusion and correction of global spinal alignments (LOP) consisted of 14 patients (plasmacytoma (n=12), cervix uteri cancer metastasis (n=1)) which were treated surgically. Low scores of HRQoL and unsuccessful non-operative approach were indications for surgical intervention in the operative groups. Repeated biopsy in the operative groups did not show tumor cells, this was evaluated as local control of tumor. Radiographical, HRQoL-parameters (VAS, ODI, SF36) and complications were analyzed and compared between groups. Kruskal–Wallis test, Fisher's exact test were performed with R 3.3.2.

Results
Patients in the LOP group showed a restoration of radiographical global spinal alignments after surgery compared with SOP group ($p<0.001$). The HRQoL-scores after 2 years are significantly higher in the operative groups than in the NOP group ($p<0.05$). Hovewer we did not find significant difference between LOP and SOP groups. It is important that no patients had local recurrence or metastasis of tumor during follow-up in the operative (LOP and SOP) groups.

Conclusion
Spinal tumor under local control is not contraindication for spinal deformity surgery. Correction of sagittal alignments may have potentially benefits.

48. Impact of Lumbar Lordosis Correction on Surgical Outcome Is Dependent on Age Decade in Elderly Adult Spinal Deformity Surgery

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Summary
Age-related difference in the effect of corrected lumbar lordosis (LL) angle on clinical outcome was investigated in adult spinal deformity (ASD) surgery. 101 patients who underwent thoracopelvic corrective fusion with minimum 2 years' follow-up were retrospectively evaluated. The impact of corrected LL angle on surgical outcome was dependent on the age decade. To establish good surgical outcome, the ideal and moderate LL should be attained in young-old and old-old age, respectively.

Hypothesis
The target LL angle for elderly spinal deformity surgery differs in each age decade

Design
A retrospective analysis of prospectively corrected consecutive case series

Introduction
Pelvic incidence (PI) is a main factor to consider for the correction alignment in ASD surgery. We determined the target LL angle by using the formula "ideal LL = 0.45PI +31.8" for restoring normal pelvic tilt. The objective of this study was to investigate an age-related difference in the effect of corrected LL angle on clinical outcome.

Methods
We retrospectively evaluated 231 consecutive patients who underwent ASD surgery. The inclusion criteria of this study were age of ≥50 years, history of thoracopelvic fusion, and minimum 2 years' follow-up. Spinopelvic radiographic parameters were investigated before and after operation. Clinical outcomes were evaluated by using the reaching rate of minimum clinical important difference (MCID; –15%) and the obtained ODI at 2 years' follow-up. The patients were stratified into 3 groups according to age as follows: middle aged (MA), 50–64 years; young old (YO), 65–74 years; and old old (OO), ≥75 years. We also stratified the patients into 3 groups according to collected LL as follows: ideal (within ideal LL ±5°), moderate (ideal LL –5° to –15°), and under (ideal LL under –15°).

Results
101 patients (MA 21, YO 49, and OO 31) were included. The preoperative sagittal profile was LL (MA 12.1°, YO 12.0, and OO 11.2), sagittal vertical axis (SVA; MA 110 mm, YO 119, OO 146), and improved to LL (MA 43.3°, YO 45.4, and OO 41.7), SVA (MA 39 mm, YO 39, and OO 48), respectively. No significant difference was observed in any of the radiographic parameters in each age decade. The MCID reaching rate and average obtained amount of ODI (table) were significantly higher in the ideal group (71.4%/24.3%) in YO and in the moderate group (69.2%/17.5%) in OO, but no significant difference was found in MA.

Conclusion
The impact of corrected lumbar lordosis angle on surgical outcome was dependent on the age decade. To establish good surgical outcome, the ideal and moderate LL should be attained in young-old and old-old age, respectively.

Age decade	Degree of correction		
	Ideal	Moderate	Under
Middle Aged (MA)	45.5%/8.3%	50.0%/10.5%	57.1%/4.4%
Young Old (YO)	71.4%/24.3%	54.5%/15.2 %	30.8%/4.8%
Old Old (OO)	42.9%/9.7%	69.2%/21.6%	27.3%/11.7%

MCID reaching rate /obtained amount of ODI

49. Comparison between Unilateral and Bilateral Pelvic Fixation Using the S2AI Technique and the Incidence of Sacro-iliac Joint (SIJ) Pain

Mostafa H. El Dafrawy; Paul D. Sponseller, MD; Micheal Raad; Khaled Kebaish, MD

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

Summary
The S2AI technique has been shown to have very low revision and complication rates. However, the long term implications of the S2AI screw crossing the Sacro-iliac joint have not been fully elucidated. Our results show that the side of SIJ pain does not correlate with the side of S2AI placement in unilateral sacropelvic fixation. Bilateral S2AI was not associated with a higher rate of SIJ pain compared to unilateral fixation.

Hypothesis
S2AI technique is not associated with increased SIJ pain.

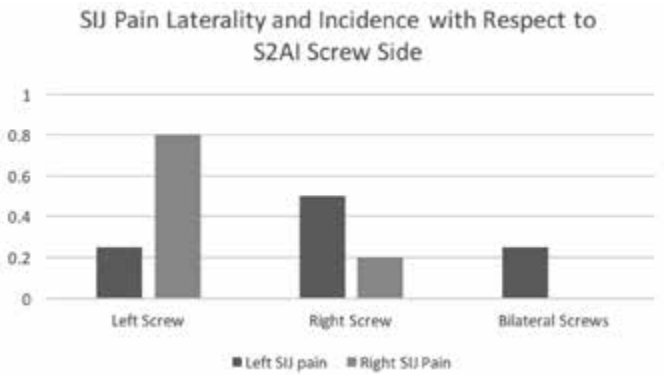
Design
Retrospective

Introduction
The S2AI technique offers the advantages of less soft tissue dissection, easier rod connection and a lower rate of complications compared to the iliac screw technique. The S2AI screws cross the SI joint and the long term implications of that are not clear.

Methods
43 consecutive patients who underwent unilateral S2AI fixation for scoliosis, kyphosis, spondylolisthesis, L-S1 nonunion were matched to 45 patients undergoing bilateral S2AI fixation based on age and follow up. Patients completed questionnaires with a body diagram to mark pain site. SIJ pain was defined as pain in the lateral anterior pelvic area or the lateral posterior sacral area after ruling out other possible causes of pain. Fischer's exact test was used to test the correlation between the S2AI screw side and the pain site. Chi2 test was to compare the incidence of SIJ pain between unilateral and bilateral S2AI cohorts. Patients with and without SIJ pain were compared with respect to baseline and surgical characteristics to delineate this entity.

Results
There was no correlation between the screw side and the pain site (p=0.29). Average visual analog pain score was 5.11 (SD=2.5). Surprisingly, patients had a higher incidence of SIJ pain on the contralateral side figure1. Testing for a correlation between the incidence of SIJ pain in the unilateral and bilateral cohorts revealed no statistically significant difference between the two groups (25% in the unilateral vs 13.33% in the bilateral group, p=0.179). SIJ pain and no SIJ pain groups were compared with respect to: age, osteoporosis, preoperative diagnosis and surgical variables. Patients with SIJ pain were more likely to have osteoporosis (60% vs 29.69%,p=0.027) and a preoperative diagnosis of scoliosis(55.56% vs 86.67,p=0.03).

Conclusion
Our results show no correlation between the side of the S2AI and the side of the reported SIJ pain, nor did it show an increased incidence of SIJ pain in patients with bilateral screws as compared to unilateral screw. These results suggest that the S2AI technique does not increase the incidence of SIJ pain in patients undergoing fusion to the pelvis.



50. Interpreting 2-Dimensional and 3-Dimensional Alignment in Adolescent Idiopathic Scoliosis – How Should Thoracic Kyphosis Be Defined?

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Summary
The advent of 3Dimensional (3D) imaging has redefined the concept of measurement of thoracic kyphosis (TK) in adolescent idiopathic scoliosis (AIS). This study demonstrates that traditional measurement of TK, as defined as a difference in T1-T12 tilt differs between 2-Dimensional (2D) and 3D. While T1-T12 tilt increased perioperatively, true kyphosis, as measure at the thoracic apex decreased.

Hypothesis
Measurement of TK differs between 2D & 3D analysis in AIS

Design
Retrospective Single-Center Radiographic Study

Introduction
AIS is often associated with thoracic apical hypokyphosis. Previous studies have described coronal and sagittal alignment using 2D radiographs, which may not project orthogonal to the true plane of TK, nor account for the difference between apical- and overall TK. By nomenclature, TK is measured as the difference in tilt between T1-T12, but does not consider the shape of the thoracic apex. The purpose of our study is to analyze and compare 2D and 3D pre-and post-opeative alignment in AIS.

Methods
Radiographic analysis of AIS patients with Type 1 curves and 6 months follow-up was performed. 2D and 3D radiographic measurements were performed on standing stereoradiographs using validated software. The thoracic ratio was created and defined as the ratio between the vertical distance from the superior endplate of the T1 to the inferior endplate of the T12 (Td), and the orthogonal transverse distance between the center of apical vertebral body and the line Td (Ta), as measured in 3D. Comparison was made between baseline 2D and 3D alignment, pre- and post-operatively

Results
22 patients (mean age 15.9yrs, 19F) were included. Comparison of 2D vs 3D alignment showed significant difference in preoperative TK (32.6 vs 24.6°, p=0.01), but not postoperatively after curve derotation (31.5 vs 33.3°, p=0.47). Perioperative alignment significantly reduced thoracic

Cobb angle (17.4 vs 42.2° p<0.005) and Apical vertebral rotation (4.5 vs 11.4°, p=0.002). 3D-TK increased from baseline to post-op (24.6 vs 33.3°, p=0.041). However, while length of the thoracic spine (Td) increased (24.5 vs 23.3cm, p<0.001), transverse apical distance (Ta) decreased (2.7 vs 3.9cm, p<0.001). This represents a decrease in true kyphosis as measured at the apex, by an increase in Thoracic Ratio (Td/Ta, 11.1 vs 7.1, p<0.001).

Conclusion
Our study shows that measurement of thoracic kyphosis as measured is 2D imaging differs to that in 3D due to the obliquity of the plane of kyphosis to the radiograph beam. Although post-operative increase in the TK was noted in 3D using the T1-T12 angle, the actual kyphosis, as determined by the thoracic ratio reduced.

51. WITHDRAWN

52. Causes for Early Readmission in AIS Surgery
Steven W. Hwang, MD; Amer F. Samdani, MD; Tracey P. Bastrom; Peter O. Newton, MD; Harry L. Shufflebarger, MD; Baron S. Lonner, MD; Paul D. Sponseller, MD, MBA; Joshua M. Pahys, MD

Summary
We reviewed risk factors associated with readmission in AIS patients from a large registry. GI complications were one of the most common reasons for early readmission (RA), representing a third of cases. Patients were readmitted an average of 2 weeks post-op due to SMA syndrome and GI upset. Overall a low pre-op SRS pain score was most consistently associated with readmission risk.

Hypothesis
Modifiable risk factors are associated with increased risk of early readmission.

Design
Review of prospectively collected data

Introduction
With increased attention on readmission, identifying risk factors associated with readmission may allow us to reduce the incidence.

Methods
We retrospectively reviewed a large dataset of prospectively collected AIS patients and divided them into readmission < 90 days and > 90 days. Univariate analysis was performed and factors found to be p<0.10 met criteria for entry into multivariate regression models. Separate models were created for < 90 readmit (RA) vs. no readmit (NO) and > 90 readmit (RA) vs. NO.

Results
2049 patients were included of which 1957 (95.5%) were not readmitted. 27 were readmitted within 90 days (1.3%) and 65 were readmitted after 90 days (3.2%). Mean time to RA was 25.6±17.6 days in the early group and 957.0±642.3 days in the late group. The common reasons for RA were wound infections (33%), GI complications (30%), and instrumentation-related (15%). GI causes for RA included GI upset (N=3), SMA syndrome (N=3), 2 undescribed GI issues and were re-admitted 13.9±4.2 days after surgery. Infection (23%) and instrumentation issues (22%) were the most common reasons for late RA. Lower pre-op SRS pain scores were consistently significant in both early and late readmission cohorts (Table).

Conclusion
The readmission rate at 2 years for AIS patients was 4.5% with GI complications as a common reason within 90 days. The only consistent predictive factor for readmission was a low pre-op SRS pain score.

Table: Bolded factors remained significant in multivariate regression models.

	No readmit (NO)	Readmit (RA)	UNIVARIATE p-value	MULTIVARIATE p- value
< 90 day readmit				
BMI percentile (%)	54 ± 30	65 ± 32	0.055	n/a
Coronal translation (mm)	**1.9 ± 1**	**3 ± 3**	**≤0.001**	**≤0.001**
SRS pain	**4 ± 0.7**	**3.7 ± 0.7**	**≤0.001**	**0.009**
OR time (min)	289 ± 117	337 ± 183	0.039	n/a
> 90 day readmit				
SRS pain	**4 ± 0.7**	**3.8 ± 0.8**	**≤0.001**	**≤0.001**
SRS mental health	4 ± 0.7	3.7 ± 0.9	0.012	n/a
Total SRS	3.9 ± 0.5	3.8 ± 0.6	0.03	n/a
LIV of L1			0.008	n/a
no	80%	65%		
yes	20%	35%		
OR time (min)	**289 ± 117**	**320 ± 145**	**0.045**	**0.015**

53. Lenke 1C AIS Curves: When do Experienced Surgeons Incorporate the Lumbar Curve?
Akhil A. Tawari, MD; Jahangir K. Asghar, MD; Stephen G. George, MD; Tracey P. Bastrom; Harms Study Group; Harry L. Shufflebarger, MD

Summary
In a radiographic review of Lenke 1C that underwent a PSF performed by experienced spinal deformity surgeons (>10 years), clinical equipoise continues to exist regarding selective versus long fusion for Lenke 1C curves

Hypothesis
Surgeon preference is the most significant factor for determining selective vs. non-selective fusion for Lenke 1C curves

Design
Retrospective review

Introduction
Despite multiple published criteria for the management of Lenke 1C, amongst experienced spinal deformity surgeons wide practice variability exists regarding factors leading to non-selective fusion of Lenke 1c curves. The factors that experienced surgeons considered in fusing Lenke 1C curves non-selectively were studied

Methods
Patients with Lenke IC curves undergoing instrumented posterior fusion with a two year minimum follow-up period were identified from a large multicenter database. Factors favoring NS fusion were identified by univariate analysis. In subsequent sub analysis, the cohort was divided into 2 surgeon groups: NS dominant – surgeons more likely to perform a NS fusion (LIV L2 or lower) & S dominant- surgeons more likely to perform a to S (Thoracic)fusion. Surgeons performing <10 cases and those exclusively performing S or NS fusions were excluded to avoid preferential bias.

Results
52 (52%) NS fusion & 48 (48%) S fusion for a total of 100 Lenke type 1C pts operated by 19 surgeons, were studied. Surgeon experience ranged from 13 to 40 yrs. In the overall analysis, Surgeon preference was the significant predictor for NS fusion. Subsequent sub analysis of the NS Dominant group (32 pts, NS - 43.8%) & S Dominant group (39 pts, NS-61.5%) found marginal overlap of the pre-operative radiographic variables. For NSD, the significant variables for NS & S included: Lumbar bend > 18°. For SD, the significance was observed for lumbar bend > 16° and significant apical lumbar translation. In both groups, there was trend toward significance for curve magnitude greater than 45°

Conclusion
Surgeon preference is the most significant predictor determining S or NS fusion for Lenke 1C curves. There continues to be equipoise in the management of 1C curves. However, curve magnitude 45° and Lumbar bends of >18° trended to non selective fusions for both SD surgeons and NSD surgeons.

54. Adding-On Improves Residual Lumbar Curve in Lenke Type 1B and 1C Curves

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Summary
Selection of LIV more cranial to last touching vertebra was the risk factor for postoperative distal adding-on in Lenke type 1B and 1C. However, postoperative distal adding-on enhanced the spontaneous correction of lumbar curve compared with the patients without distal adding-on.

Hypothesis
Postoperative distal adding-on has adverse effect for residual lumbar curve in Lenke type 1B and 1C.

Design
Retrospective study of consecutive collected data.

Introduction
Postoperative distal adding-on (DA) in adolescent idiopathic scoliosis (AIS) is one of the radiographical complications which may negatively impact postoperative clinical results. However, the risk factors for DA and the influences of DA have not been fully elucidated in Lenke type 1B and 1C curves.

Methods
47 AIS patients with Lenke type 1B or 1C curves who underwent posterior correction surgeries with selective thoracic fusion were retrospectively evaluated. The patients were divided into two groups of DA group and non-DA group based radiographs at two years after surgery. The definition of DA was referred to that by Wang et al (Spine 2011). Coronal radiographic parameters including Cobb angles, L4 tilt angle, apical translation, relation between lower instrumented vertebra (LIV), end vertebra (EV) and last touching vertebra (LTV), were compared between the two groups.

Results
10 patients (21%) out of 47 patients developed DA at two years after surgery. The DA group consisted of 7 patients of 1B and 3 1C, and the non-DA consisted of 22 1B and 15 1C. The mean LIV-EV and LIV-LTV were significantly smaller in DA group than those in non-DA group (LIV-EV; -0.1 ± 0.57 vs 0.4 ± 0.61, LIV-LTV; -0.2 ± 0.63 vs 0.67 ± 0.96). The preoperative radiographical parameters were similar between the two group. The mean L4 tilt angles before surgery were similar between the two groups (non-DA; -8.4 ± 3.5°, DA; -6.7 ± 3.8°). However, the mean L4 tilt angle at postoperative 2 years was significantly horizontalized in the DA group compared with that in the non-DA group (non-DA; -5.9 ± 6.1°, DA; -1.6 ± 5.6°). And, apical translation of lumbar curve at postoperative 2 years was smaller in the DA group (non-DA; -15.6 ± 7.6°, DA; -6.6 ± 11.7°).

Conclusion
LIV selected at more cranial to EV and LTV may be the risk factors for postoperative DA in Lenke type 1B and 1C. However, spontaneous correction of the residual lumbar curves were superior in patients who developed DA. Further investigation required to determine the clinical influence of DA in AIS.

55. Anterior Vertebral Body Tethering for the Treatment of Idiopathic Scoliosis: Feasibility, Outcomes, and Complications

Firoz Miyanji, MD, FRCSC; Luigi Aurelio Nasto, MD, PhD; Eva Habib, BSc; Andrea M. Simmonds, MD, FRCSC

Summary
Spinal fusion remains the gold standard for progressive IS, however concerns about the long-term effect of spinal fusion have led to the development of growth-modulation techniques. We present early preliminary results in a cohort of 32 consecutive patients treated with AVBT and found the technique effective in preventing curve progression and obtaining curve correction with most curves reaching a clinical success of ≤30°.

Hypothesis
Anterior vertebral body tethering (AVBT) may be limited in effectively preventing curve progression and obtaining curve correction to ≤30°

Design
Retrospective single center review

Introduction
More recently AVBT has sparked interest as a possible alternative in the management of progressive idiopathic scoliosis (IS).To date limited available

data exists regarding the efficacy and complication rate with AVBT. The aim of our study was to evaluate the clinical, radiographic and perioperative outcomes and complication rates to determine the efficacy of AVBT in skeletally immature patients with IS.

Methods

A retrospective review of all consecutive patients treated with AVBT between 2012 and 2016 was conducted after IRB approval. Demographic data was collected from chart review. Preop and most recent f/u radiographic parameters were measured by an independent reviewer. Periop outcome variables and complication data were obtained from chart review. Clinical success was set a priori as major coronal Cobb ≤30° at most recent f/u.

Results

32 patients with 34 procedures were analyzed. Mean age at surgery was 13.6±1.4years with majority female (93.8%). Mean Risser grade was 0.77±0.79 with a mean f/u of 9.4 ± 10.9 months. Mean major pre-op Cobb of 50.6°±8.6° improved to mean 18.3°±9.5° at most recent f/u(% correction:64.3%, p<0.001).Significant spontaneous curve correction was also observed in the un-instrumented curves on average by 48.7±24.2% (p<0.001).Thoracic axial rotation significantly improved on average from 15.0°± 4.2° to 8.0°±4.1°(p<0.001) as measured by scoliometer. Average number of instrumented levels was 6.8±0.9 with a mean OR time of 348.4±84min. Average EBL was 252.8±83.4cc with no patient requiring allogeneic blood. Length of hospital stay was mean 5.3±1.0 days with 84.3% of patients returning to full activity at 3 months. Clinical success was noted in 94.1% of patients at most recent f/u. We noted a 23.5% complication rate however there were no re-admission to hospital or re-operations in this cohort.

Conclusion

AVBT is effective in obtaining clinical success in skeletally immature patients with IS. Early results appear promising, however longer-term follow-up is needed to determine the true clinical benefits of this technique.

Table 1

Patient Demographics (N=32)	
Mean Age at Surgery (yrs)	13.6 ± 1.4
Gender	F= 93.8%; M=6.3%
Mean BMI	19.3 ± 2.8
Mean Risser Grade	0.77 ± 0.79
Structural Main Thoracic Curve (N, %)	31 (91.2)
Structural Lumbar Curve (N, %)	3 (8.8)
Mean Follow-up (mths)	9.4 ± 10.9

Radiographic Measures	Pre-op	First Erect	Most Recent Follow-up	% Correction	p-value
Mean Major Cobb (°)	50.6±8.6	21.1±8.8	18.3±9.5	64.3±18.0	<0.001*
Mean Un-instrumented Minor Cobb (°) #1	34.3±10.5	19.9±10.4	18.0±10.9	48.7±24.2	<0.001*
Mean Un-instrumented Minor Cobb (°) #2	25.1±8.3	17.1±7.0	16.2±7.1	35.7±27.8	<0.001*
Mean T2-T12 Kyphosis (°)	26.3± 13.5		26.9± 11.0	0.671	0.709

Outcome Variables (N=34)		Complication Type (N=8)		
Mean OR Time (min)	348.4 ± 84.0	Pulmonary	4	Respiratory complications requiring ICU readmission for BiPAP; pneumonia
Mean Blood Loss (mL)	252.8 ± 83.4	Surgical Site Infection	1	Treated with oral antibiotics
Mean Cell Saver (mL)	4.4 ± 25.7	Neurological	1	Transient upper extremity palsy following epidural anesthesia
Mean Number of Levels Instrumented	6.8 ± 0.9	Pain	2	Persistent lumbar and hip pain; persistent scapular and shoulder pain
Mean Length of Stay (days)	5.3 ± 1.0			
Clinical Success (Major Cobb curve ≤ 30°) (%)	94.1			

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

56. Pelvic Obliquity in Adolescent Idiopathic Scoliosis (AIS). An Analysis of 311 Lower Limb Radiographs.

Chris Yin Wei Chan, MS Orth; Soe Naing Kyaw, MD; Chee Kidd Chiu, MBBS, MS Orth; Siti Mariam Mohamad, BSc, MSc; Mun Keong Kwan, MBBS, MS Orth

Summary

This study showed that among AIS patients, 76.4% had PO < 10mm. PO was most severe in L6 and L5 curves. 66.7% of L5 curves and 74.1% of L6 curves had a higher right hemi-pelvis compared to 44.2% of L1 curves and 50.0% of L2 curves, which had a lower right hemi-pelvis. The most common causes of PO ≥ 10mm (24.6%) were Pelvic Hypoplasia (33.3%) and Limb Length Discrepancy (24.6%).

Hypothesis

Severity of pelvic obliquity is related to Lenke curve subtypes and the causes could be structural and non-structural.

Design

Retrospective radiographic study

Introduction

Pelvic obliquity (PO) is common among Adolescent Idiopathic Scoliosis (AIS) patients. Failure to recognise structural causes of pelvic obliquity increases the risk of post-operative decompensation following scoliosis correction.

Methods

311 patients underwent erect whole spine anteroposterior (AP), lateral and lower limb axis films. Radiographic measurements included Trans-ilium Pelvic Height Difference (TPHD/mm), Hip abduction-adduction angle (o), Lower Limb Length discrepancy (mm) and Pelvic Hypoplasia angle (o). The incidence and severity of pelvic obliquity was stratified to Lenke curve subtypes in 311

patients. The causes of pelvic obliquity were analysed in 57 patients with TPHD ≥ 10mm.

Results
The mean Cobb angle was 64.0 ± 17.2o. 69 patients had a TPHD of 0mm (22.2%).The TPHD was < 5mm in 134 (43.0%) patients, 5-9mm in 104 (33.4%) patients, 10-14mm in 52 (16.7%) patients, 15-19mm in 19 (6.1%) patients, and > 20mm in only 2 (0.6%) patients. There was a significant difference between the Lenke curve types in terms of TPHD (p=0.002). L6 curve types had the highest TPHD of 9.0 ± 6.3mm followed by L5 curves which had a TPHD of 7.1 ± 4.8mm. 44.2% of L1 curves and 50.0% of L2 curves had -ve TPHD compared to 66.7% of L5 curves and 74.1% of L6 curves which had +ve TPHD. 33.3% and 24.6% of pelvic obliquity were attributed to Pelvic Hypoplasia and Limb Length Discrepancy respectively whereas 10.5% of cases were attributed to Hip Abduction-Adduction positioning.

Conclusion
76.4% of AIS cases had pelvic obliquity < 10mm. 44.2% of L1 curves and 50.0% of L2 curves had a lower right hemi-pelvis compared to 66.7% of L5 curves and 74.1% of L6 curves which had a higher right hemi-pelvis. Among patients with pelvic obliquity ≥ 10mm, 33.3% were attributed to Pelvic Hypoplasia whereas 24.6% were attributed to Limb Length Discrepancy.

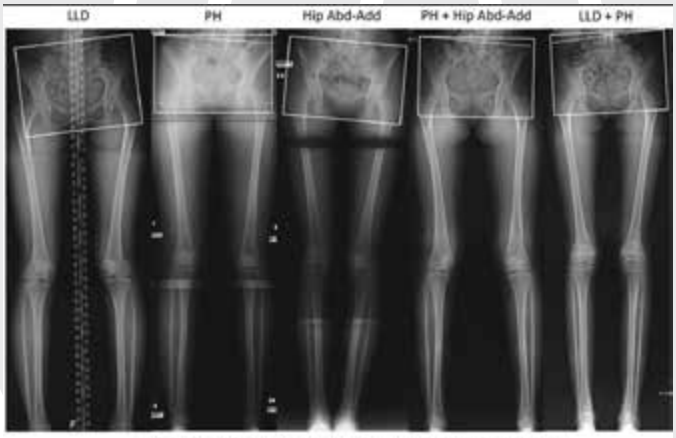

Figure 1: Illustration of the various cause of pelvic obliquity in this study

57. Pregnancy and Childbirth after Spinal Fusion for Adolescent Idiopathic Scoliosis

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Summary
AIS patients and their parents are often concerned about the role of scoliosis and surgical treatment on pregnancy. Study patients demonstrated a higher rate of cesarean delivery compared to the national average. Additionally, AIS patients reported receiving regional spinal or epidural anesthesia during spontaneous vaginal delivery at rates lower than the national average and because providers believed it was precluded by previous spine surgery. Results suggest updated education may be necessary for patients and obstetrical anesthesia providers.

Hypothesis
AIS patients will not differ from non-AIS patients in pregnancy parameters.

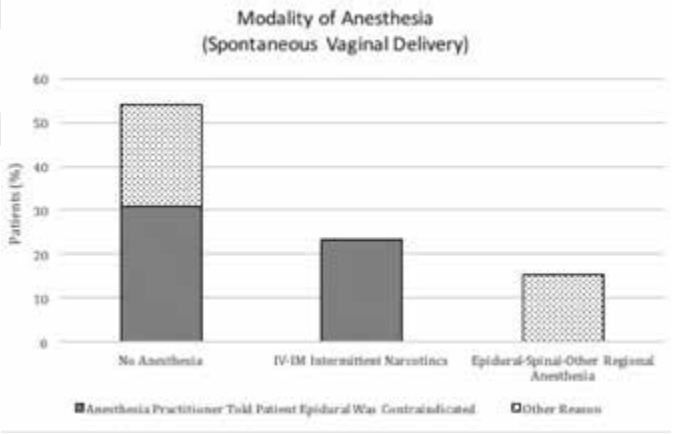
Design
Observational cohort study

Introduction
Little data exists on pregnancy and childbirth for patients with adolescent idiopathic scoliosis (AIS) treated with a spinal fusion. The current body of knowledge relies on data from patients treated with spinal fusion techniques and instrumentation no longer in use. The purpose of this study was to understand the effects of current spinal fusion on pregnancy and childbirth for patients with AIS.

Methods
Surveys were distributed to patients enrolled in a multi-center longitudinal study evaluating outcomes of spinal fusion for AIS. The survey included questions pertaining to the entire pregnancy experience including type of delivery, gestation period, and anesthesia used during labor.
Results were summarized using descriptive results and compared to national averages using chi-square.

Results
A total of 32 babies were born to 23 patients with AIS and the average gestation period was 38.6 weeks (SD 1.6). As part of prenatal care, 43% of patients reported meeting with an anesthesiologist. The most common types of delivery were cesarean (47%) and spontaneous vaginal (SVD) (41%). Of the patients with SVD, 54% had no anesthesia, 23% received IV IM narcotics, and 15% had regional spinal or epidural anesthesia. Of the 77% who did not have regional anesthesia, 70% were told by providers it was precluded by previous spine surgery. Nationally, the cesarean delivery rate is 32.2% and 61% of SVD patients received epidural or spinal anesthesia.

Conclusion
Compared to the national average, study patients had a higher rate of cesarean delivery ($p<0.05$). SVD patients in study cohort received less epidural or spinal anesthesia compared to the national average ($p<0.05$). While the presence of instrumentation following spinal fusion is an important consideration, it should not dictate a patient's delivery. A multidisciplinary team consisting of obstetrician, anesthesiologist, and orthopaedic surgeon can provide the most comprehensive information to empower a patient to make their preferred decisions regarding birth experience.



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

58. Non-Contact Sports Participation in Adolescent Idiopathic Scoliosis: Effects on Parent and Patient Reported Outcomes

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Summary
Sports participation in Adolescent Idiopathic Scoliosis (AIS) patients is a controversial topic. This study showed that patients who participated in sports are more likely to have better functionality, self-image, lower expectations, and better parental perception of deformity.

Hypothesis
AIS patients' sports participation plays a significant role in patients' and parents' mental status and self-perception of deformity.

Design
Retrospective review of prospectively collected database

Introduction
The benefits vs risks of AIS patients participating in sports is a controversial topic in the literature. The objective of this study was to determine if sports participation has a significant impact on pain, function, mental status and self-perception of deformity in AIS patients and their parents.

Methods
This is a single center, prospective study of patients (10-25 y/o) who visited a single surgeon for evaluation of primary AIS. Patients had full spine xrays and completed surveys of demographics, socioeconomics, and patient reported outcomes [PRO: Scoliosis Research Society (SRS)-30, Body Image Disturbance Questionnaire (BIDQ), and Spinal Appearance Questionnaire (SAQ: Children and Parent]. Patients were grouped into those who participated in non-competitive sports (Sports) vs those that did not (Non-Sports). Demographics, radiographic parameters and PRO were compared using parametric/non-parametric tests as appropriate with means/medians reported, respectively. Linear regression model was used to identify significant predictors of PRO.

Results
52 patients were included (Sports n=32, Non-Sports n=20). The groups had comparable age, gender, BMI, bracing status, and hx of physical therapy; all p>0.05. Sports and Non-Sports also had similar coronal deformity: Major Cobb (31.1° vs 31.5°). Sagittal alignment profiles [pelvic incidence (PI), pelvic tilt (PT), PI minus lumbar lordosis (PI-LL), thoracic kyphosis (TK), and sagittal vertical axis (SVA)] were similar between groups (p>0.05). Sports had better SRS-30 (Function, Self-Image, and Total) scores, better SAQ-Child Expectations, and SAQ-Parent Total Scores (Table; p<0.05). Regression model revealed that Major Cobb (B Coeff. -0.300) and Sport Participation (B Coeff. 0.415) were significant predictors of SRS-30 Function score, R=0.431, P<0.05.

Conclusion
Our data shows that for the same coronal and sagittal deformity, patients who participated in sports are more likely to have better functionality, self-image, lower expectations, and better parental perception of deformity. AIS patients should be encouraged to participate in safe sports and maintain acceptable levels of physical activity.

Patient/Parent Reported Outcomes	Sports	Non-Sports	*p-value*
SRS-30 Function	4.40	4.00	**0.004**
SRS-30 Pain	4.30	4.10	0.334
SRS-30 Self-Image	3.81	3.44	**0.028**
SRS-30 Mental	3.90	3.90	0.691
SRS-30 Satisfaction	3.50	3.50	0.923
SRS-30 Total	3.95	3.69	**0.044**
SAQ Child Appearance	10.00	10.00	0.472
SAQ Child Expectation	2.5	5	**0.024**
SAQ Child Total	14.37	19.03	0.093
SAQ Parent Appearance	7.14	10.00	0.115
SAR Parent Expectation	7.5	12.50	0.103
SAQ Parent Total	17.08	22.95	**0.043**
BIDQ	1.36	1.64	0.087

Table: Comparison of patients' and parents' reported outcomes between patients who participated in non-competitive sports vs. patients who did not.

