Powered by the Scoliosis Research Society

Final Program

30th International Meeting on Advanced Spine Techniques

March 22-24, 2023 - Dublin, Ireland

www.srs.org/imast2023

SRS
Scoliosis Research Society

CORPORATE PARTNERS

We are pleased to acknowledge and thank those companies that provided financial support to SRS in 2022. 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 (REO) Fund.

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30TH IMAST VENUE

The Convention Centre Dublin
Spencer Dock, N Wall Quay, North Dock
Dublin 1, D01 T1W6, Ireland

FUTURE EDUCATIONAL EVENTS

ANNUAL MEETING

58th Annual Meeting
September 6-9, 2023 | Seattle, WA, USA

59th Annual Meeting
September 11-14, 2024 | Barcelona, Spain

60th Annual Meeting
September 17-20, 2025 | Charlotte, NC, USA

61st Annual Meeting
October 7-10, 2026 | Sydney, Australia

INTERNATIONAL MEETING ON ADVANCED SPINE TECHNIQUES

31st IMAST
April 10-13, 2024 | San Diego, CA, USA

Scoliosis Research Society

SRS Executive Office 555 East Wells Street, Suite 1100 Milwaukee, WI 53202
P: 414.289.9107 F: 414.276.3349 info@srs.org www.srs.org

WELCOME

Dear Delegates and Attendees,

I would like to personally welcome you to the 30th International Meeting for Advanced Spine Techniques (IMAST), powered by the Scoliosis Research Society (SRS), in support of our continued advancements in spine surgery innovation.

Le chéile is the Irish word for "together" and sets the tone for how this IMAST will celebrate the 30th anniversary of this innovative, advanced meeting program.

This year we had more than 900 submitted abstracts and had the challenging task to narrow it to 63 Podium Presentations and 115 E-Point Presentations.

We are pleased to bring back the popular "Cases & Cocktails" sessions to kick off the meeting on Wednesday, March 22. These sessions are a great opportunity to discuss important cases in small groups with an IMAST faculty member present at each table. Topics will cover Vertebral Body Tethering, Adult Deformity and Cervical & Neurosurgery. Come hear expert opinions on tough and challenging cases in a relaxed setting.

The prestigious Whitecloud award-nominated scientific session – where the top 15 abstracts for best clinical and basic science/translational research – will be presented at the first session on Thursday, March 23. These are the best-of-the-best papers as selected by our scientific abstract reviewers.

On Friday evening, we invite you to join us for the Innovation Celebration. The event will take place at EPIC The Irish Emigration Museum and will offer all attendees an opportunity to connect with peers, reflect on the meeting, celebrate innovation, and explore the museum.

The reception will celebrate the conclusion of sessions and lead attendees into Innovation Day on Saturday hosted by SRS industry partners.

As always, we offer a special thank you to our industry partners for their continued support. Plan your schedule accordingly so that you can see all of the latest innovations in the exhibit hall and during the Hands-on Workshops. More information on these can be found beginning on page 171.

On behalf of the planning committee, it was our pleasure to put this program together to celebrate the 30th anniversary of IMAST. We hope you will find it both informative and enjoyable.

Welcome to Dublin!

Stefan Parent, MD, PhD
IMAST Committee Chair

IMAST MOBILE APP

A mobile app is available to all delegates during the 30th IMAST. The app is designed to enhance the attendee experience by providing all the information about IMAST in one convenient location that can be accessed from any smart phone or tablet with an internet connection.

TO DOWNLOAD THE 30TH IMAST MOBILE APP:

1. Search for IMAST23 in the App Store or Google Play Store and install
2. Open the downloaded app to begin using the app right away
3. To take full advantage of the app, login with your email address

Once downloaded, delegates can access all static content on the app without an internet connection, including:

- A detailed IMAST agenda, which allows delegates to create a personalized schedule (must login with an email address).
- Exhibitor information including exhibit floor plan, company descriptions and the Hands-On Workshop schedule.
- Maps of meeting space
- An alert system for real-time updates from SRS and breaking news as it happens.
- Session and overall meeting evaluations
- Abstracts
- Participate in gamification! This is a unique way to interact with your peers and engage with the presenters by collecting codes to earn points. Delegates with the most points will collect prizes.

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

ASK A QUESTION IN THE APP

Delegates can ask questions, directly through the mobile app, during the all IMAST sessions

To ask a question:

1. Click on "Agenda" and select the session you are in with the "Ask a Question" feature enabled.
2. Scroll to the bottom of the session information and click "Ask a Question" under Session Engagement. Questions already asked by attendees will be listed.
3. Click "Ask a Question" again and a text box will appear.
4. Type your question in the text box and click "Submit Question." Your question will appear within the question list.
5. If someone has asked a question you would also like answered, you can "up vote" the question by clicking the circular up arrow button to the right of the question in the list. When questions get up voted they will be pushed higher up on the page as the number of votes rise.

PARTICIPATE IN LIVE SESSION POLLS

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

Stay Up to Date With SRS During IMAST and Share Your Experiences. #SRSIMAST23

@srs_org @ScoliosisResearchSociety @srs_org @Scoliosis Research Society

GENERAL MEETING INFORMATION

GENERAL MEETING OVERVIEW

MEETING DESCRIPTION

The 30th IMAST will offer an in-person meeting experience where leading spine surgeons, innovative researchers, and the most advanced spine technologies come together in an international forum to demonstrate and discuss recent advances in spine surgery. IMAST focuses on innovative and new methods/techniques for spinal pathology. Educational content includes instructional course lectures, four-minute paper presentations, case discussions, E-Point Presentations and industry workshops all lead by a multidisciplinary and international faculty.

LEARNING OBJECTIVES

Upon completion of the IMAST, participants should be able to:

- Analyze current research on new and emerging spine deformity treatments for children and adults
- Identify appropriate candidates for endoscopic vs. minimal incision vs. open surgery
- Evaluate enabling technologies for integration into practice
- Utilize alignment goals for planning of treatment of cervical pathology

TARGET AUDIENCE

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

GENERAL MEETING INFORMATION

ADMISSION TO SESSIONS

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

CASES & COCKTAILS SESSIONS

On Wednesday, March 22 from 16:00 - 18:00, cases will be presented by faculty in three concurrent sessions. Each case presentation will be followed by attendees having the opportunity to discuss cases in small groups with an IMAST faculty member present at each table. Each table will debate the various treatment options and determine their action plan. Libations will be served during this time so that all may enjoy a relaxed atmosphere while discussing cases. All registered delegates are welcome and encouraged to attend and participate. See page 171 for more information.

Cases & Cocktails Session Topics:

- Vertebral Body Tethering
- Adult Deformity
- Challenges in Cervical and Cervical Thoracic Deformity

All delegates are encouraged to join us for the Welcome Reception immediately following the Cases & Cocktails Sessions on Wednesday, March 22 from 18:00 - 20:00.

CELL PHONE PROTOCOL

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

CME INFORMATION

ACCME 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 designates this live activity, 30th IMAST, for a maximum of 13.75 *AMA PRA Category 1 Credits*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

CME Certificates

CME certificates will be available to pre-registered

GENERAL MEETING INFORMATION

delegates upon the opening of the meeting at www.srs.org/imast2023/cme. Delegates who registered onsite may access their certificates after May 1, 2023, they will not be available prior to that date.

Delegates should log on to the website listed above and enter their last name and the ID# listed on their meeting badge. The system will 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 December 31, 2023.

Evaluations
Evaluations are available to all attendees at the commencement of the meeting. Evaluations are available in the IMAST23 mobile app.

DISCLOSURE OF CONFLICT OF INTEREST

It is the policy of SRS to insure balance, independence, objectivity, and scientific rigor in all 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 mitigated 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.

EMERGENCY & FIRST AID

The Convention Centre Dublin is fully prepared to handle emergency requests and first aid. Contact a SRS Staff person for support. Remember to note all emergency exits within the venue.

E-POINT PRENSENTATION KIOSK

There are over 100+ E-Point Presentations available to view on the E-Point Presentation kiosk located in the Exhibit Hall (Booth #11).

EXHIBITS & HANDS-ON WORKSHOPS (HOWS)

IMAST delegates are encouraged to visit the exhibits throughout the meeting during exhibit viewing times and between sessions to learn more about current technological advances. The IMAST Exhibitors are located in The Forum, Ground Level. See page 167 for the full listing of exhibitors.

IMAST delegates are encouraged to attend the Hands-On Workshops (HOW) on Thursday, March 23 and Friday, March 24. Thursday morning and lunch sessions as well as Friday lunch and afternoon sessions will be offered.

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. See page 171 for the schedule of Hands-On Workshop sessions.

FDA STATEMENT (UNITED STATES)

Some drugs and medical devices demonstrated during this virtual meeting 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 DISCLAIMERS

The materials presented during this meeting 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.

INTERNET ACCESS

Wireless Internet access is available throughout the meeting space of the Convention Centre Dublin (CCD).

To logon select...
Network: SRS Meeting
Password: IMAST2023

LANGUAGE

Presentations and course materials will be provided in English.

LOST & FOUND

Please feel free to stop by the Registration Desk if you

GENERAL MEETING INFORMATION

have lost or found an item during the course of IMAST.

NO SMOKING POLICY

Smoking is not permitted during any IMAST activity or event.

PRINTING STATION

Delegates are welcome to use the complimentary printing station, located in the Exhibit Hall (Booth #11), to print their certificate of attendance and CME certificate (pre-registered delegates only; onsite registrants will have access to their certificates beginning May 1, 2023).

REGISTRATION DESK

Location: The Forum Lobby
Hours:

Wednesday, March 22	15:00 - 18:00
Thursday, March 23	07:00 - 18:00
Friday, March 24	08:00 - 17:00

SPEAKER READY ROOM

Location: Liffey Meeting Room 2, Level 1
Presenters may upload their PowerPoint presentations onsite in the Speaker Ready Room. Please upload presentations no later than 24 hours before the session is scheduled to begin.
Hours:

Wednesday, March 22	15:00 - 18:00
Thursday, March 23	07:00 - 18:00
Friday, March 24	08:00 - 16:30

SRS COMMUNICATIONS HUB

Location: Exhibit Hall, Booth #15

Join the SRS Communications Team at their booth. Here you will find information about the IMAST app, SRS social media, Scoliosis Dialogues: An SRS Podcast, and more. It makes the perfect spot to get a selfie.

SRS MEMBERSHIP BOOTH

Location: Exhibit Hall, Booth #14
Involvement in the 30th IMAST counts towards SRS membership meeting requirements. Stop by the SRS Membership Booth for information about becoming an SRS member, upcoming meetings, and more.

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.

WELCOME RECEPTION

All registered delegates are invited to pick up their registration materials and to attend the IMAST Welcome Reception on Wednesday, March 22 from 18:00 - 20:00. The reception will be hosted in the Exhibit Hall (The Forum) at the Convention Centre Dublin, where beverages and light hors d' oeuvres will be served. There is no charge for registered delegates. Guest tickets are available for purchase ($100 USD) at the registration desk. Dress for the Welcome Reception is business casual.
The Welcome Reception is supported, in part, by Globus Medical and NuVasive.

EVALUATIONS

WE NEED YOUR FEEDBACK!

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

If you have questions,

contact SRS at cme@srs.org

On the app: *Session Evaluations:*

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

Overall Meeting Evaluation:

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

Online: www.srs.org/imast2023/cme

MEETING OVERVIEW

Times are subject to change.