59. Restoration of Thoracic Kyphosis in AIS Patients with Thoracic Hypokyposis or Lordoscoliosis Using Multiple Ponte Osteotomies With or Without Additional Bilateral Rib Osteotomies

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Summary
The addition of bilateral rib osteotomies (BRO) to multiple Ponte osteotomies (MPO) enables better kyphosis restoration in AIS pts with thoracic hypokyphosis (TH) or thoracic lordosis (TL). In both techniques, pulmonary function tests(PFT) show improvement at the end of min. two yrs.

Hypothesis
The addition of BRO to MPO provides better kyphosis restoration

Design
Retrospective

Introduction
The aim of this study was to investigate the clinical, radiologic, and pulmonary functions at the end of min.2 yrs follow up in pts with TH or TL who underwent either only MPO or additional BRO to MPO

Methods
62 AIS pts(11M,51F) with TH(n=49) or TL(n=13) who underwent MPO with or without BRO were included. GroupA: pts who underwent only MPO(n=40), GroupB: pts who underwent BRO(between T4-T10)in addition to MPO (n=22). Mean corrections in the coronal plane, and the increases in the sagittal plane parameters (T2-T12),(T5-T12) were compared between the two groups. Preop and f/up FVC, FEV1, AND FEV1/FVC values on PFT were compared between the two groups. The clinical improvements were compared by changes in the SRS-22 and ODI values. Statistical analyses were performed with repeated measures T test and two way anova for mixed measures

Results
Mean age was 15.5 (13-18).Mean f/up was 57.5 months (24-126). Correction rates for MT and TL/L curves were 88% and 78%, respectively for Group A, and 84% and 76%, respectively for Group B. Mean increases in T2-T12, T5-T12 angles in the sagittal plane, between the preoperative values and f/up values, were 19.3° and 17.8° for GroupA, and 24.2° and 21.2° for GroupB. Mean number of MPO were 3(2-5) in GroupA, and 4(2-6) in GroupB. Mean correction in pts who underwent MPO more than 3 levels was significantly higher than those with osteotomies less than 3 levels(p<0.05).

In GroupB, the mean number of BRO levels was 5(3-8).Kyphosis restoration in the sagittal plane was better in GroupB, however there was no statistically significant difference between the groups(p>0.05).Comparison of preop and f/up PFT in both groups showed statistically significant improvement(p<0,05). In f/up, SRS22r and ODI values were 4.4 and 6, respectively for GroupA, and 4.2 and 8, respectively for GroupB

Conclusion

In AIS patients with TH and TL, the addition of BRO to MPO provides better kyphosis restoration. Better restoration of thoracic kyphosis was achieved when MPO performed more than 3 levels. The addition of BRO to MPO will increase the pulling vertebral column posteriorly segment by segment in the TH or TL segments, which facilitates correction. PFT showed similar improvement at the end of two yrs

MEAN (min – max)	GROUPA (n=40)		GROUPB (n=22)	
	PREOP	FOLLOW/UP	PREOP	FOLLOW/UP
MT (°)	59,5 (43 - 76)	7 (3 - 13)	53,4 (32 - 65)	9,8 (3 - 16)
TL/L (°)	45,2 (23 – 60)	9 (5 – 19)	38,4 (22 – 65)	11 (4 – 22)
T2-T12 Kyphosis Angle (°)	+10,7 (-6 - 19)	+30 (20 - 39)	+2,5 (-18 - 16)	+26,7 (16 - 32)
T5-T12 Kyphosis Angle (°)	+3,5 (-5 - 9)	+21,3 (11 - 29)	+0,4 (-20 - 11)	+21,6 (11 - 28)
SVA (mm)	+2,15 (-5,8 – 24,8)	-3,8 (-16,7 – 24,1)	+5,2 (-6,6 – 26,1)	-4,6 (-25,7 – 9,2)
Lumbar Lordosis (°)	47,2 (18 - 65)	54,2 (36 - 66)	42,2 (25 - 60)	50,1 (38 - 62)
FVC (act. - %pred)	2,4 - 72	2,8 - 76	2,8 - 74	3,0 - 77
FEV1 (act. - %pred)	2,4 - 77	2,8 - 82	2,6 - 80	3,2 - 84
FEV1/FVC (%pred)	89 (81-98)	94 (89-100)	93 (82 – 99)	98 (95 – 100)
SRS-22r	3,6 (3,2 – 4,2)	4,4 (4,2 – 4,6)	3,2 (2,4 – 4)	4,2 (3,8 – 4,6)
ODI	12 (8 – 24)	6 (0 – 12)	16 (12 – 26)	8 (0 – 14)

60. Changes in Body Shape Following Surgical Correction in AIS Surface Topography Changes Are Associated With Improvements in Health-Related Quality of Life

Baron S. Lonner, MD; Yuan Ren, PhD; Gabrielle Kassin, BS

Summary

As a validated assessment tool, Surface topography (ST) more directly represents the scoliotic patient's external deformity than x-ray. We assessed the association of ST improvements with surgical correction in AIS. ST measurements were highly correlated with radiographic outcomes. We also found that pelvic obliquity (waist asymmetry) and sagittal balance was associated with SRS-22 outcomes. Perhaps, in the asymptomatic patient, ST can be used as a primary measurement tool after the acute post-operative period to limit x-ray exposure to the patient.

Hypothesis

Body surface topography (ST) improvements are associated with surgical correction in adolescent idiopathic scoliosis (AIS) and correlate with health-related quality of life (HRQOL).

Design

Prospective observational study

Introduction

Patients undergoing correction of AIS are most affected by body image. Radiographs have been the standard assessment tool but do not assess body shape features. Surface topography (ST), a validated, radiation-free assessment tool, directly represents the patient's deformity. We set out to assess ST improvements associated with surgical correction in AIS and correlate these changes with HRQOL.

Methods

Twenty-three consecutive operative AIS patients were enrolled and had radiographs and posterior ST obtained pre- and post-operatively (PO). ST changes were compared using paired t-test and correlations of ST with x-ray measurements and SRS-22 scores were evaluated by linear regression and Pearson correlation.

Results

Mean age at surgery was 15.0±2 years, 82.6% female with mean F/U of 1.0 year. Major Cobb angle improved from 56.9±15.6° to 13.7±4°. ST scoliosis angle corrected from 41.4±11.5° to 11.8±7.8° (p<0.0001). Trunk length increased from 401.2±32.4 to 422.3±25.8mm (Δ21.1mm; p=0.0004). Pelvic obliquity (waist asymmetry) had a nearly significant improvement (6.0±4.3 vs. 5.3±7.1mm; p=0.0643). Surface rotation was corrected from 17.4±6.7mm to 11.8±4.1mm (p<0.0001), highly correlated with clinical trunk rotation (T p=0.0022 and TL p=0.0225). ST highly correlated with radiographic parameters (Table). ST waist asymmetry correlated with satisfaction (p=0.0143), self-image (p=0.0333) and PO total (p=0.0298) domains and improvement in pain scores (p=0.0414). Sagittal balance correlated with improved function (p=0.0237).

Conclusion

ST, a radiation-free body shape assessment tool, improved with surgical correction of AIS and was highly correlated with radiographic outcomes. Perhaps, in the asymptomatic patient, ST can be used as a primary measurement tool after the acute PO period to limit x-ray exposure to the patient.

	Pre-op	Post-op	p-value	Correlation with [x-ray parameter] (p-value)
Radiographic measurements				
Major Cobb (°)	56.91±15.57	13.70±4.89	<0.0001	n/a
T2-T12 kyphosis (°)	31.75±9.97	29.63±8.80	0.2329	n/a
Lumbar Lordosis	62.13±19.64	67.50±14.48	0.7816	n/a
C7 SVA (mm)	1.74±1.40	2.37±2.41	0.6779	n/a
C7-CSVL (mm)	1.67±1.09	1.16±0.85	0.1351	n/a
Clinical Measurements				
ATR Thoracic (Th)	13.95±6.19	6.15±2.89	<0.0001	n/a
ATR Thoracolumbar (TL)	11.55±7.86	2.55±2.35	<0.0001	n/a
ST measurements				
Scoliosis Angle (°)	41.43±11.52	11.78±7.84	<0.0001	<0.0001* [Major Cobb]
T2-T12 kyphosis (°)	38.78±9.68	30.09±6.65	0.0001	0.0171*
Lumbar Lordosis (°)	36.04±10.43	31.61±9.0	0.0508	0.0322* [LL]
Surface rotation (°)	17.35±6.73	11.83±4.12	<0.0001	0.0022* [ATR Th] 0.0225* [ATR TL]
lateral deviation T4DMmax (mm)	29.57±7.90	13.52±6.07	<0.0001	Not measured
Trunk length VP-DM (mm)	401.22±32.43	422.30±25.77	0.0004	Not measured
Sagittal imbalance (mm)	29.78±18.98	25.96±21.20	0.4283	0.0163* [C7 SVA]
Coronal imbalance (mm)	13.22±8.30	10.48±8.36	0.1933	0.0050* [C7-CSVL]
Pelvic Obliquity (mm)	5.96±4.34	5.26±7.07	0.0643	Not measured
Pelvic inclination (dimples) (°)	23.61±4.92	23.57±4.59	0.5190	0.0797 [PI]
Vertebra rotation max (°)	18.61±5.96	12.96±3.59	<0.0001	Not measured

61. Selection of the Optimal Distal Fusion Level for Correction of Scheuermann's Hyperkyphosis with Posterior All Pedicle Screw Instrumentation and Fusion

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Summary

The aim of this study was to define the optimal distal fusion level in Scheuermann kyphosis (SK) patients with all pedicle screw instrumentation. Fusion to the SSV is not necessary, and relatively less fusion levels stopped at FLV could equally guarantee a satisfactory correction with equivalent occurrence of DJK and the preservation of more lumbar motility.

Hypothesis

Fusion levels stopped at FLV could equally guarantee a satisfactory deformity correction.

Design
Prospective study.

Introduction
Few studies have focused on the selection of the optimal distal fusion level for correction of SK. The objective of this study was to define the optimal distal fusion level in Scheuermann kyphosis (SK) patients with all pedicle screw instrumentation.

Methods
A prospective analysis of 45 patients with SK treated by posterior-only all pedicle screw instrumentation and fusion at our center was performed. They were 5 females and 40 males, with an average age of 18.8±5.8 years. Patients were divided into 2 groups: Group FLV (n = 24), the LIV was stopped at the FLV; Group SSV (n = 21), the LIV was distal to the FLV. Group FLV included 5 patients in whom the SSV and the FLV were the same vertebra (LIV = SSV = FLV). Thoracic kyphosis (TK), lumbar lordosis (LL), sagittal vertical axis (SVA), the distance from the center of the LIV to the posterior sacral vertical line (PSVL) and the incidence of distal junctional kyphosis (DJK) were measured.

Results
The two groups were homogeneous in terms of age, gender, BMI, number of fused levels, follow-up time and preoperative measurements. After surgery, the correction results of TK, LL and SVA were showed comparable between Group FLV and SSV. Correction amounts of SK in Group FLV and Group SSV were 51.3±11.8 % and 49.3±12.2 %, respectively. Patients in the two groups were followed up with 27.1±15.3 months and 27.4±13.4 months on average. At the last follow-up, correction results of all the parameters were maintained stable and showed similar between the two groups. 3 patients in Group FLV and 2 patients in Group SSV developed DJK, which was not statistically significant.

Conclusion
In the current study, distal junctional problems did not develop more in patients where LIV was stopped at FLV rather than SSV. Based on this study regarding SK surgery with all pedicle screw technique, fusion to the SSV is not necessary and relatively less fusion levels stopped at FLV could equally guarantee a satisfactory thoracic hyperkyphosis deformity correction with equivalent occurrence of DJK and the preservation of more lumbar motility.

62. Does Thoracolumbar Kyphosis Correction change the Acetabular Cup Anteversion in Ankylosing Spondylitis patients with a Previous Total Hip Replacement?

Bangping Qian, MD; Jun Hu, MD, PhD; Mu Qiao, MD; Ji-chen Huang, MD; Bin Wang, MD; Yang Yu, MD; ZeZhang Zhu, MD PhD; Yong Qiu, MD

Summary
The purpose of this study was to evaluated the effect that the spinal reconstruction procedure has on acetabular cup anteversion (ACA). A high prevalence of excessively anteverted acetabular component was observed in ankylosing spondylitis (AS) patients with a previous total hip replacement (THR). Spinal osteotomy procedure can reconstruct the sagittal alignment and decrease ACA.

Hypothesis
Thoracolumbar kyphosis correction affected ACA in AS patients with a previous THR.

Design
A retrospective radiographical study.

Introduction
Pelvic retroversion is an important compensatory mechanism in the setting of sagittal balance in AS patients with thoracolumbar kyphosis, leading to exaggerated acetabular anteversion. Abnormalities in acetabular orientation can promote acetabular cup malposition. Spinal osteotomy can correct thoracolumbar kyphosis and restore spinopelvic alignment in AS patients. However, few studies had evaluated the effect that the spinal reconstruction procedure has on ACA.

Methods
AS patients with thoracolumbar kyphosis who already had undergone THR surgery prior to the spinal osteotomy were included. ACA and anterior pelvic plan (APP) were measured before and after the spinal correction surgery. Spinopelvic parameters were also measured including: sagittal vertical axis (SVA), global kyphosis (GK), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS). Radiographical parameters before and after surgery were compared using the paired t-tests. The correlations of radiographical parameters were calculated via Pearson correlation coefficients. A step-wise linear regression was applied to construct the model for predicting the change in ACA.

Results
Fourteen AS patients undergoing spinal deformity correction after THR surgery (twenty-three hips) were included. ACA and APP significantly reduced from 23.1° ± 7.2° and 33.1° ± 10.0° before surgery to 9.9° ± 4.4° and 16.2° ± 8.3° after surgery ($P < 0.001$). SVA, GK, LL, PT, and SS were significantly corrected from 18.9 ± 4.8cm, 73.6° ± 16.9°, 18.7° ± 12.4°, 41.5° ± 9.6°, and 3.6° ± 4.6° preoperatively to 4.6 ± 2.5cm, 27.5° ± 12.5°, -25.4° ± 9.0°, 25.8° ± 8.2°, and 18.3° ± 5.1° postoperatively ($P < 0.001$). The change in ACA strongly correlated with the change in PT ($r = 0.874$, $P < 0.001$). The step-wise regression analysis revealed that for every degree of PT correction, ACA decreases by 0.8°.

Conclusion
A high prevalence of excessively anteverted acetabular component was observed in AS patients with a previous THR. Spinal osteotomy procedure can not only reconstruct the sagittal alignment but also decrease ACA.

63. Risk Factors for Proximal Junction Kyphosis (PJK) in Scheuermann's Kyphosis (SK)

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Summary
A large number of SK patients have postop PJK. Higher incidence of PJK is seen with all pedicle screw fixation and UIV below T3.

Hypothesis
The incidence of PJK in SK is higher in pedicle screw fixation than hybrid.

Design
Ambispective

Introduction
PJK has been well documented with pedicle screws in AIS patients. In Shcheurrman's kyphosis (SK), PJK has been reported with hybrid fixation in the presence of shorter fusions. The literature is deficient about PJK in SK with all pedicle screw constructs.

Methods
Xray and chart review of all SK patients operated with all pedicle screw (PS), hybrid fixation (HF), and anterior/posterior fusions with hybrid fixation (AP) were reviewed. Number of fusion levels, percent correction, UIV, LIV, pre and postop PJK, sagittal balance, and demographic data was collected. PJK was defined as more than 10 degrees Fisher's exact test, Kruskal-Wallis, Wilcoxon ranked sum test were used.

Results
84 total patients: PS (n=29), HF (n=24), and AP (n=31). Median preop kyphosis was significantly higher in the AP compared to PS and HF (89 vs 77 vs 81.5,p<0.001). Median postop kyphosis was significantly higher in the PS cohort (50.3 vs HF: 45.5 vs AP: 43, p=0.048). Median percent correction was highest in the AP cohort (51.8 vs HF:43.8 vs PS:32.9, p<0.001). Pre and post sagittal balance was similar across the three cohorts. Overall, at postop 47.6% of patients had PJK, and at final 70.2%. Immediate postop-PJK was significantly higher in PS 13.4 vs HF: 7.8 vs AP:8, p =0.008). However, final PJK was similar across the three groups (PS:19 vs HF:15 vs AP:14, p=0.07). T2 was the most common UIV for AP (71%) and HF (71%) compared to T3 for PS (59%), p<0.001). Overall, significantly higher postop-PJK was seen with UIV below T3 (13.7 vs 9.4, p =0.043).

Conclusion
Incidence of PJK appears to be higher in SK compared to that reported in AIS. Patients with pedicle screw fixation appear to be at the highest risk. UIV at T3 or proximally has significantly lower PJK.

64. Surgeon Operated Trans-Cranial Motor Evoked Potentials (tcMEP) in Spinal Deformity Surgery - A Viable Option in Resourced Challenged Environments?

Robert Dunn, FCS (SA) Orth

Summary
SCM technologists are not available in resource challenged environments. We present our experience of 108 consecutive surgeon monitored cases with 49 less that 13 years old, 47 teenagers and 12 adults. Case mix was 54 AIS, 27 neuromuscular scoliosis, 14 congenital, 2 old TB and 11 miscellaneous. The vast majority was posterior based surgery. There was a 100% negative predictive value and 8% alert incidence allowing intra-operative action with positive patient outcome.

Hypothesis
to evaluate the use of surgeon operated trans-cranial motor evoked potentials (tcMEP) in spinal deformity surgery

Design
Review of prospectively collected patient demographic, surgical and spinal cord monitoring data.

Introduction
Spinal deformity surgery carries the risk of loss of neurological function which may be permanent. Intra-operative spinal cord monitoring allows this risk to be reduced by providing feedback to the surgeon while the corrective manoeuvres are performed but a dedicated technician is often not an option in a resource limited environment. Surgeon operated technology is an option.

Methods
A review was conducted on a single surgeon series of 108 consecutive cases utilising transcranial motor evoke potentials. Forty-nine patients were 13 years old or less, 47 were 14 – 18, and 12 adults. The cohort consisted of 54 AIS, 27 neuromuscular scoliosis, 14 congenital, 2 old TB and 11 miscellaneous. The vast majority were posterior based procedures.

Results
In 4 cases initial traces could not be obtained. One was a severe myelopathy and further efforts to monitor were abandoned. In one case the anaesthetist had broken protocol and once converted to TIVA the traces improved. Two others were poor initially but improved as the case progressed. In 8 cases intra-operative traces were lost. One was thought to be due to hypothermia and the patient woke intact. Two were unrelated to surgical intervention and recovered spontaneously with patients waking intact. Four cases deteriorated during the corrective manoeuvre (one delayed) and recovered with reduction of correction. One case required removal of instrumentation after repeated loss each time rods were inserted and awoke with a weak leg but recovered and was re-operated two weeks later.

Conclusion
Surgeon operated tcMEP's is a viable option in deformity correction with a 100% negative predictive value and an 8% incidence of signal loss during correction allowing immediate remedial action.

65. Minimally Invasive Surgery in Neuromuscular Scoliosis: A Superior Approach for Severely Impaired Patients

Vishal Sarwahi, MD; Jesse Galina, BS; Stephen F. Wendolowski, BS; Francisco Javier Laplaza, MD; Terry D. Amaral, MD

Summary
Minimally Invasive Scoliosis surgery (MIS) has known benefits in adolescent idiopathic scoliosis patients. This technique has not been evaluated in neuromuscular scoliosis patients. This study finds that MIS approach has significant perioperative and safety benefits over standards PSF with similar Cobb and pelvic obliquity correction.

Hypothesis
Minimally invasive scoliosis surgery in neuromuscular patients improves perioperative outcomes.

Design
Ambispective chart review

Introduction
Minimally invasive surgery (MIS) approach has been shown to decrease blood loss, pain, transfusion rate and hospital stays in adolescent idiopathic scoliosis (AIS) patients. This approach has never been reported on neuromuscular patients, who have multiple co-morbities and complications, and can benefit greatly from this technique. This study seeks to compare the peri-operative outcomes of MIS approach to standard PSF approach in neuromuscular patients.

Methods
A review of neuromuscular scoliosis patients operated on from 2005-2016 by a single surgeon. PSF was performed from 2005-2016. MIS approach was adopted in 2014. Perioperative outcomes such as length of operation, transfusions, neuro-monitoring signal changes, estimated blood loss (EBL), and length of stay were recorded. Pre- and posop XRs were reviewed for Cobb angle, kyphosis, levels fused and pelvic obliquity. Median and interquartile ranges were calculated for non-normative distributions and Fisher's exact test and Wilcoxon Rank Sums tests were used.

Results
139 neuromuscular scoliosis patients underwent surgery from 2005-2016: 14 MIS and 125 PSF. Patients were of similar age (14 vs 13.6, p = 0.83), preop Cobb angle (66 vs 68.95°, p = 0.68), and preop pelvic obliquity (8.4 vs 8.65, p = 0.84). PSF patients had significantly longer surgeries (390 vs 347.4min, p = 0.023) and longer anesthesia (547 vs 495min, p = 0.023). EBL was higher in PSF, though not significant (800 vs 600, p = 0.11). Postop Cobb (MIS: PSF; 22 vs 27.65, p = 0.52), and postop pelvic obliquity (MIS: PSF; 5 vs 2.6, p = 0.072) were similar. MIS patients had significantly more fixation points than PSF (31 vs 28, p = 0.010). MIS patients also had significantly less postoperative complications (0% vs 29%, p=0.04), and shorter length of stay (6 vs 10 days, p = 0.005).

Conclusion
Minimally invasive approach provides comparable results for postop Cobb, pelvic obliquity, as well as the greatest benefits to patients in terms of decreased complications, blood loss, surgery length, and hospital stay despite more fixation points. MIS should be strongly considered in this group of complex patients.

66. Surgical Treatment of Segmental Spinal Dysgenesis: Selection of An Optimal Type of Fusion

Olga Pavlova; Alexander Gubin, MD, PhD; Sergey Ryabykh, MD, PhD

Summary
Segmental spinal dysgenesis (SSD) is a rare congenital pathology often complicated by progressive lower paresis due to mechanical instability of the spine

Hypothesis
Antero-posterior instrumented fusion provides better correction of kyphoscoliosis and fusion rate in SSD than non-instrumented arthrodesis

Design
Systematic Review

Introduction
The aim of this study is to select optimal treatment strategy of SSD

Methods
We analyzed 45 patients with SSD (37 from the literature and eight from our institution)

Results
Anterior fusion (AF) was perfomed in two patients (4.4%), posterior fusion (PF) in 11 patients (24.4%) and antero-posterior fusion (APF) in 33 patients (73.2%). In group PF, neurological stabilization was achieved in six cases (54.5%) and neurological deterioration occurred in five cases (45.5%). Correction of spinal deformity and fusion was reached in seven cases (63.6%) and progression of spinal deformity occurred in four (36.4%). In group APF, neurological improvement or stabilization was achieved in 31 cases (93.9%) and deterioration in two cases (6.1%). Correction of spinal deformity and fusion was reached in 31 cases (93.9%) and progression of spinal deformity occurred in two cases (6.1%). Non-instrumented fusion was performed in 32 patients (non-IF) and 13 patients underwent additional instrumented fixation (IF). In group non-IF, neurological improvement or stabilization was achieved in 26 cases (81.2%) and deterioration in six cases (18.8%). Fusion was reached in 25 cases (78.1%) and progression of spinal deformity occurred in seven cases (21.9%). At group IF neurological improvement or stabilization was achieved in 11 (84.6%) and deterioration in two (15.4%) cases. Correction of spinal deformity was achieved in 12 cases (92.3%) and deformity changes after surgery was unknown in one patient.

Conclusion
Resection of hypoplastic vertebrae with screw fixation provides favorable deformity correction and neurological stabilization but limited by immature vertebral structures in newborns, infants, and some toddlers.

67. The Effect of Pre-Operative Halo Gravity Traction (HGT) for Severe Spinal Deformities on the Neck Disability Index. Is Long-term HGT Harmful to the Neck?

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Summary
184 pts with severe spinal deformity were treated with Halo Gravity Traction (HGT) preoperatively. The Neck Disability Index (NDI) improvements is seen at 4 and 8 week time points and relapses to bases line values at 12 weeks and 6 weeks post op.

Hypothesis
HGT does not adversely affect the Neck Disability Index

Design
Retrospective review of prospective data

Introduction
The use of halo gravity traction as an integral part of the pre-op management of severe spinal deformities, to gradually correct the curves prior to definitive spine surgery. There is a dearth of information in the literature on the effects of HGT on the C-spine, using the neck disability index (NDI) instrument. The purpose of this study is to report on the Effect of HGT on the C-spine using the NDI, prior to definitive surgery at a single site in West Africa.

Methods
184 pediatric and adult pts from a single site in West Africa were reviewed between 2012-16. NDI questionnaire was evaluated before HGT and at 4-week intervals before definitive surgery and at 6 weeks post op. Paired T-Test was done to evaluate the changes in NDI.

Results
184pts, 84F and 100M. Mean age 15.1 (SD=5.7). Diagnoses: 93 idiopathic, 36 congenital, 33 Post Tb, 12 Neuromuscular, and 10NF. Curve type:116

kyphoscoliosis, 47 Kyphosis and 21 Scoliosis. The mean duration of HGT was 96days (SD=40). Mean Pre HGT coronal Cobb: 124 deg, corrected 30 % in HGT, Sag cobb pre HGT 130 deg, corrected 31% post HGT. NDI score in Gp1: 4 wks post HGT (63pts), Grp 2: 8, wks post HGT (65pts), Grp Grp 3: 12 wks post HGT (43Pts); Grp 4: 6 weeks post op (49pts) ; Grp 5: 4, 8 and 12 weeks post HGT (37pts), showed significant improvements in the NDI scores at 4 and 8,week time points (Grp 1,2 and 5) and return to baseline values at 12 weeks and 6 weeks post op (Grp 3,4 and 5) Table 1

Conclusion
The results of this study showed that HGT improves NDI at 4 and 8 weeks. However this improvement wanes and relapses to baseline values at 12 weeks post HGT and at 6 weeks post op. It can be stated that prolonged HGT does not adversely affect the NDI but may result in cervical deconditioning at longer terms(>12 weeks) implying a need for neck rehabilitation program for long term use of HGT.

	N	Pre HGT	4wks Post HGT	8wks post HGT	12wks Post HGT	6wks Post Op	p-value
		Mean NDI Scores					
Group 1	63	17.48,	14.08	-	-	-	0.02
Group 2	65	15.76	-	12.7	-	-	0.01
Group 3	43	16.99	-	-	17.45	-	0.81
Group 4	49	17.30	-	-	-	14.05	0.09
Group 5	37	17.29	13.79				0.09
	37	17.29	-	11.87	-	-	0.004
	37	17.29			16.80	-	0.81

68. Minimally Invasive Percutaneous Screw Osteosynthesis for Hangman's Fracture
Shuhei Osaki, MD, PhD; Yasuo Ito, MD, PhD

Summary
Percutaneous osteosynthesis was performed in 11 hangman's fractures. A dynamic reference arc was attached through a small incision and cancellous lag screws were inserted through small lateral incisions under intraoperative CT-based navigation. All patients underwent surgery without complications and achieved bone union. This technique would be a safe and useful method for the treatment of hangman's fractures.

Hypothesis
To describe the technique for percutaneous osteosynthesis using intraoperative CT-based navigation for hangman's fracture and analysis of clinical results.

Design
Retrospective case series.

Introduction
Stable hangman's fractures are usually treated conservatively. However, in some instances such as polytrauma patients, operative treatment may be required. In this study, we describe a percutaneous osteosynthesis for hangman's fractures.

Methods
Eleven patients with hangman's fractures were treated in this study. Mean age was 57 years. The fractures resulted from falls in 6 patients, traffic accidents in 4 patients and a falling object in 1 patient. Nine patients (82%) had chest and/or head injuries. All fractures were evaluated by radiographs and CT imaging. Percutaneous osteosynthesis was performed in the patients with Levine-Edwards classification type I, and type II without C2/3 disc injury. Surgical procedure; a dynamic reference arc was attached to the spinous process of the axis through a small incision. After image acquisition, the fluoroscope workstation generated 3-dimensional (3D) reconstructions. We made two small lateral incisions. Cancellous lag screws were inserted over guidewires. Bilateral screw positions could be assessed by intraoperative 3D fluoroscopy imaging. Postoperatively, patients wore a rigid cervical collar until bone union was achieved.

Results
Type I fractures were observed in 6 patients and type II in 5 patients. The average surgical time was 101 minutes. No intraoperative complications occurred. Union was achieved in all patients. In a 72-year-old male with type II fracture, unilateral partial screw backout was observed at the fifth postoperative week. After re-instruction of a cervical collar fixation and administration of intermittent parathyroid hormone, eventual union was achieved without screw backout progression.

Conclusion
Percutaneous osteosynthesis using lag screws has the benefit of less muscle disruption, maintaining a normal cervical ROM and early rehabilitation. In this study, all patients underwent surgery without complications and achieved bone union. Minimally invasive percutaneous screw osteosynthesis using intraoperative CT-based navigation seems to be a safe and useful method for the treatment of hangman's fractures.

69. WITHDRAWN

70. Paediatric Spinal Tuberculosis - Surgical Options and Outcomes
Robert Dunn, FCS (SA) Orth

Summary
Although medical management is the mainstay for TB spondylodiscitis, surgery is indicated for severe deformity, progressive neurological deterioration, biopsy and large abscess drainage. We present our experience in 53 consecutive cases including uninstrumented / instrumented, anterior and posterior cases with the vast majority improving their neurological status, 13 non-ambulators becoming ambulatory with 28 degrees maintained kyphotic correction and 15% revision rate.

Hypothesis
To assess our surgical management of paediatric spinal tuberculosis in terms of indications, procedure employed, complications, correction and neurological outcome.

Design
Retrospective review of single surgeon prospectively collected data in surgical database

Introduction
Although medical management is the mainstay for TB spondylodiscitis, surgery is indicated for severe deformity, progressive neurological deterioration, biopsy and large abscess drainage. The paediatric patient provides challenges of ongoing growth, implant purchase due to small size and soft bone. We present our experience in 53 surgically managed cases.

Methods
53 patients were identified from the senior author's prospectively maintained database. 58% thoracic, 13% thoraco-lumbar, 11% lumbar, 11%

cervicothoracic and 7% cervical. Indications for surgery included: deformity (38%), neurological compromise (51%), instability (23%), revision of surgery (10%), failure of medical management (15%), and diagnosis (6%). Surgical procedures included instrumented fusion (24), uninstrumented fusion (24), graft revision (4), biopsy (2), drainage of psoas abscess (1) and costotransversectomy (1). 37 were anterior and posterior (37) with 10 posterior only and 1 anterior only.

Results
Acute correction of kyphotic deformity was achieved with an average improvement of 28.2° in the instrumented group and 12.2° in the uninstrumented group. The instrumented group maintained correction better with an average follow-up of 20.8 months. There were 4 incidental durotomies, 2 post-operative wound infections requiring debridement, 4 graft failures requiring revision and 3 patients had transient deterioration of neurology.

Conclusion
Surgical management of spinal tuberculosis is effective and safe in the paediatric group. Where possible, instrumented fusion results in better maintained correction of deformity. One can expect neurological improvement following decompression.

71. The Spine Oncology Study Group Outcome Questionnaire (SOSGOQ): Analysis of Validity and Test-Retest Reliability

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Summary
The SOSGOQ is the first spine oncology specific HRQOL outcome measure. Construct validity and test-retest reliability was evaluated prospectively using a multicenter cohort and the SOSGOQ has shown to be a valid and reliable outcome measure for spine oncology patients.

Hypothesis
The Spine Oncology Study Group Outcome Questionnaire (SOSGOQ) is a valid and reliable spine oncology specific outcome measure.

Design
multicenter prospective observational cohort study.

Introduction
The evaluation of health related quality of life (HRQOL) is essential in palliative care. In response to the absence of a spine oncology specific outcome measure, the SOSGOQ was developed. The objective of this study was to assess construct validity and test-retest reliability of the SOSGOQ.

Methods
Patients who underwent surgery and/or radiotherapy as treatment for spinal metastases were eligible for inclusion in an international multicenter prospective observational study conducted by the AOSpine Knowledge Forum Tumor. Patient demographic, tumour, treatment and quality of life data were collected. Correlation (Spearman's rank) of the SOSGOQ subdomains to the corresponding subdomains of the SF-36 or the NRS-pain score was used to evaluate construct validity. The total scores of the SOSGOQ and SF-36 are inversely related. Test-retest reliability was assessed at 12 weeks post-treatment, followed by the re-test 4-9 days later using the Intraclass Correlation Coefficient (ICC). Internal consistency of the SOSGOQ subdomains was investigated using Cronbach's alpha.