	Wednesday, March 22	Thursday, March 23	Friday, March 24
Morning		07:00 – 18:00 Registration Open 08:00 – 09:00 Hands-On Workshops* *with breakfast* 09:00 – 09:30 Exhibit Viewing & Refreshment Break* 09:30-12:00 Session 1: Whitecloud Nominees & Keynote Address 12:00 - 12:15 Exhibit Viewing & Lunch Pick-Up*	08:00 – 17:00 Registration Open 07:30 – 08:30 Hands-On Workshops* *with breakfast* 08:30 – 09:00 Exhibit Viewing & Refreshment Break* 09:00 – 11:00 Concurrent Sessions 5A & 5B 11:00 – 11:30 Exhibit Viewing & Refreshment Break* 11:30 – 12:30 Hands-On Workshops* *Lunch served in HOW rooms*
Afternoon	15:00 – 18:00 Registration Open	12:15 - 13:15 Hands-On Workshops* *Lunch served in HOW rooms* 13:15 - 13:45 Exhibit Viewing* 13:45 – 15:15 Concurrent Sessions 2A & 2B 15:15 – 15:45 Exhibit Viewing & Refreshment Break* 15:45 – 16:55 Concurrent Sessions 3A & 3B 16:55 – 17:15 Exhibit Viewing* 17:15 – 18:45 Session 4	12:30 – 12:45 Exhibit Viewing* 12:45 – 14:15 Concurrent Sessions 6A & 6B 14:15 – 14:30 Exhibit Viewing* 14:30 – 15:30 Hands-On Workshops* *with snacks & coffee* 15:30 – 16:00 Exhibit Viewing & Refreshment Break* 16:00 – 17:30 Session 7
Evening	16:00 – 18:00 Cases & Cocktails Discussion Sessions 18:00 – 20:00 Exhibit Viewing & Welcome Reception*		18:30 – 19:30 Faculty Reception* *(invitation only)* 19:00 – 21:00 Innovation Celebration*

**Denotes non-CME session*

Saturday, March 25, 2023
Innovation Day*

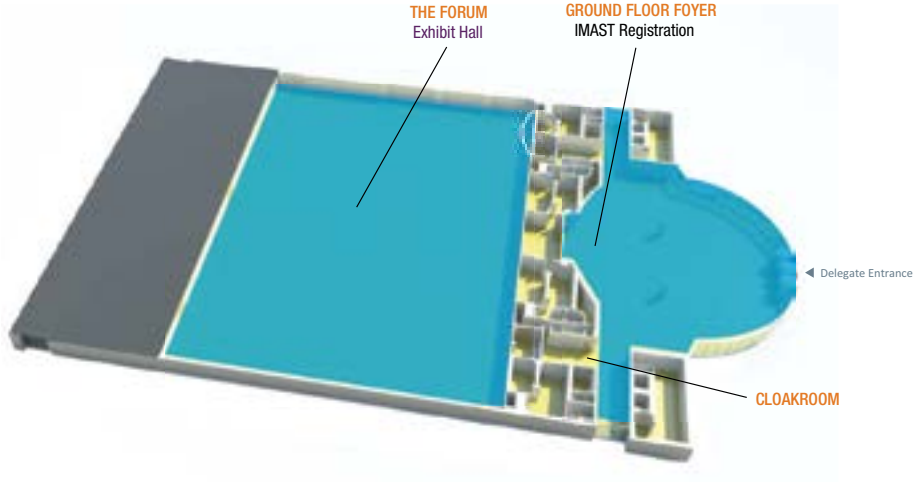
Hosted by SRS Industry Partners. Please refer to the IMAST website for additional information.

MEETING SPACE FLOOR PLAN

THE CONVENTION CENTRE DUBLIN (CCD)

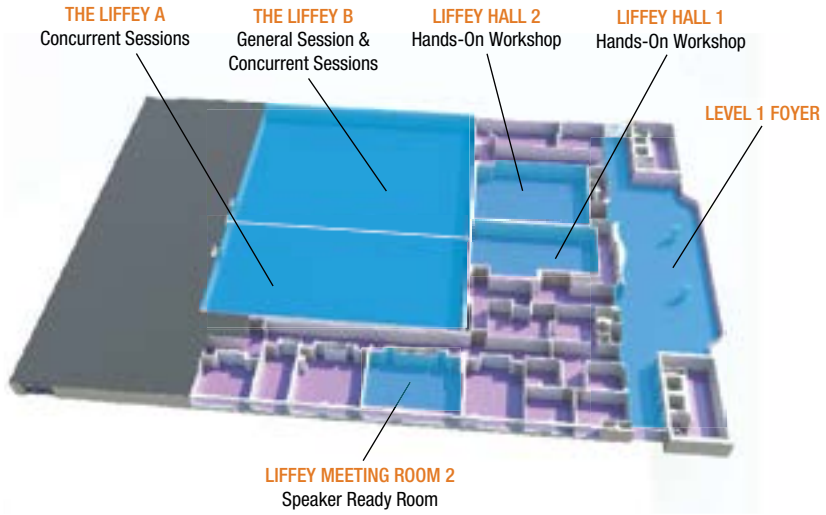
GROUND LEVEL

FUNCTION / EVENT	LOCATION
Registration	Forum Lobby
Exhibit Hall	The Forum
Cloakroom	Forum Lobby



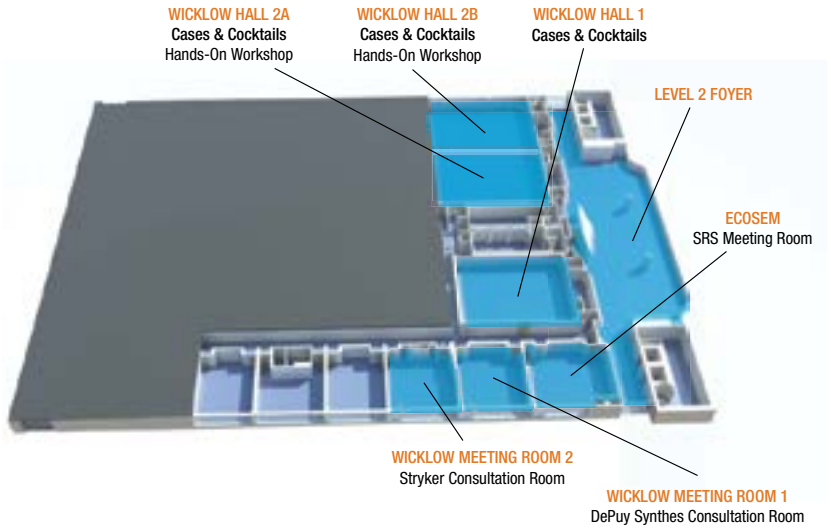
LEVEL 1

FUNCTION / EVENT	LOCATION
Speaker Ready Room	Liffey Meeting Room 2
General Session & Concurrent Sessions	The Liffey B
Concurrent Sessions	The Liffey A
Hands-On Workshops	Liffey Hall 1, Liffey Hall 2



LEVEL 2

FUNCTION / EVENT	LOCATION
Cases & Cocktails	Wicklow Hall 1, Wicklow Hall 2A, Wicklow Hall 2B
Hands-On Workshops	Wicklow Hall 2A, Wicklow Hall 2B
Industry Consultation Rooms	Wicklow Meeting Rooms 1 - 2



CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
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Serena S. Hu, MD	United States	No Relationships
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Kota Watanabe, MD, PhD	Japan	DePuy Synthes (b, d); Medtronic (d)
Muharrem Yazici, MD	Turkey	No Relationships
IMAST COMMITTEE (IF NOT LISTED ABOVE)		
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Alaaeldin Azmi Ahmad, MD	United States	Triaspine (b); Proximie (b)
Ahmet Alanay, MD	Turkey	Medtronic (a); DePuy Synthes (a); Globus Medical (b); ZimVie (b, g)

If noted, the relationships disclosed are as follows: a – grants/research support; b – consultant; c – stock/shareholder (self-managed); d – speaker's bureau; e – advisory board or panel; f – employee, salary (commercial interest); g – other financial or material support (royalties, patents, etc.)

CONFLICT OF INTEREST DISCLOSURES

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Chee Kidd Chiu, MBBS, MSOrth	Malaysia	No Relationships
Cristina Sacramento Dominguez, MD	Spain	No Relationships
Meric Enercan, MD	Turkey	No Relationships
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Bhavuk Garg, MS	India	No Relationships
Tenner Guillaume, MD	United States	Zimmer Biomet (b, d); NuVasive (b, d)
Brian Hsu, MD	Australia	Stryker Spine (d, g)
Kristen E. Jones, MD, FAANS	United States	Medtronic (a, b); SI Bone (a, b); Mizuho (a)
Takashi Kaito	Japan	No Relationships
Baron Zarate Kalfopulos, MD	Mexico	No Relationships
Han Jo Kim, MD	United States	Zimmer Biomet (g); Stryker Spine (g); Alphatec Spine (b); Surgical Acuity (g); Vivex Biologics (e); Aspen Medical (e); SI Bone (a); NuVasive (b)
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Jean-Charles Le Huec, MD, PhD	France	Medtronic (d); SI Bone (d)
David E. Lebel, MD, PhD	Canada	No Relationships
Jung-Hee Lee, MD, PhD	South Korea	No Relationships
Jean-Christophe A. Leveque, MD	United States	NuVasive (d)
Morio Matsumoto, MD, PhD	Japan	No Relationships
Emmanuel N. Menga, MD	United States	Evolution Spine (b, g); Globus Medical (b)
Marissa M. Muccio	United States	PRNY PC dba Scoliosis Specialty Center (c, f)
Ali Öner, MD	Turkey	No Relationships
Eric C. Parent, PhD	Canada	No Relationships
Stefan Parent, MD, PhD	Canada	Spinologics Inc. (c, g); EOS Imaging (a, b, g); Setting Scoliosis Straight Foundation (a); The Canada Foundation for Innovation (a); The Natural Sciences and Engineering Research Council of Canada (a); Canadian Institute of Health Research (a); Medtronic (a, b); DePuy Synthes (a, b); Stryker Spine (b); Orthopediatrics (d, g)
Bangping Qian, MD	China	No Relationships

If noted, the relationships disclosed are as follows: a – grants/research support; b – consultant; c – stock/shareholder (self-managed); d – speaker's bureau; e – advisory board or panel; f – employee, salary (commercial interest); g – other financial or material support (royalties, patents, etc.)

CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
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Juan S. Uribe, MD	United States	Misonix (b); SI Bone (b); Mainstay Medical (b)
Wai Weng Yoon, MBBS, FRCS, BSc	United Kingdom	No Relationships
CME COMMITTEE (IF NOT LISTED ABOVE)		
John M. Caridi, MD	United States	Stryker Spine (b)
Samuel K. Cho, MD	United States	Globus Medical (a, g); Stryker Spine (b); Medtronic (a)
Dean Chou, MD	United States	Globus Medical (b, g); Orthofix (b)
David H. Clements III, MD	United States	DePuy Synthes (a, d); NuVasive (a, d, g)
Ujjwal K. Debnath	United States	No Relationships
Pablo J. Diaz-Collado, MD	United States	Medtronic (b); OnPoint Surgical, Inc. (b, e)
Joseph P. Gjolaj, MD, FACS, FAOA	United States	DePuy Synthes (b); NuVasive (b); NuVasive (a); Silony Medical (b); Mymedicalimages (c)
Paul A. Glazer, MD	United States	Alphatec Spine (b); Globus Medical (b)
Ann M. Hayes, PT, DPT	United States	No Relationships
Steven W. Hwang, MD	United States	Zimmer Biomet (b, d); NuVasive (b, d); Auctus (c); DePuy Synthes (d)
Mark C. Lee, MD	United States	No Relationships
Marcus D. Mazur, MD	United States	Cerapedics (e)
William A. Phillips, MD	United States	Wolters Kluwer (g)
PROGRAM COMMITTEE (IF NOT LISTED ABOVE)		
Michael C. Albert, MD	United States	OrthoPediatrics (b)
Md Yousuf Ali	Bangladesh	No Relationships
Keith R. Bachmann, MD	United States	DePuy Synthes (b); Stryker Spine (b)
Junseok Bae, MD	South Korea	No Relationships
Paloma Bas Hermida, MD	Spain	No Relationships
Saumyajit Basu	India	No Relationships
Jennifer M. Bauer, MD	United States	DePuy Synthes (b); Proprio (b); OrthoPediatrics (b)
Griffin R. Baum, MD	United States	Stryker Spine (b); Playback Health (e)
James T. Bennett, MD	United States	No Relationships
Shay Bess, MD	United States	DePuy Synthes (a); Globus Medical (a); Stryker Spine (a, b, d, e, g); Medtronic (a); NuVasive (a, g); Orthofix (b); SI Bone (a); Stryker Spine (a, b, d, e, g); carlsmed (a); Alphatec Spine (b); Sea spine (a)
David B. Bumpass, MD	United States	Medtronic (b, d)

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Patrick J. Cahill, MD	United States	No Relationships
Michael S. Chang, MD	United States	Corelink (b); Stryker Spine (b); Spinewave (b); BK (b)
Ivan Cheng, MD	United States	NuVasive (b, c, g); Globus Medical (g); Spine Wave (g); Cytonics (c); Surgalign (b); SeaSpine (b)
David B. Cohen, MD	United States	No Relationships
Joseph Davey, MD	United States	No Relationships
Romain Dayer, MD	Switzerland	DePuy Synthes (a, d); Medtronic (a, d)
Eugenio Dema, MD	Italy	No Relationships
Satoru Demura	Japan	No Relationships
Christopher J. DeWald, MD	United States	Alphatec Spine (b, c, g); Smaio (b, g)
Bassel G. Diebo, MD	United States	Spinevision (b)
Mostafa H. El Dafrawy	United States	No Relationships
Jeffrey L. Gum, MD	United States	Acuity (b, g); DePuy Synthes (b); Medtronic (a, b, e, g); NuVasive (b, g); Stryker Spine (b, g); FYR Medical (b); National Spine Health Foundation (e); Global Spine Journal (a, g); Spine Deformity (g); The Spine Journal (g); Cingulate Theraputics (c); Cerapedics, Inc. (g); Biom'Up (a); Pfizer (a); Empirical Spine (a); Norton Healthcare (f); Baxter (g); Pacira Pharmaceuticals (g); Broadwater (g); NASS (g)
Michael J. Heffernan, MD	United States	No Relationships
David Lazarus, MD	United States	OrthoPediatrics (b)
Darren R. Lebl, MD	United States	DePuy Synthes (b); HS@, LLC (c); ISPH II, LLC (c); NuVasive (g); Remedy LOgic (c, e); Viseon, Inc. (b, c); Woven Orthopedic Technologies (c)
Elizabeth L. Lord, MD	United States	Medtronic (b); NuVasive (b); AOSpine (a, e)
Scott J. Luhmann, MD	United States	Stryker Spine (g); OrthoPediatrics (b, g); Medtronic (g); Globus Medical (g); Lippincott (g); Medtronic (g)
Amy L. McIntosh, MD	United States	NuVasive (b)
Ahmad Nassr, MD	United States	AO Spine NA (a); Premia Spine (a); 3 Spine (a)
Karl E. Rathjen	United States	Mati Theraputics (c)
Rajiv K. Sethi, MD	United States	Alphatec Spine (b); NuVasive (b); Orthofix (g); Surgalign (b); Stryker Spine (b)
Fernando Techy, MD	United States	Amedica (g)
Khoi D. Than, MD	United States	Bioventus (b); DePuy Synthes (b); Accelus (b); SI Bone (d); Cerapedics (b)
Surya Prakash Rao Voleti, MD, MS	India	No Relationships
Mitsuru Yagi, MD, PhD	Japan	Medtronic (b); DePuy Synthes (b); Zimmer Biomet (b); Asahi Kasei Pharma (b)
Zezhang Zhu, PhD	China	No Relationships
AM EDUCATION COMMITTEE (IF NOT LISTED ABOVE)		
Luiz Müller Ávila	Brazil	No Relationships
Ali A. Baaj, MD	United States	DePuy Synthes (b)
Benjamin D. Elder, MD, PhD	United States	DePuy Synthes (b); Injectsense (c, e); SI Bone (a, b); Stryker Spine (a)

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Mark A. Erickson, MD	United States	NuVasive (b, d); Medtronic (b, d)
Manish Gupta, PhD	India	No Relationships
Megan Johnson, MD	United States	No Relationships
Eren Kuris, MD	United States	Seaspine (b); Spineart (b)
A. Noelle Larson, MD	United States	Globus Medical (b); OrthoPediatrics (b); Zimmer Biomet (b); Medtronic (b)
Daniel J. Miller, MD	United States	No Relationships
Jeffrey P. Mullin	United States	Medtronic (a, b); NuVasive (b); SI Bone (b)
Brian J. Neuman, MD	United States	Baxter (d)
Ibrahim Obeid, MD	France	Alphatec Spine (g); DePuy Synthes (a, b); Medtronic (b); Spineart, Medicrea (g)
Javier Pizones, MD, PhD	Spain	DePuy Synthes (a); Medtronic (a, b); Stryker Spine (b)
Túlio A. Rangel, MD	Brazil	OrthoPediatrics (b)
Nick Sekouris, PhD	Greece	No Relationships
Alpaslan Senkoylu, MD	Turkey	No Relationships
Justin S. Smith, MD, PhD	United States	Alphatec Spine (c); Zimmer Biomet (b, g); NuVasive (a, b, c, g); This COI no longer relevant but website won't allow me to delete it (g); DePuy Synthes (a, b); Cerapedics (b); AOSpine (a); SeaSpine (b); This COI no longer relevant but website won't allow me to delete it (g); Carlsmed (b)
Byron F. Stephens, MD	United States	Stryker Spine (a); NuVasive (b); NuVasive (a); Carbofix (b)
FACULTY (IF NOT LISTED BELOW)		
Todd J. Albert, MD	United States	DePuy Synthes (g); ZIMMER Biomet (g); JP Medical Publishers (Book Royalties) (g); Thieme Medical Publishers (Book Royalties) (g); Springer (Book Royalties) (g); Elsevier, Inc. (Book Royalties) (g); NuVasive (b); Innovative Surgical Designs, Inc. (c); Care Equity (c); InVivo Therapeutics (c); Spinicity (c); CytoDyn Inc. (c); Paradigm Spine, LLC (c); Strathspey Crown (c); Surg.IO LLC (c); Augmedics (c); Morphogenesis (c); Precision Orthopedics (c); Pulse Equity (c); Physician Recommended Nutriceuticals (c); Back Story LLC (Board of Directors) (e); HS2, LLC (c); Hospital for Special Surgery (Board of Directors) (e); Parvizi Surgical Innovations (PSI) (c)
Christopher P. Ames, MD	United States	Stryker Spine (g); Biomet Zimmer Spine (g); DePuy Synthes (a, b, g); NuVasive (g); Next Orthosurgical (g); K2M (b, g); Medicrea (b, g); Medtronic (b); Agada Medical (b); Titan Spine (a); ISSG (g); Operative Neurosurgery (g); SRS (a); ISSG (g); Global Spinal Analytics (g); University of California, San Francisco (f); Carlsmed (b); SRS (g)
Randal R. Betz, MD	United States	Abyrx (c); Orthopediatric Corp. (b, c); DePuy Synthes (b, d, g); Electrocore (c); Globus Medical (b, d, g); H-CYTE, Inc. (c); Orthobond (c); SpineGuard (b, c, g); Thieme Medical Publishers (g); Wishbone Medical (c); Pacira / Iovera (b, c); Life Unit (b, e); Molecular Surface Technologies (c, e); SpineSTUD (c); SpineWelding (b); NOFUSCO (c, e)

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Jason Pui Yin Cheung, MD, MBBS, MS, FRCS	China	No Relationships
Benny T. Dahl, MD, PhD, DMSci	United States	Stryker Spine (b)
Robert K. Eastlack, MD	United States	Alphatec Spine (c); Aesculap (b, g); Globus Medical (g); DePuy Synthes (b); NuVasive (a, b, c, g); SI Bone (a, b, c, g); Seaspine (a, b, c, g); Spine Innovation (c); Neo (b); San Diego Spine Foundation (e); Carevature (b); Medtronic (b); Spinal Elements (b); Silony (b); Biedermann-Motech (b); Radius (d)
Christopher Kleck, MD	United States	Medtronic (a, b, e); SI Bone (a, d); Globus Medical (a); SeaSpine (a, b); Biocomposites (b); Allosource (b); Medacta (a, b)
Tyler Koski, MD	United States	NuVasive (b, g); Medtronic (g); seaspine (b, e)
Lawrence G. Lenke, MD	United States	Medtronic (b); broadwater (g); ABRYX (b); AOSPINE (a, g); Setting Scoliosis Straight Foundation (a); Acuity Surgical (b, g); Scoliosis Research Society (g); EOS Technology (a)
Gabriel Liu, MBBS	Singapore	No Relationships
Baron S. Lonner, MD	United States	DePuy Synthes (a, b, d, e, g); Zimmer Biomet (b, g); OrthoPediatrics (a, b, c, e); Spine Search (c)
Praveen V. Mummaneni, MD, MBA	United States	Globus Medical (b); Stryker Spine (b); DePuy Synthes (b); NREF (a); Spinicity/ISD (c); Thieme Publishers (g); Springer Publishers (g); ISSG (a); AO spine (a); NREF (a); NIH (a); NuVasive (b)
Gregory M. Mundis Jr., MD	United States	Stryker Spine (g); NuVasive (a, b, c, e, g); SeaSpine (a, b, c, e); VISEON (b, e); Carlsmed (b, c, e)
Venu M. Nemani, MD, PhD	United States	Medtronic (b, d); NuVasive (d); Stryker Spine (d)
Peter O. Newton, MD	United States	Spinologics (g); Globus Medical (b); DePuy Synthes (a, g); Mirus (b); EOS Imaging (a); Stryker Spine (a, b, g); Medtronic (a, d); Pacira (b); NuVasive (a); OrthoPediatrics (a); Thieme Publishing (g); Zimmer Biomet (a); Scoliosis Research Society (e); International Pediatric Orthopedic Think Tank (e); Harms Study Group/Setting Scoliosis Straight Foundation (e)
Paul Park, MD	United States	Globus Medical (b, g); NuVasive (b, g); DePuy Synthes (a, b); ISSG (a); SI Bone (a); Cerapedics (a); LifeNet (b); Accelus (b)
Amer F. Samdani, MD	United States	DePuy Synthes (b); Ethicon (b); Globus Medical (b); NuVasive (b, g); Stryker Spine (b); ZimVie (b, g); Medical Device Business Services (b); Mirus (b); Orthofix (b)
Suken A. Shah, MD	United States	DePuy Synthes (a, b, e, g); Stryker Spine (a, g); Globus Medical (a, b); Setting Scoliosis Straight Foundation (a, e); Pacira Biosciences (e)
Jesse Shen, MD, PhD	Canada	No Relationships
Daniel J. Sucato, MD, MS	United States	No Relationships
Corey T. Walker, MD	United States	No Relationships
Michelle C. Welborn, MD	United States	DePuy Synthes (b, d, e); Stryker Spine (b, d); NuVasive (b, d); Zimmer Biomet (a, d, e); Astrozenica (e)
Hee-Kit Wong, FRCS	Singapore	SpineGuard (e)

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Caglar Yilgor, MD	Turkey	Medtronic (b)
AUTHORS (IF NOT LISTED ABOVE)		
Mohamed Abdalla, MBBS	United Kingdom	No Relationships
Celeste Abjornson, PhD	United States	DePuy Synthes (a); Camber Spine (a, b, c, e); Centinel Spine (a, b)
Sonja Adomeit, MS	Germany	No Relationships
Mehran Afshar, MBBS	United Kingdom	No Relationships
Nicole Agaronnik, BS	United States	No Relationships
Nitin Agarwal, MD	United States	Thieme Medical Publishers (g); Springer International Publishing (g)
Amer Ahmad, MD	United States	No Relationships
Hassam Ahmed, BS	United Kingdom	No Relationships
Matti Ahonen, MD, PhD	Finland	No Relationships
Bisola Ajayi, PA-R	United Kingdom	No Relationships
Suha Aktas, MD	Turkey	No Relationships
Nima Alan, MD	United States	No Relationships
Daniel Alber, BS	United States	No Relationships
Md Yousuf Ali	Bangladesh	No Relationships
Luiz Eduardo Almeida, MD	Brazil	No Relationships
Daniel Alsoof, MBBS	United States	No Relationships
Terry D. Amaral, MD	United States	No Relationships
Vardhaan Ambati, MD	United States	No Relationships
Jason B. Anari, MD	United States	DePuy Synthes (b)
Mikkel î Andersen, MD	Denmark	Cerapedics (a)
George Anderson, BS	United States	No Relationships
Emilie Andre, MD	France	No Relationships
Andreas K. Andresen, MD, PhD	Denmark	No Relationships
Fares Ani, MD	United States	No Relationships
Alexandre Ansorge, MD	Switzerland	No Relationships
Ajay Anthony, MD	United States	Abbott (a, b); Boston Scientific (a, b); PainTeq (a, b); Saluda (a, b); Vertos (a)
Juan Silva Aponte, BS	United States	No Relationships
Kasra Araghi, BS	United States	No Relationships
Kimberly Ashayeri, MD	United States	No Relationships
Anthony L. Asher, MD	United States	Globus Medical (b)
Ali Asma, MD	United States	No Relationships
Aaron M. Atlas, BS	United States	No Relationships
Luiz Müller Ávilae	Brazil	No Relationships
Sule Turgut Balci, MD	Turkey	No Relationships
Christine Baldus, RN	United States	No Relationships
Keith Baldwin, MD, MPH, MSPT	United States	Pfizer Inc. (c)
Tungish Bansal, MS	India	No Relationships
Hongda Bao, MD	China	No Relationships

If noted, the relationships disclosed are as follows: a – grants/research support; b – consultant; c – stock/shareholder (self-managed); d – speaker's bureau; e – advisory board or panel; f – employee, salary (commercial interest); g – other financial or material support (royalties, patents, etc.)