Results
Construct validity was evaluated in 238 patients in nine participating centers. Test-retest reliability was investigated in 36 patients in two of the nine participating centers, where 26 underwent radiotherapy alone and the remaining 10 underwent surgery with or without additional post-operative radiotherapy. The SOSGOQ subdomains showed a strong to very strong correlation with the corresponding subdomains of the SF-36 (Spearman's rank=-0.61 to -0.83) and the NRS pain score (Spearman's rank=0.71). Reliability of the overall SOSGOQ demonstrated to be excellent with an ICC of 0.84.

Conclusion
Correlation of the SOSGOQ subdomains to the corresponding subdomains of the SF-36 and the NRS-pain score confirmed the construct validity. In addition, the test-retest reliability demonstrated to be excellent. The SOSGOQ is a valid and reliable spine oncology specific HRQOL measure.

72. Metastatic Spine Tumour Surgery: Does Perioperative Allogenic or Salvage Blood Transfusion Influence the Survival and Cancer Progression?

Aye Sandar Zaw, MBBS, MPH; Shashidhar Bangalore Kantharajanna, MD; Aditya Parkash Singla; *Naresh Kumar, FRCS (Ortho), DM*

Summary
We did a retrospective analysis to evaluate the influence of perioperative blood transfusion in 247 patients undergoing metastatic spinal tumour surgery (MSTS). A separate cohort of 42 patients who underwent MSTS were evaluated prospectively to evaluate the safety of salvage blood transfusion. Analysis revealed that neither blood transfusion exposure nor the types of transfusions were found to be associated with overall survival and progression-free survival. The factors influencing overall survival were primary tumour type and preoperative ECOG while primary tumour type was the only factor having impact on progression-free survival.

Study design: Retrospective review with a prospective cohort study

Hypothesis
We hypothesized that the tumour progression or survival after MSTS is not influenced by perioperative transfusions including salvaged blood transfusions.

Introduction
The impact of allogenic blood transfusion (ABT) or salvage blood transfusion (SBT) on cancer related outcomes after MSTS has not been studied. Salvaged blood transfusion has not found wide application in MSTS due to the theoretical concern of tumor dissemination. This is despite our previous reports on in-vivo and laboratory studies of the safety of blood salvaged during MSTS. We aimed to evaluate the influence of perioperative ABT or SBT on disease progression and survival in patients undergoing MSTS.

Methods
We included 247 patients who underwent MSTS at a single tertiary institution between 2005 and 2014. The impact of the use of perioperative ABT (either

exposure to or quantities of transfusion) on disease progression and survival was assessed using Cox regression analyses while adjusting for potential confounding variables. A separate cohort of 42 patients who underwent MSTS between January 2014 and January 2016 were divided into three groups depending on transfusion history: (i) no blood transfusion (NBT) group (ii) salvaged blood transfusion (SBT) group and (iii) allogeneic blood transfusion (ABT) group. Primary outcome measure was comparison of progression-free survival (PFS) rates between the three groups. Overall survival (OS), postoperative complication rates and length of hospital stay (LOS) were also studied as secondary outcomes.

Results
Of 247 patients, 133 patients (54%) received ABT. The overall median unit of blood transfused was 2 units (range: 0-10units). Neither blood transfusion exposure nor quantities of transfusion were found to be associated with overall survival (Hazard ratio [HR]:1.15, P=0.35) & (HR:1.10, P=0.11) and progression-free survival (HR:0.87, P=0.18) & (HR: 0.98, P=0.11) respectively. There was a trend towards better PFS, increased OS, lesser LOS and fewer complications in SBT group compared to ABT or NBT group though the differences were not significant. Univariate and multivariate Cox regression analyses revealed that the factors influencing overall survival were primary tumour type and preoperative ECOG while primary tumour type was the only factor having impact on progression-free survival.

Conclusion
This is the first study providing evidence that disease progression and survival in patients undergoing MSTS are less likely to be influenced by perioperative ABT or SBT. The worse oncological outcomes are more likely to be caused by the clinical circumstances necessitating blood transfusion but not transfusion itself. However, given that ABT can have propensity towards developing postoperative complications, utilization of patient's own blood for overall blood management interventions would be worthwhile rather than relying solely on ABT.

73. Evaluating PROMIS in Spine Tumor Patients
David N. Bernstein, MBA, MA; Owen Papuga, PhD; Emmanuel N. Menga, MD; Paul T. Rubery, MD; Addisu Mesfin, MD

Summary
No PRO tool is commonly used in spine tumor patients. We had patients complete PROMIS domains & ODI/NDI questionnaires. We found PROMIS PF & PI correlated well with the ODI/NDI. In general, PROMIS Depression did not correlate well.

Hypothesis
PROMIS will correlate well with "Gold Standard" spine disability PRO tools (ODI/NDI)

Design
Retrospective analysis of prospectively collected data.

Introduction
A number of spine-specific PRO tools exist, as well as PROMIS, a universal PRO tool. However, to date, there is no widely used PRO tool for spine tumor patients.

Methods
Fifty-four unique visits from 33 patients with spine tumors (27 metastatic; 6 primary) from a single academic medical center who had fully completed PROMIS PF, PI and Depression domains and either an ODI or NDI questionnaire on the same visit were identified. Patients presenting between 5/2015 and 12/2016 were included. Both the NDI and ODI were recorded as percentages. Spearman correlation coefficients were calculated to assess concurrent validity. $p<0.05$ was significant.

Results
Twenty-six unique visits (48%) were men, while 28 unique visits (52%) were women. Ten visits involved primary tumors (18.5%) and 44 visits involved metastatic tumors (81.5%). The average age was 56 years (range, 14-79). The average reported ODI and NDI percentages were 43.2 (range, 0.0-80.0) and 32.3 (range, 6.7-66.0), respectively. PROMIS PF, PI and Depression scores were 35.0 (range, 20.0-51.3), 63.5 (range, 32.2-77.8) and 51.0 (range, 34.2-69.5), respectively. There was a strong correlation between PROMIS PF and PI and ODI/NDI percentages among all patients, women, and patients with metastatic tumors (All, PF: θ= 0.77, $p<0.001$; PI: θ= 0.76, $p<0.001$/ Women, PF: θ= 0.85, $p<0.001$; PI: θ= 0.81, $p<0.001$/Metastatic, PF: θ= 0.82, $p<0.001$; PI: θ= 0.73, $p<0.001$). There was a moderate and strong correlation between PROMIS PF and PI and ODI/NDI percentages in men, respectively (PF: θ= 0.63, $p<0.001$; PI: θ= 0.70, $p<0.001$). PROMIS Depression was poorly correlated with ODI/NDI percentages among all patients (θ= 0.56, $p<0.001$), men (θ= 0.55, $p = 0.004$), women (θ= 0.57, $p = 0.002$) and patients with metastatic spine tumors (θ= 0.50, $p<0.001$). A strong correlation existed between PROMIS Depression and ODI/NDI percentages in primary spine tumor patients (θ= 0.81, $p = 0.0042$). Other correlations involving primary spine tumor patients were not significant.

Conclusion
PROMIS PF and PI domains appear to correlate well with the ODI/NDI in patients with spine tumors, suggesting either can be used to track these PROs in spine tumor patients. In general, there was poor correlation between PROMIS domains and the ODI/NDI, suggesting mental health is not similarly captured across PRO tools.

Table 1 Correlation between ODI/NDI and PROMIS Domains

	ODI/NDI				
	All Data	Men	Women	Metastatic Lesion	Primary Lesion
	n = 54	n = 26	n = 28	n = 44	n = 10
PROMIS Domain					
PF	0.77	0.63	0.85	0.82	0.56
	p<0.001	p<0.001	p<0.001	p<0.001	p = 0.095
PI	0.76	0.70	0.81	0.73	0.80
	p<0.001	p<0.001	p<0.001	p<0.001	p = 0.0056
Depression	0.56	0.55	0.57	0.50	0.81
	p<0.001	p=0.004	p=0.002	p<0.001	p=0.0042

74. Predictive Factors for Survival in Surgical Series of Symptomatic Metastatic Epidural Spinal Cord Compression: A Prospective North American Multicenter Study in 142 Patients
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Summary
Symptomatic Metastatic Epidural Spinal Cord Compression (MESCC) is

associated with shortened survival and worsened quality of life. We aim to identify key preoperative predictors of survival in 142 surgical MESCC patients. Slow growing tumor, absence of lymph node/organ metastasis, and higher preoperative score on SF-36v2 physical component are preoperative predictors for longer survival.

Hypothesis
Using the AOSpine North America MESCC database, considered Class I evidence, we can identified the key preoperative factors independently associated with longer overall survival in adult patients who underwent surgical treatment for a single symptomatic MESCC lesion.

Design
Prospective cohort study

Introduction
Symptomatic Metastatic Epidural Spinal Cord Compression (MESCC) afflicts up to 10% of all cancer patients and is associated with shortened survival and worsened quality of life. This study aims to identify the key survival predictive factors in MESCC patients who were surgically treated for a single symptomatic lesion.

Methods
Kaplan-Meier, log-rank tests and Cox proportional hazards regression were used. Of the 17 potential preoperative predictors of survival considered in univariable analysis, non-collinear factors with <10% missing data, ≥10 events per stratum, and $p<0.05$ were tested through a backward stepwise selection process; proportional hazard assumption was assessed.

Results
The median survival (MS) was 7 months. A total of 88 patients died and 54 were censored. Univariate analyses yielded seven significant predictors for survival: growth of primary tumor (Tomita Grade I vs. II/III), sex, presence of lymph node/other organ metastasis, BMI, and SF-36v2 physical component, EQ-5D and Oswestry disability index (ODI) scores. Since the ODI*time term was significant, it was included in the multivariable model. Tomita tumor Grade I (HR: 0.361, 95% CI: 0.199-0.794, p=0.0009), absence of lymph node/other organ metastasis (HR: 0.489, 95% CI: 0.301-0.794, p=0.0038), and SF-36v2 physical component score (HR: 0.945, 95% CI: 0.920-0.970, $p<0.0001$) had an independent effect on overall survival.

Conclusion
Slow growing tumor (Tomita tumor Grade I), absence of lymph node/other organ metastasis, and lower degree of preoperative physical disability, as reflected by a higher score on the SF-36v2 physical component questionnaire, are preoperative clinical factors associated with longer survival in surgical MESCC patients.

75. Intermediate Screw in Thoracolumbar Fracture fixation - Does it Maintain the Correction

Abduljabbar Alhammoud, MD; *Osama Aldhamasheh;* Mahmood Arbash; Ashik M. Parambathkandi; Abdul Moeen Baco

Summary
Retrospective case series of 100 patients with thoracolumbar spine fractures with or without intermediate screw to detect the effects of intermediate screw in maintaining the surgical correction.

Hypothesis
Intermediate screws are effective at maintaining the surgical correction after surgical fixation of thoracolumbar spine fractures

Design
Retrospective case series

Introduction
Thoracolumbar spine fractures are one of the most common types of traumatic injury, with approximately 90% of spinal fractures occurring at the thoracolumbar segment. Those fractures can be managed conservatively or surgically. The pedicle screw–rod construct is a popular method in posterior instrumentation and fusion. This can be done using either conventional surgery or percutaneously using the minimally invasive technique (MIS). The screw is usually inserted in the above and below pedicle of the fractured vertebra and sometimes into the fractured vertebra as well. We aim to figure out if use of the intermediate screw will maintain the correction of the fractured vertebra

Methods
We retrospectively reviewed the radiographs of all adult patients who underwent surgery for TL fracture fixation between 2011 and 2015.Radilogical parameters (local kyphotic angle and vertebral body height) where taken pre-operatively, post-operatively, and upon final follow up

Results
100 patients with thoracolumbar spine fractures, 84% males, average age 35.2 years where involved in this study with at least a 6 month follow up There were 34 patient with IS and 66 without IS. No significant difference was detected between the two groups in regards to the local kyphotic angle and vertebral body height p-value 0.59 and 0.69 respectively.

Conclusion
Adding IS does not affect radiological parameters in thoracolumbar fracture in short term follow up.

76. WITHDRAWN

77. Multicenter Evaluation of the Incidence of Pre- and Postoperative Malalignment in Degenerative Spinal Fusions

Arash Emami, MD; Jean-Christophe A. Leveque, MD; Samuel R. Schroerlucke, MD; Nitin Khanna, MD; P. Bradley Segebarth, MD; Jim A. Youssef, MD; John Pollina, MD, FACS; Isaac O. Karikari, MD; *Nikhil Sahai;* Ioannis D. Siasios, MD; Juan S. Uribe, MD

Summary
A significant subset of degenerative lumbar fusion patients have malalignment that is unaddressed or worsened.

Hypothesis
Patients undergoing one- or two-level fusion for degenerative conditions may have malalignment of pelvic parameters not addressed by the fusion procedure

Design
Multicenter retrospective case series

Introduction
Postoperative spinopelvic malalignment (PI-LL > 10°) has been shown to be associated with lower postoperative quality of life and increased adjacent segment disease even in short-segment spinal fusions. The incidence of

spinopelvic malalignment before and after degenerative spinal fusions in large-sample studies is previously unreported. The purpose of this study was to assess spinopelvic alignment pre and postoperatively in patients who underwent one- or two-level lumbar fusions for degenerative indications to determine the incidence of malalignment at each time point.

Methods

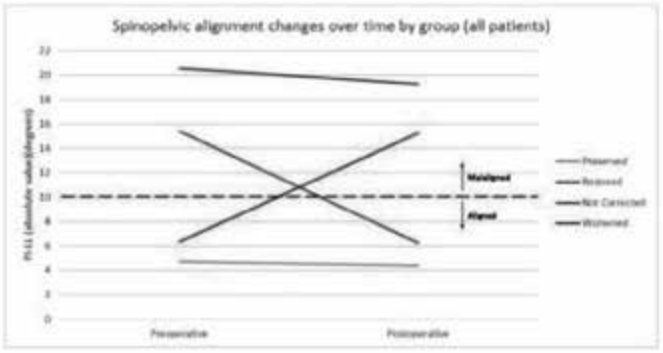
18 institutions enrolled 619 patients in a retrospective multicenter study. Inclusion required treatment with a 1 or 2-level lumbar spinal fusion for a degenerative indication with available pre and postoperative standing lateral xrays. Digital measurements for LL, PI, and pelvic tilt made at each time point. "Aligned" spinal alignment was considered when PI-LL was between -10° and 10° (inclusive), with "malaligned" thresholds being outside of that range. Single-level surgery was performed in 68% of cases and spondylolisthesis was present in a majority (51%) of patients. The most common levels treated were L4-5 (71%) followed by L5-S1 (66%). Fusion constructs included posterolateral only without interbody (90 cases, 15%) and cases with interbody fusion, including anterior or lateral interbody fusion (309 cases, 50%), posterior interbody fusion (192 cases, 31%), or combination (28 cases, 5%).

Results

229 patients (37.0%) were malaligned preop and 217 patients (35.1%) were malaligned postop. Alignment was preserved pre- to postop in 321 patients (51.9%) and 81 (13.1%) had their alignment restored postoperatively. In nearly a quarter of patients (148, 23.9%) alignment was not corrected (malaligned both pre and postop) while 69 patients (11.2%) worsened from aligned preop to malaligned postop

Conclusion

This is the first multicenter study to evaluate spinopelvic alignment characteristics in degenerative lumbar fusion patients, finding over 1/3 of patients being malaligned pre and postop, and demonstrating a significant subset of patients whose fusion did not address or worsened alignment. These data suggest that alignment preservation/restoration considerations be incorporated into the decision making for all, not just deformity, spinal fusions.



Average PI-LL change from preop to postop by category

78. The Effect of Symptom Duration on Outcomes after Fusion for Spondylolisthesis

John Fleming, MD; Steven D. Glassman, MD; Adam Miller, BS; John R. Dimar, MD; Mladen Djurasovic, MD; Leah Yacat Carreon, MD, MSc

Summary

In 123 patients undergoing primary lumbar spine surgery for grade 1 spondylolisthesis, duration of symptoms prior to surgery was not a useful predictor of improvement of back pain or disability scores.

Hypothesis

Longer duration of symptoms leads to worse outcomes in patients undergoing primary decompression and fusion for grade 1 spondylolisthesis.

Design

Retrospective review of prospectively collected data.

Introduction

Prior studies have shown that the duration of leg pain impacts surgical outcomes in patients undergoing decompression for disc herniation or stenosis. The effect of symptom duration on surgical outcomes after decompression and fusion for lumbar spondylosis has been debated, as prior studies have shown conflicting results. The aim of this study is to determine if the duration of symptoms prior to surgery in patients with spondylolisthesis affects postoperative outcomes after one or two level decompression and fusion.

Methods

Patients undergoing primary lumbar spine surgery for grade 1 spondylolisthesis at a single Quality Outcomes Database (QOD) participating site were identified. Demographic, surgical and Patient Reported Outcomes (PROs) data including baseline and 12 month post-op Oswestry Disability Index (ODI), Back Pain (BP, 0-10), Leg Pain (LP, 0-10) and EuroQOL-5D (EQ-5D) scores were collected. Individual medical records were reviewed for data on duration of symptoms prior to surgery. Patients were stratified into three cohorts — those with preoperative symptom duration of less than one year, one to two years, or greater than two years.

Results

Complete data was available in 123 patients. Significant Improvement in ODI, BP, and LP scores were observed in all groups. At 12-month follow-up, there was no statistically significant difference in improvement in ODI, BP or LP among the cohorts. However, there was a trend towards significance with better improvement in LP scores in patients with a symptom duration of less than one year to those with symptom duration greater than two years (p=0.058).

Conclusion

The duration of symptoms up to two years prior to surgery may not be a useful predictor of improvement of back pain or disability scores in patients with spondylolisthesis requiring decompression and fusion. Although there was a positive trend for improvement in leg pain for those with a shorter duration of symptoms, this did not reach statistical significance in our study.

	Symptom Duration			
	<One Year	One to Two Years	>Two Years	p-value
N	43	32	48	
Age	58.8	62.6	59.6	0.334
Baseline				
Back Pain	7.3	6.6	6.6	0.126
Leg Pain	7.1	6.7	6.4	0.378
ODI	53.2	47.1	51.7	0.248
Twelve-month				
Back Pain	3.9	4.0	4.0	0.976
Leg Pain	2.7	3.2	3.3	0.655
ODI	32.4	31.0	30.6	0.918
Twelve-month Change				
Back Pain	3.3	2.6	2.7	0.508
Leg Pain	4.5	3.5	3.1	0.153
ODI	20.8	16.1	21.1	0.355

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

79. The Effect of Tranexamic Acid on Operative Time, Bleeding and Complications in Lumbar Spine Surgery, a Double Blind RCT.

Signe Elmose, BS; Mikkel Andersen, MD; Else Bay Andresen, MD; Leah Yacat Carreon, MD, MSc

Summary
In this randomized double blind placebo controlled study of tranexamic acid during minor spinal surgery, mean postoperative blood loss in the patients who received TXA was statistically significantly lower compared to placebo. However, operative time and intraoperative blood loss between the two groups were similar.

Hypothesis
To investigate the effect of tranexamic acid (TXA) compared to placebo in low-risk adult patients undergoing elective minor lumbar spine surgery on operative time, estimated blood loss and complications.

Design
Double-blind, randomized, placebo-controlled, parallel-group study.

Introduction
Reducing and controlling blood loss are important to practices safe surgery, therefore using the antifibrinolytic drug tranexamic acid (TXA) could be relevant in spine surgery. Studies have shown that TXA reduces blood loss during major spine surgery. But there are no studies on the effect of TXA in minor lumbar spine surgery.

Methods
We enrolled adult patients with ASA grades 1 to 2, scheduled to undergo minor lumbar decompressive surgery at Middelfart Hospital, Denmark. Patients with thromboembolic disease, coagulopathy, hypersensitivity to TXA or history of convulsion were excluded. Randomization in blocks of 10, to two groups: TXA or placebo. Anticoagulation therapy was discontinued 2-7 days preoperatively. Prior to the incision, patients received either a bolus of TXA (10mg/kg), or an equivalent volume of saline solution (placebo). Statistically significance level < 0.05.

Results
Of the 250 patients enrolled, 17 patients were excluded; leaving 233 cases for analysis (TXA n=117, placebo n=116). The demographics of the two groups were similar, except for a higher number of women in the TXA group (TXA=50%, placebo=32%, p=0.017). There was no significant difference in operative time (TXA=50min±18, placebo=55min±24, p=0.11) or intraoperative blood loss (TXA=56ml±48, placebo=69ml±83, p=0.7) between the two groups. Postoperative blood loss measured from drain output in the TXA group (13ml±23) was 62 % lower than in the placebo group (35ml±44), which was statistically significant (p<0.001). No difference in complications.

Conclusion
Tranexamic acid does not have a significant effect on operative time, intraoperative blood loos or complications. However, the use of TXA can significantly reduce the postoperative blood loss in minor lumbar spine surgery.

80. Prognostic Factors for Satisfaction after Decompression Surgery for Lumbar Spinal Stenosis

Rune Tendal Paulsen, MD; Jamal Bech Bouknaitir, MD; Søren Fruensgaard, MD; Signe Elmose, BS; Leah Yacat Carreon, MD, MSc; Mikkel Østerheden Andersen, MD

Summary
This study investigated baseline predictors of patient satisfaction one year after surgery for lumbar spinal stenosis. 2562 patients were treated with posterior decompression surgery between 2009 and 2014 at three regional centers in Denmark. Outcome parameters were significantly improved at one year follow-up. Smoking, long duration of leg pain, cancerous- and neurological disease were found to influence on satisfaction at one year follow-up.

Hypothesis
The hypothesis of this study was that baseline parameters influenced on patient satisfaction one year after posterior decompression surgery for lumbar spinal stenosis.

Design
Retrospective register study of prospectively collected data

Introduction
Surgical treatment for lumbar spinal stenosis (LSS) is associated with both short- and long term benefits with improvements in patient function and pain. Even though most patients are satisfied postoperatively, some studies report that up to one third of patients are dissatisfied.

Methods
This multicenter register study included 2562 patients. Patients were treated with various types of posterior decompression. Patients with previous spine surgery or concomitant fusion were excluded. Patient satisfaction was analyzed for associations with age, sex, body mass index (BMI), smoking status, duration of pain, number of decompressed vertebral levels, comorbidities and patient-reported outcome measures (PROM) which were used to quantify the effect of the surgical intervention.

Results
62.4% of the patients were satisfied at one year follow-up but 15.1% reported dissatisfaction. The satisfied patients showed significantly greater improvement in all outcome measures compared to the dissatisfied patients. The outcome scores for the dissatisfied patients were relatively unchanged or worse compared to baseline. Association was seen between dissatisfaction, duration of leg pain, smoking status, patient comorbidities. Patients with good walking capacity at baseline were less prone to be dissatisfied compared to patients with poor walking capacity

Conclusion
This study found smoking, long duration of leg pain, cancerous- and neurological disease to be associated with patient dissatisfaction whereas good walking capacity at baseline was positively associated with satisfaction after one year.

81. Back pain improves significantly following discectomy for treatment of lumbar disc herniation

Kirk Owens, MD; Leah Yacat Carreon, MD, MSc; Erica Bisson, MD, MPH; Mohamad Bydon, MD; Eric Potts, MD; Steven D. Glassman, MD

Summary
From the N2QOD database, 2262 patients with lumbar disc herniation and back pain scores ≥ 5/10 underwent discectomies. There were statistically significant (p<0.000) improvements from baseline to three and 12 months

post-operative for back pain (7.7 to 2.9 to 3.2), leg pain (7.5 to 2.3 to 2.5), ODI (26.2 to 11.6 to 11.2) and EQ-5D (0.42 to 0.76 to 0.74).

Hypothesis
Patients with lumbar disc herniation with substantial back pain improve with decompression alone.

Design
Longitudinal cohort.

Introduction
Although lumbar disc herniation (LDH) classically presents with lower extremity radiculopathy, there are patients who have substantial back pain with their radiculopathy. The purpose of this study is to determine if patients with lumbar disc herniation with substantial back pain improve with decompression alone.

Methods
Analysis of the National Neurosurgery Quality and Outcomes Database (N2QOD) identified 2262 patients with LDH and a baseline back pain score ≥ 5 of 10 who underwent 1 or 2-level lumbar discectomy only. Standard demographic and surgical variables were collected, as well as patient reported outcomes including back and leg pain scores (0-10), Oswestry Disability Index (ODI), and EuroQoL 5D (EQ-5D) at baseline and at 3 and 12 months postoperatively.

Results
The mean age of the cohort was 49.79 years and 1195 (52.8%) were male. Mean BMI was 30.1 kg/m2. About half of the patients (1103, 48.8%) underwent single level discectomy and the other half (1159, 51.2%) had 2-level discectomy. Average blood loss was 44cc. Most of the patients (2217, 98%) were discharged home with routine postoperative care. The average length of stay was 0.53 days. At 3 months and 12 months postoperatively, there were statistically significant ($p<0.000$) improvements in back pain (7.7 to 2.9 to 3.2), leg pain (7.5 to 2.3 to 2.5) and ODI (26.2 to 11.6 to 11.2). Patients with a single-level discectomy had statistically significant better 12 month back pain (4.25 vs 4.71, $p<0.000$), leg pain (4.87 vs 5.25, $p=0.010$) and ODI (14.17 vs 15.93, $p<0.000$) scores compared to patients with a two-level discectomy but this may not be clinically relevant.

Conclusion
Patients with LDH who have substantial back pain can be counseled to expect improvement in their back pain scores 12 months after surgery after a discectomy.

82. The Feasibility and Efficacy of Robotic Assisted Pedicle Screw Placement

Joseph M. Lombardi, MD; Joseph L. Laratta, MD; Melvin C. Makhni, MD, MBA; Jamal Shillingford, MD; Ronald A. Lehman, MD

Summary
Use of robotic assisted pedicle screw placement is a safe an effective means of instrumenting the spine when registration is achieved. Open surgery and cases greater than 3 levels typically involve more complex anatomy, which likely accounts for higher rates of registration failure.

Hypothesis
This study aims to evaluate the early experience at a single institution with the use of robotically assisted pedicle screw placement. We hypothesize that robotic assisted pedicle screw placement is efficacious and feasible when intra-operative registration is achieved.

Design
A retrospective review was performed on all patients who underwent spine surgery with use of a robotic assisted pedicle screw placement system. All surgeries were performed by three fellowship trained spine surgeons at a single institution from the time period of January 1st, 2016 to July 1st, 2016. Three independent researchers documented data from the operative reports, imaging modalities and technical notes of each surgeon.

Introduction
The use of robotic assistance for the placement of pedicle screws continues to gain in popularity. Its proposed advantages are especially marked in instances of advanced scoliotic deformity or complex revision surgery.

Methods
Screws were classified as A) successfully placed by robot, B) breech or malposition of screw placed by robot, or C) robot placement aborted in favor of manual instrumentation. Other data points recorded included percutaneous versus open screw placement, number of surgical levels instrumented as well as rates of screw complications which occurred during each attending's first ten cases versus all subsequent cases.

Results
Robotic assisted pedicle instrumentation was successfully utilized in 54 of 63 patients (85.7%) who met inclusion criteria. Of all patient's enrolled, 412 of an attempted 456 pedicle screws were successfully instrumented (90%). Thirty-eight screws were unable to be placed due to loss of registration (8.3%). Six screws were deemed to be placed in malposition based on intraoperative xray and/or CT scan and required removal and re-instrumentation (1.3%). Forty-two of the forty-four screws (95%) that were unable to be placed by the robot were in the open surgery group ($p=0.05$). There was no difference detected in unsuccessful screw placement during each operators' first ten cases versus subsequent cases. There was a statistically significant difference in screw malpositioning/registration errors occurring in spinal surgery greater than 3 levels. ($p=0.04$).

Conclusion
Use of robotic assisted pedicle screw placement is a safe an effective means of instrumenting the spine when registration is achieved.

83. The Effect of 1- or 2-level Posterior Lumbar Interbody Fusion on Global Sagittal Balance

Jaehwan Cho, MD; Chang Ju Hwang, MD, PhD; Dong-Ho Lee, MD, PhD; Choon Sung Lee, MD, PhD

Summary
Global sagittal balance as well as lumbar sagittal profiles improved after 1- or 2-level PLIF even in patients with degenerative lumbar disease accompanying sagittal imbalance (C7-S1 sagittal vertical axis >5cm) preoperatively. However, it requires attention to apply to all patients with sagittal imbalance because exact mechanisms are not identified.

Hypothesis
Global sagittal balance could show improvement following 1- or 2-level posterior lumbar interbody fusion

Design
Retrospective comparative study

Introduction
Sagittal imbalance is associated with poor clinical outcomes in patients with degenerative lumbar disease. However, there is no consensus on the impact of posterior lumbar interbody fusion (PLIF) on local and global sagittal balance. The purpose of this study was to reveal the effect of 1-level or 2-level PLIF on global sagittal balance.

Methods
This study included 88 patients who underwent a 1- or 2-level PLIF for spinal stenosis with spondylolisthesis. All patients were followed up for >2 years. Clinical outcomes included a visual analog scale, ODI and EQ-5D. Radiological parameters included, lumbar lordosis, sacral slope, pelvic tilt, pelvic incidence, thoracic kyphosis, C7–S1 sagittal vertical axis (SVA), and segmental angle. Fusion, loosening, and subsidence rates were also evaluated. Patients were divided into two groups according to their preoperative C7–S1 SVA (Group N: SVA ≤ 5 cm vs. Group I: SVA > 5 cm) and their clinical and radiological outcomes were compared.

Results
All clinical outcomes and radiological parameters improved postoperatively. Preoperative demographic and clinical data showed no difference except in the anxiety/depression domain (2.7 for group N and 2.2 for group I, p = 0.016) of EQ-5D. No differences were found in postoperative clinical outcomes. In group N, lumbar lordosis, pelvic tilt, and thoracic kyphosis slightly improved. In group I, C7–S1 SVA decreased from 9.5 cm to 3.8 cm in group I (p < 0.001). Furthermore, all sagittal parameters were improved in group I.

Conclusion
Global sagittal balance improved after short-level lumbar fusion surgery in patients with spinal stenosis with spondylolisthesis who showed sagittal imbalance preoperatively. Further analysis is required to evaluate which parameters could impact the restoration of global sagittal balance.

84. Lumbar Fusion Surgery versus Laminectomy for Spondylolisthesis: Re-admission, Re-operation, and Patient Reported Outcomes for 491 Patients from the QOD Registry

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Summary
The QOD dataset was queried for patients undergoing elective spine surgery for spondylolisthesis.

Hypothesis
Laminectomy with fusion results in higher patient reported outcomes for the treatment of degenerative spondylolisthesis.

Design
Registry analysis

Introduction
The AANS has initiated the Quality Outcomes Database (QOD), a prospective longitudinal registry to measure the safety and quality of spinal surgery. In the present study, 12-month outcomes data for patients undergoing either laminectomy with fusion or laminectomy alone for grade 1 degenerative spondylolisthesis were compared.

Methods
491 patients undergoing elective spine surgery for degenerative grade 1 or 2 lumbar spondylolisthesis were identified. Patients undergoing laminectomy with fusion (fusion) were compared to those undergoing laminectomy (lami) alone. Baseline, 3-month, and 12-month follow-up readmission rates, re-operation rates, and patient reported outcomes [NRS for back and leg pain, ODI and EQ-5D] were collected and compared.

Results
For patients presenting with Grade1 spondylolisthesis, 23% (112/491) underwent lami alone while 77% (379/491) underwent lami with fusion. There were no readmissions at 30-days for the lami group, while there were 15 (4%) for the fusion group. The percentage of cases returning to the OR within one year was similar for the lami (5.4%) versus the fusion group (7.4%). At baseline, the fusion group had higher NRS back pain (6.93±2.4 vs 6.2±3.0, p<0.01) and ODI (47.2±22.4 vs 34.3±15.6, p<0.001) scores than the lami group, however, NRS leg pain scores were equivalent (6.5±2.8 vs 6.8±2.4). Patients in both surgical treatment groups improved significantly at the 3- and 12-month time points when compared to baseline on all outcomes measures. When comparing absolute difference in outcomes at 12-months to baseline, NRS back pain (3.9±2.9 vs 3.0±3.5, p=0.014) and ODI (25.2±17 vs 18.0±15, p<0.001) scores improved to a greater extent in the fusion group compared to lami group whereas NRS leg pain scores improved equally in both groups (4.1±3.6 vs 4.2±3.7).

Conclusion
Both lami alone as well as lami with fusion were associated with significant improvements in all four patient-reported outcomes at one-year follow up for patients with lumbar spondylolisthesis. Patients undergoing fusion report significantly greater improvement in back pain and less disability at 12-months as compared to those in the lami group, while both groups had equivalent improvement in leg pain. Ultimately the relative performance of the two techniques will be dependent on durability and longer follow up is ongoing with the QOD.

85. Patient Profiling Can Identify Spondylolisthesis Patients at Risk for Conversion from Nonoperative to Surgical Treatment

Peter G. Passias, MD; Gregory W. Poorman, BA; Samantha R. Horn, BA; Thomas J. Errico, MD; Michael Gerling, MD

Summary
A prospective, randomized, multicenter trial assessing demographics, diagnoses, and patient expectations and attitudes between spondylolisthesis patients who opted for surgery and nonoperative patients. Self-evaluation of symptoms and attitudes of surgery predicted patients who eventually opted for surgical treatment. Operative patients exhibited significant improvement compared to nonoperative patients.