CONFLICT OF INTEREST DISCLOSURES

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William R. Barfield, PhD	United States	No Relationships
Ben Barkham, MBBS	United Kingdom	No Relationships
Carlos Barrios, PhD	Spain	No Relationships
Nicholas Bastidas, MD	United States	No Relationships
Tracey P. Bastrom, MA	United States	No Relationships
Valentina Battistoni, BS	United States	No Relationships
Gregory Benes, BS	United States	No Relationships
Annette Bennedsgaard Jespersen, MD, PhD	Denmark	No Relationships
Clara Berlin, MD	Germany	No Relationships
Jason Bernard, MD, FRCS	United Kingdom	DePuy Synthes (c); Stryker Spine (d, e, g); Globus Medical (d)
Sigurd H. Berven, MD	United States	Globus Medical (e); Medtronic (b, e, g); Stryker Spine (b, g); Accelus (b); Innovasis (b, e); Camber spine (b); Novapproach (b, g); Green Sun Medical (e, g)
Nazihah S. Bhatti, BS	United States	No Relationships
Celaleddin Bildik, MD	Turkey	No Relationships
Craig M. Birch, MD	United States	No Relationships
Tim Bishop, FRCS	United Kingdom	No Relationships
Erica F. Bisson, MD, MPH	United States	Stryker Spine (b); Mirus (b, c); Nview (c); Medtronic (b); Proprio (b, c)
Collin W. Blackburn, MD	United States	No Relationships
Michael Bober, MD	United States	Mereo (e); Ultragenyx (a, e)
Venkat Boddapati, MD	United States	No Relationships
Kevin Bondar, MD	United States	No Relationships
Julianna Bono, BS	United States	No Relationships
Luca Boriani, MD	Italy	No Relationships
Peter Boucas	United States	No Relationships
Peter Boufadel, BS	United States	No Relationships
Mathieu Boulet, MD	Canada	No Relationships
Conor T. Boylan, MD, BS	United Kingdom	No Relationships
Brett A. Braly, MD	United States	Stryker Spine (b)
Ted Braun, MD	United States	No Relationships
Keith H. Bridwell, MD	United States	No Relationships
Moritz Brielmaier, MD	Germany	No Relationships
Rachel Bronheim, MD	United States	No Relationships
Jaysson T. Brooks, MD	United States	DePuy Synthes (b); OrthoPediatrics (b); Medtronic (b)
Morgan Brown, MS	United States	Norton Healthcare (f); Pfizer (a); Texas Scottish Rite Hospital (a); Alan L. & Jacqueline B. Stuart Spine Research (a); Cerapedics, Inc. (a); Scoliosis Research Society (SRS) (a); Medtronic (a); Biom'Up (a); Empirical Spine, INC (a); National Spine Health Foundation (a); Stryker Spine (a)
Michael J. Brush, BS	United States	No Relationships
Xochitl Bryson, BA	United States	No Relationships

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Patrick Buchanan, MD	United States	Abbott (a, b); Painteq (a, b)
Aaron J. Buckland, MBBS, FRCSA	Australia	NuVasive (a, b); SI Bone (a); Medtronic (b)
Chanthong Budsayavilaimas, MD	Thailand	No Relationships
Thomas J. Buell, MD	United States	No Relationships
Aonnicha Burapachaisri, BS	United States	No Relationships
Shane Burch, MD	United States	Medtronic (a, b, e); NuVasive (b, f); NuVasive (a, b)
Mohamad Bydon, MD	United States	No Relationships
Akaila Cabell, MD	United States	No Relationships
Juan Cabrera, MD	Chile	No Relationships
Gaston Camino-Willhuber, MD	United States	No Relationships
Frank P. Cammisa Jr, MD	United States	DePuy Synthes (b); NuVasive (a, b, g); Mallinckrodt Pharmaceuticals (a); 4WEB Medical/4WEB, Inc. (a, b, e, g); Camber Spine (a); Centinel Spine, Inc. (a); ISPH 3 Holdings, LLC (c); Ivy Healthcare Capital Partners, LLC (g); ISPH II & III, LLC (g); VBVP VI & X, LLC (g); Medical Device Partners II & III, LLC (g); Healthpoint Capital Partners, LP (e, g); Spine Biopharma, LLC (b, e, g); Synexis LLC (b, e, g); Orthobond Corporation (c, e); Tissue Differentiation Intelligence, LLC (c); Woven Orthopedic Technologies (c, e); Accelus (b, g)
Lisa Cannada, MD	United States	No Relationships
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Leah Y. Carreon, MD, MS	Denmark	Johnson & Johnson, Cerapedics (a)
Leah Y. Carreon, MD	United States	Medtronic (a); Cerapedics, Empirical Spine, Biom'Up (a); Stryker Spine (a)
Miguel Cartagena Reyes, BS	United States	No Relationships
René M. Castelein, MD, PhD	Netherlands	Stryker Spine (a); Cresco Spine (c); Dutch Scoliosis Center (c)
Anthony A. Catanzano, MD	United States	No Relationships
Andrew K. Chan, MD	United States	No Relationships
Dong-Gune Chang, MD, PhD	South Korea	No Relationships
Stuart Changoor, MD	United States	No Relationships
Pongsthorn Chanplakorn, MD	Thailand	No Relationships
Léonard Chatelain, MD	France	No Relationships
Ling Chen, MD	China	No Relationships
Vivian Chene	United States	No Relationships
Kenneth M. Cheung, MD, MBBS, FRCS	China	Medtronic (b); NuVasive (a, b); Globus Medical (b); Avalon spinecare (a); AO Spine (a); OrthoSmart (g)
Erika Chiapparelli, MD	United States	No Relationships
Robert H. Cho, MD	United States	DePuy Synthes (b, e); NuVasive (b); OrthoPediatrics (b); Prosidyan (b); Ergobaby (b, e); Mighty Oak Medical (b)
Minjun Choi, MD	South Korea	No Relationships
Anne Christopher, MD	United States	No Relationships
Timothy Chryssikos, MD, PhD	United States	No Relationships
Chun Kee Chung, MD, PhD	South Korea	No Relationships
Giovanni Ciani, MD	Italy	No Relationships

If noted, the relationships disclosed are as follows: a – grants/research support; b – consultant; c – stock/shareholder (self-managed); d – speaker's bureau; e – advisory board or panel; f – employee, salary (commercial interest); g – other financial or material support (royalties, patents, etc.)

CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Chiara Cini, MD	Italy	No Relationships
John C. Clohisy, MD	United States	No Relationships
Daniel Coban, MD	United States	No Relationships
Alex Coffman, BS	United States	Medtronic (c)
Ryan Coghlan, MS	United States	Pfizer (b, g); QED therapeutics (b, g); Biomarin (b, g)
Ting Cong, MD	United States	Sustain Surgical (c, g)
Domagoj Coric, MD	United States	Medtronic (b, g); Stryker Spine (g); Globus Medical (b, g); Spine Wave (b, c, g); Accelus (b, g); Premia Spine (c, g); RTI (g); 3Spine (c)
Pier Francesco Costici, MD	Italy	No Relationships
Oscar Covarrubius, BS	United States	No Relationships
Kofi Cox, BS	United Kingdom	No Relationships
Charles H. Crawford III, MD	United States	Alphatec Spine (g); NuVasive (b, g); Medtronic (a, b, e, g)
Bryan W. Cunningham, PhD	United States	Gelita Medical, GmbH (a, b); Medcura, Inc. (a)
Matthew E. Cunningham, MD, PhD	United States	Sustain Surgical (c)
Cloe Curri, MD	Italy	No Relationships
Stephanie Da Paz, MD	Germany	No Relationships
Luis Eduardo Carelli Teixeira Da Silva, MD, MS	Brazil	Medtronic (b, e); Stryker Spine (b); Ulrich medical (b); AOSpine (g); Brazilian Spine Society (e)
Mohamed Dallae	Turkey	No Relationships
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Christy L. Daniels, MS	United States	Norton Healthcare (f); Medtronic (a); Pfizer (a); Cerapedics, Inc. (a); Biom'Up (a); Empirical Spine, Inc. (a); Stryker (a)
Pooja Dave, BS	United States	No Relationships
Charlotte De Bodman, MD	Switzerland	No Relationships
Rafael De la Garza Ramos, MD	United States	No Relationships
Sergio De Salvatore, MD	Italy	No Relationships
Abel De Varona Cocero, BS	United States	No Relationships
Malcolm R. DeBaun, MD	United States	Nsite Medical (c, g); DePuy Synthes (b); SI Bone (b); Next Science (b); Metalogix (b, g); Resolute (b, g); Shukla (b, g)
Ujjwal K. Debnath, MD, FRCS DM	India	No Relationships
Timothy Deer, MD	United States	Abbott (a, b, e, g); Vertos (a, b, c, e); SpineThera (b, c); Saluda (a, b, c); Mainstay (a); Nalu (b, c, e); Cornerloc (b, c); Ethos (b, c); SPR Therapeutics (a, b, c, e); Medtronic (b); Boston Scientific (a, b); PainTeq (a, b, c); TissueTeq (b, e); Spinal Simplicity (b, c); Avanos (a)
Nuri Demircie	Turkey	No Relationships
Satoru Demurae	Japan	No Relationships
Wenqiang Deng, MBBS	China	No Relationships
Mehul Desai, MD	United States	SPR Therapeutics (b, c); Nalu (b); Virdio (b, c); SynerFuse (c)
David Dickerson, MD	United States	Abbott (a, b, d, e); SPR (a, b, d, e); Vertos (b, d, e); Biotronik (b, e); Pfizer (e); Myovant (e)

If noted, the relationships disclosed are as follows: a – grants/research support; b – consultant; c – stock/shareholder (self-managed); d – speaker's bureau; e – advisory board or panel; f – employee, salary (commercial interest); g – other financial or material support (royalties, patents, etc.)

CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Anthony M. DiGiorgio, DO	United States	No Relationships
Pinar Yalinay Dikmen, MD	Turkey	No Relationships
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Jon-Paul P. DiMauro, MD	United States	No Relationships
Mladen Djurasovic, MD	United States	Medtronic (b, g); NuVasive (b, g)
yusuke dodo, MD	Japan	No Relationships
Matthew Dow, MD	United States	No Relationships
James E. Dowdell, MD	United States	No Relationships
Thomas J. Dowling III, MD	United States	No Relationships
Luke C. Drake, MD	United States	No Relationships
Marcel Dreischarf, PhD	Germany	Raylytic GmbH (f)
Caroline E. Drolet, PhD	United States	No Relationships
Jerry Du, MD	United States	No Relationships
Pingguo Duan, MD	China	No Relationships
Ashley Duncan, RN	United States	No Relationships
Jonathan Duncan, MD	United States	Abbott (a)
Conor J. Dunn, MD	United States	No Relationships
Wesley M. Durand, MD	United States	No Relationships
Lily Q. Eaker, BA	United States	No Relationships
Mostafa H. El Dafrawye	United States	No Relationships
Faisal Elali, BS	United States	No Relationships
Elias Elias, MD,	United States	No Relationships
Jonathan Elysee, MS	United States	No Relationships
Arash Emami, MD	United States	NuVasive (a)
John B. Emans, MD	United States	No Relationships
Gokhan Ergene, MD	Turkey	No Relationships
Melissa Erickson, MD	United States	Medtronic (b); Globus Medical (b); Restor3D (b); DePuy Synthes (b)
O.Nuri Eroglu, MD	Turkey	No Relationships
Marie Fahey, PhD	United States	Abbott (f)
Jordan Fakhoury	United States	No Relationships
Michael J. Faloon, MD	United States	Stryker Spine (b); Centinel Spine (a)
Steven Falowski, MD	United States	Abbott (a, b, d, e); Medtronic (a, b); Saluda (a, b, c, d, e); SPR (b, c); Aurora (a, b, c, d, e)
Daniel Farivar, BS	United States	No Relationships
Joseph Ferguson, MD	United States	No Relationships
Emmanuelle Ferrero, MD, PhD	France	Implanet (b); Medtronic (b)
Richard G. Fessler, MD, PhD	United States	DePuy Synthes (b); Spinal Elements (b, g); InQ Innovations (g); Orthofix (b)
Michael Fields, MD	United States	No Relationships
Benjamin Fitch, BS	United States	No Relationships
Jesus Burgos Flores, MD	Spain	No Relationships