Hypothesis
Certain patient profiling variables can adequately assess patient likelihood of choosing surgical treatment for spondylolisthesis

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

Design
Prospective, multicenter, randomized trial

Introduction
Degenerative spondylolisthesis patients often face the decision of whether or not to undergo surgical treatment. Identifying and understanding patient characteristics that may influence crossover from nonoperative to operative treatment arms will aid understanding of what motivates patients towards pursuing surgery.

Methods
Degenerative spondylolisthesis patients randomized to nonoperative care in a prospective, multicenter study were evaluated over 8 years of enrollment. Two cohorts were defined: crossover (CROSS): those who at any point received surgery, and non-crossover (non-CROSS): those who remained nonoperative. Demographics, diagnoses, and patient expectations and attitudes were compared between CROSS and non-CROSS groups by chi-square and t-tests. A Cox proportional hazards model was used to explore which variables maintained significance after adjusting other variables.

Results
145 patients were included, 80 of which crossed over to surgery. Crossover patients were older, however there were no significant differences in race, gender, or comorbidities. A Cox proportional hazards model, not including treatment preference, described younger age, female gender, and white-race as predictors of crossover. Inclusion of treatment preference as a factor revealed treatment preference and 'problem getting worse' as the only predictors for crossover. Clinically, stenosis, neurological deficits, and listhesis levels did not show a significant relationship with crossing over, despite sufficient power. Additionally, HRQL metrics did not show a significant relationship with crossover. Crossover patients exhibited significantly greater long-term improvements, a finding which was maintained throughout follow-up.

Conclusion
Self-evaluation of symptoms and attitudes towards surgery were the only predictors of crossover from nonoperative to operative care. All degenerative spondylolisthesis cohorts saw significant improvement after surgery.

86. Dynamic Stabilization of the Lumbar Spine in Patients with Degenerative Spondylolisthesis and Lumbar Spine Instability. 5 Years Follow-Up.

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Summary
Dynamic stabilization proved to be an effective surgical technique in our prospective study conducted on 126 patients. All patients showed significant improvement according to the ODI, SF-36 and VAS scales at all control periods up to 60 months after surgery. Complications recorded in the group of patients with Nitinol (TiNi) showed a characteristic pattern.

Hypothesis
Dynamic stabilization of the lumbar spine region using TiNi rods can improve surgical outcomes and quality of life compared to titanium fixation.

Design
Prospective clinical multicenter study.

Introduction
Surgical treatment of lumbar degenerative disc disease (DDD) and spondylolisthesis with or without segment instability with the implementation of fusion is the "gold standard" of treatment, but is associated with a large number of complications. The use of TiNi as a material for the rods can significantly decrease the rate of complications.

Methods
126 patients underwent surgical treatment using TiNi rods between 2010 and 2012. All patients were divided into three groups depending on the level of intervention and the clinical picture. Consequently, each group was divided into two subgroups - with TiNi and titanium rods. Radiographs, CT, MRI and clinical outcomes were examined preoperatively, at 6, 12, 24, 48 and 60 months.

Results
The mean patient age was 54 years. Minimum follow - up period was 5 years. Statistical analysis was performed using SPSS 21.2. Statistically better results ($p \theta 0.05$) were shown 5 years after surgery in all groups with nitinol rods. One of the main evaluation criteria in our study was the extent of preserved mobility of the spine segments fixed with nitinol rods. In all patient groups where nitinol rods were used for stabilization, mobility was present at all times throughout the observation (up to 60 months).

Conclusion
The use of nitinol rods in lumbar stabilization surgery showed good results in comparison with titanium rods. Further investigation, including multicenter studies, will allow to more clearly define the indications and contraindications for this type of implants.

87. Obesity Worsens Patient Reported Outcomes Following Surgery for Degenerative Lumbar Spondylolisthesis: An Analysis of the Quality Outcomes Database

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Summary
In an analysis of national spine registry data, obesity was associated with worse disability, quality of life, and satisfaction 12-months postoperatively.

Hypothesis
Obesity results in inferior patient reported outcomes (PRO) following surgery for degenerative lumbar spondylolisthesis (DLS)

Design
Retrospective analysis of prospectively-collected data from a national spine registry

Introduction
Two conflicting randomized trials on surgery for DLS call for identification of patients who may benefit most from surgery. This study investigates the impact of obesity on PROs following surgery for DLS.

Methods
452 patients were identified who underwent surgery for grade 1 or 2 DLS. Patients were stratified by obesity:BMI 30-35 kg/m2 (obese), BMI 35-40

kg/m2 (severe obesity), and BMI≥40 kg/m2 (morbid obesity) and were compared to BMI<30 kg/m2 (nonobese). Baseline and one year follow-up parameters were collected. PROs included the North American Spine Society (NASS) satisfaction questionnaire, numeric rating scale (NRS) back pain, NRS leg pain, Oswestry Disability Index (ODI), and EuroQoL-5D (EQ-5D).

Results

We identified 108 patients BMI 30-35 (23.9%), 70 BMI 35-40 (15.5%), 36 BMI≥40 (8.0%), and 238 BMI<30 (52.6%). BMI 35-40/BMI≥40 were younger (mean 59.8 and 58.7 vs 63.4 years, p=0.02, p=0.01), had a higher proportion with diabetes (38.6% and 30.6% vs 11.3%, p<0.01), and had higher ASA grades than nonobese (62.9% and 80.6% vs 34.2% ASA grades 3/4, p<0.01, p=0.04). All groups BMI>30 were less independently ambulatory than nonobese (86.1%, 78.6%, and 75.0% vs 93.3%, p=0.03, p<0.01, p<0.01). BMI>40 received more fusions than nonobese (94.4% vs 79.8%, p=0.03). All groups BMI>30 had higher blood loss, (265.8, 314.6, 376.0 vs 215.5 ml, p=0.01, p<0.01, p=0.01) and operative times (203.5, 206.5, 225.6 vs 174.3 min, p=0.01, p<0.01, p<0.01). Both groups BMI>35 had longer hospitalizations (3.3, 3.7 vs 2.9 days, p=0.04, p=0.01) and BMI 35-40 had fewer discharges to home or home health than nonobese (80% vs 86.9%, p=0.01). At baseline, all groups BMI>30 had worse NRS back pain, both groups BMI>35 had worse ODI, and BMI≥40 had worse EQ-5D than nonobese (p<0.05). All cohorts improved significantly from baseline for back and leg pain, ODI, and EQ-5D at 12 months (p<0.01). In multivariate analyses, including adjustment for baseline PROs, increasing obesity was associated with worse ODI, EQ-5D, and NASS satisfaction at 12 months (p<0.05).

Conclusion

Increasing severity of obesity was associated with worse disability, quality of life, and satisfaction 12-months postoperatively. Preoperative weight loss may be considered to optimize outcomes.

Multivariate Analysis of Increasing Obesity[1] on Patient Reported Outcomes at 1 year

	Adjusted Odds Ratio (95% CI)	p-value
NRS Back Pain	1.5 (0.8-2.7)	0.25
NRS Leg Pain	1.8 (0.9-3.5)	0.11
ODI	51.3 (1.1- 2306.0)	0.04*
EQ-5D	0.94 (0.91-0.98)	<0.01*
NASS Satisfaction	3.1 (1.6-6.1)	<0.01*

[1] obesity as an ordinal predictor with groupings: BMI < 30 kg/m^2 (nonobese), BMI 30-35 kg/m^2 (obese), BMI 35-40 kg/m^2 (severe obesity), BMI ≥ 40 kg/m^2 (morbid obesity) * statistically significant (p < 0.05)

88. Clinical Relevance of a New Classification System for Degenerative Spondylolisthesis of the Lumbar Spine

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Summary

There is no consensus for a comprehensive analysis of degenerative spondylolisthesis of the lumbar spine (DSLS). A new classification system for DSLS based on sagittal alignment was previously proposed. Its clinical relevance with health-related quality of life scores (HRQOLs) and demographic parameters was explored.

Hypothesis

It was hypothesized that this radiographical classification system was correlated clinical and radiographical parameters as well as HRQOLs.

Design

Single-center retrospective cohort

Introduction

Various classifications attempted to provide further understanding of degenerative spondylolisthesis of the lumbar spine (DSLS). However, they were based on etiology, topography, or slippage grading (percentage) and were restricted to a segmental analysis. Therefore, the role of regional or global malalignment was not considered. Recently, several studies reported the close relationship between DSLS and sagittal alignment. The aim of the study was to explore the relationships between classification types and patient demographics, radiographical parameters and health related quality of life scales (HRQOLs).

Methods

Health-Related Quality of Life Scales (HRQOLs) and clinical parameters were collected: SF-12, ODI, low back and leg pain visual analog scales (BP-VAS, LP-VAS). Radiographical analysis included Meyerding grading and sagittal parameters: segmental lordosis (SL), L1-S1 lumbar lordosis (LL), T1-T12 thoracic kyphosis (TK), pelvic incidence (PI), pelvic tilt (PT), and sagittal vertical axis (SVA). Patients were classified according to three main types: 1A: preserved LL and SL; 1B: preserved LL and reduced SL (≤5°); 2A: PI-LL≥10° without pelvic compensation (PT<25°); 2B: PI-LL≥10° with pelvic compensation (PT≥25°); type 3: global sagittal malalignment (SVA≥40mm).

Results

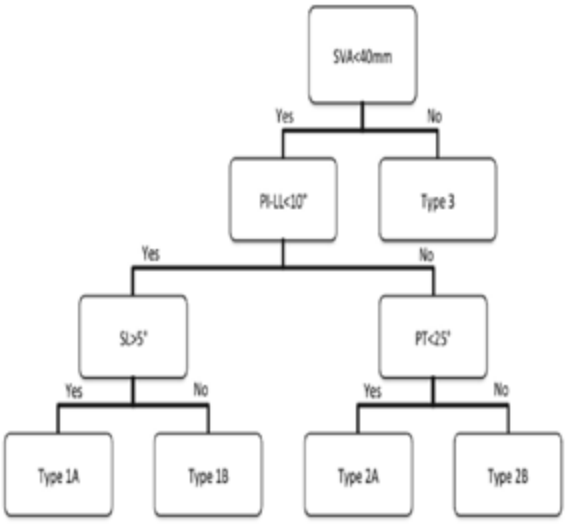
166 patients (119 F: 47 M) suffering from DSLS were included. Mean age was 67.1 ± 11 years. DSLS demographics were respectively: type 1A: 73 patients, type 1B: 3, type 2A: 8, type 2B: 22, type 3: 60. Meyerding grading was: grade 1 (n=124), grade 2 (n=24). Affected levels were: L4-L5 (n=121), L3-L4 (n=34), L2-L3 (n=6), and L5-S1 (n=5). Mean sagittal parameter values were: PI: 59.3° ± 11.9°; PT: 24.3°± 7.6°; SVA: 29.1 ± 42.2 mm; SL: 18.2° ± 8.1°. DSLS types were correlated with age, ODI and SF-12 PCS (rho= 0.34, p<0.05; rho= 0.33, p<0.05; rho= -0.20, p=0.01, respectively).

Conclusion

This classification was consistent with age and HRQOLs and could be a preoperative assessment tool. Its therapeutic impact has yet to be validated.

PAPER ABSTRACTS

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



89. Radiographic Evaluation of Intervertebral Cage Subsidence in Lateral Retroperitoneal Transpsoas Lumbar Interbody Fusion

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Summary
Cage subsidence was radiographically evaluated in lateral retroperitoneal transpsoas lumbar interbody fusion (LLIF). LLIF has an advantage in the prevalence of subsidence due to the large rectangular intervertebral cage. However, intraoperative endplate injury should be avoided.

Hypothesis
LLIF has the advantage in terms of the prevalence of cage subsidence compared to posterior lumbar interbody fusion (PLIF).

Design
Retrospective study

Introduction
LLIF has become widespread as a less invasive alternative to conventional approach for the treatment of degenerative diseases in the lumbar spine. However, cage subsidence can lead to potential complications in interbody fusion. Thus, cage subsidence was radiographically reviewed in LLIF, and compared to PLIF.

Methods
Radiographic data were collected on 122 patients (28 males and 94 females; age range, 45-84 years) who underwent LLIF with a minimum follow-up of six months. All patients received supplemental pedicle screw fixation. Subsidence was graded based on the amount of cage subsidence into the vertebral endplate: Grade 0, 0%; Grade 1, 1-25%; Grade 2, 26-50%; Grade 3, 51-75%; Grade 4, 76-100%. The prevalence of cage subsidence was compared with 68 patients (age range; 50-82 years) who underwent PLIF.

Results
LLIF was performed at a total of 334 levels. 32 cages subsided on the immediate post-operative radiograph, which were judged as intraoperative endplate injury (9.6%). Cage subsidence (6.6%; Grade 1, 17 levels; Grade 2, 5 levels) was found at 10 levels six weeks after surgery and at 12 levels 3 months postoperatively. Construct length (p=<0.001) and an amount of gains in disc height (p=0.027) had a significant negative correlation with increasing subsidence rates. Age (p=0.653), gender (p=0.748), body mass index (p=0.929), cage height (p=0.293) were not significantly related to the occurrence of cage subsidence. The prevalence of cage subsidence in PLIF (35.8%, 39/109 levels; no intraoperative endplate injury) was significantly higher than that in LLIF.

Conclusion
Although LLIF has the advantage in terms of the prevalence of cage subsidence compared to PLIF, intraoperative endplate injury should be avoided.

90. Monosegmental Circumferential Reduction and Fusion for High Grade Spondylolisthesis in Adolescents.

Andrew G. King, MB, ChB, FRACS, FACS, FAOA; Pouya Alijanipour, MD; Michael Heffernan, MD

Summary
We report a consecutive series of 11 patients from a single surgeon over a 13 year interval. All patients had anterior placement of a lordotic cage followed by posterior fusion using pedicle screws and rods confined to L5-S1. There was no posterior decompression and the lamina of L5 was left intact. There were no cases of significant neuralgia, nerve root deficit, retrograde ejaculation, failed fusion, or revision.

Hypothesis
Circumferential fusion and restoration of a normal slip angle are the most important criteria for successful outcome in high grade spondylolisthesis. Correction of both listhesis and slip angle can be best achieved from an anterior approach and placement of a lordotic cage. L5 nerve root lesions can be avoided by avoiding middle column lengthening. Extension of fusion across a normal L4/L5 disc is unnecessary.

Design
A retrospective single center single surgeon series

Introduction
While most authors recommend circumferential fusion for high grade spondylolisthesis in adolescents, it is carried out through a TLIF approach along with a wide posterior decompression, removal of the lamina of L5, and bilateral L5 nerve root decompression. An anterior approach allows a more complete discectomy, partial reduction of listhesis, and placement of lordotic cages. Posterior based reduction often results in middle column elongation and nerve root stretching. Restoration of a normal slip angle obviates the need for nerve root decompression.

Methods
Follow up averaged 54 months (range 14-124). Data included pre and postoperative slip percentage, slip angle, and pelvic incidence. At initial and last follow up a Ferguson anterior lumbosacral radiograph, a spot lumbosacral lateral radiograph, and a full length sagittal radiograph were obtained. Males were specifically queried about the presence of retrograde ejaculation.

Results
Preoperative pelvic incidence averaged 79 degrees pre and postoperatively. Mean percent slip corrected from 55 percent to 18 percent. Preoperative slip

angle averaged 5 degrees and was minus 6 degrees postoperatively. There were no revisions or hardware failures. One case had numbness of a toe that resolved. There were no cases of retrograde ejaculation and two male patients had subsequently fathered children. PEEK cages allowed visualization of bony fusion across the disc space in all cases.

Conclusion
Monosegmental circumferential reduction and fusion using an anteriorly placed lordotic cage and posterior pedicle screw fixation without decompression is recommended for high grade spondylolisthesis in adolescents.

91. The Association of Frailty with Chin-Brow Vertebral Angle Compensatory Ability in 122 Cervical Deformity Patients and with global Sagittal Vertebral Angle in 813 Global Deformity Patients

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Summary
The C2-C7 SVA (cSVA) and Chin-Brow Vertebral Angle (CBVA) scores in the ISSG-Ames cervical deformity classification are categorized into three severity cohorts, akin to the SRS-Schwab thoracolumbar classification global SVA (SVA). Increasing SVA grades are more strongly associated with increased frailty than cSVA. CBVA is more strongly associated with frailty than cSVA. This suggests that either frailty has more impact on a functional measurement like CBVA than a radiographic measurement like cSVA, or increasing CBVA leads to increasing frailty.

Hypothesis
Cervical deformity patients are more frail than equivalently graded global deformity patients.

Design
Retrospective review of prospective multicenter database

Introduction
Cervical deformity can have a greater impact on function if it affects the ability to maintain a level gaze, however, more energy is required to maintain alignment with global sagittal deformity. This study investigates whether comparable grades of C2-C7 SVA (cSVA), Chin-Brow Vertebral Angle (CBVA), and sagittal vertical axis (SVA) are associated with different frailty scores.

Methods
Patient's cSVA, CBVA, and SVA scores were categorized according to the Ames and SRS-Schwab, respectively. Frailty was assessed using the Adult Spine Deformity Frailty Index (ASD-FI) and Adult Cervical Deformity Frailty Index (ACD-FI) and split into three cohorts: not frail (NF), frail (F), and severely frail (SF). Association of the cSVA, CBVA and SVA classifications with frailty were assessed.

Results
Of 813 patients in a multi-center global deformity database, the mean frailty score was 0.34 and mean SVA was 6.9 cm (Table 1). The Goodman Gamma correlation coefficient for SVA was 0.47 (ASE 0.04). In a cervical deformity multi-center database with 122 patients, the mean frailty score was 0.26 (Table 1). The Goodman Gamma correlation coefficient for cSVA and ASD-FI was 0.15 (ASE 0.16), however that for CBVA was 0.64 (ASE 0.28). Age was also significantly associated with SVA (gamma 0.49 ASE 0.05), but not with cSVA.

Conclusion
While increasing SVA, cSVA, or CBVA scores all tended to increase with increasing frailty, the correlation between cSVA was weak, that between gSVA and frailty was moderate, and that between CBVA and frailty was strong. This suggests that either increasing frailty may impact a patient's ability to functionally compensate for cervical deformity, leading to worsening CBVA scores, or worsening CBVA may lead to accumulation of more deficits and increasing frailty.

Frailty	SVA 0 (<4cm)	SVA + (4-9.5cm)	SVA ++ (>9.5cm)	cSVA 0 (<4cm)	cSVA + (4-8cm)	cSVA ++ (>8cm)	CBVA 0 (1-10°)	CBVA + (11-25° or -10-0°)	CBVA ++ (>25° or <-10°)
Not Frail	162	49	60	9	10	1	5	1	0
Frail	89	61	120	13	23	6	3	5	1
Severely Frail	23	30	96	2	7	1	1	0	1

92. Comparative Analysis of Changes in Spinal Canal Dimension and Myelopathy Improvement Between Patients with and without Cervical Deformity

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Summary
Spinal canal volume and stenotic levels were consecutively and prospectively measured in cervical spondylotic myelopathy (CSM) patients from baseline and 1-year postoperatively. Realignment was shown to contribute to improvements in spinal canal volume and functional outcomes more significantly than direct decompression.

Hypothesis
Increase in canal volume is associated with improvement in functional outcomes

Design
Prospective consecutive series

Introduction
For patients with cervical deformity, simple decompression of stenosis may not be sufficient to relieve spinal cord compression and restore neurologic function. No comparison exists between deformity and non-deformity patients in amount of spinal canal volume change after realignment or decompression, respectively.

Methods
Patients with preoperative and 1-year MRI's available were assessed for spinal canal volume using imaging software and stenotic vertebral levels using Pavlov's method from C2-T1. Primary analysis evaluated changes in spinal cord volume, number of stenotic levels, and myelopathy score (mJOA) from baseline to 1-year between cervical deformity (CD) patients and those without deformity

(non-D) using t-tests. Cervical deformity was defined as one or more of the following: cervical kyphosis (>10°), cervical scoliosis (>10°), cervical SVA >4cm, or horizontal gaze impairment (chin-brow vertical angle >25o).

Results
14 patients with CD (age 60.2 years, BMI: 32.1, 54% female) were compared to 17 non-D patients (age 51.2 years, BMI: 27.7, 56% female). CD patients were corrected with constructs averaging 8.0 levels fused, were not decompressed (4/14), and a vertebral-body osteotomy (8/14). Non-D patients were corrected with constructs averaging 3.5 levels fused with decompression (17/17), and no vertebral-body osteotomies (0/17). Baseline canal volume was similar across deformity groups: (CD: 259.3 mm2 vs. non-D: 279.1, p=0.267). Change in volume to 1-year was similarly non-different (CD: +75.5 mm2 vs. non-D: +46.9mm2, p=0.149). CD patients presented with comparable number of stenotic levels (CD: 4.7 vs. non-D: 4.2, p=0.484) and change in stenotic levels after surgery (CD: -2.0 vs. non-D: -1.8, p=0.807). Lastly, mJOA improvement was similar (CD: +0.50 vs. non-D: +1.8, p=0.449).

Conclusion
Among CD patients, realignment contributes to improvements in spinal canal and functional outcomes more significantly than direct decompression, with little additive impact of direct decompression. These findings are in stark contrast to the critical role of direct decompression among CSM patients without primary CD.

93. The Effect of Prolonged Pre-Operative Halo Gravity Traction for Severe Spinal Deformities on the Cervical Spine Radiographs

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Summary
37 patients with severe spinal deformity were treated with Halo Gravity Traction (HGT) preoperatively. ADI, C2-C7 Lordosis and SVA were used to evaluate the effect of HGT on the Cervical Spine No adverse effects on the cervical radiographs were seen with the long term use of HGT. Dynamic views did not demonstrate any signs of instability at C1-C2

Hypothesis
HGT does not adversely affect the cervical radiographs

Design
Retrospective review of prospective data

Introduction
The use of halo gravity traction is an integral part of the pre-op management of severe spinal deformities, to gradually correct the curves prior to definitive spine surgery. There is a dearth of information in the literature on the effects of HGT on the C-spine. This study reports on the Effect of HGT on the C-spine radiographs prior to definitive surgery at a single site in West Africa.

Methods
37 randomly selected pediatric and adult pts from a single site in West Africa who had sequential cervical spine radiographs at three time points were reviewed between 2013-2015. Radiographic assessment of the C-spine including ADI, SVA and C2-C7 Lordosis was done at pre HGT and at 4 week intervals. Paired T-Test was done to evaluate the changes in ADI, C2-C7 Lordosis and SVA during the milestones in HGT.

Results
37pts, 18F and 19M. Mean age 15.1yrs. (Range 3-32yrs). Diagnoses:22 idiopathic, 6 congenital, 3 Post Tb, 2NM and 4NF. Curve type: 30 kyphoscoliosis, 5 Kyphosis and 2 Scoliosis. The mean duration of HGT was 125 days. Mean Pre HGT coronal Cobb:130deg, corrected 30 % in HGT; Sag cobb pre HGT146deg, corrected 32% post HGT. Pre HGT ADI averaged 3.17mm (SD 0.63) and did not significantly change at 4 wks but reduced at 8wks (2.80mm, SD=0.56) and 12 wks (2.67mm, SD0.51) post HGT (p=0.02). Pre HGT SVA avg 20.7mm, SD 14.98) significantly improved at 4wks, (11.55mm SD 10-26), 8wks (7.54mm SD 6.78) and 12 wks (8.88mm, SD 4.5) (p=0-001). Pre HGT C2-C7 lordosis averaged 43deg and was reduced at 4wks (26deg), 8 wks (17.8deg) and 12 wks(16.7deg post HGT) (p<0.001). There was no incidence of atlanto-axial instability on flexion extension radiographs at any interval.

Conclusion
Prolonged HGT traction, while providing partial correction of severe spine deformities, also appeared to have no adverse effect on atlanto-axial stability or cervical alignment. The results of this study show that HGT can be safely applied for several weeks in the preop management of severe spine deformities in the pediatric and adult patients.

94. The Cervical Spine Realignment after Kyphosis Correction of the Old Atlantoaxial Anterior Dislocation

Yiwei Chen, MD; Junlong Zhong, MD; Zhiyun Li, MD; Zhimin Pan, MD; Zhaoxun Zeng, MD; *Kai Cao, MD, PhD*

Summary
Twenty-one consecutive old atlantoaxial anterior dislocation-related kyphosis patients underwent correction were included in this cohort. Kyphosis correction effectively realigned the cervical spine, which significantly improved patients' neck function and health related quality of life (HRQoL).

Hypothesis
Correction on old atlantoaxial anterior dislocation-related kyphosis could realign the cervical spine and improve the patients' neck function and HRQoL.

Design
A Prospective study.

Introduction
Old atlantoaxial anterior dislocation not only brings about myelopathy, but dislocation-related kyphosis also results in cervical malalignment which permanently influences patients neck function and HRQoL. Few study reported the association of realignment of cervical spine and improvement of HRQoL after kyphosis correction in this scenario. This study is to investigate the effect of kyphosis correction on realign the cervical spine as well as the significant independent factors associated with the improvement of HRQoL.

Methods
Consecutive old atlantoaxial anterior dislocation-related kyphosis patients underwent C1-2 reduction and fusion were included in this cohort. MRI, CT and upright X-ray of spine were taken pre- and postoperatively. Cervical alignment

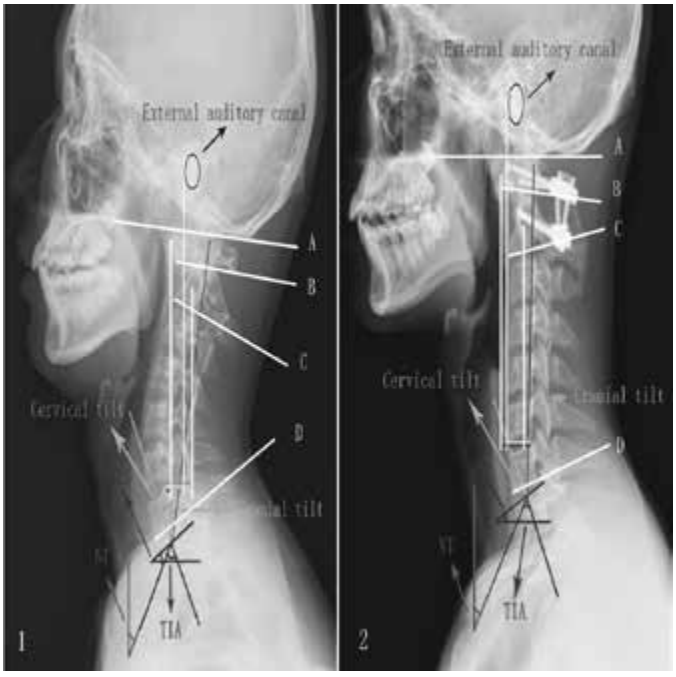
parameters including C0-1, C1-2, C0-2, C2-7 cobb angle, C1-7 sagittal vertical axis (SVA), C2-7 SVA, center of gravity to C7 SVA (CG-C7 SVA), Thoracic inlet angle (TIA), Neck Tilt (NT), Cervical Tilt, Cranial Tilt and T1 Slope (T1S) were measured. JOA, NDI and SF-12 PCS were assessed preoperatively and follow-up. Significant independent parameters associated with HRQoL were analyzed by stepwise regression analysis. All patients were followed up at least 2 years.

Results

Total 21 patients (9 female, 12male, age of 48.1±6.3, BMI of 23.3±2.9) were included in this cohort. C1-2 cobb angle, C2-7 cobb angle, TIA, Cervical Tilt, T1S were significantly improved from -3.97±16.2°, -29.16±11.2°, 73.09±13.3°, 30.37±8.5°, 29.15±8.8° preoperatively to -13.51±8.1°(P=0.04), -17.99±12.0°(P=0.02), 67.06±11.6°(P=0.004), 23.08±10.3°(P=0.04), 23.95±6.9°(P=0.003) follow-up. JOA, NDI and SF-12 PCS were significantly improved from 8.07±2.5, 42.46±4.8, 31.31±5.1 to 14.23±2.1(P<0.001), 8.23±2.9(P<0.001), 45.92±1.9(P<0.001), respectively. Multiple linear regression indicated that the C1-2 cobb angle was identified as independent parameter significantly associated with JOA, NDI and SF-12 PCS.

Conclusion

Reduction and fusion surgery can effectively correct the old atlantoaxial anterior dislocation-related kyphosis and realign the cervical spine. The restore of C1-2 cobb angle was the independent parameter to improve the HRQoL.



95. Effect of Cervical Decompression Surgery on Gait in Adult Cervical Spondylotic Myelopathy Patients

Ram Haddas, PhD; Kevin Ju, MD; Theodore A. Belanger, MD; *Isador H. Lieberman, MD, MBA, FRCSC*

Summary

Surgical decompression resulted in faster walking speeds with longer steps with increase in spine and lower extremity function and efficiency. Cervical spondylotic myelopathy patients walk slower with reduced trunk and lower extremity function and efficiency in comparison to an asymptomatic group. Post-operative CSM patients actually had similar walking patterns in comparison to an asymptomatic group.

Hypothesis

The purpose of this study was to evaluate the effect of cervical decompression surgery on the biomechanics of the lower extremities and spine during gait in patients with CSM before and after s

Design

A non-randomized, prospective, concurrent control cohort study of patients with CSM before and after cervical decompression compared to an asymptomatic group.

Introduction

Gait imbalance is a frequent symptom of CSM, and has been reported to be improved by surgical intervention. Clinical studies have determined that individuals with CSM have a slower gait speed, prolonged double support duration and reduced cadence, knee flexion and ankle plantar flexion compared to healthy controls.

Methods

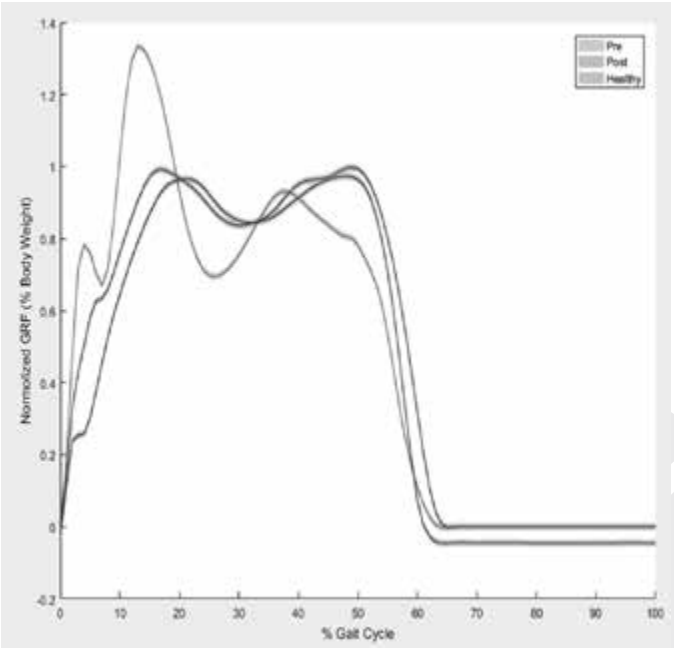
Eight subjects with CSM who have been deemed appropriate surgical candidates performed gait analysis a week before (Pre) and 3 months after the surgery (Post3). Twenty healthy volunteers served as a control group. The patient walked at his/her self-selected speed along a 10 m walkway. Spine and lower extremity kinematic and vertical GRF were measured.

Results

After cervical decompression surgery, CSM patients had significantly faster walking speed (Pre: 0.82 vs Post3: 1.03 m/s, p=0.050), longer step (Pre: 0.48 vs Post3: 0.60 m, p=0.013) and stride length (Pre: 0.98 vs Post3: 1.14 m, p=0.050). A significantly smaller ankle plantar flexion ROM (Pre: 29.46 vs Post3: 20.87 deg, p=0.033) was seen during the stance phase. In comparison to the control group, CSM patients preoperatively presented with a significantly slower gait speed (0.24 m/sec; p=0.037), decreased step length (0.11 m; p=0.014), stride length (0.20 m; p=0.019) and increased step width (0.05 m; p=0.001). Furthermore, CSM patients showed a significantly larger ankle (5º; p=0.024) ROM and smaller knee (15º; p=0.050) ROM in the sagittal plane, along with greater ankle (2º; p=0.050) ROM in the coronal plane. Minor differences in gait found between the post-surgical CSM patients in comparison to the control group.

Conclusion

Cervical decompression surgery improved the gait pattern in patients with CSM. Based on our preliminary results, surgical decompression resulted in faster walking speeds with longer steps with increase in spine and lower extremity function and efficiency.



96. Outcomes of Complex Craniovertebral Anomalies in Children after Preoperative Planning with Surgeon Directed Multiplanar Reconstruction CT

Arjun Dhawale, MD; Kshitij Chaudhary, MD; Avi Shah, MS; Abhay Nene, MD

Summary

Pre-operative planning with surgeon-directed multiplanar 3D reconstruction helps surgeon to plan fixation in pediatric CVJ anomalies. Ability of the surgeon to manipulate DICOM images preoperatively has advantages over conventional PACS imaging.

Hypothesis

Surgeon-directed multiplanar and nonorthogonal 3D CT reconstruction provides more information than conventional orthogonal CT reconstructions for pre-operative planning of complex craniovertebral junction anomalies.

Design

Retrospective review of prospective data

Introduction

Internal fixation in complex craniovertebral junction (CVJ) anomalies in young children is challenging due to small size and dysplastic posterior elements. Surgical planning in these cases needs reconstruction in non-orthogonal planes for assessment of feasibility of screw size and trajectory..

Methods

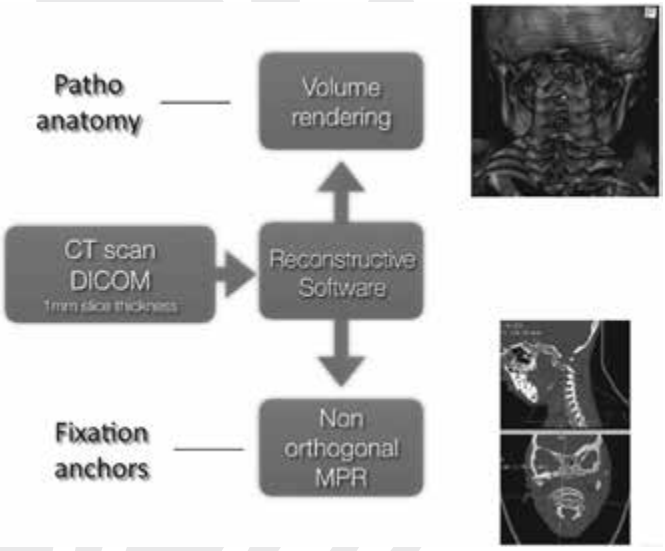
We prospectively studied 10 consecutive children with quadriparesis with CVJ anomalies. Clinical features, dynamic cervical radiographs, MRI and CT were evaluated. CT DICOM data was processed using reconstructive software to create multiplanar reconstructions and virtual 3D models. Multiplanar reconstruction information was compared with that obtained from conventional imaging (PACS) with respect to pathoanatomy and fixation anchors and graded by two surgeons (by consensus) as A - substantial new information, B- confirmatory , improved understanding of anatomy, and C - no new information. Feasibility of screw trajectories was ascertained. All patients underwent C1-2 /Occipitocervical (OC) fusion. Technical difficulties/ complications were recorded.

Results

Out of the 10 patients, six children were syndromic with mean age of 7.9 years with neurology Frankel C (9) and D (1). Three patients had basilar invagination and 7 had os odontoideum. C1-2 fusion (3) and OC fusion (7) was performed with 35 cervical fixation anchors (lateral mass screws, pars/pedicle screws, laminar screws, transarticular screws, laminar hooks). Substantial new information (A) was obtained in all cases for fixation anchors and in 50% for pathoanatomy. Mean follow-up was 12 months. There was neurological improvement in 9 cases to Frankel D/E. Post-operative MRI showed satisfactory decompression and CT accurate screw placement (92%). Complications were non-dominant vertebral artery injury (1), hook dislodgement with neurological worsening (1).

Conclusion

Pre-operative planning with multiplanar 3D reconstruction of CT provides more information and helps plan surgery in pediatric CVJ anomalies. Ability of the surgeon to manipulate DICOM images preoperatively has advantages over conventional ways of processing preoperative information.



97. En Bloc Cervical Laminoplasty Using Translaminar Screws (T-laminoplasty)

Tae-Ahn Jahng, MD PhD; Soo-Eon Lee, MD

Summary

The authors have newly developed an en bloc cervical laminoplasty using a trans- laminar screw (T-laminoplasty) to preserve the posterior midline structures so as to maintain spinal stability and prevent postoperative axial pain and deformity.

Hypothesis

Newly developed laminoplasty is safe and clinically effective.

Design

prospective study

Introduction

Cervical laminoplasty is a popular surgical procedure for patients with multilevel compressive cervical lesions. However, several reports have noted its limitations and shortcomings.

Methods
After exposure of posterior cervical spine with preserving the midline ligamentous structure, en bloc laminotomy was performed and made a laminectomized block. While laminotomized block was lifting, the trans-laminar trajectory from the lamina to the contralateral lateral mass was prepared. Then, a trans-laminar screw was inserted with suspension of the laminotomized block to expand the spinal canal, passed through the laminar spacer, and finally was fixed in the contralateral lateral mass. Next, a following screw was inserted to the adjacent segment from the opposite side, and further screw fixations were made using this alternating fashion.

Results
Twenty patients were underwent T-laminoplasty and 83 segments were operated. Clinical outcomes were statistically improved during the mean follow-up period of 19.7 months. Radiologic outcomes of cervical lordosis and range of motion were preserved with expansion of the cross-sectional area of the spinal canal. Additionally, no re-stenosis or laminar settlement was observed at the last follow-up.

Conclusion
T-laminoplasty can be one of surgical options for multilevel compressive cervical lesions. With midline ligamentous structures preserving procedure, it was possible to get enough canal decompression and foraminal decompression while obtaining good clinical and radiologic outcomes.

98. Neurological Complications Following Minimally Invasive Direct Lateral Approach for Lumbar Interbody Fusion Using a Novel Retractor System without a Posterior Blade

Robert S. Lee, FRCS; Fady S. Sedra, FRCS; Lester F. Wilson, FRCS Eng

Summary
Lateral interbody fusion is becoming increasing popular in the treatment of degenerative spinal disease. Traditional lateral access retractor systems have a tubular expansile design which puts pressure on the posterior lumbosacral plexus. An alternative dual blade retractor that splits the psoas and has no compulsory posterior blade is presented. This study shows a low rate of neurological complications (all transient) which may be related to the lack of the posterior blade putting pressure on posterior neural structures

Hypothesis
Minimally invasive lateral interbody fusion done with a dual blade retractor and no posterior blade reduces the rate of neurological complications that are traditionally associated with this approach

Design
This was a review of prospectively collected complication data. 131 patients with mean age 62.2 (32.1-83.4) were included. 77 were female and 54 male

Introduction
Lateral interbody fusion is becoming increasing popular in the treatment of degenerative spinal disease. Traditional lateral access retractor systems have a tubular expansile design which puts pressure on the posterior lumbosacral plexus. We describe results from an alternative dual blade retractor which splits the psoas and can be rigidly fixation to spine with optional anterior and posterior blades. Hence there is no pressure on posterior neural structures with less risk of neurological complications

Methods
All patients were asked about neurological symptoms. We recorded any neurological complication (sensory and motor deficit) and the recovery time. All data was collected prospectively and then extracted from database for analysis

Results
A total of 131 patients were treated with 248 levels. The most common pathology was degenerative lumbar scoliosis followed by spondylolisthesis. Surgical levels were from L1/2 to L4/5 with a single level in 55 patients, two levels in 45 patients, three levels in 21 patients and 4 levels in 10 patients. 55 patients had cages inserted at the L4/5 level. Immediately after surgery, 9% of patients (12/131) had transient sensory abnormalities (decreased sensation and paraesthesia) in the thigh or pain. All of these recovered within 12 weeks following surgery. One patient having a 3 level operation involving the L4/5 level sustained a femoral nerve palsy which developed the day after surgery and resolved after 8 weeks

Conclusion
Minimally invasive lateral interbody fusion done without a posterior blade attachment has minimal neurological complications. The lack of posterior blade may be important in reducing the risk of neurological injury.

99. Minimally Invasive Midline Posterior Interbody Fusion with Cortical Screws Decreases Blood Loss and Surgical Time compared to Open Transforaminal Lumbar Interbody Fusion

Charles H. Crawford, MD; Kirk Owens, MD; Mladen Djurasovic, MD; Jeffrey L. Gum, MD; *John R. Dimar, MD;* Leah Yacat Carreon, MD, MSc

Summary
In a consecutive series of cases from a single surgeon, a less invasive midline technique had lower blood loss and shorter operative time compared to the open transforaminal lumbar interbody fusion technique.

Hypothesis
Minimally invasive midline posterior interbody fusion with cortical screws decreases blood loss and surgical time compared to open transforaminal lumbar interbody fusion.

Design
Comparative retrospective cohort.

Introduction
Single-level posterior interbody fusion is commonly performed for degenerative lumbar conditions. A less invasive technique of midline exposure limited only to the facets and fixation with laterally directed cortical screws was introduced with the intent of decreasing surgical morbidity. The purpose of this study was to determine if posterior interbody fusion with posterior midline exposure and fusion will have less blood loss and shorter operative times than traditional open transforaminal interbody fusion.

Methods
A consecutive series of patients who underwent posterior interbody fusion with either a midline only exposure (MIDLIF) or full exposure of the transverse processes with a posterolateral fusion using a traditional open transforaminal lumbar interbody fusion (TTLIF) were identified. All cases were performed by a single board-certified, mid-career spine surgeon who recently transitioned from a traditional pedicle screw and posterior interbody technique to a less invasive

technique with cortical screw trajectory. Demographic and peri-operative data were collected and compared.

Results
There were 30 cases in the MIDLIF and 28 in the TTLIF group. Both groups were similar with respect to age, BMI, gender, ASA grade and operative level. The MIDLIF group had significantly lower estimated blood loss (278cc vs 444cc, p<0.004) and shorter operative time (174 minutes vs 212 minutes, p=0.005) compared to the TTLIF group.

Conclusion
A less invasive midline technique had lower blood loss (mean difference of 164cc) and shorter operative time (mean difference of 41 minutes) compared to the traditional TLIF technique. These differences could translate into potential cost savings associated with shorter operative time and reduced cell saver/ transfusion requirements.

	MIDLIF	OpenTLIF	
N	30	28	
Males, N	8	9	0.647
Age, years, mean	61.90	58.50	0.153
BMI, kg/m^2, mean	34.67	34.72	0.979
ASA Grade, N			
2	3	5	0.378
3	27	22	
4	0	1	
Estimated Blood Loss, cc, mean	277.50	444.46	0.004
Operative Time, min, mean	173.87	211.74	0.005
No of Surgical Levels, N			0.978
1	23	22	
2	6	5	
3	1	1	
No of Interbody Fusions, N			0.760
1	26	25	
2	4	3	

100. Human versus Robot: A Propensity-Matched Analysis of the Accuracy of Free Hand versus Robotic Guidance for Placement of S2 Alar-Iliac (S2AI) Screws

Jamal Shillingford, MD; Joseph L. Laratta, MD; Joseph M. Lombardi, MD; Alexander Tuchman, MD; *Paul J. Park, MD;* Ronald A. Lehman, MD; Lawrence G. Lenke, MD

Summary
Traditionally, S2 alar-iliac (S2AI) screw placement required fluoroscopic guidance for accurate screw placement, increasing surgical time and radiation exposure. Herein, we present the first series comparing a free hand and robotic technique for S2AI screw placement.

Hypothesis
There is no difference in the accuracy of S2AI screws placed by a free hand compared to a robotic-guided technique.

Design
Retrospective matched cohort analysis.

Introduction
Spinopelvic fixation utilizing S2AI screws provides optimal fixation across the lumbosacral junction allowing for solid fusion, especially in long segment fusion constructs.

Methods
The records of 68 consecutive patients who underwent S2AI screw placement by either robotic or free hand technique between 2015-2016 were reviewed. Propensity scores were created after identifying preoperative characteristic imbalances to reduce selection bias. Screw position and accuracy was evaluated using 3D manipulation of an intraoperative CT Scan.

Results
A total of 51 patients (105 screws) were matched, 23 (46 screws) in the robot group (RG) and 28 (59 screws) in the free hand group (FHG). There was one 3-screw and one 4-screw construct in the FHG. The mean age in the RG and FHG were 61.6+-12.0 yrs and 57.9+-14.6 yrs (p-value=0.342) respectively. The average caudal angle in the sagittal plane was significantly larger in the RG (31.0+-10.0° vs 25.7+-8.8°, p-value=0.005). When comparing the RG to the FHG, there was no difference in the horizontal angle, measured in the axial plane using the PSIS as a reference (42.8+-6.6° vs 41.1+-8.1°, p-value=0.225), or the S2AI to S1 screw angle (11.3+-9.9° vs 9.4+-7.0°, p-value=0.256), respectively. There was no difference in the overall accuracy rates of the RG and FHG (97.8% vs 94.9%, p-value=0.630). Additionally, there were no significant intraoperative neurovascular or visceral complications associated with S2AI screw placement.

Conclusion
Free hand and robotic-guided S2AI screw placement both prove to be safe and reliable techniques for achieving spinopelvic fixation.

101. Does The Plate Maintain a Sagittal Plane Correction after Anterior Cervical Discectomy and Fusion Compared to a Stand Alone Cage?

Abduljabbar Alhammoud, MD; Mohanad Aboulebda; Mohamed Fahd Faleh; Ohmed Khilji; Abdul Moeen Baco

Summary
Retrospective case series of 65 patients underwent ACDF to detect the difference between plate and cage versus stand alone cage in marinating sagittal plan correction

Hypothesis
plate and cage is superior to stand alone cage in maintaining sagittal plane correction after ACDF

Design
Retrospective case series

Introduction
Anterior cervical discectomy and fusion is the treatment of choice for cervical degenerative disc disease which causes neurological symptoms such radiculopathy or myelopathy. It can be done by different techniques which include several options for implants such as disc spacers made of autograft or of allograft bone, porous metal as well as anterior plates and screws. Anterior cervical discectomy and fusion with stand alone cage (ACDF-CA) is a successful option to treat cervical disc disease, but long-term follow-up showed complications including cage subside as well as pseudoarthrosis. Thus, anterior cervical decompression and fusion with stand cage and plate (ACDF-CPA) was developed in order to decrease the complication of stand cage alone. However this has also been shown to have complications like dysphagia. The purpose of this study is to compare the role of anterior plate constructs (ACDF-CPC) and stand alone cage (ACDF-CA) in maintaining of sagittal plane correction.

Methods
We retrospectively reviewed the lateral cervical radiographs of all patients who underwent ACDF by stand cage alone or cage and plate at Hamad General Hospital, Doha, Qatar between 2011 and 2015. The choice of the operation was dependent on the surgeon's preference and experience. Radiological findings (cervical lordosis, segmental lordosis, cage subsidence, disc height) are compared (pre-op, 3-6 months post op, 12 months post op).

Results
Sixty five patients underwent ACDF, 88 operative levels, 29 (44.6%) ACDF-CA and 36(55.6%) underwent ACDF-CPC. There were 41(63.1%) males and 24(36.9%) females, average age 47.7 years (SD: 9.32), 40% done by orthopedic spine surgeons and 60% done by neurosurgeon. Most common operated level is C5-C6 followed by C6-C7. ACDF-CA showed better surgical correction than ACDF-CPC in regards to cervical lordosis and segmental lordosis (p value: 0.692, CI: (-4.8,7.28) whereas ACDF-CPC maintains correction more than ACDF-CA at final follow up despite insignificant statistically (p value: 0.506, CI: (-7.05,3.54).No difference detected in disc height and cage subsides between two groups.

Conclusion
ACDF by stand cage alone or anterior plate achieved good clinical outcome and significant correction in sagittal plane. ACDF-CPC is superior to ACDF-CA in maintaing the post-operative sag

102. In Vivo Analysis of Kambin's Triangle and the Clinical and Radiographic Results Following the Use of 14mm Extra Wide 3D Porous Lamellar Titanium TLIF Cages

Robert S. Lee, FRCS; Lester F. Wilson, FRCS Eng

Summary
Some concerns have been voiced regarding the stability of the TLIF construct compared to other fusion techniques due to the smaller width of the cage. Our in vivo measurements of Kambin's triangle show the width to be 20mm. A comparison of 40 consecutive patients who underwent MIS TLIF with 14mm extra wide porous lamellar titanium cages with 40 patients who had 10mm cages inserted show minimal subsidence and better initial outcome scores.

Hypothesis
Kambin's triange is wider than reported in cadaveric studies. Extra Wide 14mm 3D Porous Lamellar Titanium TLIF Cages can feasibly be inserted safely and confer greater initial stablility and pain relief

Design
An in vivo anatomical study and retrospective review of prospectively collected data from a two surgeon series

Introduction
Some concerns have been voiced regarding the stability of the TLIF construct compared to other fusion techniques. This may be due to the smaller width of TLIF cages compared to anterior and lateral implants. Cadaveric measurements of Kambin's triangle have reported widths of no more than 11mm at L2/3 and L3/4 and 12mm at the L4/5 level. We believe that this is underestimated and that in vivo widths are greater. The usual width of TLIF cages is 10mm but the insertion of extra wide 14mm TLIF cages can confer greater stability and less subsidence. This may translate into better initial pain scores and higher fusion rates.

Methods
A standard MIS Wiltse approach was made to perform the TLIF. After performing the facetectomy, a caliper was used to measure the distance between the lateral border of the traversing nerve root and the exiting nerve root at L4/5 and L5/S1. Measurements were performed in 30 patients. 40 consecutive patients who underwent MIS TLIF with 14mm cages (Group 1) were then compared to a series of 40 patients who had 10mm cages inserted (Group 2). A retrospective review of prospectively collected outcome data (VAS leg, VAS back , EQ-5D, EQ-5D VAS and ODI) was then performed and radiographs analysed.

Results
The width of Kambin's triangle was greater than 20mm in 28 out of the 30 patients. Mean cage size in both groups was 12mm x 32mm. At 6 months less than 0.5mm subsidence was noted in Group 1 compared to 1mm in Group 2. Both groups showed excellent outcomes (VAS leg 1.5, VAS back 1.0, ODI 18, ED-5D 23.5, EQ-5D VAS 82.5) but at 6 weeks the initial decrease in VAS back was greater in Group 1

Conclusion
The anatomy of Kambin's triangle allows the insertion of extra wide 14mm cages which may confer extra initial stability.

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

103. Is It Surgical Volume, Surgeon's Experience, Or The Number of Surgeons That Determine Safety, Efficacy, and Efficiency?

Vishal Sarwahi, MD; Jesse Galina, BS; Stephen F. Wendolowski, BS; Jon-paul Dimauro, MD; Yungtai Lo, PhD; Terry D. Amaral, MD

Summary
The dual surgeon approach can be beneficial for less experienced surgeons. However, for a high volume surgeon, having a secondary surgeon has no significant benefits in terms of perioperative outcomes.

Hypothesis
Highly experienced and/or high volume surgeons do not benefit from a dual surgeon approach.

Design
Ambispective Chart Review

Introduction
Recent literature suggests that utilizing two surgeons for spine deformity correction surgery can improve perioperative outcomes. However, the surgeon's experience and surgical volume are likely as important. This study seeks to evaluate effect of these factors for spine deformity correction through PSF.

Methods
Ambispective chart and XR review of all pediatric spinal deformity patients undergoing spinal deformity surgeon from 2012-2016 was performed. Patient demographics, XR and periop parameters were collected. Surgical cases were collated based on primary surgeon. Analysis was performed for single vs dual attending surgeons, surgical experience (<,> 10 yrs), and surgical volume (<,> 70 cases/yr.). Median values, Wilcoxon Rank Sums test, Kruskal-Wallis test, and Fisher's exact test were utilized.

Results
196 cases, performed by 4 attendings, had complete records. 2 surgeons are highly experienced, 1 of whom is also high volume. The four cohorts were a highly experienced/high volume surgeon operating alone (n=58), two junior surgeons (n=86), a highly experienced surgeon with a junior surgeon (n=22), and the highly experience and high volume surgeon together (n=30). Preop Cobb (p=0.73), kyphosis (p=0.59), coronal balance (p=0.80), and sagittal balance (p=0.28) were similar between the groups. The high volume surgeon had significantly lower EBL (400 vs 600, $p < 0.001$), fewer levels fused (11.5 vs 13, $p = 0.005$), shorter length of surgery (247 vs 300, $p <0.001$), and anesthesia times (378 vs 424, $p<0.001$). High volume surgeon patients were extubated in the OR significantly more compared to all other surgeons (92 vs 81%, p=0.036). Highly experienced surgeons fused significantly fewer levels compared to less experienced surgeons (12 vs 13, p=0.05). When the high volume surgeon operated with another attending, there were no significant changes in outcomes.

Conclusion
High volume surgeons have better outcomes than dual surgeons, irrespective of the experience of the dual surgeons. High volume surgeons do not benefit from the addition of a second surgeon.

104. Minimally Invasive Surgery in Patients with Adolescent Idiopathic Scoliosis is Safer, Cost Efficient with Similar Curve Correction and SRS-30 Outcomes as Standard PSF

Vishal Sarwahi, MD; Rachel Gecelter, MS1; Stephen F. Wendolowski, BS; Chhavi Katyal, MD; Jesse Galina, BS; Terry D. Amaral, MD

Summary
SRS 30, validated sports activity questionnaire (SAQ) outcomes, and OR costs were analyzed in AIS patients undergoing PSF utilizing MIS approach compared to standard PSF surgery in a case controlled manner. MIS patients have significantly lower transfusion risk, OR costs, and fewer pedicle screws. However, the length of surgery tends to be higher compared to the PSF approach.

Hypothesis
Minimally invasive surgery in AIS has better functional outcomes, increased costs, and similar radiographic corrections.

Design
A retrospective case-controlled matched study.

Introduction
MIS in patients with idiopathic scoliosis is an innovative technique comparable to the standard open posterior approach. We seek to compare the two different approaches in case-control matched manner in the AIS population.

Methods
21 MIS patients were matched with 21 PSF controls based on age, Cobb angle, BMI, and levels fused. Charts and XRs were reviewed for intra-op, post op and radiographic measurements. Outcomes were analyzed on SRS 30 and a statistically validated sports activity questionnaire. OR costs (implant cost, equipment, blood products, etc.) were calculated for each surgery. Wilcoxon signed-rank tests and McNemar's tests were utilized.

Results
MIS patients had significantly fewer fixation points (17 vs 20, $p<0.001$), but a longer median anesthesia time (10 vs 7.1 hrs, p=0.005). There was no significant difference between EBL (400 vs 500cc, p=0.131), however transfusion rate was lower in MIS (1 vs 6, p=0.025). % Cobb correction, VAS score, length of stay and complications were not significant (p=0.987, p=0.187, p=0.479, p=0.317). SRS 30 and SAQ were not significantly different (p=0.902, $p>0.05$). OR costs in MIS were significantly lower and on average $4,200 less than the control ($p<0.001$).

Conclusion
Minimally invasive scoliosis surgery has similar radiographic, functional, and athletic return outcomes to the standard PSF approach, but significantly fewer transfusions and fixation points, and cost savings. These results suggest MIS may have economic and patient safety benefits, which need to be greatly considered.

105. One-Stage Spine-Shortening by Using Posterior Vertebral Column Resection for Severe Spinal Deformity Associated with Symptomatic or Asymptomatic Spinal Cord Malformations: It May Be a Choice to Leave Cord Malformations Untreated

Yang Junlin, PhD; Huang Zifang, MD PhD

Summary
spine-shortening osteotomy was introduced for cord tethered treatment, this technique by using one-stage PVCR technique to treat severe spinal deformity

with cord malformations were evaluated in this study, which seems to be safe and effective.

Hypothesis
Spine-shortening technique by using one-stage posterior vertebral column resection (PVCR) is effective for severe rigid spinal deformity with cord malformations.

Design
Retrospective study

Introduction
To evaluate the safety and efficacy of spine-shortening by using one-stage posterior vertebral column resection (PVCR) for severe rigid spinal deformity with cord malformations.

Methods
The records of 32 severe spinal deformity patients with cord malformations treated with spine-shortening by using posterior vertebral column resection (PVCR) from January 2010 to December 2013 were retrospectively analyzed. Intraoperative multimodal neurophysiological monitoring (IONM) was used in all cases. Radiographic parameters and neurological complications were analyzed to evaluate the clinical safety and efficacy.

Results
Spine-shortening by using one-stage PVCR was successfully conducted in all 32 patients. The mean main curve and kyphosis were corrected from 119.8° and 119.1° to 58.6° and 53.9° respectively, with 51.4% and 54.3% corrective rates. The average correction losses of major curve and kyphosis were 2.3° and 2.6° respectively at a mean follow-up of 37.6 months. Intraoperative monitoring events occurred in 9 patients; of these 9 patients, three suffered transient spinal cord injury who all recovered within one year (without permanent paralysis).

Conclusion
In our study, spine-shortening by using one-stage PVCR technique seems to be safe and effective in treating severe spinal deformity with cord malformations. Comprehensive understanding of the technique and intensive intraoperative neuromonitoring improved the safety of patients during these challenging complex spine deformity procedures.

106. WITHDRAWN

107. Major Complications following Surgical Correction of Spine Deformity in 253 Patients with Cerebral Palsy

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Summary
Perioperative and delayed major complications were reviewed in 253 patients with a minimum of 2yr follow-up with cerebral palsy (CP) who underwent surgical treatment of their spinal deformity. There was a 25% complication rate in the perioperative period, with an 8.3% rate of reoperation. The rate of delayed complications was 13%, with an 8.7% reoperation rate.

Hypothesis
Patients undergoing CP spine deformity surgery have high complication rates.

Design
Observational cohort study

Introduction
Understanding the risk of major complications following the surgical treatment of spine deformities in patients with CP is critical. The purpose of this study was to report on the rate of major perioperative and delayed complications following spinal fusion and instrumentation to treat spinal deformity in patients with CP.

Methods
A prospectively collected (2008-2014), multicenter database of patients with CP who had surgical correction of their spine deformity (scoliosis or kyphosis) was reviewed for all major complications. Patients with minimum 2yr f/u or who died within 2yrs were included. A complication was defined as major if it resulted in reoperation, re-admittance or prolonged hospital stay, was considered life-threatening, or resulted in significant injury. Overall complication and revision rates were calculated for periop (occurring ≤6wks postop) and delayed (>6wks postop) complications.

Results
253 patients met inclusion. 78 (31%) patients had a major complication, 19 (8%) of which had >1. There were a total of 95 (38%) major complications, 63 (25%) occurred periop (Table). The most common periop complications were wound (n=15, 5.9%) and pulmonary issues (n=30, 11.9%), specifically deep infections (n=11, 4.35%) and respiratory failure (n=23, 9.1%). Delayed complications (n=32, 13%) were primarily deep infections (n=9, 3.6%) and instrumentation (n=7, 2.8%) related. There were 43 additional surgeries for an overall return to OR rate of 17% (8.3% peri-op, 8.7% delayed). 37 (14.6%) surgeries were spine related (wound or instrumentation-related). 11 patients died following surgery, 2 directly related to the spine surgery. The deaths occurred from 3mo to 5.6yrs postop, with 4 occurring within 1 year of surgery.

Conclusion
Spinal deformity surgery in the CP patient has a higher major complication rate than that reported for Adolescent Idiopathic Scoliosis. When counseling patient caregivers, a major perioperative complication rate of 38% with a spine-related reoperation rate of 14.6% can be anticipated.

Complication Type	Total	Periop	Delayed	Additional Surgeries	Spine-Related Reoperations
Gastrointestinal	6 (2.4%)	3 (1.2%)	3 (1.2%)	3 (1.2%)	0 (0%)
Death	2 (0.8%)	0 (0%)	2 (0.8%)	0 (0%)	0 (0%)
Instrumentation	8 (3.2%)	1 (0.4%)	7 (2.8%)	8 (3.2%)	8 (3.2%)
Medical	15 (5.9%)	11 (4.4%)	4 (1.6%)	4 (1.6%)	2 (0.8%)
Neurologic	1 (0.4%)	1 (0.4%)	0 (0%)	0 (0%)	0 (0%)
Pain	1 (0.4%)	1 (0.4%)	0 (0%)	1 (0.4%)	1 (0.4%)
Pseudarthrosis	2 (0.8%)	0 (0%)	2 (0.8%)	2 (0.8%)	2 (0.8%)
Pulmonary	33 (13.0%)	30 (11.9%)	3 (1.2%)	1 (0.4%)	0 (0%)
Reoperation	2 (0.8%)	1 (0.4%)	1 (0.4%)	2 (0.8%)	2 (0.8%)
Wound	25 (9.9%)	15 (5.9%)	10 (4.0%)	22 (8.7%)	22 (8.7%)
Total	**95 (37.6%)**	**63 (24.9%)**	**32 (12.6%)**	**43 (17%)**	**37 (14.6%)**

108. Artificial Intelligence (AI) Can Predict Complications Better Than Traditional Statistical Testing Following Posterior Cervical Fusion (PCF)

Jun S. Kim, MD; Varun Arvind, MD; Deepak A. Kaji; John M. Caridi, MD; Samuel K. Cho, MD

Summary
AI Neural networks can "learn" from patient data, accurately forecast postoperative complications following PCF, and outperform logistic regression.

Hypothesis
AI better predicts post operative complications than logistic regression.

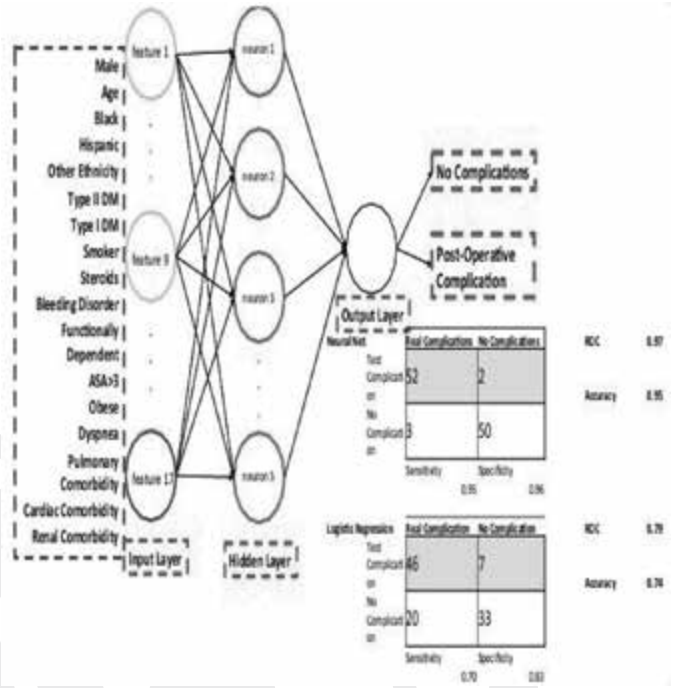
Design
Retrospective cohort

Introduction
Current clinical research relies on statistical models to identify independent risk factors of postoperative complications. However, complex interplay between risk factors is rarely accounted for, which can lead to inaccurate patient morbidity and mortality. Neural network is a machine learning classification system inspired by the human brain. Each network contains a large cluster of neurons which collectively but uniquely weigh the importance of input variables. Optimization of each individual neuron allows for the system to "learn" through repetitive epochs and minimizes error.

Methods
A retrospective cohort analysis was performed on national surgical data from 2011-14. Patients undergoing PCF were separated into cohorts randomly. AI was trained on cases from 2011-2013 and subsequently tested on 2014 cases to simulate real world performance. A random under-sampling algorithm was chosen to account for class imbalance during training and testing. Bayesian regularization was also implemented to prevent overfitting during training and testing. Models were trained with 17 key demographic and operative variables as predictors. We defined postoperative complication as venous thromboembolism, surgical site infection, cardiac complications, or mortality. Feature selection was performed using principal component analysis. Model efficacy was assessed with area under the receiver-operator curve (AUROC) and accuracy.

Results
A total of 106 patients met the inclusion criteria, with 55 patients who experienced major post-operative complication. The final AI model had an accuracy of 95.3%, with an AUROC of 0.979. The logistic regression had a comparatively lower accuracy of 74.5% and an AUROC of 0.795.

Conclusion
This is the first case of using AI in spine literature with AUROC and accuracy values, which far exceed those of logistic regression. Although machine learning algorithms often succeed as classifiers, interpretability of its decision-making process may be obscured by the algorithm's complexity. The power of this network lies in its simplicity, with only one hidden layer comprised of five neurons. The combination of interpretability and accuracy suggests these algorithms can be applied to real time clinical workflow.



109. Hip Flexion Weakness Following Lateral Transpsoas Interbody Fusion

Joes Nogueira-Neto, PhD; Luis Marchi, PhD; Rafael Aquaroli; Elder Camacho; Rodrigo A. Amaral, MD; Leonardo A. Oliveira; Etevaldo Coutinho, MD; *Luiz Henrique Pimenta, MD, PhD*

Summary
Several groups have used LLIF as a less invasive option for the lumbar spine. Hip flexion weakness is a highly prevalent occurrence after this surgery. In the work, we show that, although highly prevalent, this is a transitory event.

Hypothesis
This work evaluated the motor deficit following the passage through the psoas muscle in the LLIF approach.

Design
We conducted a prospective, non-randomized, controlled, single center study.

Introduction
Minimally invasive lateral interbody fusion (LLIF) through retroperitoneal transpsoas approach to has gained many of adepts in the last decade. The technique requires blunt dissection through the psoas muscle to reach the lumbar spine. It has been shown that it can cause some collateral effects related to the psoas muscle and the lumbar plexus, which runs through. Thigh pain, numbness, paresthesia, and weakness are some examples of plexopaties and the loss of contractile power of the psoas fibers stands for an iatrogenic inhibition.