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
John (Jack) M. Flynn, MD	United States	Zimmer Biomet (b); Wolters Kluwer Publishers (b); Law firms (g)
Kevin T. Foley, MD	United States	Medtronic (b, c, g); NuVasive (c); Discgenics (c, e, g); RevBio (c, e); Accelus (c, e); Triad Life Sciences (c); DuraStat (c, e); True Digital Surgery (c, e); Vori Health (c)
Bailli Fontenot, BS	United States	No Relationships
Mitchell Fourman, MD	United States	No Relationships
Hayley Fowler, BS	United States	No Relationships
Jeanne M. Franzone, MD	United States	OrthoPediatrics (b)
Robert Funk, MD	United States	No Relationships
Jesse M. Galina, BS	United States	No Relationships
Daniel O. Gallagher, BS	United States	No Relationships
Adrian C. Gardner, FRCS Tr & Orth	United Kingdom	No Relationships
Michael Gardner, MD	United States	Globus Medical (b); DePuy Synthes (b); SI Bone (b); KCI (b); OsteoCentric (b); NSite Medical (c); Imagen Technologies (c)
Michael Garneau, BS	United States	No Relationships
Alessandro Gasbarrini, MD	Italy	No Relationships
Aaron Gaul, BS	United States	No Relationships
Rachel Gecelter, BS	United States	No Relationships
Matthew J. Geck, MD	United States	Difusion (c); SpineHope (e)
Chris Gilligan, MD	United States	Abbott (e); Iliad Lifesciences (b); Mainstay Medical (b, c); Persica (e)
Astrid H. Gimbel, BS	Denmark	No Relationships
Federico P. Girardi, MD	United States	NuVasive (b, g); Ortho Development Corp (b, g); DePuy Synthes (b, g); Bonovo Orthopedics, Inc. (c); Healthpoint Capital Partners, LP (c); BICMD (c); Tissue Differentiation Intelligence, LLC (c); Spineart USA, Inc. (b); Ethicon, Inc. (b)
Mika Gissler, PhD	Finland	No Relationships
Steven D. Glassman, MD	United States	Medtronic (b, g); Medtronic (a); Stryker Spine (b); Norton Healthcare (f); American Spine Registry (e); NuVasive (a); Integra (a); Intellirod (a); Pfizer (a); International Spine Study Group (a); Medtronic (a); Proprio (b)
Michael P. Glotzbecker, MD	United States	NuVasive (b, d); DePuy Synthes (d); Medtronic (b, d); NSite (b); orthobullets (b, c); PSSG, HSG (a)
Vijay K. K. Goel, PhD	United States	No Relationships
Tae Sik Goh, MD, PhD	South Korea	No Relationships
Halil Gok, MD	Turkey	No Relationships
Bahadir Gokcen, MD	Turkey	No Relationships
Jacob L. Goldberg, MD	United States	No Relationships
Jeffrey Goldstein, MD	United States	No Relationships
Christopher R. Good, MD	United States	Stryker Spine (b, e, g); Medtronic (a, b, e, g); Augmedics (c, e); NSite (c)
Oren Gottfried, MD	United States	No Relationships

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Harsh Grewal, MD	United States	Zimmer Biomet (b); Auctus Surgical (c)
Priyanka Grover, MS	Germany	Raylytic GmbH (f)
Pierre Guigui, MD	France	No Relationships
Jeremy Guinn, BS	United States	No Relationships
Trevor Gulbrandsen, MD	United States	No Relationships
Arjun Gupta, BS	United States	No Relationships
Mihir Gupta, MD	United States	No Relationships
Lawrence L. Haber, MD	United States	OrthoPediatrics (b, c, g); Zimmer Biomet (d)
Henryk Haffer, MD	Germany	No Relationships
Regis W. Haid Jr., MD	United States	Globus Medical (c, g); Medtronic (g); NuVasive (b, c, g); SpineWave (c); Remedy Health (Formerly Vertical Health, formerly SpineUniverse) (c); University of Miami (Honorarium) (g); University of Iowa (Honorarium) (g); Cervical Spine and Decompression & Stabilization (Honorarium) (g); UC Davis Health, Dept. of Neurological Surgery (Honorarium) (g)
Colin Haines, MD	United States	Medtronic (b); Globus Medical (b); Spineart (b); Innovasis (b); Precision Spine (b)
Shahnawaz Haleem, MBBS	United Kingdom	No Relationships
James Hall, MD	United States	No Relationships
Henry Halm, MD	Germany	NuVasive (b, g); Silony Medical (a, b, e)
Thamer Hamdan, MBBS	United Kingdom and Iraq	No Relationships
D. Kojo Hamilton, MD, FAANS	United States	NuVasive (a)
Azmi Hamzaoglu, MD	Turkey	Medtronic (a, b)
Junghoon Han, MD	South Korea	No Relationships
Christina K. Hardesty, MD	United States	OrthoPediatrics (b, g); Medtronic (b)
Jennifer Harpe-Bates	United States	Medtronic (b)
Andrew B. Harris, MD	United States	No Relationships
Brett Harris, BS	United States	No Relationships
Jacob Harris, BS	United States	No Relationships
Taylor Harris, BS	United States	No Relationships
Sayyida Hasan, BS	United States	No Relationships
Jason J. Haselhuhn, DO	United States	No Relationships
Fthimnir Hassan, MPH	United States	No Relationships
Hamid Hassanzadeh, MD	United States	NuVasive (a, b, c, d); Orthofix (a, b, d); DePuy Synthes (b)
Janice Havasy, MD	United States	No Relationships
Zhong He, MD	China	No Relationships
Jeremy Heard, BS	United States	No Relationships
Daniel J. Hedequist, MD	United States	Medtronic (b)
Ilkka J. Helenius, MD, PhD	Finland	Medtronic (a, b); Stryker Spine (a, b); NuVasive (a); Globus Medical (b); Cerapedics (a)
Nathan R. Hendrickson, MD	United States	No Relationships
Jeffrey M. Henstenburg, MD	United States	No Relationships

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NAME	COUNTRY	DISCLOSURE(S)
Pernille Hermann, MD, PhD	Denmark	No Relationships
Robert Heros, MD	United States	Abbott Medical (a, b); Biotronik (b); Boston Scientific (b, d); Ethos Laboratories (a); Mainstay Medical (a, b, d); Saluda Medical (a, b)
Eduardo Hevia, MD	Spain	No Relationships
Jessica H. Heyer, MD	United States	No Relationships
Bren Hines, RN	United States	No Relationships
Takashi Hirase, MD	United States	No Relationships
Dan Hoernschemeyer, MD	United States	Zimmer Biomet (a, b); OrthoPediatrics (b, c); Biomarin (d)
Grant D. Hogue, MD	United States	Tether Implant Corporation (g); Medtronic (b)
Kenneth J. Holton, MD	United States	No Relationships
Yusuke Hori, MD, PhD	United States	No Relationships
Richard Hostin, MD	United States	No Relationships
M. Timothy Hresko, MD	United States	No Relationships
Zongshan Hu, PhD	China	No Relationships
Jeremy Huang, BS	United States	No Relationships
Janine Huertgen, MS	Germany	RAYLYTIC GmbH (f)
Alexander P. Hughes, MD	United States	NuVasive (a); Kuros Biosciences (a)
Matthew A. Hunt, MD	United States	No Relationships
Jennifer K. Hurry, MASc	Canada	No Relationships
Ibrahim Hussain, MD	United States	3DBio (b); Johnson and Johnson (b)
Zion Hwang, MBBS, BS	United Kingdom	No Relationships
Ki S. Hwang, MD	United States	Centinel (a); Stryker Spine (b)
Mohab Ibrahim, MD	United States	No Relationships
Cassim Igram, MD	United States	Medtronic (b); AlloSource (b)
Go Ikeda	Japan	No Relationships
Kenneth D. Illingworth, MD	United States	OrthoPediatrics (b); Medtronic (e)
Bailey Imbo, BA	United States	No Relationships
Weisbein Jacqueline, MD	United States	Medtronic (a, b); Abbott (a, b, e); Vertos (b, e); SI Bone (b); Saluda (a, b); Biotronik (b, e)
Amit Jain, MD	United States	Stryker Spine (b); DePuy Synthes (b); Globus Medical (b)
Viral V. Jain, MD	United States	No Relationships
Pilan Jaipanya, MD	Thailand	No Relationships
Jessica Jameson, MD	United States	Abbott (a, b); Nevro (a, b); Saluda (a, b); SI Bone (b); Medtronic (b); Boston Scientific (b)
Alysha Jamieson, BS	United States	No Relationships
Nadine M. Javier, BS	United States	No Relationships
Ehsan Jazini, MD	United States	Stryker Spine (b); Medtronic (b); Innovasis (b)
Ira Jeglinsky-Kankainen, PhD	Finland	No Relationships
Jun Jiang, MD	China	No Relationships
Christopher Jine	United States	No Relationships
Michael B. Johnson, MBBS, FRACS	Australia	euros SAS France (a, e)

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NAME	COUNTRY	DISCLOSURE(S)
Douglass Johnson, MD	United States	No Relationships
Morgan Jones, FRCS	United Kingdom	NuVasive (d)
Richard Jones, MD	United States	No Relationships
Rachel Joujon-Roche, BS	United States	No Relationships
Kathryn Jurenovich, DO	United States	No Relationships
Pramod N. Kamalapathy, BS	United States	No Relationships
Robert Kamil, BS	United States	No Relationships
Adam S. Kanter, MD	United States	NuVasive (c, e); Zimmer Biomet (g)
Kursat Kara, MD	Turkey	No Relationships
Selhan Karadereler, MD	Turkey	No Relationships
Nikos Karavidas	Greece	No Relationships
Judson W. Karlene	United States	NuVasive (d)
Michelle Kars, MD	United States	No Relationships
Shuzo Kato, MD	Japan	No Relationships
Gun Keorochana, MD	Thailand	No Relationships
Kyle Kesler, MD	United States	No Relationships
Marc Khalifeé, MD, MS	France	NovaSpine (c)
Ursalan Khan, MBBS	United Kingdom	No Relationships
Nikita Khusainov, MD	Russia	No Relationships
Feyzi Kilic, MD	Turkey	No Relationships
Duhan Kilickane	Turkey	No Relationships
Chi Heon Kim, MD, PhD	South Korea	Richard Wolf spine (RIWOspine) (b)
Dong Suk Kim, MD	South Korea	No Relationships
Ho-Joong Kim, MD	South Korea	No Relationships
Hong Jin Kim, MD	South Korea	No Relationships
Jun-Hoe Kim, MD	South Korea	No Relationships
Taeshin Kim, MD	South Korea	No Relationships
David Kim, MD	United States	No Relationships
Nathan S. Kim, BS	United States	No Relationships
Mwaura Kimani, FRCS, MMed MSc	Australia	No Relationships
Frank Kleinstuck, MD	Switzerland	DePuy Synthes (a, d)
John J. Knightly, MD	United States	No Relationships
Denis Knobel, MD	United States	No Relationships
Dmitry Kokushin, MD	Russia	No Relationships
Alexander Koo, BA	United States	No Relationships
Max Korsun, BS	United States	No Relationships
Stefan Krebs, MD	Germany	No Relationships
Chaiwat Kriwattanapong, MD	Thailand	No Relationships
Oscar Krol, BS	United States	No Relationships
Richard Kruse, MD	United States	OrthoPediatrics (b)
Tesfaldet Kurban, BSc	United Kingdom	No Relationships
David Kurland, MD, PhD	United States	No Relationships

If noted, the relationships disclosed are as follows: a – grants/research support; b – consultant; c – stock/shareholder (self-managed); d – speaker's bureau; e – advisory board or panel; f – employee, salary (commercial interest); g – other financial or material support (royalties, patents, etc.)

CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Michael Kutschke, MD	United States	No Relationships
Brian Kwon, MD	United States	NuVasive (b, d, e, g); Amplify Surgical (e); Surgalign (e)
Lawal A. Labaran, MD	United States	No Relationships
Renaud Lafage, MS	United States	No Relationships
Virginie Lafage, PhD	United States	Globus Medical (b); Alphatec Spine (b); NuVasive (g); Stryker Spine (d); DePuy Synthes (d)
Christopher Lai, BS	United States	No Relationships
Joanna L. Langner, MS	United States	No Relationships
Tomi Lanre-Amos, MD	United States	No Relationships
Darryl Lau, MD	United States	NuVasive (b); Alphatec Spine (b); Stryker Spine (b); Cerapedics (b, e)
Raj S. Lavadi, MBBS	United States	No Relationships
Vivian Le, MPH	United States	No Relationships
Jordan Lebovic, MD, MBA	United States	No Relationships
Nicole Lee, PhD	Singapore	No Relationships
Chan-Hyun Lee, MD, PhD	South Korea	No Relationships
Jung Sub Lee, MD, PhD	South Korea	No Relationships
Nathan J. Lee, MD	United States	No Relationships
Pittavat Leelapattana, MD	Thailand	No Relationships
Devon Lefever, MD	United States	No Relationships
Ronald A. Lehman, MD	United States	Medtronic (b, g); Stryker Spine (g); Department of Defense (a); National Institute of Health (a); Pacira (b)
Nichole S. Leitsinger, BS	United States	No Relationships
Claudia Leonardi, PhD	United States	No Relationships
Thamrong Lertudomphonwanit, MD	Thailand	No Relationships
Vijay Letchuman, MD	United States	No Relationships
Robert Levy, MD	United States	No Relationships
Stephen J. Lewis, MD, FRCS(C)	Canada	Medtronic (a, d); Stryker Spine (b, d, e); DePuy Synthes (a, d); Scoliosis Research Society (d); AO Spine (a, d, e)
Jie Li, MD	China	No Relationships
Song Li, MD, PhD	China	No Relationships
G.Ying Li, MD	United States	Medtronic (e)
Irene Li, MS	United States	No Relationships
Benita Liao, MD	United States	No Relationships
Christa LiBrizzi, MD	United States	No Relationships
Isador H. Lieberman, MD	United States	Globus Medical (b, g); Bioventus (b); SI Bone (b, g)
Kevin B. Lim, MD, FRCS(Orth), MBA	Singapore	No Relationships
Adrian Lin, BS	United States	No Relationships
Hannah Lin, BS	United States	No Relationships
Breton G. Line, BS	United States	International Spine Study Group (b)
Changwei Liu, MD	China	No Relationships