Methods
60 patients with mean age 61.8 years were enrolled. All subjects underwent to a lateral retroperitoneal transpsoas approach for lumbar interbody fusion using EMG guidance. One to three lumbar levels were accessed in these cases (mean levels 1.4; 63% one-level; 68% included L4L5). Isometric hip flexion strength at sitting position was determined bilaterally with a hand-held dynamometer. The mean of 3 peak force (N) measurements was calculated. Standardized

isometric strength tests were performed preop and postop on day 10, 6 weeks, 3 months and 6 months. Ipsilateral and contralateral sides to the surgical access were compared.

Results
Hip flexion at the ipsilateral side was diminished ($p<0.001$) at the early postop but at 6 weeks had reached preop values ($p>0.12$). Mean values for preop, 10d, 6w, 3m and 6m from hip flexion measure were: (Ipsilateral) 13N; 9.7N; 13.7N; 14.4N; 16N; (Contralateral) 13.3N; 13.4N; 15.3N; 15.9N; 16.1N. Neither the level nor the number of levels treated had clear association with thigh symptoms, but weaker the hip flexion was more tight symptoms were found.

Conclusion
Early postoperative period of transpsoas access present hip flexion weakness after surgery. However, it was observed that this occurrence is transient. EMG use is still imperative in transpsoas access and larger casuistic studies are required to complete the understanding of those effects, collateral damages and complications. In addition, patient education should be widely applied to alert regarding the hip flexion weakness in order to prevent falls, cage subsidence and other complications.

110. The Relationship of Older Age on Perioperative Outcomes Following Thoracolumbar Three-Column Osteotomy for Adult Spinal Deformity: An Analysis of 300 Consecutive Cases

Darryl Lau, MD; Vedat Deviren, MD; *Christopher P. Ames, MD*

Summary
This study shows older patients have higher complication rate following three column osteotomy (3CO), but age alone is not an independent risk factor for complications. Rather other items such as blood loss and comorbidities are independently associated with perioperative morbidity.

Hypothesis
We hypothesize that older age is not an independent risk factor for perioperative complications.

Design
This is a retrospective study of a consecutive cohort of patients.

Introduction
3CO are increasingly being used in the elderly population to correction rigid spinal deformity. There is hesitation to perform 3CO for the correction of thoracolumbar spinal deformities in older patients due to concern for high morbidity. This study assesses whether age is independently associated with perioperative outcomes.

Methods
All patients who underwent 3CO for correction of thoracolumbar adult spinal deformity by the senior author from 2006-2016 were identified. Demographic, clinical, and surgical data were collected. Bivariate and multivariate models were used to test associations between age and perioperative complication, intensive care unit (ICU) stay, and hospital stay.

Results
A total of 300 patients were included, and 38.3% were male. Mean age was 63.7 years: less than 50 years (31), 50-64 years (108), 65-70 years (137), and 80 years or older (24). There were no deaths. Overall perioperative complication rate was 24.7%: 18.0% medical and 7.0% surgical. As age group increased, there were significantly higher rates of total complications ($p=0.002$) and medical complications ($p<0.001$): less than 50 years (9.7%, 6.5%), 50-64 years (16.7%, 10.2%), 65-79 years (31.4%, 22.6%), and 80 years or older (41.7%, 41.7%). However on multivariate analysis, age was not independently associated with perioperative complications. Rather, renal disease and blood loss greater than 2500 ml were independent risk factors. Surgical complication rates were similar among age groups. Longer ICU ($p=0.167$) and hospital ($p=0.018$) stays were observed in older age groups: less than 50 years (1.6 days, 7.3 days), 50-64 years (2.3 days, 7.7 days), 65-79 years (2.0 days, 8.2 days,), and 80 years or older (3.2 days, 11.0 days). Specifically, patients age 80 years or older was independently associated with longer ICU ($p=0.028$) and hospital ($p=0.003$) stay.

Conclusion
Age was not independently associated with perioperative complications following 3CO. Frailty and comorbidities that accompany older age are likely why older patients experience more complications. However, older age is independently associated with longer ICU and hospital stay.

111. MRSA Swab Results Did Not Change Treatment or Outcome in Spinal Fusion Patients

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Summary
The results of a preoperative MRSA nasal swab had no correlation with subsequent surgical site infection (SSI) or antibiotics.

Hypothesis
Preoperative MRSA nasal swabs do not correlate with development of SSIs.

Design
Retrospective

Introduction
Previous studies have reported that nasal colonization with MRSA is an important predictor for subsequent SSI with MRSA. Our purpose was to investigate if the MRSA swab results were predictive of SSI in pediatric spinal fusion patients.

Methods
A retrospective chart review of all patients who underwent posterior spinal fusion surgery between 2004-2014 was conducted to determine preoperative MRSA colonization status and SSI infection rates and organisms. Lengthening procedures for distraction based systems were excluded. Patients who did not receive a MRSA swab, who had less than 1 year of follow-up, or who underwent fusion for tumor or infection were also excluded. Prior to 10/1/2012 patients were given vancomycin for infection prophylaxis; beginning 10/1/2012 patients received ceftazidime and cefazolin for prophylaxis. Powdered vancomycin was added to all bone grafts after 2004.

Results
1200 patients met inclusion criteria. 2.3% (n= 28/1200) of patients were positive for MRSA. 3.1% (n= 37/1200) of patients developed an SSI. There was no significant difference in infection rates between patients whose MRSA swab was positive or negative (positive swab= 1 SSI, negative swab= 36

SSIs, p= 0.88). 3 of the SSIs were caused by MRSA. Patients treated prior to 10/1/2012 had a positive MRSA swab rate of 2.6% (n= 16/615) vs 1.9% (n= 7/371) for patients treated after 10/1/2012. This difference was not significant (p= 0.46). The rate of SSI differed significantly between the two groups (p= 0.009), with those prior to 10/1/2012 having a higher rate of postoperative infection (4.4%, n=27/615) than those after 10/1/2012 (1.7%, n= 10/575). Chart review revealed that the antibiotic regimen was not altered for any patients due to a positive MRSA swab.

Conclusion
The results of a preoperative MRSA nasal swab had no relationship to SSI rates.

112. Meta-Analysis of Risk Factors Associated with Surgical Site Infection after Spinal Arthrodesis

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Summary
Surgical site infection (SSI) after spine surgery may have devastating consequences and is a major concern in Adult Spinal Deformity (ASD) patients undergoing long fusions. A meta-analysis of 26 manuscripts with 425,565 patients identified patient and surgical-risk factors for SSI. Patient-related risk factors included: obesity, diabetes, smoking status, age and American Society of Anesthesiologists (ASA) score. Surgical risk factors included: revision surgery, operating room (OR) time, osteotomy and number of levels fused.

Hypothesis
Patient and Procedure-specific risk factors for SSI could be identified via a meta-analysis

Design
Meta-analysis

Introduction
Although many risk factors for SSI have been described in the literature, methodologies and study cohorts vary widely. This meta-analysis sought to review the existing data and isolate significant risk factors for SSI in patients undergoing ASD surgery.

Methods
PubMed Medline, Embase and Cochrane databases were reviewed. Studies including either ASD patients or patients undergoing spinal fusion surgery (single or multilevel, anterior, posterior or combined approach) were considered. Studies that included an odds ratio (OR) for SSI or sufficient data to calculate an OR were included. A meta-analysis was performed using RevMan 5.1. Depending on heterogeneity (I^2), OR with 95% CIs were calculated using either the fixed-effects model (when I^2 >60%) or the random-effects model (when I^2 <60%).

Results
6,480 unique manuscripts were identified and reviewed. 26 manuscripts with 425,565 patients met the criteria for inclusion. A total of 9 significant risk factors for SSI were identified and grouped into two different categories (Table). Patient-related factors for SSI included obesity, diabetes, ASA score, tobacco use and age. Surgical risk factors included revision surgery, OR time, use of osteotomy and number of levels fused.

Conclusion
This meta-analysis identifies significant risk factors for SSI following spine arthrodesis. This included modifiable patient factors such as obesity, diabetes and smoking status and non-modifiable risk factors like ASA score and age. Surgical risk factors included revision status, OR time, osteotomy use and number of levels fused. These factors should be considered in patient counseling as well as treatment approach and surgical strategy.

		OR	CI Low	CI High	Sig
Patient-related	Obesity	1.68	1.47	1.91	<0.001
	Diabetes	2.18	1.61	2.95	<0.001
	ASA score	1.95	1.61	2.37	<0.001
	Smoker	1.21	1.06	1.38	0.005
	Age	1	1	1.01	0.03
Surgery-related	Revision surgery	1.85	1.67	2.06	<0.001
	OR Time	1.23	1.07	1.4	0.003
	Osteotomy	2.18	1.75	2.71	<0.001
	N level fused	2.74	1.77	4.23	<0.001

***Table** – Risk factors for SSI after spine arthrodesis and their ORs with 95% CI. Risk factors were grouped in 2 categories: patient-related and surgery-related*

113. Deep Infections Differ Following Spinal Fusion for Idiopathic, Syndromic and Neuromuscular Deformity

Brian T. Sullivan, BS; Oussama Abousamra, MD; Varun Puvanesarajah; Amit Jain, MD; Matthew J. Hadad; Paul D. Sponseller, MD, MBA

Summary
Data of 1220 patients who underwent spinal deformity correction by a single surgeon were reviewed. Deep surgical site infection was observed in 63 patients, with rates in syndromic scoliosis being more common than idiopathic but less than neuromuscular scoliosis. Infections with Gram negative organisms were more common than Gram positives in syndromic as well as neuromuscular scoliosis. Gram negative antibiotic prophylaxis may be indicated in surgical correction of syndromic scoliosis.

Hypothesis
The spectrum of causative organisms responsible for deep surgical site infections (DSSI) differs between syndromic, idiopathic and neuromuscular scoliosis.

Design
Retrospective cohort review.

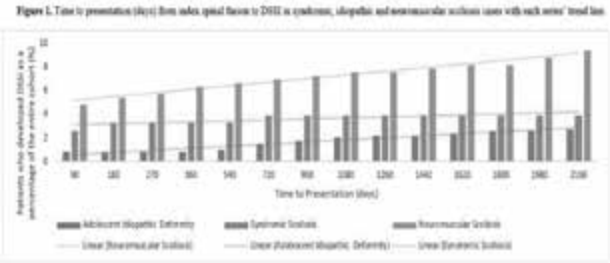
Introduction
The causative organisms isolated from DSSI, following idiopathic and neuromuscular spinal fusion, have been previously reported. The aim of this study is to characterize and compare these with the causative organisms in DSSI following spinal fusion for syndromic scoliosis (SS).

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

Methods
Records of patients, ≤ 21 years old, who underwent spinal fusion for deformity correction, were reviewed. Spine deformity etiologies included SS, adolescent idiopathic (scoliosis or kyphosis) deformity (AISK) and neuromuscular scoliosis (NMS). All procedures were performed by a single surgeon between 2000 and 2015. "Growth friendly" procedures were excluded. Patients who had confirmed DSSI upon surgical site exploration were identified. DSSI was defined as intraoperative findings consistent with infection or positive tissue cultures during surgical site exploration. Infections were classified as early (≤ 30 days postop) or late (> 30 days postop).

Results
1220 patients were studied (154 SS; 734 AISK; 332 NMS). DSSI was confirmed in 63 patients (7 SS; 25 AISK; 31 NMS) (Table 1). The rates of early and late DSSI was 1.9% and 2.6% in SS, 0.8% and 2.6% in AISK, and 3.3% and 6.0% in NMS. Early and late DSSI rates were significantly different between AISK and NMS groups (early: p=0.002; late: p=0.005). Late infections were more common than early ones in all groups. The ratio of late to early infections was highest in AISK 3.1, followed by NMS 1.8 and SS 1.3. The ratio of observed gram positive: gram negative microorganisms was 0.8:1 in SS, 3.2:1 in AISK, and 1:1 in NMS. Only one patient had MRSA.

Conclusion
DSSI in syndromic spine deformity correction was more common than AISK and observed to have a propensity for gram negative organisms, particularly in the early postop period. Gram negative antibiotic coverage, as recommended for NMS, may be indicated for SS patients undergoing spinal fusion. Further research on these patterns may help understand the biology of DSSI and target prevention.



	Syndromic (7 pts.)		Idiopathic (25 pts.)		Neuromuscular (31 pts.)	
	Early (3 pts.) (4 organisms)	Late (4 pts.) (5 organisms)	Early (6 pts.) (10 organisms)	Late (19 pts.) (7 organisms)	Early (11 pts.) (14 organisms)	Late (20 pts.) (29 organisms)
Single Gram +	1			7	1	3
Single Gram -	1	1	2		1	3
Multiple Gram +			1		1	6
Multiple Gram -	1				1	
Mixed		2	2		1	4
Negative Culture		1	1	12	2	4
Organisms	2 E. coli 1 Coag (-) Staph 1 Klebsiella	1 S. aureus 1 E. faecium 1 S. pneumoniae 1 P. aeruginosa 1 Enterobacter	2 Coag (-) Staph 2 E. faecium 1 S. aureus 1 P. acnes 1 P. aeruginosa 1 Klebsiella 1 Serratia 1 Unspecified Gram negative	3 P. acnes 2 Coag (-) Staph 2 S. aureus	4 P. aeruginosa 3 E. coli 2 Coag (-) Staph 1 S. aureus 1 Klebsiella 1 P. mirabilis 1 Serratia 1 Citrobacter	8 Coag (-) Staph 5 S. aureus 3 E. faecium 3 P. acnes 2 E. coli 1 Enterobacter 1 P. aeruginosa 1 Klebsiella 1 P. mirabilis 1 Citrobacter 1 Streptococcus 1 Unspecified Gram negative

114. Revision Spine Surgery in Patients without Clinical Signs of Infection: How Often are There Occult Infections in Removed Hardware?
Isador H. Lieberman, MD, MBA, FRCSC; Xiaobang Hu, PhD, CCRP

Summary
Occult infection is present in 9.3% of patients who underwent revision spine surgery and hardware removal although they did not have clinical signs of infection. There is no correlation between pre-operative ESR, CRP, procalcitonin levels and positive culture results.

Hypothesis
Occult infection is uncommon in revision spine surgery. Pre-operative inflammatory markers are sensitive to detect occult infection.

Design
Retrospective comparative study

Introduction
Hardware removal is commonly required during revision spine surgeries. However, the presence and significance of occult infections in removed hardware has not yet been established in those patients who have no clinical signs of infection. The purpose of this study is to examine the incidence of occult infection in a series of revision spine surgeries and to study its correlation with pre-operative inflammatory markers.

Methods
Data were retrospectively reviewed from all patients who underwent revision spine surgery and hardware removal by a single surgeon between 2010 and 2016. Culture of the removed hardware and surrounding tissue is a routine practice of this surgeon. Those patients who had pre-operative clinical signs of infection were excluded from this study. The results of hardware and surrounding tissue cultures were obtained from medical records. The patients' diagnosis and pre-operative inflammatory marker levels (ESR, CRP, procalcitonin) were recorded.

Results
A total of 162 consecutive patients were included in this study. The patients' mean age was 61 years (range 14 - 88). One hundred and three patients (63.6%) were female. Seventy two patients (44.4%) had loose hardware and 88 patients (54.3%) had pseudarthrosis. Post-operatively, the hardware and/or surrounding tissue culture was positive in 15 patients (9.3%). The most common identified organisms were Propionibacterium acnes (7/15, 46.7%) and Staphylococcus (6/15, 40.0%). The other identified organisms were Pseudomonas aeruginosa (1/15, 6.7%) and Serratia marcescens (1/15, 6.7%). Only four patients with positive cultures had elevated pre-operative ESR and CRP levels. Only two patients with positive cultures had elevated pre-operative procalcitonin levels. There is no correlation between the patients' pre-operative ESR, CRP, procalcitonin levels and positive culture results (p>0.05).

Conclusion
Occult infection is present in 9.3% of patients who underwent revision spine surgery and hardware removal although they did not have clinical signs of infection. Those commonly used pre-operative inflammatory markers such as ESR, CRP and procalcitonin are not sensitive enough to detect occult infections in these patients.

115. Does the Presence of an Intraspinal Anomaly Increase Neurologic Complications and Lessen the Correction Rate in Severe Pediatric Spinal Deformity?

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Summary
Presence of an intraspinal anomaly may increase neurologic risk and decrease surgical correction in patients with severe spinal deformity. From a pediatric dataset of patients with curves >100° ± vertebral column resection [VCR], we compared patients with an intraspinal anomaly to those without. We found similar rates of correction, IONM changes, and neurologic injury between the groups. A larger percentage of patients with an intraspinal anomaly underwent a VCR, and we assume this spinal shortening procedure may mitigate neurologic risk.

Hypothesis
Patients with severe pediatric deformity and an intraspinal anomaly (ISA) will have a higher incidence of intraoperative IONM changes, postoperative deficits, and less curve correction than patients without ISAs.

Design
Prospective observational multi-center study.

Introduction
Several reports have established the incidence of ISA in patients with pediatric deformity, but none in a cohort of patients with severe deformity (>100° ± VCR). We sought to 1) establish an incidence of ISA in these patients and 2) report on clinical and radiographic outcomes.

Methods
We identified patients with >100° ± VCR and compared those with an ISA to those with No ISA.

Results
Intraspinal anomalies were found in 31/166=18.7% patients (Idiopathic=10.5%, Congenital=24.5%, Neuromuscular/Syndromic=27.6%), with the most common anomaly being tethered cord (29%=9/31). Those patients with ISA as compared to those with No ISA were similar with respect to preoperative major (ISA=91.4 ± 37.4°, No ISA=100.6 ± 35.7°, p=0.21) and sagittal (ISA=96.9 ± 30.5°, No ISA=99.5 ± 38.7°, p=0.73) Cobb angles and had similar 2-year results (major ISA=36.0 ± 22.4°, No ISA=42.0 ± 25.3°, p=0.24; Sagittal ISA=40.3 ± 21.5°, No ISA=46.3 ± 24.3°, p=0.21). Surgeons performed a VCR in 18/31 (58.1%) of patients with ISA compared to 54/135 (40%) in those with No ISA. Similar percentages of patients in both groups had obtainable SSEPs (ISA=97%, No ISA=96%, p=0.9) and tcMEPS (ISA=81%, No ISA=91%, p=0.2). Changes in tcMEPs occurred in 45% of patients overall and were similar between the 2 groups (ISA=44%, No ISA=46%, p=0.6). At 2 years post-op, 1 patient persisted with a new neurologic deficit.

Conclusion
Treatment of severe pediatric deformity poses high risk, but this does not appear to be compounded by the presence of an ISA. Similar correction, rates of IONM changes, and new post-op deficits occurred in both cohorts. A higher percentage of patients with ISA underwent a VCR, and perhaps this attenuated neurologic risk in this highly demanding population.

Table 1: Comparison Between Patients Without Intraspinal Anomaly and Intraspinal Anomaly

	No ISA (n=135)	ISA (n=31)	p value
Age at Surgery (N)	15.8 ± 2.7	14.7 ± 2.8	0.06
Primary Diagnosis (N)			
Idiopathic	68	8	
Congenital	46	15	
NM/Other	21	8	
Number of Levels Fused	13.6 ± 2.1	13.7 ± 2.9	0.80
Major Cobb Angle			
Pre-Op (°)	100.6 ± 35.7	91.4 ± 37.4	0.21
2 yrs Post-Op (°)	42.0 ± 25.3	36.0 ± 22.4	0.24
% correction	60.8 ± 19.7	58.9 ± 19.4	0.86
Kyphosis			
Pre-Op (°)	99.5 ± 38.7	96.9 ± 30.5	0.73
2 yrs Post-Op (°)	46.3 ± 24.3	40.3 ± 21.5	0.21
VCR	54 (40%)	18 (58%)	
Surgical Time ± SD (min)	425.6 ± 183.8	483.2 ± 215.0	0.13
Estimated Blood Loss ± SD (mL)	1571.9 ± 741.5	1153.6 ± 767.1	**0.01**
Length of Hospitalization (Days)	10.4 ± 6.7	11.9 ± 8.8	0.78

116. Comorbid Psychiatric Diagnoses are Associated with Poor Outcomes of Adult Spinal Deformity Surgery at 2 Year Follow Up

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Summary
Many patients undergoing surgical correction for Adult Spinal Deformity (ASD) have co-existing psychological disorders. This data showed that these patients had higher surgical readmission and revision rates at 2yr FU.

Hypothesis
Psychological comorbidity plays a significant role in surgical outcomes of ASD.

Design
Retrospective review of prospectively collected database

Introduction
Recent research revealed that 1 in 3 patients (pts) admitted to the hospital to undergo surgical treatment for ASD are psychologically impaired. However, data was limited to the hospital course only, with no investigation of long-term outcomes.

Methods
A retrospective review of NY State Department of Health database (SPARCS) was performed. SPARCS has a unique identification code for each pt allowing investigators to track him/her across multiple admissions. ICD-9 codes identified pts admitted between 2009-2011 with diagnoses of ASD and underwent ≥4 levels of thoracolumbar fusion with minimum 2yr follow-up. Pts who were carrying a clinical psychiatric diagnosis at time of admission (Depression, Anxiety, Stress or Sleep Disorder based on DSM IV were grouped (Psych)). Univariate analysis compared demographics, complications, revisions and readmissions between the groups. Multivariate binary logistic regression models identified independent predictors of these outcomes with age, gender and Deyo score as covariates.

Results
4,691 pts (Psych, n=817, 17.4% vs. NoPsych, n=3874, 82.6%) were included. Age (59.51 years) and gender (58.4%) were similar between the groups. The frequencies of disorders within Psych were Depressive Disorder (57.4%), Sleep

Disorder (33.4%), Anxiety Disorder (33.2%), and Stress Disorder (6.2%). Fusion length was similar between the groups. At minimum of 2yr follow-up, Psych had a significantly higher complication rate (47.1 vs. 32.5%), specifically, device related complications (19.3 vs. 10.8%), sepsis (4.3 vs. 0.9%), infection (8.3 vs. 3.8%), hematoma (4.0 vs.1.4%), and DVT (4.5 vs. 2.0%) all p<0.001. Psych pts had a higher readmission rate for any indication (85.6% vs. 49.6% of NoPsych) and a higher revision rate (34.5% vs. 16.0%), all p<0.001. Regression model revealed that Psych group had increased risk of any complication: OR: 1.59 (1.36-1.86), revision surgery OR: 2.54 (2.14-3.03), and any readmission [OR: 4.32 (3.48-5.36)], all p<0.001

Conclusion
Despite similar demographics, patients with ASD who had comorbid clinical psychiatric diagnoses were more likely to experience surgical complications and revision after spinal fusion. Proper patient counseling and psychological screening/support is recommended as a compliment to ASD treatment.

117. Unplanned Immediate Return to Operating Room After Spine Surgery: Significance of Immediate Postoperative Radiographs

Dennis Chen, MD; Francis H. Shen, MD; Adam, L Shimer, MD; Brian Urbani, MS; Anuj Singla, MD; *Keith Bachmann, MD*

Summary
Post-operative radiographs are commonly obtained in the recovery room after spine surgery for documenting adequacy and accuracy of the surgical procedure. The purpose of this study is to look at the utility and relevance of these radiographs in providing vital information leading to immediate revision. Only 0.10% patients in our study (2 out of 1804) underwent revision based on postoperative radiographs showing inappropriate/ failed hardware.

Hypothesis
Immediate post-operative radiographs do not provide any significant information over intraoperative fluoroscopy imaging and may be avoided.

Design
Retrospective analysis; single center data

Introduction
Immediate postoperative radiographs are routinely obtained in the recovery room to verify the level, alignment of the spine, implant position, and the adequacy of the procedure. However with the ability to utilize intraoperative imaging for this purpose, the need for immediate post-operative radiographs need to be validated. The purpose of this study is to look at the utility and relevance of these post-operative radiographs in providing critical information that may require immediate intervention.

Methods
Retrospective analysis of all spine surgeries (elective and emergent), performed at a single center from 2011 to 2016, was done and cases returning to operating room within 48 hours were identified. Indication of immediate revision was reviewed and utility of immediate post-operative radiographs in guiding immediate revision was analyzed.

Results
A total of 1804 elective and urgent spinal surgeries were performed by 7 surgeons. 22 patients returned to operating room within 48 hours of their index procedures. 14 out of 22 patients(0.7%) were included as true unplanned immediate revision cases after excluding 8 planned staged procedures/ aborted (medical reasons)cases . 12 out of 14 patients had an return to OR secondary to persistent/ new neurologic deficit and persistent abscess. Only 0.10% patients (2 out of 1804) had immediate revision based on postoperative radiographs showing inappropriate/ failed hardware. Both cases involved instrumentation at cervicothoracic region and intraoperative imaging provided limited visualization.

Conclusion
Routine recovery room radiographs played a role in the decision to emergently return to the OR in 0.10% (2/1804) cases at our institution. The potential benefit of immediate recovery room radiographs following spine surgery should be weighed against the added healthcare cost and patient discomfort associated with obtaining these radiographs. Imaging may be delayed to a more elective time without any significant risk in majority of spine cases.

118. End Vertebra vs Apical Vertebra: Where Are We More Likely to Misplace?

Vishal Sarwahi, MD; Stephen F. Wendolowski, BS; Jesse Galina, BS; Beverly Thornhill, MD; Yungtai Lo, PhD; Terry D. Amaral, MD; *Rachel Gecelter, MS1*

Summary
UIV presents more of a risk for pedicle screw misplacement and abnormal morphology when compared to LIV and apical vertebra. UIV had a significantly lower percentage of normal pedicles compared to apex major, apex minor, or LIV (59.1% vs. 76.1% vs. 77.3% vs. 98.7%; p<0.001). UIV was more likely to have screws misplaced (Odds Ratio (OR) =7.56, 95% CI 4.01-14.30; p<0.001) and abnormal pedicles (OR = 2.81, 95% CI 1.52-5.19; p=0.001) compared to any other location studied.

Hypothesis
UIV is at an increased likelihood for pedicle screw misplacement

Design
Retrospective CT scan study

Introduction
Pedicle screws placement remains technically demanding. Thoracic curve apex is considerably difficult due to unique morphology and rotation. In comparison upper end vertebrae have smaller pedicles and limited soft tissue exposure. This study seeks to evaluate the likelihood of screw misplacement at the end vertebra and apex.

Methods
Retrospective review of charts, radiographs, and postop CT scans of spinal deformity patients who underwent PSF with pedicle screw constructs between 2004 and 2011. Pedicles located at the upper and lower instrumented vertebra (UIV and LIV), and the apex major (Major) and minor (Minor) were evaluated. Pedicle morphology was studied on preop CT and screw misplacements on postop CT. Screws were considered normal (Norm), anterior (Ant), lateral (Lat) or medial (Med). Logistic regression was utilized.

Results
188 patients met the inclusion criteria, 172 had preoperative CT scans and 133 had postoperative CT scans. UIV had a significantly lower percentage of normal pedicles (Type A) compared to apex major, apex minor, or LIV (59.1%

vs. 76.1% vs. 77.3% vs. 98.7%; p<0.001). UIV had significantly the lowest percentage of normal normally placed screws compared to LIV, apex major, or apex minor (69.4% vs.97.3% vs. 87.6% vs. 92.1%; p<0.001). In a logistic regression adjusted for preoperative Cobb angles, UIV was more likely to have screws misplaced (Odds Ratio (OR) =7.56, 95% CI 4.01-14.30; p<0.001) and abnormal pedicles (OR = 2.81, 95% CI 1.52-5.19; p=0.001) compared to any other location studied. In abnormal pedicles, 41 (39.8%) of the 103 UIV screws were misplaced, whereas 10 (16.4%) of the 61 apex major, apex minor, or LIV screws were misplaced (p = 0.007).

Conclusion
UIV presents more of a risk for pedicle screw misplacement and abnormal morphology when compared to LIV and apical vertebra. We believe these findings can aid in the surgeon's pre- and intra-operative management to ensure increased success in accurate and safe pedicle screw placement.

119. Natural History Of Lumbar Degenerative Kyphosis With Conservative Treatment - Do Clinical Symptoms and Radiological Parameters Progress?

Whoan Jeang Kim, MD; Kun Young Park, MD; Shann Haw Chang, MD; Jae Won Lee, MD

Summary
We evaluated the natural history of conservatively treated LDK patients. Radiologic parameters have progressed but there were no correlation between radiologic parameters and clinical symptoms. Decisions for treatment of LDK should not be determined by the radiologic parameters but by carefully determining the patients' demand and disability level.

Hypothesis
To evaluate the correlation between clinical symptoms and radiologic findings of LDK with conservative treatment.

Design
Retrospective

Introduction
The correlation between the clinical symptoms and the radiologic findings of ASD is widely known. However, in LDK, which mainly occur in Asian population, dynamic sagittal imbalance occurs during ambulation. So its pathogenesis and natural history is different and not widely recognized compared to other ASD resulting many controversial for treatment. To make clear the natural history of LDK, we analyzed the correlations of clinical and radiologic factors.

Methods
From June 2006 to Jan. 2016, 31 patients, who were diagnosed with a LDK and underwent conservative treatment, were studied. Mean age of the patients was 72.5 years old and the mean follow-up period was 58 months. In every case, clinical and radiologic evaluation was conducted on the first visit and the last follow-up. Clinical evaluations were done using VAS and ODI. Radiographic evaluation were performed including SRS-Schwab sagittal modifiers(PT, SVA, PI-LL, TK, TLK, LL, PI,SS).

Results
Patients who were diagnosed with LDK and underwent conservative treatment showed no significant differences in the clinical outcomes between the first visit and the final follow-up. The mean VAS was 3.2 at initial visit and 3.4 at final follow-up. The mean ODI score was 31.9 at initial visit and 34.7 at final follow-up. Of the radiologic evaluation, radiological parameters except TK, PI, PT, SS significantly increased. The mean SVA, TLK, LL, and PI-LL changed from 8.5cm, 15.9°, 6.2°, and 51.1° at initial visit and to 17cm, 19.5°, -5.4°, and 67.4° at final follow-up. Moreover, there were no significant correlation between the clinical symptoms and the radiologic parameters including SRS-Schwab sagittal modifiers of the first visit and the final follow-up.

Conclusion
Conservative treatment in LDK patients, radiologic parameters have progressed but there were no correlation between radiologic parameters and clinical symptoms. Futhermore, SRS Schwab sagittal modifiers showed weak clinical relevance. Decisions for treatment of LDK should not be determined only by the radiologic parameters showing the deformation degree, but by carefully determining the patients' demand and disability level.

120. Adult Spinal Surgery in Patients with Previous THA: Should We Do the Spine First?

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Summary
Patients with Spine-Hip syndrome could require both Total Hip Arthroplasty (THA) and spinal fusions. This study showed that spinal fusion increases the risk of failure in patients with previous THA at 2 yr follow up.

Hypothesis
Spinal fusion after THA for adult spinal degeneration or deformity increases the risk of THA complications and revisions.

Design
Retrospective review of prospectively collected database

Introduction
Patients with Spine-Hip syndrome could require both THA and spinal fusions. There is conflicting literature examining the outcomes of these patients when spinal fusion occurs after THA.

Methods
A retrospective review of NY State Department of Health database (SPARCS) was performed. SPARCS has a unique identification code for each patient allowing investigators to track him/her across multiple admissions. ICD-9 codes identified adult patients who underwent elective THA from 2009-2011. Patients who had subsequent spinal fusion (Short: 2-3 levels or Long: ≥4 levels) with diagnoses of (AIS or DDD) were identified. Univariate analysis compared demographics, complications, subsequent THA, and readmissions between Short, Long and No spinal Fusion groups. Multivariate binary logistic regression models controlling for age, gender, and Deyo score were utilized to investigate the impact of spinal fusion on THA outcomes up to the end of 2013.

Results
50,300 THA patients were included (No fusion: n=49,579, short fusion: n=484, long fusion: n=237). Groups had comparable age (63.1-65.3 y/o), gender (F: 54.1-56.5%), and Deyo score (0.51-0.71). At 2 yr FU, overall THA

complication rate (3.4, 6.6, 11.8%), dislocation rate (1.7, 3.5, 7.2%), and hip enthesopathy/bursitis (1.0, 2.7, 2.5%) progressively increased between the groups, all $p<0.05$. The THA revision rates for any reason also increased (3.7, 7.3, 11.6%, $p<0.05$). Subsequent THA rate was significantly higher in Long fusion only (12.6%, 11.4%, 17.7%, $p<0.05$). Regression models revealed that short and long increased the risk of dislocation by OR: 2.2 (1.4-3.6), and OR: 4.4 (2.7-7.3). They also increased the risk of any THA complications by OR: 2.1 (1.4-3), OR: 3.9 (2.6-5.8), and THA revision for any reason by OR: 2.0(1.4-2.8), OR: 3.2(2.1-4.8). Only long fusion increased the rate of subsequent THA by OR: 1.5 (1.1-2.2). All OR were significant with $p<0$.

Conclusion
Operating on the spine first remains a challenging question. This is the largest study to date showing that ASD surgery increases the risk of complications and revisions in patients with THA. Specifically, long spinal fusion pts had 4.4 greater odds of dislocating their hip, 3.2 and 1.5 greater odds of revising the same hip, or experiencing subsequent THA, respectively

121. Which Sagittal Modifiers Significantly Deteriorate Health Related Quality of Life Investigated in Elderly Volunteers – Four Year Follow-up Study

Daisuke Togawa, MD; Shin Oe, MD; Tomohiko Hasegawa, MD, PhD; Yu Yamato, MD, PhD; Go Yoshida; Sho Kobayashi, MD, PhD; Tatsuya Yasuda, MD; Tomohiro Banno, MD; Yuki Mihara, MD; Yukihiro Matsuyama, MD, PhD

Summary
This prospective cohort study has determined which combinations of sagittal modifiers significantly deteriorate HRQOLs in elderly volunteers. Although the group having abnormalities in all 3 modifiers was the worst, the combinations including SVA abnormality caused significant HRQOL deteriorations in four years.

Hypothesis
Sagittal vertical axis is the best sagittal modifier to predict HRQOL deterioration in elderly.

Design
Prospective Cohort Study

Introduction
Health related quality of life (HRQOL) associated with spinal malalignment in elderly was not well investigated yet. The purpose of this cohort study was to investigate the changes in whole spinal alignment and HRQOLs in volunteers regarding to the types of sagittal abnormalities.

Methods
In 2012 and 2016, musculoskeletal examinations were performed in the volunteers with age over 50. Whole spine and pelvic X-rays were taken in standing position with standardized fashion, and radiographic parameters were measured by software. Both + and ++ sagittal modifiers in SRS Schwab classification (PI-LL, SVA, PT) were defined as abnormality. Volunteers were grouped due to the combination of modifier abnormalities in 2012 study; Group N (all modifiers: normal), 1A: PI-LL only, 1B: SVA only, 1C: PT only, 2AB: PI-LL and SVA, 2BC: SVA and PT, 2CA: PT and PI-LL, and Group 3: all 3 modifiers. HRQOLs were investigated by Oswestry Disability Index (ODI) and EuroQOL (EQ5D). Every 3 sagittal modifiers and HRQOLs evaluated after four years (2016) were investigated in each group.

Results
In this cohort study, 345 volunteers (130 males (M), 215 females (F)) were investigated both in 2012 and 2016. Average age in 2012 was 72.2 years old. Baseline data (2012) and data in 2016 were shown in Table 1. Among 345 volunteers, Group N included 109 volunteers (M: 43, F: 66), 1A: 15 (M: 6, F: 9), 1B: 56 (M: 30, F: 26), 1C: 24 (M: 2, F: 22), 2AB: 34 (M: 22, F: 12), 2BC: 13 (M: 4, F: 9), 2CA: 23 (M: 4, F: 19), and Group 3: 71 (M: 12, F: 59). HRQOLs (ODI and EQ5D) in 2016 were significantly worse in Groups 1B (13.6, 0.817), 2AB (15.0, 0.789), 2BC (18.5, 0.760), and group 3 (23.9, 0.733).

Conclusion
Groups with PT abnormality were significantly included more females. Health related QOL significantly deteriorated in the Groups with SVA abnormality (Group 1B, 2AB, 2BC, and 3) compared to the other groups.

			2012 (average)					2016 (average)				
Group	Abnormality (+ and ++)	N	PI-LL	SVA	PT	EQ5D	ODI	PI-LL	SVA	PT	EQ5D	ODI
ALL		345	8.7	46.2	18.4	0.830	12.1	9.9	28.5	22.6	0.806	15.3
N		109	-2.2	12.3	12.0	0.858	9.1	-3.3	-7.8	15.3	0.856	11.3
1A	PI-LL	15	13.0	16.3	14.9	0.813	11.3	5.4	-14.8	19.3	0.793	11.3
1B	SVA	56	-0.3	59.2	12.5	0.852	11.8	2.3	34.0	17.0	0.817	13.6
1C	PT	24	1.5	15.4	23.9	0.810	8.8	4.0	5.2	26.3	0.826	11.5
2AB	PI-LL, SVA	34	16.4	71.8	14.9	0.842	12.5	16.4	45.7	20.6	0.789	15.0
2BC	SVA, PT	13	0.2	68.1	25.0	0.842	12.8	13.5	61.1	28.5	0.760	18.5
2CA	PT, PI-LL	23	18.4	24.3	24.7	0.878	8.0	13.9	19.1	27.4	0.858	9.1
3	PI-LL, SVA, PT	71	28.8	95.6	30.2	0.771	17.5	33.0	87.7	34.9	0.733	23.9

122. Global Alignment and Proportion (GAP) Score Better Correlates to HRQoL Scores and Better Predicts Mechanical Complications Compared to SRS-Schwab Sagittal Modifiers

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Summary
Schwab sagittal modifiers have been accepted as alignment targets but addressing these does not always prevent mechanical complications. GAP score comprises PI-based proportional parameters and better correlates to HRQoL scores and better predicts mechanical complications compared to Schwab modifiers.

Hypothesis
Schwab modifiers are insufficient in quantifying sagittal plane deformity for all PI sizes.

Design
Retrospective analysis of a prospectively collected data of adult spinal deformity pts.

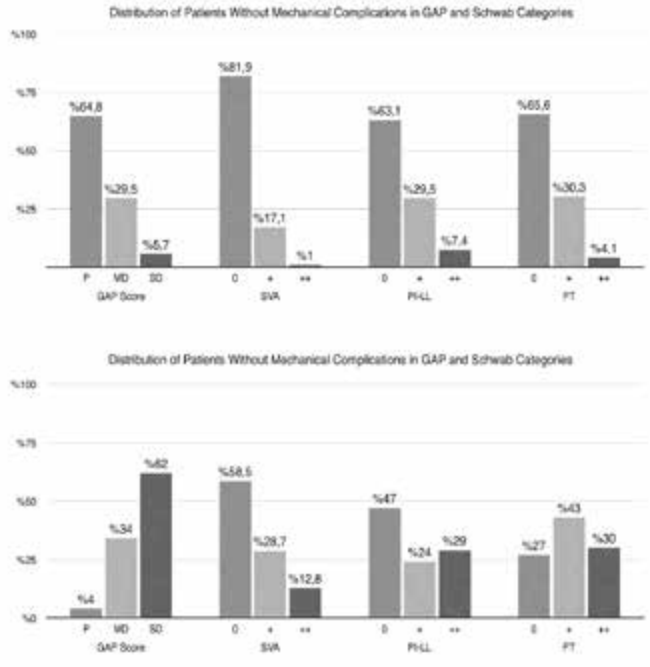
Introduction
Schwab modifiers were established on the basis of patient-reported outcomes. Their impact on mechanical complications has not been studied. GAP score

comprised PI-based parameters of Relative Pelvic Version (Measured minus Ideal Sacral Slope), Relative Lumbar Lordosis (Measured minus Ideal LL), Lordosis Distribution Index (L4-S1 lordosis/L1-S1 lordosis x100), Relative Spinopelvic Alignment (Measured minus Ideal Global Tilt) and age factor. GAP score of 0-2 is proportioned, while 3-6 is moderately disproportioned and ≥7 is severely disproportioned. GAP score quantifies spinopelvic shape and alignment on the basis of a given person's respective realignment needs for every PI size. Schwab modifiers rely on a given absolute value which may work for average PI sizes but not for pts in upper and lower normal PI values. Aim was to compare GAP and Schwab Modifiers in prediction of mechanical complications and correlations to HRQoL.

Methods
Inclusion criteria were ≥4 levels fusion, and ≥2y f/up. Mechanical complications were PJK/PJF, DJK/DJF, rod breakage and implant-related complications. Correlations between Schwab modifiers and GAP Score to HRQoL were found using Pearson's Partial Correlation Coefficient where pre-op scores were the control variable. The distribution of Schwab modifiers and GAP categories in pts with and without mechanical complications were compared using McNemar-Bowker test.

Results
222 pts met inclusion criteria. Mean age: 52.2±19.3(18-84) years. Mean f/up: 28.8±8.2(24-62) months. GAP had better partial correlation coefficients to ODI, COMI, SF-36 PCS, MCS and SRS-22 subdomains when compared to PT, PI-LL and SVA ($p<0.01$). In 122 pts that did not experience mechanical complications the distribution of Schwab modifiers and GAP categories were similar ($p>0.05$) (Figure). In 100 pts that had mechanical complications GAP had a better prediction with an increasing trend of complications as the category worsens ($p<0.001$) (Figure).

Conclusion
GAP is a single comprehensive score that better correlates to HRQoL scores and better predicts mechanical complications compared to Schwab modifiers.



123. Ligament Augmentation Reduces Proximal Junctional Kyphosis and Proximal Junctional Failure in Adult Spinal Deformity

Michael Safaee, MD; Vedat Deviren, MD; Justin K. Scheer; Darryl Lau, MD; Joseph Osorio, MD, PhD; Fred H. Nicholls, MD, MA, FRCSC; *Christopher P. Ames, MD*

Summary
Ligament augmentation is associated with reductions in proximal junctional angle and decreased rates of proximal junctional failure.

Hypothesis
Use of ligament augmentation results in decreased change in proximal junctional angle and rate of proximal junctional failure.

Design
Retrospective comparative study performed at a single center. 200 patients were included; 100 each before and after implementation of ligament augmentation. A minimum of 6 months follow-up were required for inclusion. Outcomes included change in proximal junctional angle and rate of revision surgery due to proximal junctional failure.

Introduction
Proximal junction kyphosis (PJK) is a well-recognized complication of adult spinal deformity surgery. There is no standardized definition, but most describe PJK an increase in the proximal junctional angle (PJA) of greater than 20°. Ligament augmentation is a novel strategy for PJK reduction that provides strength to the upper instrumented vertebrae (UIV) and adjacent segments while also reducing junctional stress.

Methods
Ligament augmentation was applied to a consecutive series of adult spinal deformity patients at a single center. Demographics including age, gender, indication for surgery, surgical approach, and use of three-column osteotomies, vertebroplasty, or hook fixation at the UIV were collected. PJA was measured preoperatively and at last follow-up. Univariate and multivariate analyses were performed to identify factors associated with change in PJA and proximal junctional failure (PJF), defined as PJK requiring surgical correction.

Results
A total of 200 consecutive patients were included; 100 patients each before and after implementation of this technique. Mean age of the ligament augmentation cohort was 66 years with 67% women. Over half of these cases (51%) were revision surgeries with 38% involving a combined anterior/lateral and posterior approach. The mean change in PJA was 6° in the ligament augmentation group compared to 14° in the control group ($p<0.001$). Eighty-four patients had a change in PJA of less than 10°. In a multivariate linear regression model, age ($p=0.016$), hook fixation at the UIV ($p=0.045$), and ligament augmentation ($p<0.001$) were associated with change in PJA. Only ligament augmentation (OR 0.193, $p=0.012$) showed a significant associated with PJF.

Conclusion
Ligament augmentation represents a novel technique for PJK/PJF prevention. Compared to a well-matched historical cohort, it is associated with a significant decrease in PJK and PJF. These data suggest a role for this technique in surgery for adult spinal deformity, particularly in high risk cases.

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

Multivariate analysis for change in PJA and PJF

Variable for PJA	B coefficient	p value
Age	0.166 (0.032 - 0.301)	0.016
Male gender	-1.583 (-4.536 - 1.371)	0.292
UIV	-1.809 (-4.933 - 1.315)	0.255
Hook fixation at UIV	-4.450 (-8.800 - -0.101)	0.045
Vertebroplasty	0.871 (-2.547 - 4.289)	0.616
Ligament augmentation	-7.879 (-10.956 - -4.802)	<0.001

Variable for PJF	Odds Ratio (95% CI)	p value
Age	1.027 (0.974 - 1.083)	0.321
Male gender	0.308 (0.081 - 1.155)	0.083
UIV		
Cervical	6.273 (0.208 - 189.122)	0.291
Upper thoracic	0.164 (0.021 - 1.245	0.080
Lower thoracic	0.445 (0.094 - 2.099)	0.306
Lumbar	1 (reference)	-
Hook fixation at UIV	0.168 (0.011 - 2.590)	0.201
Vertebroplasty	1.22 (0.356 - 4.177)	0.751
Ligament augmentation	0.193 (0.053 - 0.701)	0.012

UIV: upper instrumented vertebrae

124. Use of Prophylactic Techniques to Prevent Proximal Junctional Failure (PJF) Following Adult Spinal Deformity (ASD) Surgery Does Not Prevent PJF, However Prophylaxis Might Reduce Need for Revision Surgery

Shay Bess, MD; Breton G. Line, BSME; Virginie LaFage, PhD; Renaud Lafage, MS; Christopher P. Ames, MD; Douglas C. Burton, MD; Robert A. Hart, MD; Richard Hostin, MD; Michael F. O'Brien, MD; Gregory M. Mundis, MD; Munish C. Gupta, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; Khaled M. Kebaish, MD; Themistocles S. Protopsaltis, MD; Peter G. Passias, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; *Justin S. Smith, MD, PhD;* International Spine Study Group

Summary
Operative techniques are used to prevent PJF, however comparison of 565 ASD patients receiving surgical PJF prophylaxis (PRO) or no prophylaxis (NONE) demonstrated PJF was more common in PRO vs NONE, but revision surgery was less in PRO vs NONE. HOOK and TETHER groups had lower revision rates for PJD than CEMENT.

Hypothesis
Surgical PJF prophylaxis techniques will prevent PJF and revision surgery following ASD surgery

Design
Prospective, observational study

Introduction
PJF is a source of morbidity following ASD surgery. Different surgical techniques are used prevent PJF with variable efficacy. Purpose: evaluate the incidence of postoperative PJF and failure patterns for ASD patients receiving PJF prophylaxis vs. patients not receiving prophylaxis.

Methods
Operative ASD patients (≥5 levels fused) were identified from a multi-center ASD database. Patients evaluated for use of intraoperative PJF prophylaxis (PRO) vs. no prophylaxis (NONE). PRO was sub-divided according to prophylactic technique used (CEMENT, HOOK, TETHER). Radiographs reviewed for postoperative PJF (vertebral fracture at UIV, UIV+/-1, and/or UIV proximal soft tissue failure with associated UIV implant dislodgement) at 6 weeks, 6 months, 1, 2, and 3 years, until PJF and/or revision surgery for PJF performed. Vertebral location and etiology of PJF recorded.

Results
565/565 patients eligible for study were evaluated. PRO (n=185) and NONE (n=380) had similar age, body mass index, preop and postop coronal and sagittal spinopelvic alignment, postop change in spinal alignment, fusion terminus at upper thoracic vs thoracolumbar spine, and 3 column osteotomy ($p>0.05$). PRO had slightly more fusion levels (11.9 vs. 11.1) and pelvic fixation (84.3 vs 75.8%) vs. NONE, respectively ($p<0.05$). PJF incidence was greater for PRO (33.0 vs 24.7%), however revision surgery was less for PRO (6.6 vs 21.3%) vs NONE, respectively ($p<0.05$). Etiology of PJF was similar for PRO vs NONE, however most common locations of PJF for PRO were UIV(52.5%) and UIV-1 (36.1%), whereas NONE predominantly failed at UIV (92.5%; $p<0.05$). PJF incidence was similar for HOOK (n=101), TETHER (n=35) and CEMENT (n=49), but revision surgery was lower for HOOK (5.6%) and TETHER (0%) vs CEMENT (n=22%; $p<0.05$).

Conclusion
Prophylactic techniques might not reduce the incidence of PJF following ASD surgery but may reduce the severity of PJF and need for revision surgery. Efforts to refine the efficacy of PJF prophylactic techniques should focus upon failure prevention at UIV and UIV-1.

125. Lumbar Total Disc Replacement by the Lateral Approach – Up to 10-year Follow-Up

Luiz Henrique Pimenta, MD, PhD; Luis Marchi, PhD; Joes Nogueira-Neto, PhD; Leonardo A. Oliveira; Etevaldo Coutinho, MD; Rodrigo A. Amaral, MD

Summary
Lumbar total disc replacement (LTDR) performed by the lateral approach (LLIF) was shown to be biomechanically superior to anterior placed discs due to the maintenance of the ALL. This work shows clinical and radiological results of a long-term follow-up.

Hypothesis
The purpose of this study was to analyze radiological and clinical results with a minimum 5-year follow-up (FUP) of lateral lumbar total disc replacement (TDR) for the treatment of symptomatic degenerative disc disease.

Design
Prospective non-randomized single-center study.

Introduction
The lateral disc is placed by the lateral approach, with maintenance of ALL, a biomechanically superior construction in comparison to anterior-inserted TDRs.

Methods
Cases treated with LTDR done by a lateral transpsoas approach (LLIF) with maintenance of anterior longitudinal ligament. 60 cases enrolled (31 males; 66 levels; average age 42.8y/o). 11/60 patients (18%) were lost to FUP or had not completed at least a 5-year FUP, and 49 were enrolled (53 levels) in the analysis. Mean FUP for this work was 93 months (60-122). Endpoints included VAS and ODI questionnaires, radiographic outcomes (radiographs and CT) such as maintenance of disc motion, complications, reoperation, and heterotopic ossification (HO) grades.

Results
The mean surgical duration was 122m with mean 58mL of EBL. No intraoperative complication occurred. All but three patients stood up/ walked

at the same day. The exceptions were one case within apnea post anesthesia and two case with quadriceps motor deficit (resolved within 4mos with physiotherapy). In total, five levels(10%; 5/53) required to be fused by LLIF. One case due CrCo allergy(at 2m); four due persistent pain from different causes(at 7, 9, 24 and 88mos). 2 cases(4%; 2/49) evolved with ALD that required surgery (at 24 and 96mos). 1 case required SI fusion at 63m. No complication occurred in the retrieval surgeries. It was identified one partial disc migration at 60m with no need for retrieval. Flex/ext films from 38 levels were available at least at a 5y FUP. HO grade 0= 13%; I= 18%; II= 32%; III= 16%; IV (no motion)= 21% (8 cases). Most HO cases(85%) occurred in the lateral aspect of the disc space. Patient-reported outcomes showed significant improvement ($p<0.01$) maintained up to minimum 5y. VAS back pain: preop 8.5, postop early 2.5, and last FUP 3.0. ODI: preop 54%, postop early 31%, and last FUP 21%.

Conclusion
The benefits of this option include fast mobilization and low rate of adjacent level disease. The data show satisfactory sustained pain relief and improved physical function for patient with the disc. LTDR done by the LLIF seems an effective treatment for feasible for mild DDD.

126. Pedicle Screw Impinging the Aorta: A Diagnostic Dilemma Resolved on Prone CT Scan

Vishal Sarwahi, MD; Beverly Thornhill, MD; Adam L. Wollowick, MD; Stephen F. Wendolowski, BS; *Rachel Gecelter, MS1*; Jesse Galina, BS; Terry D. Amaral, MD

Summary
Pedicle screw (PS) aortic misplacements are asymptomatic but are a treatment dilemma. A CT scan in both supine and prone position better delineates aorta-screw relationship.

Hypothesis
Prone CT better delineates the aorta-screw relationship in patients with screw impingement on supine CT

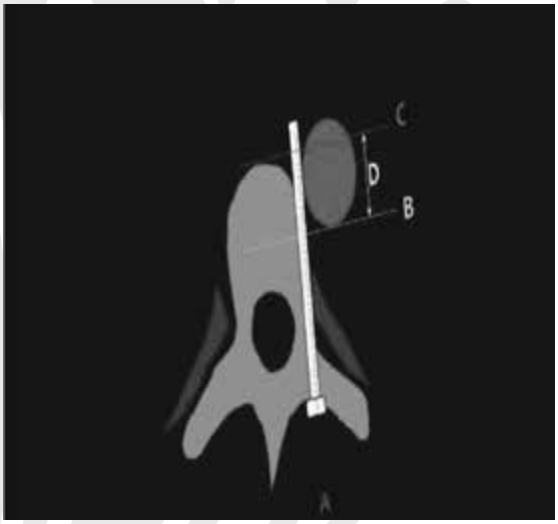
Design
Retrospective chart review

Introduction
PS misplacement rate is reported between 6-15%. Studies looking at misplacements on a per patient basis show up to 14% of patients have screws at risk (impinging vital structures). A screw abutting the aorta is a management challenge and often requires vascular surgery intervention. However, CT scans routinely done in supine position may overestimate screw-aorta relationship. This study introduces the role of CT scan in prone position as an additional diagnostic step in such a scenario. Change in patient position may allow the aorta to roll away and, in most cases, reveal an uncompromised aorta. This will allow safe removal of pedicle screws without any vascular intervention.

Methods
111 patients with post-op CT, who underwent PSF for spinal deformity, from 2004-2009, were evaluated. Patients with concerning screw-aorta relationship underwent a prone CT scan. Mobility of the aorta was determined as follows (Figure 1): Distance (D) was calculated by measuring the distance between line drawn from posterior margin of aorta (B) perpendicular to the long axis of screw (A) and a parallel line to A passing through the anterior margin of the body of vertebra (C) in mm was measured at the level, below and above the level of misplaced screw using CT scans. This was to document general mobility of the aorta. Distance (D) was compared using prone and supine CT scans. Pair t-test and signed rank tests were utilized.

Results
2295 screws were reviewed, 45 screws in 27 patients were in proximity to the aorta. 36 of these were in close proximity, but not impinging (>1cm aorta-screw distance). 14 screws (7 patients) were impinging (<1cm). On prone CT, 13 out of the 14 instances the aorta moved away from the screw (median 2.6mm). The mean distance above the level of the misplaced screw was 2.97mm ($p=0.17$), and 3.8mm ($p=0.001$) below. In one instance the relationship was unchanged on prone CT. No screw was noted to violate the lumen or distort the aorta.

Conclusion
Supine CT-scan alone is not entirely accurate in determining screw-aorta relationship. Prone-CT scan provides additional information for better delineation. This additional diagnostic step can change the treatment option by limiting the need for vascular intervention. When in doubt, the additional use of an arteriogram can allow for improved visualization.



127. Mechanical Loading of the Upper-most Instrumented Vertebra: Normative Values and Impact on Proximal Junctional Kyphosis in Adult Spinal Deformity Surgery

Tejbir Pannu; *Renaud Lafage, MS;* Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Gregory M. Mundis, MD; Richard Hostin, MD; Christopher P. Ames, MD; Lawrence G. Lenke, MD; Munish C. Gupta, MD; Han Jo Kim, MD; Shay Bess, MD; Jeffrey L. Gum, MD; Frank J. Schwab, MD; Virginie LaFage, PhD; International Spine Study Group

Summary
Proximal junctional kyphosis (PJK) remains one of the greatest unsolved issues in adult spinal deformity (ASD) surgery. This study establishes important references of magnitude and direction (flex/ext) of bending moments for each vertebral level in an asymptomatic population. ASD patients who developed radiographic PJK exhibited larger bending moments than the normative population.

Hypothesis
Patients with PJK have an increase in mechanical loading at the UIV compared to non-PJK patients and asymptomatic subjects

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

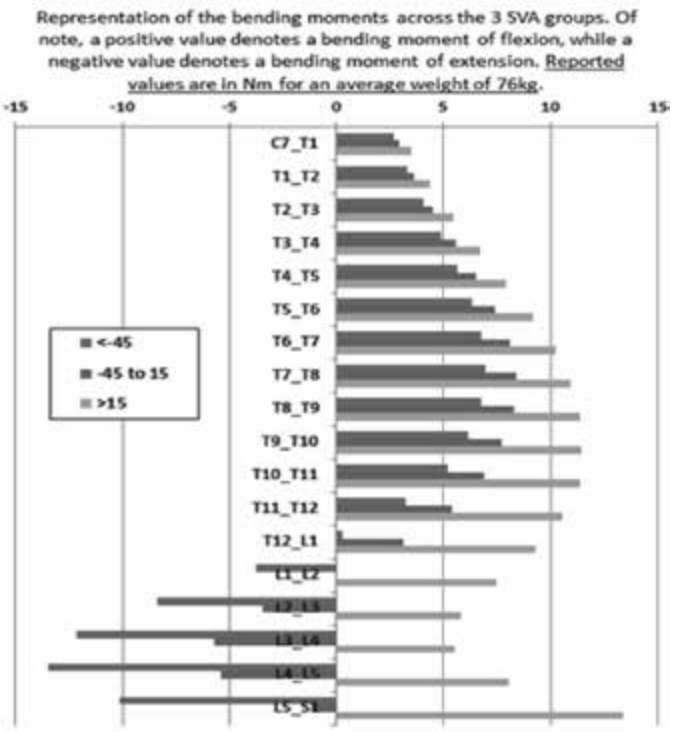
Design
Retrospective review of 2 prospective cohorts

Introduction
The abrupt transition from fused to unfused spine following instrumented fusion for ASD results in mechanical loading at the proximal junction and risk of PJK. Our objective was to establish the expected mechanical loading at different vertebral levels in a normal population and to explore the contribution of loading at the proximal junction to PJK after ASD surgery

Methods
This study included two cohorts, normative (n=116, asymptomatic volunteers) and ASD (n=289, age >18 yrs, UIV below T7, LIV=Pelvis). Based on anthropometric data the center of mass of the segments above each vertebra was calculated as well as the resulting bending moments. Patients in the ASD cohort were grouped into PJK and No-PJK based on standard definitions, and the mechanical loading at the UIV for these ASD subgroups were compared with each other and the normative cohort

Results
In the normative cohort, the thoracic spine was loaded in flexion (max at T8), and the lumbar spine was loaded in extension (max at L4). Bending moments significantly correlated with SVA (r>.4 from T4 to T10, and r>.7 from T11 to S1, Figure); for subject with SVA>15mm, the entire spine was loaded in flexion. Among the ASD cohort, 278 of 289 patients had complete data (64yo, 71% women). The pre- to post-op sagittal alignment improved: PT=25° to 21°, PI-LL=22° to 2°, SVA=79mm to 33mm (p<.05). Analysis of bending moments at the most common UIV (T10=60%) demonstrated that PJK patients had a significantly larger bending moment than non-PJK patients (13.7±3.8Nm vs. 10.6±4.6Nm, p<.001) and normative patients for the same level (13.7±3.8Nm vs 8.4±3.8Nm, p=.037)

Conclusion
This study establishes important references of magnitude and direction (flex/ext) of bending moments for each vertebral level in an asymptomatic population. Positive SVA was associated with increased flexion moments. ASD patients who developed radiographic PJK exhibited larger bending moments than the normative population. Further analysis should investigate the relationship between mechanical loading and PJK progression



128. Long-Term Clinical and Radiologic Outcomes of Lumbar Total Disc Replacements (More Than 10 Years Follow-up)

Onur Levent Ulusoy, MD; Sezgi Burcin Barlas, MD; Gokce Feride Inan, MD; Ayhan Mutlu, MD; Alim Can Baymurat, MD; Cem Sever, MD; *Sinan Kahraman, MD;* Tunay Sanli, MA; Meric Enercan, MD; Azmi Hamzaoglu, MD

Summary
In the surgical treatment of lumbar degenerative disc disease (DDD) ,total disc replacements (TDR) have low disc and facet joint degeneration (DD and FJD) at index and adjacent levels (AL) in long term .The range of motion (ROM) of the index levels are preserved even 10 years after surgery

Hypothesis
TDR preserves index segments (sgs) motion and has low adjacent DD and FJD rates after min.10 yrs

Design
Retrospective

Introduction
The purpose of this study was to evaluate the long-term of clinical and radiologic outcomes of pts whom underwent TDR for lumbar DDD

Methods
16pts (12f,4m)(29 sgs) who underwent TDR between 2003-2006, had complete radiological data and followed-up more than 10 yrs were included into this study. All pts were evaluated using preop and final f/up standing AP/LAT, dynamic x-rays, lumbar low dose CT and MRIs, analyzed by two radiologists. ROM of index and non-index sgs were measured between preop and f/up at dynamic x-rays. All FJD of index and non-index sgs at preop and f/up were classified using Pathria class. with CT. Phirmann class. was used for the assesment of adjacent DD between preop and f/up MRIs. Marginal homogenity test was used for statistical analyses. ODI and VAS scores were used for clinical improvements

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

Results
The mean age was 41.5(34-54).The mean f/up was 12.3 yrs(10-14).The mono sgs TDRs were in 6 pts and 8 pts were bi-sgs. The others were tri-sgs (1) and four-sgs (1). Dynamic x-rays revealed that mean ROM was 12° (5-15) at index sgs, while the mean ROM at non-index levels was 8°. 12 of the pts(%75) showed 1 grade increase in FJD at index levels. The other levels remained stable. In 7 pts(%43) there was AL FJD (5 cranial, 2 caudal). Comparison between preop and f/up MRIs and showed mild DD (1 grade) at AL in 6 pts(%37). We found mild acceleration (1 grade) in FJD between preop and f/up CT scans in both index and ALs (P<0.05). A mild degeneration (1 grade) was found at AL in terms of DD between preop and f/up MRIs (P<0.05).None of TDRs showed any radiologic signs of loosening, subsidence, dislocation or heterotopic ossification. ODI and VAS scores improved from pre op to final follow up (44/16.5) and(7/2)

Conclusion
The results of this study revealed that there were no changes in ROM (5°-15°) between preop and f/up dynamic x-rays at index sgs. CT scans showed that 1 grade FJD occured at index (%75) and non-index(%43) sgs. Comparison between preop and f/up MRIs showed mild AL DD in only %37 of the cases after TDRs. Despite the low number of pts, we believe that TDRs in DDD have low mechanical failure rates and the ROM of index sgs are preserved even 10 yrs after surgery

129. Return of Shoulder Function Following Posterior Spinal Fusion

Gabriela A. Villamor, BA; David L. Skaggs, MD, MMM; Paul D. Choi, MD; Vernon T. Tolo, MD; Priscella S. Chan, MS; Joshua Yang, BA; *Lindsay M. Andras, MD*

Summary
Families and patients can be reassured that although shoulder pain and limitations may be observed in the acute postoperative period, this generally resolves by 6 weeks for both AIS and non-AIS patients.

Hypothesis
Functional shoulder limitations will be seen in the acute postoperative period following PSF but will resolve by 3 months.

Design
Prospective, single center

Introduction
Shoulder pain and limitations have been observed following PSF. This is the first study to evaluate shoulder limitations after PSF with a standardized functional assessment.

Methods
Patients undergoing PSF above T6 (both AIS and non AIS) were prospectively enrolled. Data was collected at three time points: preop, 6 weeks postop (range 4-8 weeks), and/or 3 months (range 12-16 weeks) postop. At each time point, the QuickDash Questionnaire was collected and scored from 0-100, with lower scores signifying less pain and more ability. Functional assessments were conducted with the Mallet Classification Scale (scale of 0-25) and Hospital for Sick Children Active Movement Scale (scale of 0-35).

Results
37 AIS patients and 12 non-AIS patients were enrolled. For AIS patients, preoperative QuickDash scores (m=6.4) were not significantly different from postoperative scores at 6 weeks (m=11.3, p=0.17) or 3 months (m=9.5, p=0.32). There were no differences between preoperative Mallet scores (m=25) and postoperative scores at 6 weeks (m=24.9, p=0.82) or 3 months (m=24.9, p=0.10). There were no differences between Movement scores preoperatively (m=34.9) and postoperatively at 6 weeks (m=35, p=0.95) or 3 months (m=35, p=0.61). For non-AIS patients, QuickDash scores were as follows: preoperative m=17.8; 6 weeks postoperative m=31.4; and 3 months postoperative m=15.7. Although there was a trend toward higher scores at the 6 week visit, this was not significant (p=0.30). There were no differences between preoperative Mallet scores (m=24.8) and postoperative scores at 6 weeks (m=24.7, p=0.90) or 3 months (m=24.7, p=0.88). There were no differences between preoperative Movement scores (m=34.7) and postoperative scores at 6 weeks (m=34.7) or 3 months (m=35, p=0.49).

Conclusion
Standardized functional assessments find shoulder function returning to normal in most cases by 6 weeks following PSF.