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Wanyou Liu, MS	China	No Relationships
Zhen Liu, PhD	China	No Relationships
Wing-Kin Liu, MBBS	United Kingdom	No Relationships
Yungtai Lo, PhD	United States	No Relationships
Joseph M. Lombardi, MD	United States	No Relationships
Nicholas Lopreiato, MD	United States	No Relationships
Craig R. Louer, MD	United States	NSite Medical (e); NuVasive (a); DePuy Synthes (b); Zimmer Biomet (a)
Philip K. Louie, MD	United States	No Relationships
Darren F. Lui, FRCS	United Kingdom	Stryker Spine (a, b); Zimmer Biomet (b); Carbofix (a); Ovidius Medical (a); Edge Medical (a); Biocomposites (b)
Brett Lullo, MD	United States	No Relationships
Daniel C. Lu, MD, PhD	United States	Seaspine (g); Boston Scientific (a); Medtronic (a); Abbott (a)
Kristopher M. Lundine, MD, MSc, FRCSC, FRACS	Australia	Stryker Spine (b); OrthoPediatrics (b)
Shengbiao Ma, MD	China	No Relationships
Yanyu Ma, PhD	China	No Relationships
Omri Maayan, BS	United States	No Relationships
bruna maccaferri, MD	Italy	No Relationships
Mohamed Macki, MD	United States	No Relationships
Constance Maglaras, PhD	United States	No Relationships
Rajesh Malhotra, MD	India	No Relationships
Erin M. Mannen, PhD	United States	No Relationships
Saihu Mao, MD, PhD	China	No Relationships
Sai-hu Mao, PhD	China	No Relationships
Damon E. Mar, PhD	United States	Agada Medical Ltd. (b)
Randall E. Marcus, MD	United States	Blue Cross Blue Shield Association Medical Advisory Panel & Pharmacy & Medical Policy Committee (e)
Gonzalo Mariscal, MD	Spain	No Relationships
David S. Marks, FRCS, FRCSOrth	United Kingdom	NuVasive (d); Stryker Spine (d)
Michelle Claire Marks, PT, MA	United States	Setting Scoliosis Straight (f)
Christopher T. Martin, MD	United States	Medtronic (a, b); SI Bone (a); Medtronic (a, b)
Justin Mathew, MD	United States	No Relationships
Takuya Matsunaga, PhD	Japan	No Relationships
Noor Maza, MD	United States	No Relationships
Shrijith MB, MD	India	No Relationships
Paul C. McAfee, MD, MBA	United States	No Relationships
Brian McCormick, MD	United States	No Relationships
Christopher L. McDonald, MD	United States	No Relationships
Tyler C. McDonald, MD	United States	No Relationships
Kimberly McFarland, BS	United States	No Relationships
Maureen McGarry, BS	United States	No Relationships
George McKay, FRCS	United Kingdom	No Relationships

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Hossein S. Mehdian, MD, FRCS(Ed)	United Kingdom	No Relationships
Nishank Mehta, MS	India	No Relationships
Jwalant S. Mehta, MD, FRCS (Orth), MCh (Orth), MS (Orth), D Orth	United Kingdom	Stryker Spine (a, b, g); DePuy Synthes (a); NuVasive (a); POSNA (a); FDA (a); Growing Spine Foundation (a); Childrens' Spine Foundation (a); Elite Health Services (c); AO Spine (d)
Robert K. Merrill, MD	United States	No Relationships
Scott Meyer, MD	United States	No Relationships
Giorgos Michalopoulos, MD	United States	No Relationships
Nathan Miller, MD	United States	No Relationships
Yuichiro Mima, MD, PhD	Japan	No Relationships
Jamshaid Mir, MD	United States	No Relationships
Stuart L. Mitchell, MD	United States	Pfizer (c)
Aditya Mittal, BS	United States	No Relationships
Kevin C. Mo, BS	United States	No Relationships
Kevin Moattari, BS	United States	No Relationships
Susan Moeschler, MD	United States	No Relationships
Marina Moguilevtch, MD	United States	No Relationships
Ramkumar Mohan, MBBS	Singapore	No Relationships
Sarthak Mohanty, BS	United States	No Relationships
Robert A. Morgan, MD	United States	No Relationships
Kyle W. Morse, MD	United States	Sustain Surgical (c, e)
Hamisi M. Mraja, MD	Turkey	No Relationships
Maximilian Muellner, MD	Germany	No Relationships
Jeffrey P. Mulline	United States	Medtronic (a, b); NuVasive (b); SI Bone (b)
Robert F. Murphy, MD	United States	Stryker Spine (b)
Farah Musharbash, MD	United States	No Relationships
Nallammai Muthiahe	United States	No Relationships
Ayhan Mutlu, MD	Turkey	No Relationships
Camryn Myers, BA	United States	No Relationships
Takeo Nagura, MD, PhD	Japan	No Relationships
Masaya Nakamura, MD, PhD	Japan	No Relationships
Yunjin Nam, MD	South Korea	No Relationships
Alma Rechev Ben Natan, BA	United States	No Relationships
Kevin M. Neal, MD	United States	OrthoPediatrics (b, g)
Matthew P. Newton Ede, FRCS Tr & Orth	United Kingdom	NuVasive (a, d); Stryker Spine (d); DePuy Synthes (d)
Stacy Ng, FRCSEd(Orth)	Singapore	No Relationships
Emily Nice, BS	United States	No Relationships
Sung Hyun Noh, MD	South Korea	No Relationships

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Pierce D. Nunley, MD	United States	Stryker Spine (b, g); Zimmer Biomet (g); NG Medical (b); Spineology (b, c, g); Camber Spine (e); IMSE (b, d, g); Accelus Spine (b, g); Kuros (b, d); Intrinsic Therapeutics (d); NEO Spine (b, d); Regeltec (b, e); NuVasive (b, d); 3Spine (a, b, e)
Peter M. Obid, MD	Germany	AO Foundation (a)
Brooke K. O'Connell, MS	United States	No Relationships
Thierry A. Odent, MD, PhD	France	No Relationships
Leonardo Oggiano, MD	Italy	No Relationships
Yoji Ogura, MD	Japan	No Relationships
Kouhei Ohnishi, PhD	Japan	No Relationships
David O. Okonkwo, MD, PhD	United States	NuVasive (b, g); Zimmer Biomet (b, g)
Catherine Olinger, MD	United States	Globus Medical (b); Proprio (b)
Jarod Olson, BS	United States	No Relationships
Nicholas A. O'Malley, BS	United States	No Relationships
Yousi A. Oquendo, MD, MSE	United States	No Relationships
Lindsay Orosz, MS, PA-C	United States	No Relationships
Kirk Owens, MD	United States	Medtronic (a, b, g); NuVasive (b, g); Pfizer (a); Cerapedics (a); Biom'Up (a); Empirical Spine, Inc. (a); Stryker (a)
Stephane Owusu-Sarpong, MD	United States	No Relationships
Alp Ozpinar, MD	United States	No Relationships
Cagatay Ozturk, MD	Turkey	No Relationships
Joshua M. Pahys, MD	United States	DePuy Synthes (b); NuVasive (b); Zimmer Biomet (b)
Anthony Pajak, BS	United States	No Relationships
Ludovica Pallotta, MD	Italy	No Relationships
Woei Jack Pan, FRCSEd(Orth)	Singapore	No Relationships
Sung Cheol Park, MD	South Korea	No Relationships
Christine Park, BA	United States	No Relationships
Ann M. Parr, MD, PhD	United States	No Relationships
Gregory K. Paschal, MS	United States	No Relationships
Philip K. Paschal, MS	United States	No Relationships
Lara Passfall, BS	United States	No Relationships
Peter G. Passias, MD	United States	Zimmer Biomet (b); Allosource (g); CSRS (a); Globus Medical (g); Medtronic (b); SpineWave (b); Terumo (b); Cerapedics (b, g); SpineVision (a, b, g)
Neil Patel, MD	United States	No Relationships
Denis Patterson, MD	United States	Aurora Spine (a, b, d); Abbott Medical (a, b, d); Flowonix (a, b); Nevro (a); Saluda (a, b, d); AIS (b, d, e); Abbvie (b, d); Amgen (b, d); CornerLoc (b, c, d, e); Lundbeck (b, d); Pajunk Medical (b, d); Vertos (b, d, e)
Carl B. Paulino, MD	United States	No Relationships
Tuna Pehlivanoglu, MD	Turkey	No Relationships
Baris Peker, MD	Turkey	No Relationships
Brenton Pennicooke, MD, MS	United States	Cerapedics (e)
Erlick Pereira, MBBS	United Kingdom	No Relationships

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NAME	COUNTRY	DISCLOSURE(S)
Francisco Javier S. Perez-Grueso, MD	Spain	No Relationships
Gregory Perrier, BS	United States	No Relationships
Maty Petcharaporn, BS	United States	No Relationships
Thomas Pfandlsteiner, MD	Germany	No Relationships
Vy Pham, MD	United States	No Relationships
Stephen Plachta, MD	United States	No Relationships
David W. Polly Jr., MD	United States	SI Bone (b, g); Globus Medical (b, g); Medtronic (a); MizuhoOSI (a); Springer (g)
Selina C. Poon, MD	United States	Medtronic (d); DePuy Synthes (d)
Eric A. Potts, MD	United States	Medtronic (b, g)
Greg Poulter, MD	United States	Medtronic (a, b, e, g)
Mahmud Poznovich, MD	Russia	No Relationships
Anjali Prior, BA	United States	No Relationships
Dylan J. Proctor, BS	Australia	No Relationships
Themistocles S. Protopsaltis, MD	United States	Globus Medical (b); NuVasive (b); Stryker Spine (b); Medtronic (b); Altus (g); OnePoint Surgical (g); Medtronic (g)
Xiaojiang Pu, PhD	China	No Relationships
Andrew Pugely, MD	United States	Medtronic (a, b); Globus Medical (a, b, g); United Health Care (e)
Jun Qiao, PhD	China	No Relationships
Xiaodong Qin, PhD	China	No Relationships
Yong Qiu, MD	China	No Relationships
Yong Qiu, PhD	China	No Relationships
Theodore Quan, BS	United States	No Relationships
Alejandro Quinonez, BS	United States	No Relationships
Sheeraz Qureshi, MD	United States	AMOpportunities (g); Tissue Differentiation Intelligence (c); Globus Medical (b, d); SpineGuard, Inc. (b); Simplify Medical, Inc. (e); Minimally Invasive Spine Surgery Group (e); Paradigm Spine (b); Surgalign (b); Spinal Simplicity, LLC (e); Stryker Spine (b, g); Viseon, Inc. (a, b); HS2, LLC (c); Contemporary Spine Surgery (e); North American Spine Society (NASS) (e); Annals of Translational Medicine (ATM) - (e); Hospital Special Surgery Journal (e); Lumbar Spine Research Society (LSRS) (e); Cervical Spine Research Society (CSRS) (e); Association of Bone and Joint Surgeons (ABJS) (e); International Society for the Advancement of Spine Surgery (ISASS) (e)
Micheal Raad, MD	United States	No Relationships
Tina Raman, MD	United States	No Relationships
Namith Rangaswamy, MS	India	No Relationships
Jon Raso, BS	United States	No Relationships
Karl E. Rathjene	United States	Mati Theraputics (c)

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Sravisht Iyer, MD	United States	Globus Medical (b); Healthgrades (e); Innovasis (a); HS2, LLC (c); Stryker Spine (b)
Nolan Reinhart, BS	United States	No Relationships
Ann Richey	United States	No Relationships
Lee Riley, MD	United States	LifeNet Health (e)
Lawrence A. Rinsky, MD	United States	No Relationships
Guillame Riouallon, MD	France	Medtronic (b); Euros (b, d, e)
Joshua Rivera, BS	United States	No Relationships
Kyle Robinson, BS	United States	No Relationships
Luis Miguel Anton Rodrigalvarez, MD	Spain	No Relationships
Juan Carlos Rodriguez-Olaverri, MD	United States	No Relationships
Kenneth J. Rogers, PhD	United States	No Relationships
Benjamin D. Roye, MD, MPH	United States	No Relationships
Christina C. Rymond, BA	United States	No Relationships
Rodrigo Saad-Berreta,	United States	No Relationships
Priyanshu Saha, MBBS, BS	United Kingdom	No Relationships
Comron Saifi, MD	United States	NuVasive (b, c); Alphatec Spine (c); Restor3D (c)
Andrew A. Sama, MD	United States	DePuy Synthes (e, g); Ortho Development Corp (g); Centinel Spine (c); Spinal Kinetics, Inc. (a); Vestia Ventures MiRus Investment LLC (c); ISPH II LLC (c); Clariance, Inc. (b, e); ISPH 3 LLC (c); Kuros Biosciences AG (b, e); VBros Venture Partners X (c); Medical Device Business Services Inc (b)
Benjamin M. Sampedro,	United States	No Relationships
Solomon Samuel, D. Eng.	United States	No Relationships
James O. Sanders, MD	United States	OrthoPediatrics (b); Greensun (c); Tether Implant Corporation (g); GE (c); Abbott Labs (c); Abbvie (c)
Tunay Sanli, MA	Turkey	No Relationships
Zeeshan M. Sardar, MD	United States	Medtronic (b)
Michele Sarin, MS	United States	No Relationships
Sheryl Z. Sawe	China	No Relationships
Keith Scarfo, MD	United States	No Relationships
Justin K. Scheer, MD	United States	No Relationships
Jessica Schmerler, BS	United States	No Relationships
Grant Schmidt, MD	United States	No Relationships
Andrew J. Schoenfeld, MD	United States	AAOS (d); North American Spine Society (e); Journal of Bone and Joint Surgery (e); Springer (g); Wolters Kluwer Health (g)
Lindsay R. Schultz, BS, CCRP	United States	No Relationships
Frank J. Schwab, MD	United States	Mainstay Medical (b); International Spine Study Group (e); Zimmer Biomet (b, g); Medtronic (b, g); VFT Solutions, See Spine (c)
Joseph Schwab, MD	United States	No Relationships
Nicole A. Segovia	United States	No Relationships

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NAME	COUNTRY	DISCLOSURE(S)
Jonathan N. Sembrano, MD	United States	NuVasive (a); Orthofix (a)
Sahin Senay, MD	Turkey	No Relationships
Sergio Sessa, MD	Italy	No Relationships
Saman Shabani, MD	United States	No Relationships
Mark E. Shaffrey, MD	United States	No Relationships
Neil V. Shah, MD, MS	United States	No Relationships
Pratyush Shahi, MBBS, MS	United States	No Relationships
Hania Shahzad, MBBS	United States	No Relationships
Evan D. Sheha, MD	United States	No Relationships
Shubhankar Shekhar, MBBS	India	No Relationships
Niloufar Shekouhi, BS	United States	No Relationships
Francis H. Shen, MD	United States	Globus Medical (g); Medtronic (b, e); NuVasive (b); CarboFix (c); Musculoskeletal Transplant Foundation (e)
John T. Sherrill, PhD	United States	No Relationships
Brandon Sherrod, MD	United States	No Relationships
Benlong Shi, MD, PhD	China	No Relationships
Tomoyuki Shimono, PhD	Japan	No Relationships
Won Chul Shin, MD, PhD	South Korea	No Relationships
Dong Ah Shin, PhD	South Korea	No Relationships
M. Wade Shrader, MD	United States	No Relationships
Shibin Shu, PhD	China	No Relationships
Jennifer Shuee	United States	No Relationships
Harry L. Shufflebarger, MD	United States	Stryker Spine (b, d, g); OnPoint Surgical (e); SeaSpine (d)
Susan Sienko, PhD	United States	No Relationships
Devender Singh, PhD	United States	No Relationships
Varinder Singh Alg, MBBS	United Kingdom	No Relationships
Kumar Sinha, MD	United States	No Relationships
Richard L. Skolasky, PhD	United States	No Relationships
Jonathan R. Slotkin, MD	United States	No Relationships
John T. Smith, MD	United States	Globus Medical (b, g); NuVasive (b); OrthoPediatrics (b); GS Medical (b); Wishbone (b)
Nolan Smith, BS	United States	No Relationships
Ellen M. Soffin, MD, PhD	United States	No Relationships
Reuben C. Soh, MBBS, FRCS	Singapore	Medtronic (b, d); NuVasive (d)
Gbolabo Sokunbi, MD	United States	Stryker Spine (b); Camber (b)
Eric Solomon, BS	United States	No Relationships
Jan Sorensen, MS	Ireland	No Relationships
Paul Soriano, MD	United States	No Relationships
Alex Soroceanu, MD, FRCS(C), MPH	Canada	No Relationships
Jonathan Spilsbury, FRCS Tr & Orth	United Kingdom	No Relationships

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Paul D. Sponseller, MD, MBA	United States	DePuy Synthes (a, g); Globus Medical (g); OrthoPediatrics (g); NuVasive (b)
Parishkrita Srivastavae	United States	No Relationships
John Stokes, MD	United States	Genesys spine (g); Difusion (c); Summit Medventures (c)
Joseph D. Stone, MD	United States	No Relationships
European Spine Study Group	Spain	DePuy Synthes (a); Medtronic (a)
Harms Study Group	United States	DePuy Synthes (a); Alphatec Spine (a); NuVasive (a); Stryker Spine (a); Medtronic (a); POSNA (a); Washington University (a); FDA (a); Zimmer Biomet (a); CHU St. Justine's (a)
International Spine Study Group	United States	DePuy Synthes (a); Stryker Spine (a); Medtronic (a); Globus Medical (a); NuVasive (a); Orthofix (a); SI Bone (a); SeaSpine (a); Carlsmed (a)
Pediatric Spine Study Group	United States	NuVasive (a); DePuy Synthes (a); OrthoPediatrics (a); Zimmer Biomet (a); Medtronic (a); Globus Medical (a); Pediatric Spine Foundation (a); Stryker Spine (a); nView Medical (g); Boston Orthotics & Prosthetics (g); Pacira (g)
Rachel Su, BA	United States	No Relationships
Tejas Subramanian, BS	United States	No Relationships
Seoung Woo Suh, MD, PhD	South Korea	No Relationships
Se-Il Suk, MD, PhD	South Korea	No Relationships
Hamdi Sukkarieh, MD	United States	No Relationships
Xu Sun, MD	China	No Relationships
Satoshi Suzuki, MD, PhD	Japan	No Relationships
Caroline Taber, BS	United States	No Relationships
Shunya Takano, MS	Japan	No Relationships
Vishwas R. Talwalkar, MD	United States	No Relationships
Benita Tamrazi, MD	United States	No Relationships
Lee A. Tan, MD	United States	Medtronic (b); Stryker Spine (b); Accelus (b)
Soji Tani, MD, PhD	United States	No Relationships
Michael Tawil, BS	United States	No Relationships
Alekos A. Theologis, MD	United States	Alphatec Spine (b, g); DePuy Synthes (b); Stryker Spine (b); Ulrich Medical USA (e); Restor3D (b, e); Surgalign (b); Icotec (b); Carbofix (b)
Ravindra Thimmaiah, MD, FRCS Tr & Orth	United Kingdom	No Relationships
J. Alex Thomas, MD	United States	NuVasive (a, b, g); TrackX Technologies (b, c, f)
George H. Thompson, MD	United States	OrthoPediatrics (b, c, e, g)
Jeremy Thompson, MD	United States	No Relationships
Beverly Thornhill, MD	United States	No Relationships
Peter Tretiakov, BS	United States	No Relationships
Eeric Truumees, MD	United States	Stryker Spine (a, g); Medtronic (a)
Emily Tsange	United Kingdom	No Relationships
Olivia Tuma, BS	United States	No Relationships
Luis M. Tumialán, MD	United States	No Relationships

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CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Jay D. Turner, MD	United States	NuVasive (a, b); SeaSpine (a, b, g); Alphatec Spine (a, b)
Armagan C. Ulusaloglu, MD	United States	No Relationships
Onur Levent Ulusoy, MD	Turkey	No Relationships
Sara Van Nortwick, MD	United States	No Relationships
Eric S. Varley, DO	United States	No Relationships
Arya G. Varthi, MD	United States	No Relationships
Shaleen Vira, MD	United States	No Relationships
Michael S. Virk, MD, PhD	United States	DePuy Synthes (b); OnPoint Surgical (b); Brainlab Inc (b)
Keshin Visahan, BS	United States	No Relationships
Sergey Vissarionov, PhD	Russia	No Relationships
Michael G. Vitale, MD, MPH	United States	Zimmer Biomet (b, g); Stryker Spine (b)
Francesco Vommaro, MD	Italy	No Relationships
John S. Vorhies, MD	United States	Nview (c, e); Nsite (c, e)
Ardalan Seyed Vosoughi, PhD	United States	DePuy Synthes (f)
Sayed Wahezi, MD	United States	Abbott (a); Boston Scientific (a, b)
Arnaav Walia	United States	No Relationships
Sam Walters, MBBS	United Kingdom	No Relationships
Sandra H. Wane	China	No Relationships
Bin Wang, MD	China	No Relationships
Michael Y. Wang, MD	United States	Surgalign (b); Stryker Spine (b); DePuy Synthes (b, g); Spineology (b); ISD (c); Medical Device Partners (c); Kinesiometrics (c); Pacira (b)
Minghao Wang, MD, PhD	United States	No Relationships
Stephen F. Wendolowski, BS	United States	No Relationships
Jaques Williams, MD	United States	No Relationships
Tyler K. Williamson, MS, BS	United States	No Relationships
Bethany Wilson, BS	United States	No Relationships
Derron Wilson, MD	United States	Abbott (b, d, e); Biotronik (b, e)
Jason Woloff, BS	United States	No Relationships
Cynthis Wonge	United States	No Relationships
Chunyang Wu, MD	China	No Relationships
Hao-Hua Wu, MD	United States	No Relationships
Andrew G. Wue	Singapore	No Relationships
Hui Xu, MD	China	No Relationships
Jiang Xu, MD	China	No Relationships
Yanjie Xu, MD	China	No Relationships
Tugay Yagci, MD	Turkey	No Relationships
Kento Yamanouchi, MD	Japan	No Relationships
Tarek Yamout, MD	United States	No Relationships
Jae Hyuk Yang, MD, PhD	South Korea	No Relationships
Elizabeth L. Yanik, PhD	United States	No Relationships
Ziming Yao, PhD	China	No Relationships

If noted, the relationships disclosed are as follows: a – grants/research support; b – consultant; c – stock/shareholder (self-managed); d – speaker's bureau; e – advisory board or panel; f – employee, salary (commercial interest); g – other financial or material support (royalties, patents, etc.)

CONFLICT OF INTEREST DISCLOSURES

NAME	COUNTRY	DISCLOSURE(S)
Burt Yaszay, MD	United States	Stryker Spine (a, b, g); DePuy Synthes (a, b); NuVasive (a, b, g); Globus Medical (g); OrthoPediatrics (g); Biogen (b); Medtronic (b)
Yasemin Yavuz, PhD	Turkey	No Relationships
Inez Yeo, BS	Singapore	No Relationships
Samrat Yeramaneni, PhD	United States	No Relationships
Petya Yorgovae	United States	No Relationships
Altug Yucekul, MD	Turkey	No Relationships
Elizabeth Yu, MD	United States	Empirical Spine (a); AONA (d)
James J. Yue, MD	United States	Abbott Labs (a, b, d, e); Globus Medical (b); Royal Biologics (g); Aesculap SPine (b, g)
Jay Zaifman, BA	United States	No Relationships
William Zelenty, MD	United States	No Relationships
Xin Zhang, MD	China	No Relationships
Xue Jun Zhang, MD	China	No Relationships
Hong Zhang, MD	United States	Globus Medical (g)
Eric Zhao, BS	United States	No Relationships
Zhenhai Zhou, MD, PhD	China	No Relationships
Yitong Zhu, MD	China	No Relationships
Tais Zulemyan, MSc	Turkey	No Relationships

If noted, the relationships disclosed are as follows: a – grants/research support; b – consultant; c – stock/shareholder (self-managed); d – speaker's bureau; e – advisory board or panel; f – employee, salary (commercial interest); g – other financial or material support (royalties, patents, etc.)

15:00 - 18:00

Registration Open
The Forum Lobby

16:00 - 18:00

Concurrent Sessions | Cases & Cocktails 1-3

Cases & Cocktails 1: Vetebral Body Tethering
Wicklow Hall 1

Session Moderator: *Ahmet Alanay, MD*

Table Moderators: *Baron S. Lonner, MD, Firoz Miyanji, MD, Randal R. Betz, MD, Ron El-Hawary, MD, Stefan Parent, MD, PhD, & Per D. Trobisch, MD*

Cases & Cocktails 2: Adult Deformity
Wicklow Hall 2A

Session Moderator: *Eric O. Klineberg, MD*

Table Moderators: *Han Jo Kim, MD, Lawrence G. Lenke, MD, Ferran Pellisé, MD, PhD, Rajiv K. Sethi, MD, Kota Watanabe, MD, PhD, & Venu M. Nemani, MD, PhD*

Cases & Cocktails 3: Challenges in Cervical & Cervical Thoracic Deformity
Wicklow Hall 2B

Session Moderator: *Christopher P. Ames, MD*

Table Moderators: *Robert K. Eastlack, MD, Caglar Yilgor, MD, Benny T. Dahl, MD, PhD, DMSci, Amer F. Samdani, MD, Tyler Koski, MD, & Gregory M. Mundis Jr., MD*

18:00 - 20:00

Welcome Reception & Exhibitor Viewing
The Forum

A hosted reception featuring hors d'oeuvres, cocktails, exhibitor viewing and reunions with colleagues and friends. The Welcome Reception is included in the registration fee for all delegates. Dress for the Welcome Reception is business casual. If you have already registered and would like to add the Welcome Reception and/or purchase guest ticket(s), please visit the Registration Desk located in The Forum Lobby.