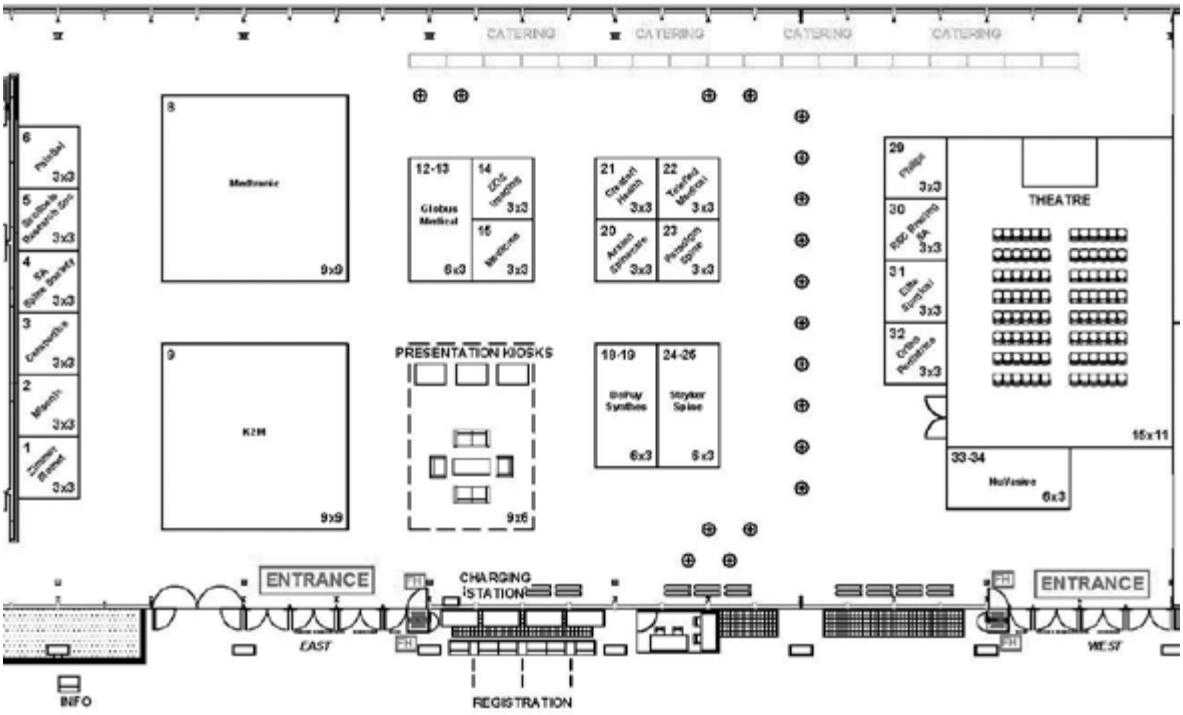
EXHIBITS & WORKSHOPS

The Scoliosis Research Society
gratefully acknowledges

NUVASIVE

for their support of the IMAST Welcome Reception, Breakfasts, Beverage Breaks, Ribbon Wall, Charging Station, Course Reception, and Newsletter.

EXHIBITS & WORKSHOPS



IMAST Exhibit Hall

The IMAST Exhibit Hall is located in the Ballroom on Level 1 of the CTICC.

Hours:
Wednesday, July 12 – 15:00-21:00
Thursday, July 13 – 8:00-17:30
Friday, July 14 – 8:00-16:45

Visit SRS at Booth #5

Don't forget to stop by the SRS booth (#5) in the Exhibit Hall for information about:

- Becoming an SRS member
- Upcoming SRS meetings
- *Spine Deformity: The Official Journal of the Scoliosis Research Society*
- SRS E-Text
- REO Fund and so much more!

IMAST Exhibitors

Company	Booth Number
Avalon Spinecare	20
Cerapedics	3
Creatori Health	21
DePuy Synthes	18
Elite Surgical	31
EOS Imaging	14
Globus Medical	12
K2M	9
Medicrea	15
Medtronic	8
Misonix	2
NuVasive	33
OrthoPediatrics	32
PainSol	6
Paradigm Spine	23
Philips	29
RSC Bracing, South Africa	30
Scoliosis Research Society	5
South African Spine Society	4
Stryker Spine	24
Telefied Medical Imaging	22
Zimmer Biomet	1

EXHIBITS & WORKSHOPS

2017 IMAST Exhibitor Descriptions

Avalon Spinecare (HK) Limited – Booth #20
Unit 608-613, IC Declopment Centre
6 Science Park West Avenue, HKSTP, Shatin
Hong Kong, China

We are a Hong Kong company dedicated to the research and development of novel strategies for assessment and treatment of patients with spinal deformities. We have assembled a strong multidisciplinary team to execute our mission to bring innovation to improve spine health.

Current information is lacking on the global prevalence of spinal deformities in subjects of different ages. Early detection may facilitate better prevention and treatment of spinal deformities. In collaboration with the University of Hong Kong and the Hong Kong Polytechnic University, we have recently developed an intelligent smartphone based measuring tool, SpineScan3D, that allows rapid scanning and profiling of the shape of an individual's back and the detection of early deformities in axial, coronal and sagittal planes. Data storage and identification allows for longitudinal follow-up and assessment of health related quality of life.

Integrating the experience from spine care specialists and engineers, our joint effort can overcome the challenges of conventional methods and ultimately facilitate spine research and development of more effective prevention and treatment strategies.

Cerapedics, Inc. – Booth #3
11025 Dover Street, Suite 1600
Westminster, CO 80021 USA
www.cerapedics.com

Cerapedics is an orthobiologics company focused on developing and commercializing novel bone grafts that enhance and accelerate bone growth in a variety of orthopaedic procedures. The company has developed a technology platform based on a synthetic small peptide, P-15, which has a novel mechanism of action designed to support safer and more predictable bone formation compared to commercially available growth factors. i-FACTOR™ Bone Graft is the company's lead product.

Creatori Health – Booth #21
4 B Oude Westhof Village Sq., Oude Wsthof
Bellville, 7530 South Africa
www.creatorihealth.com

Creatori Health is a local, South African distribution company, priding ourselves on association with strong international brands. With over thirteen years in the market, we have grown and adapted to an ever-changing medical field. With national coverage, experienced and skilled technical and administrative support, we aspire to offer exceptional service. We are excited to be representing Ulrich Medical and Vexim Spinejack at the IMAST Congress in Cape Town.

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Raynham, MA 02767 USA
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.

Elite Surgical Supplies – Booth #31
54 De Havilland Cres, Persequor
Pretoria, 0020, South Africa
www.elitesurgical.com

Originally founded in 1973 as a medical device manufacturer, and still the only local arthroplasty manufacturer in South Africa. Elite Surgical has achieved international manufacturing recognition through its contributions to Research and Development in Orthopaedics and through its compliance to the European CE, American FDA and ISO series of quality certifications. The company produces many leading-edge arthroplasty, spinal, sports medicine and specialist orthopaedic devices. Elite Surgical's commitment to experimental research resulted in such pioneering achievements as the use of cross-linked polyethylene in the 1970's, and innovative product developments under the ARD brand name in the 1980's and 1990's. Elite Surgical adheres to strict FDA and CE regulations in terms of quality assurance. Some may say this is a strong unique selling proposition, but Elite knows no boundaries when it comes to product development either. Some product ranges have spanned three decades of development and clinical trial.

EOS Imaging – Booth #14
10, Rue Mercoeur
75011 Paris, France
www.eos-imaging.com

EOS imaging is a med-tech company based in Paris, France that designs, develops and markets EOS, an innovative medical imaging system dedicated to orthopedics and osteoarticular pathologies. 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.

EXHIBITS & WORKSHOPS

Globus Medical – Booth #12
Valley Forge Business Center
2560 General Armistead Avenue
Audubon, PA 19403 USA
www.globusmedical.com

Globus Medical is a leading medical device manufacturer with the singular focus of improving the quality of life for patients with musculoskeletal disorders. Founded in 2003, Globus continues to deliver innovation every day by integrating biomechanical solutions into the continuum of care advanced through novel implant and instrument designs. Our dedication to providing exception response starts with understanding surgeon customers and the challenges they face. We actively listen to and interact with the surgeon community regarding patient pathologies, complex surgical techniques and tough clinical challenges. Backed by state-of-the-art fabrication and testing facilities, our engineers are able to quickly prototype and test products iteratively. This process enables us to focus on developing products and ideas to advance patient care. Additionally, our world-class research facility, The Musculoskeletal Education and Research Center (MERC), further supports our mission by provided educational opportunities and high-quality research to support healthcare professions around the world. Additional information can be accessed at www.globusmedical.com.

K2M – Booth #9
600 Hope Parkway, SE
Leesburg, VA 20175 USA
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.

Medicrea – Booth #15
5389 route de Strasbourg, Vancia
69140 Rillieux-la-Pape, France
www.medicrea.com

Medicrea specializes in bringing pre-operative digital planning and pre and post-operative analytical services to the world of complex spine. Through the lens of predictive medicine, Medicrea leads the design, integrated manufacture, and distribution of 30+ FDA approved implant technologies, utilized in over 100k spinal surgeries to date. Operating in a $10 billion marketplace, Medicrea is an SME with 160 employees worldwide, which includes 55 at its USA Corp. subsidiary in NYC. The Company has an ultra-modern manufacturing facility in Lyon, France housing the development and production of 3D-printed titanium patient-specific implants.

By leveraging its proprietary software analysis tools with big data and deep learning technologies supported by an expansive collection of clinical and scientific data, Medicrea is well-placed to streamline the efficiency of spinal care, reducing procedural complications and limiting time spent in the O.R.

Medtronic – Booth #8
710 Medtronic Parkway
Minneapolis, MN 55432 USA
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.

Misonix – Booth #2
1938 New Hwy
Farmingdale, NY 11735 USA
www.misonix.com

The Misonix BoneScalpel® is a novel and unique surgical device in that it offers a gentler osteotomy as compared to standard bone cutting tools. It efficiently slices crystalline bone while leaving elastic soft tissues largely unaffected during incidental contact. This can be particularly important during spinal surgery where bone segments are frequently removed in close vicinity to the spinal cord, nerve roots and major arteries. Ultrasonic cutting of bone is made possible by amplifying an electrical signal and converting it into a high back-and-forth motion of a blunt blade at the extremely high frequency of 22,500 times per second.

NUVASIVE® – Booth #33
7475 Lusk Blvd.
San Diego, CA 92121 USA
www.nuvasive.com

NuVasive is a global medical device company focused on transforming spine surgery 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 and increasingly expert software systems like its game-changing iGA™ surgical planning and reconciliation technology that centers on achieving the global alignment of the spine. NuVasive believes its integrated approach and expertise can fundamentally evolve spine care by delivering improved patient experiences, and better economics for healthcare systems. With $962 million in revenues (2016), NuVasive has an approximate 2,300 person workforce in more than 40 countries around the world. For more information, please visit www.nuvasive.com.

NuVasive Exhibitor Consultation Room: Meeting Room 1.93 (Level 1, CTICC)

OrthoPediatrics – Booth #32
2850 Frontier Drive
Warsaw, IN 46582 USA

OrthoPediatrics is the only company focused exclusively on pediatric orthopedics and committed to the cause of improving the lives of children with orthopedic conditions. In the hands of skilled surgeons, our products can relieve the pain of children who are confined to a wheelchair, while enabling others to walk for the first time.

PainSol – Booth #6
25 Clew Street, Monument Ext1
Krugersdorp, Gaunteng 1739 South Africa

PainSol, is a division of Ecomed Medical Pty Ltd, specialising in Pain Management. Our products being:
- PainSol Medical Pain Bag (Primary Conservative Treatment)
- Halyard V4 Advanced RF Generator and consumables (Secondary Primary Conservative Treatment)

PainSol are the Distributors for the Halyard V4 Advanced RF Generator for South Africa, Sub-Sahara Africa, Mauritius, Madagascar, Seychelles and Re-Union Island.

The Halyard V4 Advanced RF Generator is a world renowned, 4 lesioned RF Generator of superior quality, featured in the Gauci 2nd edition Technical Manual. In addition to the standard pulsed and thermal RF approach, the generator has a unique and patented Cooled RF capability, which is safer and offers a more effective neurolysis in the management of pain. Further, it is the only RF Generator that is capable of IDL and Disc Biaculoplasty, in a single functional unit, also the only RF Generator that self-calibrates each time the Generator initialises, ensuring good patient results. The Halyard Advanced V4 RF Generator, offers diverse applications, a range of cannula, at affordable prices. PainSol offers training to Surgeons, assists Surgeons in theatre, and has related literature.

All PainSol's RF cases are administered, professionally and ethically according to the correct protocol.

For further Information please contact PainSol Head Office:
Work: 010 590 9094
Fax: 010 590 9096
Email: admin@painsol.co.za
Cell: 082 651 1621

PARADIGM SPINE, GmbH – Booth #23
Eisenbahnstrasse 84
78573 Wurmlingen, Germany
Guntmar Eisen
www.paradigmspine.com

Paradigm Spine, LLC was founded in 2004 to be a leader in the field of non-fusion spinal implant technology. The Company has offices in New York and Germany, and sells its five core medical device products in more than 45 countries worldwide. Paradigm Spine, LLC has successfully received FDA PMA approval of the coflex® interlaminar stabilization device in the United States in October of 2012. The coflex® technology has been implanted in more than 100,000 patients, and is selling in over 45 countries. The core market for coflex® is lumbar spinal stenosis patients.coflex-F® is an interspinous stabilization device that offers an alternative to pedicle screw fixation as an adjunct to intervertebral fusion in cases of degenerative disc disease with or without mild instabilities in the lumbar spine. The DSS® Stabilization Systems provides dynamic and rigid stabilization for customized spine stabilization. It is indicated for patients with degenerative disc disease at one to three levels from L1 to S1, including conditions suchas grade 1 spondylolisthesis. The HPS™ is a pedicle screw based system for multisegmental fusion of the thoracolumbar spine that offers the option to stabilize the last to be treated segment dynamically, thus shortening the length of fusion. DCI™ is a tissue sparing, motion preserving and minimally invasive cervical implant. It provides stable, controlled motion in the cervical spine allowing the spine to be functionally dynamic.

Philips – Booth #29
54 Maxwell Drive
Woodmead, Johannesburg
PO Box 58088 Newville 2114 South Africa
www.innovationandyou.philips.com

Philips is a technology company focused on improving people's lives through meaningful innovation across the health continuum, from healthy living and prevention to diagnosis, treatment, recovery and home care. It's a unique perspective empowering us all to create a healthier future.

Creating a healthier future, together at Philips, we look beyond technology to the experiences of patients, providers and caregivers across the health continuum from healthy living to prevention, diagnosis, treatment, recovery and home care. We unlock insights leading to meaningful innovations from hospital to home. Our solutions combine clinical breadth and depth of expertise, technology and services, actionable data, consultative new business models and partnerships. Together, with our customers, we take risks and share responsibility – so that we can transform how care is delivered and experienced. It's a unique perspective empowering us all to create a healthier future.

EXHIBITS & WORKSHOPS

RSC Bracing, South Africa – Booth #30
12 Molteno Road, Oranjezicht
Cape Town, Western Campe 8001 South Africa
www.orthopro.co.za

The RSC (Rigo System Cheneau) Brace is a three dimensional bracing system used for the conservative management of Idiopathic Scoliosis. The brace is used in combination with Physiotherapy Scoliosis Specific Exercises.

The RSC Brace follows the original bracing principals of Dr Jacques Cheneau. Cheneau braces were initially modelled on the Scoliosis classifications of King, and later Lenke. After 15 years of research Dr Manuel Rigo, Scoliosis expert, found that the King and Lenke classifications while useful for surgical correction of Scoliosis, were not adequate for brace design, not all curve patterns being addressed. Rigo Classification was then developed, addressing 15 curve profiles relating curve pattern to brace design (Rigo, 2005). This lead to better results in treatment (Weiss, 2003; Weiss et al, 2006; Rivett et al, 2014). RSC brace has altered the natural history of scoliosis (curves 20-50°), preventing progression. Curves have improved in compliant patients, with good in-brace corrections.

The brace provides detortional forces in three planes of the body: derotation, deflection and sagittal normalisation (Rigo and Weiss, 2008; Rigo et al, 2010). Large expansion spaces in the brace allow active correction, by breathing into the spaces pushing out sunken areas of trunk and spine. Specialist Physiotherapy is included to promote the same principals. This method complies with the SOSORT and SRS Guidelines for conservative management of Infantile, Juvenile and Adolescent Scoliosis.

The RSC Brace and Scoliosis Specific Physiotherapy were introduced in South Africa in 2004, successfully bracing over 1500 patients. RSC S.A. is a group of C.P.O's, specialist Scoliosis Physiotherapists and Schroth therapists in private practice, specialising in conservative management of spinal deformity.

Scoliosis Research Society – Booth #5
555 E. Wells Street, Suite 1100
Milwaukee, WI 53202 USA
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 1,000 of the world's leading spine surgeons, researchers, physician assistants and orthotists who are involved in research and treatment of spinal deformities.

South African Spine Society – Booth #4

www.saspine.org

Make sure to visit the South African Spine Society (SASS) booth in the Exhibition Hall. Here you can receive information on:
- Becoming a member of SASS
- The benefits of being a member of SASS
- Upcoming SASS 2018 meeting

Stryker Spine – Booth #24
2 Pearl Court
Allendale, NJ 07401 USA
+1-201-749-8000
www.stryker.com

Stryker is one of the world's leading medical technology companies and, together with our customers, we are driven to make healthcare better. The Company offers a diverse array of innovative products and services in Orthopaedics, Medical and Surgical, and Neurotechnology and Spine that help improve patient and hospital outcomes. Stryker is active in over 100 countries around the world.

Telefied Medical Imaging Limited – Booth #22
Flat D, 2/F., Valiant Industrial Centre
2-12 Au Pui Wan Street
Fo Tan, N.T., Hong Kong
www.telefield-imaging.com/hk

Telefield Medical Imaging Limited, a subsidiary of Telefield Holdings Limited, was established in Hong Kong since 2012. We are an innovative company focusing on medical imaging equipment research, development and manufacture.

Scolioscan, a high-quality and unique professional medical imaging equipment, is used for Scoliosis screening. Unlike traditional X-Ray equipment, Scolioscan features an advanced 3D imaging technology which is absolutely radiation-free. It can provide a reliable screening process, close monitoring as well as an unlimited frequency of assessment to evaluate curve progression on a highly safe and accurate basis.

Scolioscan is to be installed and used in hospitals, clinics, laboratories and research institutions. It has been clinically tested since 2013. Collectively, over 2,000 adolescent idiopathic scoliosis patients have been assessed using Scolioscan.

Our Scolioscan equipment has obtained CE Approval in 2016, plus awards from different organizations over the past years. Besides, the company has owned patents, including inventions, in multiple countries.

The equipment is now being manufactured in Hong Kong. Other than the assembly plant in HK, our Holdings have an ISO certified factory in Guangzhou, China, for manufacturing other electronic and lifestyle wellness products.

Zimmer Biomet – Booth #1
310 Interlocken Parkway, #120
Broomfield, CO 80202 USA
www.zimmerbiomet.com

Zimmer Biomet was created to redefine musculoskeletal healthcare, and to help improve the lives of those we serve. Our singular goal is to help achieve exceptional outcomes for patients, healthcare professionals, investors, our Team Members, and the communities in which we work. Zimmer Biomet is uniquely positioned to accelerate the pace of innovation and to drive growth. This simple but powerful philosophy is summarized by our tagline, "Your progress. Our promise." It reminds us that, together, we can achieve more when we work together in pursuit of our shared goals.

EXHIBITS & WORKSHOPS

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.

Schedule

	Wednesday July 12	Thursday July 13	Friday July 14
Morning		**7:45-8:45**	**7:45-8:45**
		Misonix – Room 1.41	Medtronic – Room 1.41
			DePuy Synthes – Room 1.43
Lunch		**12:30-13:30**	**12:00-13:00**
		K2M – Room 1.41	K2M – Room 1.41
		NuVasive – Room 1.43	NuVasive – Room 1.43
		Medtronic – Room 1.61	Zimmer Biomet – Room 1.61
		Globus Medical – Room 1.63	
Afternoon	**17:00-19:00**	**17:15-18:15**	
	K2M – Room 1.41	K2M – Room 1.41	
	NuVasive – Room 1.43	DePuy Synthes – Room 1.43	
	Zimmer Biomet – Room 1.61	Zimmer Biomet – Room 1.61	
		Telefield Medical – Room 1.63	

HOW Descriptions

WEDNESDAY, JULY 12 – 17:00-19:00

K2M

Room 1.41

Peds to Adults: Techniques to Optimize Spinal Balance
FACULTY: Christopher Ames, MD; Benny Dahl, MD, PhD, DMSci; Hans Snyckers, MD

Spinal balance is a critical component of correction in both pediatric and adult deformity patients. This workshop will review spinal parameters and tools and techniques to optimize spinal balance in all three planes. Time will be allotted for case presentations, discussion, question and answer, and hands-on.

NuVasive

Room 1.43

XLIF: Designed. Proven. Transforming.
FACULTY: Juan S. Uribe, MD and Ian Zondagh, MD

Zimmer Biomet

Room 1.61

Surgeon Preservation – The Use of Power in the OR & Current Concepts for Sacroiliac Fixation
Course Structure: Didactic and Hands On
FACULTY: David L. Skaggs, MD and Lindsay M. Andras, MD

THURSDAY, JULY 13 – 7:45-8:45

Misonix

Room 1.41

Ultrasonic BoneScalpel Techniques for Treating the Complex Spine
FACULTY: Suken Shah, MD and Johannes Du Preez, MD

The Ultrasonic BoneScalpel Techniques for Treating the Complex Spine workshop is a hands-on 60 minute demonstration detailing how to use this ultrasonic instrument in a variety of complex spine procedures. The workshop presentations will feature surgical techniques, clinical experiences and case reviews for using the BoneScalpel to cut and remove bone. Surgeons will review the clinical benefits of targeted viable autograft bone removal, reduced blood loss and protection of soft tissue including neural structures. Attendees will have the opportunity for an open-discussion with the faculty and a hands-on demonstration and trial.

EXHIBITS & WORKSHOPS

THURSDAY, JULY 13 – 12:30-13:30

K2M

Room 1.41

Identification & Treatment of Hidden Degenerative Deformity
FACULTY: Justin Smith, MD, PhD and Robert Lee, BSc, MBBS, FRCS

Degenerative cases often conceal a hidden deformity component. During this workshop, our faculty will discuss how to identify this pattern during the pre-operative planning phase, and provide tools and techniques to help restore and maintain total body balance.

NuVasive

Room 1.43

MAGEC Masters Roundtable: Surpassing Surgical and Post-operative Challenges
FACULTY: Ettienne Coetzee, MD; David Marks, MD; Suken Shah, MD; Muharrem Yazici, MD

Medtronic

Room 1.61

Spinal Navigation and Robotics; Enhancing your Surgical outcomes through Advanced Procedural Solutions
FACULTY: Dean Chou, MD and Ronald A. Lehman, Jr., MD

Globus Medical

Room 1.63

REFLECT™, A Nonfusion Technique and Treatment for Adolescent Idiopathic Scoliosis
FACULTY: Amer Samdani, MD

THURSDAY, JULY 13 – 17:15-18:15

K2M

Room 1.41

Fusion through Design: A Look at Lamellar 3D Technology
FACULTY: Robert Lee, BSc, MBBS, FRCS

During this workshop we will explore the science behind lamellar 3D technology, imaging properties, and implant selection through a series of case presentations and interactive discussions.

DePuy Synthes

Room 1.43

Correction Techniques in Adult Deformity – Open & MIS Perspective
FACULTY: Munish C. Gupta, MD and Daniel M. Sciubba, MD

Zimmer Biomet

Room 1.61

Avoidance and Management PJK and DJK in Adult Deformity Surgery
Course Structure: Didactic
FACULTY: Frank J. Schwab, MD and Justin S. Smith, MD, PhD

Telefield Medical

Room 1.63

Ultrasound Imaging of Patients with Idiopathic Scoliosis
FACULTY: René Castelein, MD, PhD and Yongping Zheng, PhD

We will share experiences on using a novel radiation-free 3D ultrasound imaging system, Scolioscan, for scoliosis assessment in Utrecht and Hong Kong. Collectively, over 2000 adolescent idiopathic scoliosis patients have been assessed using Scolioscan. It has potentials for scoliosis mass screening, frequent monitoring of curve progression and treatment outcome, and improving brace design and fitting.

Scolioscan has been installed at the University Medical Centre Utrecht, The Netherlands, since September 2016, and over 50 scoliosis patients have been scanned. The reliability and validity were analyzed in 2D and 3D. Very good intra- and inter-operator reproducibility has been shown together with a very good correlation between X-ray Cobb angle and several coronal ultrasound measurements, obtained using both manual and automatic methods. The possibilities of ultrasound to provide information on the sagittal and transverse plane, to obtain bending films and the ability to measure progression of the scoliotic curves are subjects of our ongoing studies. With its 3D analysis software, 3D spine models can be formed to measure rotation and deformity in coronal and sagittal planes. It will be demonstrated during the workshop.

FRIDAY, JULY 14 – 7:45-8:45

Medtronic

Room 1.41

Sacropelvic Fixation; Creating Foundation for Sagittal Alignment
FACULTY: Lawrence G. Lenke, MD and Christopher I. Shaffrey, MD

DePuy Synthes

Room 1.43

Advanced Techniques in AIS
FACULTY: Suken A. Shah, MD; Stefan Parent, MD, PhD; Heiko Koller, MD

FRIDAY, JULY 14 – 12:00-13:00

K2M

Room 1.41

Principles of Dual Differential Correction for Treatment of AIS
FACULTY: Laurel Blakemore, MD and Martin Gehrchen, MD, PhD

This workshop will focus on the Dual Differential Correction Technique: differential rod bending, differential material, dual rod placement for curve correction and the restoration of kyphosis in AIS patients. We will include the latest clinical studies along with case examples.

NuVasive

Room 1.43

iGA: A Comprehensive Approach to Planning and Achieving Integrated Global Alignment
FACULTY: Christopher I. Shaffrey, MD and Juan S. Uribe, MD

Zimmer Biomet

Room 1.61

Decision Making for the Long Term in the Pediatric Patient
Course Structure: Didactic
FACULTY: Amer F. Samdani, MD

NOTES

AUTHOR INDEX

The Scoliosis Research Society
gratefully acknowledges

ZIMMER BIOMET

for their support of the IMAST Lunch with
Experts Session.

AUTHOR INDEX

Key:
1-129 = Paper Presentation
RT = Roundtable Session
ICL = Instructional Course Lecture
DB = Debate Series
CP = Case Presentation
CS = Complication Series
LE = Lunch with Experts
S = Special Symposia (A or B)
VS = Video Based Session

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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 Scoliosis Research Society is to foster the optimal care of all patients with spinal deformities.

MEMBERSHIP

SRS is open to orthopaedic surgeons, neurosurgeons, researchers and allied health professionals who have a practice that focuses on spinal deformity.

Active Fellowship (membership) requires the applicant to have fulfilled a five-year Candidate Fellowship and have a practice that is 20% or more in spinal deformity. Only Active Fellows may vote and hold elected offices within the Society.

Candidate Fellowship (membership) is open to all orthopaedic surgeons, neurosurgeons and to researchers in all geographic locations who are willing to commit to a clinical practice which includes at least 20% spinal deformity. Candidate Fellows stay in that category for five years, during which time they must meet all of the requirements and demonstrate their interest in spinal deformity and in the goals of the Society. 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. Candidate Fellows may serve on SRS committees.

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.

See website for membership requirement details: http://www.srs.org/professionals/membership

SRS MEMBERSHIP INFORMATION SESSION

Join us and learn more about the Scoliosis Research Society

How to Apply
Benefits of Membership
Leadership Opportunities
Scholarships
Networking
Education

July 14, 17:00-17:30 - Meeting Room 2.4 (CTICC Level 2)

PROGRAMS AND ACTIVITIES

SRS is focused primarily on education and research and include the Annual Meeting, the International Meeting on Advanced Spine Techniques (IMAST), Hands-On Courses, 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 and printable membership applications, please visit the SRS website at www.srs.org.

Board of Directors, Councils, Committees & Taskforces

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ABOUT SRS

Committee & Taskforce (TF) Chairs

Adult Deformity	Ram Mudiyam, MD, MBA
Awards and Scholarship	Jeffrey S. Kanel, MD
Bylaws and Policies	Evalina L. Burger, MD
CME	David H. Clements, III, MD
Coding	Matthew D. Hepler, MD
Communications	John P. Lubicky, MD
Corporate Relations	David W. Polly, Jr., MD
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Directed Research TF	Steven D. Glassman, MD
Development	Serena S. Hu, MD
Education	Praveen M. Mummaneni, MD
E-Text	Amer F. Samdani, MD
Ethics & Professionalism	Kamal N. Ibrahim, MD, FRCS(C), MA
Fellowship	Hee-Kit Wong, MD
Finance	J. Abbott Byrd, III, MD
Global Outreach	Ferran Pellisé Urquiza, MD, PhD
Growing Spine	Scott J. Luhmann, MD
Health Policy	D. Raymond Knapp, MD
Historical	George H. Thompson, MD
IMAST	Ronald A. Lehman, Jr., MD
Long Range Planning	David W. Polly, Jr., MD
Morbidity & Mortality	Darrell S. Hanson, MD
Nominating	David W. Polly, Jr., MD
Non-Operative Management	Richard Hostin, MD
Patient Education	Kevin M. Neal, MD
Pediatric Device TF	Michael G. Vitale, MD
Performance Measures TF	Robert A. Hart, MD
Program	Muharrem Yazici, MD
Research Grant	Patrick J. Cahill, MD
Safety & Value	Rajiv K. Sethi, MD
Translation	Andre Luis F. Andujar, MD
Website	Todd Milbrandt, MD, MS
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Author Index

52ND ANNUAL MEETING & COURSE 2017

SEPTEMBER 6-9

PHILADELPHIA PA USA

Scoliosis Research Society presents

IMAST 2018

25th International Meeting
on Advanced Spine Techniques

July 11–14, 2018

LOS ANGELES
CALIFORNIA, USA

www.srs.org

Abstract submission open - November 1, 2017

Abstract deadline - February 1, 2018

MEETING OVERVIEW

Wednesday, July 12, 2017		
8:00 - 14:00	Board of Directors Meeting; Exhibit Set-Up	
14:00 - 21:00	Delegate Registration Open	Ballroom Gallery
15:00 - 16:45	Special Symposia 1A-B	Auditorium I & Auditorium II
17:00 - 19:00	*Hands-On Workshops	Meeting Rooms 1.41, 1.43, 1.61
19:00 - 21:00	Welcome Reception	Exhibit Hall – Ballroom
Thursday, July 13, 2017		
7:45 - 17:00	Registration Open	Ballroom Gallery
7:45 - 8:45	*Hands-On Workshops with Breakfast	Meeting Room 1.41
8:00 - 8:45	Breakfast & Exhibit Viewing	Exhibit Hall – Ballroom
9:00 - 10:35	General Session	Auditorium I
10:35 - 11:05	Refreshment Break & Exhibit Viewing	Exhibit Hall – Ballroom
11:05 - 12:30	Concurrent Sessions 2A-C: Abstract Sessions	Auditorium I, Auditorium II, Meeting Room 2.4
12:30 - 13:30	Lunch & Exhibit Viewing; *Hands-On Workshops	Exhibit Hall – Ballroom; Meeting Rooms 1.41, 1.43, 1.61, 1.63
13:45 - 14:45	Concurrent Session 3A-C: ICLs	Auditorium I, Auditorium II, Meeting Room 2.4
14:45 - 15:00	Walking Break & Exhibit Viewing	Exhibit Hall – Ballroom
15:00 - 15:40	Concurrent Sessions 4A-C: Roundtable Sessions	Auditorium I, Auditorium II, Meeting Room 2.4
15:40 - 16:10	Refreshment Break & Exhibit Viewing	Exhibit Hall – Ballroom
16:10 - 17:10	Concurrent Sessions 5A-C: Debates & Worst Complications Sessions	Auditorium I, Auditorium II, Meeting Room 2.4
17:10 - 17:15	Passing Break	
17:15 - 18:15	*Hands-On Workshops with Beverages & Snacks	Meeting Rooms 1.41, 1.43, 1.61, 1.63
Friday, July 14, 2017		
7:45 - 16:00	Registration Open	Ballroom Gallery
7:45 - 8:45	*Hands-On Workshops with Breakfast	Meeting Rooms 1.41, 1.43
8:00 - 8:45	Breakfast & Exhibit Viewing	Exhibit Hall – Ballroom
9:00 - 10:00	Concurrent Sessions 6A-C: Abstract Sessions	Auditorium I, Auditorium II, Meeting Room 2.4
10:00 - 10:30	Refreshment Break & Exhibit Viewing	Exhibit Hall- Ballroom
10:30 - 12:00	Concurrent Sessions 7A-C: Abstract Sessions	Auditorium I, Auditorium II, Meeting Room 2.4
12:00 - 13:00	Lunch & Exhibit Viewing; *Hands-On Workshops	Exhibit Hall – Ballroom; Meeting Rooms 1.41, 1.43, 1.61
13:10 - 14:10	Concurrent Sessions 8A-C: Case Presentations	Auditorium I, Auditorium II, Meeting Room 2.4
14:10 - 14:30	Walking Break & Exhibit Viewing	Exhibit Hall – Ballroom
14:30 - 15:30	Concurrent Sessions 9A-C: Abstract Session & ICLs	Auditorium I, Auditorium II, Meeting Room 2.4
15:30 - 15:45	Walking Break	
15:45 - 16:45	Concurrent Sessions 10A-C: ICLs	Auditorium I, Auditorium II, Meeting Room 2.4
19:00 - 22:00	Course Reception	Clivia & Jasminum Conservatory - CITCC
Saturday, July 15, 2017		
8:30 – 12:00	Registration Open	Ballroom Gallery
8:30 – 9:00	Breakfast; Exhibits Closed	Ballroom
9:00 - 10:00	Concurrent Sessions 11A-C: ICLs	Auditorium I, Auditorium II, Meeting Room 2.4
10:00 - 10:15	Walking Break	
10:15 - 11:15	Session 12: ICL	Auditorium I
11:15 - 11:45	Walking Break & Lunch Buffet	Ballroom
11:45 - 13:00	Session 13: Lunch with the Experts	Auditorium I
13:00	Adjourn	

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