The Welcome Reception is supported, in part, by Globus Medical and NuVasive.

07:00 - 18:00

Registration Open
The Forum Lobby

08:00 - 09:00

Hands-On Workshops *(with breakfast)*
Liffey Hall 1 & Liffey Hall 2
For the full schedule, please refer to page 172.

09:00 - 17:15

Exhibit Hall Open
The Forum

09:00 – 09:30

Refreshment Break & Exhibit Viewing
The Forum

09:30 - 12:00

Session 1: Whitecloud Nominees & Keynote Address
The Liffey B

Moderators:	*Eric O. Klineberg, MD & Stefan Parent, MD, PhD*
09:30 - 09:35	Welcome Address *Stefan Parent, MD, PhD*
09:35 - 09:40	Paper #1: Incidence of Tether Breakage in Anterior Vertebral Body Tethering *Patrick J. Cahill, MD; Firoz Miyanji, MD; Brett Lullo, MD; Amer F. Samdani, MD; Baron S. Lonner, MD; Joshua M. Pahys, MD; Steven W. Hwang, MD; Lawrence L. Haber, MD; Ahmet Alanay, MD; Suken A. Shah, MD; Stefan Parent, MD, PhD; Laurel C. Blakemore, MD; Dan Hoernschemeyer, MD; Kevin M. Neal, MD; Harms Study Group; Peter O. Newton, MD†*
09:40 - 09:45	Paper #2: Coronal Decompensation Following Vertebral Tethering in Idiopathic Scoliosis *Yoji Ogura, MD; Michelle C. Welborn, MD; A. Noelle Larson, MD; Laurel C. Blakemore, MD; Firoz Miyanji, MD; Lindsay M. Andras, MD; Stefan Parent, MD, PhD; Ron El-Hawary, MD†*
09:45 - 09:50	Paper #3: Follow-Up Report on Prospective FDA IDE Study on Vertebral Body Tethering for Idiopathic Scoliosis *Amer F. Samdani, MD; Joshua M. Pahys, MD; Harsh Grewal, MD; Jason Woloff, BS; Alejandro Quinonez, BS; Emily Nice, BS; Solomon Samuel, D. Eng.; Steven W. Hwang, MD†*
09:50 - 09:59	Discussion
09:59 - 10:04	Paper #4: What is the Rate of MRI-Identified Degenerative Disc Disease in Adolescent Idiopathic Scoliosis? Does it Impact SRS-22 Scores? A Review of 968 Cases *Conor T. Boylan, MD, BS; Ravindra Thimmaiah, MD, FRCS Tr & Orth; George McKay, FRCS; Adrian C. Gardner, FRCS Tr & Orth; Matthew P. Newton Ede, FRCS Tr & Orth; Jwalant S. Mehta, FRCS (Orth), MCh (Orth), MS (Orth), D Orth; Jonathan Spilsbury, FRCS Tr & Orth; David S. Marks, FRCSOrth; Morgan Jones, FRCS**
10:04 - 10:09	Paper #5: Rotational Changes Following Use of Direct Vertebral Rotation in Adolescent Idiopathic Scoliosis: A Long Term Radiographic and Computed Tomography Evaluation *Dong-Gune Chang, MD, PhD; Lawrence G. Lenke, MD; Se-Il Suk, MD, PhD; Hong Jin Kim, MD; Jae Hyuk Yang, MD, PhD; Seoung Woo Suh, MD, PhD; Yunjin Nam, MD; Sung Cheol Park, MD**

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science/Translational Paper

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

10:09 - 10:14	Paper #6: Concave and Convex Growth do not Differ over Tethered Vertebral Segments, Even with Open Tri-Radiate Cartilage *Daniel Farivar, BS; Michael Heffernan, MD; Ron El-Hawary, MD; A. Noelle Larson, MD; Firoz Miyanji, MD; Stefan Parent, MD, PhD; Lindsay M. Andras, MD; Pediatric Spine Study Group; David L. Skaggs, MD, MMM†*
10:14 - 10:23	Discussion
10:23 - 10:28	Paper #7: What Are We Transfusing? A Prospective Trial Evaluating the Quality of Intraoperatively Salvaged Red Blood Cells in Spinal Deformity Surgery *David Kurland, MD, PhD; Daniel Alber, BS; Darryl Lau, MD**
10:28 - 10:33	Paper #8: Reoperation Rate after PSF Varies Significantly by Lenke Type *Peter Boufadel, BS; Baron S. Lonner, MD; Amer F. Samdani, MD; Joshua M. Pahys, MD; Suken A. Shah, MD; Paul D. Sponseller, MD, MBA†*
10:33 - 10:38	Paper #9: Decompression With or Without Fusion for Grade 1 Degenerative Lumbar Spondylolisthesis: 60-Month Outcomes From the QOD *Andrew K. Chan, MD; Erica F. Bisson, MPH; Mohamad Bydon, MD; Steven D. Glassman, MD; Kevin T. Foley, MD; Christopher I. Shaffrey, MD; Eric A. Potts, MD; Mark E. Shaffrey, MD; Domagoj Coric, MD; John J. Knightly, MD; Paul Park, MD; Michael Y. Wang, MD; Kai-Ming G. Fu, MD, PhD; Jonathan R. Slotkin, MD; Anthony L. Asher, MD; Michael S. Virk, MD, PhD; Vivian Le, MPH; Dean Chou, MD; Regis W. Haid Jr., MD; Praveen V. Mummaneni, MBA†*
10:38 - 10:47	Discussion
10:47 - 10:52	Paper # 10: The Incidence of Foetal Scoliosis and the chances of Successful Delivery *Sam Walters, MBBS; Ben Barkham, MBBS; Emily Tsang; Priyanshu Saha, MBBS, BS; Zion Hwang, MBBS, BS; Bisola Ajayi, PA-R; Varinder Singh Alg, MBBS; Ursalan Khan, MBBS; Mohamed Abdalla, MBBS; Shahnawaz Haleem, MBBS; Tesfaldet Kurban; Jason Bernard, MD, FRCS; Tim Bishop, FRCS; Darren F. Lui, FRCS**
10:52 - 10:57	Paper #11: Greater than 70% of LIV Selection is at L3 or Below in Early Onset Scoliosis. Is There Any Role for a More Selective Approach? *Michael J. Heffernan, MD; Claudia Leonardi, PhD; Lindsay M. Andras, MD; Bailli Fontenot, BS; G.Ying Li, MD; Luke C. Drake, MD; Joshua M. Pahys, MD; John T. Smith, MD; Peter F. Sturm, MD; Michael P. Glotzbecker, MD; Benjamin D. Roye, MPH; Pediatric Spine Study Group†*
10:57 - 11:02	Paper #12: Does a Dedicated "Scoliosis Team" and Surgical Standardization Improve Outcomes in Adolescent Idiopathic Scoliosis Surgery and Is It Reproducible? *Vishal Sarwahi, MD; Sayyida Hasan, BS; Keshin Visahan, BS; Yungtai Lo, PhD; Terry D. Amaral, MD; Jon-Paul P. DiMauro, MD**
11:02 - 11:11	Discussion
11:11 - 11:16	Paper #13: Effects on Clinical Outcomes and Analysis on Culture Positive Patients who Underwent Primary Lumbar Fusion *Philip K. Paschal, MS; Gregory K. Paschal, MS; Celeste Abjornson, PhD; Andrew A. Sama, MD; Federico P. Girardi, MD; Darren R. Lebl, MD; Frank P. Cammisa Jr, MD**
11:16 - 11:21	Paper #14: Trends and Rates of Reporting of Gender, Race, Ethnicity, and Other Socioeconomic Determinants of Health in Spine Surgery Randomized Clinical Trials *Eric Solomon, BS; Mihir Gupta, MD; Rachel Bronheim, MD; Rachel Su, BA; Nolan Reinhart, BS; Aditya Mittal, BS; Valentina Battistoni, BS; Miguel Cartagena Reyes, BS; Juan Silva Aponte, BS; Hamid Hassanzadeh, MD†*

Key: † = Whitecloud Award Nominee – Best Clinical Paper * = Whitecloud Award Nominee – Best Basic Science/Translational Paper

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

11:21 - 11:30	Paper #15: Cost-Effectiveness Analysis of Weight-Loss Programs Use in Obese Patients Undergoing Spinal Deformity Surgery *Juan Silva Aponte, BS; Miguel Cartagena Reyes, BS; Micheal Raad, MD; Amit Jain, MD†*
11:30 - 11:33	Discussion
11:33 - 11:36	Preview of 58th Annual Meeting | Seattle, Washington, USA *Rajiv K. Sethi, MD*
11:36 - 11:39	Preview of 31st IMAST | San Diego, California, USA *Eric O. Klineberg, MD & Per Trobisch, MD*
11:39 - 11:43	Introduction of the President *Marinus de Kleuver, MD, PhD*
11:43 - 12:00	Keynote Address *Serena S. Hu, MD*

12:00 - 12:15

Lunch Pick-Up
The Forum

12:15 - 13:15

Hands-On Workshops *(lunch pick-up available inside HOW rooms)*
Liffey Hall 1, Liffey Hall 2, Wicklow Hall 2A, Wicklow Hall 2B
For the full schedule, please refer to page 172.

13:15 - 13:45

Exhibit Viewing
The Forum

13:45 - 15:15

Concurrent Sessions 2A-B | Education Sessions
Session 2A: Culture of Innovation in Spine Surgery: Ideas, Execution & Adoption
The Liffey A

Moderators:	*Ahmet Alanay, MD, Neel Anand, MD, & Caglar Yilgor, MD*
13:45 - 13:54	Design Thinking and Innovation in Surgery: How to Navigate at Inflection Points *Christopher P. Ames, MD*
13:54 - 14:00	Discussion
14:00 - 14:09	A Framework for our Disclosures: Principles of Industry Partnership *Peter O. Newton, MD*
14:09 - 14:15	Discussion
14:15 - 14:24	Moving Research into Practice: Diffusion Patterns vs Evidence Development *Caglar Yilgor, MD*
14:24 - 14:30	Discussion
14:30 - 14:39	New Technology Adoption: Considerations and Implementation Strategies *Michelle C. Welborn, MD*
14:39 - 14:45	Discussion
14:45 - 14:54	Can We Preserve Patient Safety and Trust without Stifling Innovation? *Suken A. Shah, MD*
14:54 - 15:00	Discussion
15:00 - 15:15	Panel Interactive Discussion

Session 2B: Patient-Specific Approaches and Implants in Spine Surgery: 2023 vs 2033
The Liffey B

Moderators: *Rajiv K. Sethi, MD, & Eric O. Klineberg, MD*

13:45 - 13:50 Personalized Spine Care: Is it Here to Stay? What are the Main Considerations?
Rajiv K. Sethi, MD

13:50 - 14:00 Pre-Bent Anatomical Rods: A Demonstration & Pro/Con Discussion
Christopher J. Kleck, MD & Brian Hsu, MD

14:00 - 14:05 AI Algorithms in Support of Surgical Decisionmaking: Has AI Become Better Than Us?
Ferran Pellisé, MD, PhD

14:05 - 14:10 Patient-Specific Navigation in Spine Surgery: An Update on Robotics, Computer Assisted Surgery, and 3D Printed Technology
Jesse Shen, MD, PhD

14:10 - 14:15 Q & A

14:15 - 14:30 Global Perspectives Panel: Conundrums and Barriers to Adding New Patient-Specific Technology
Brian Hsu, MD, MD, Eric O. Klineberg, MD, Ferran Pellisé, MD, PhD, Gabriel Liu, FRCS(Orth), MSC, & Rajiv K. Sethi, MD

14:30 - 14:35 Augmented Reality: Is it Here Yet and How Will it Help Personalize Care?
Han Jo Kim, MD

14:35 - 14:40 Patient Genomics and Outcomes: Is the Future Now?
Christopher P. Ames, MD

14:40 - 14:45 Patient-Specific Preoperative Optimization: Let's Not Forget Mental Health
Venu M. Nemani, MD, PhD

14:45 - 14:50 Preoperative Optimization: Why Don't We Practice Before the Big Show?
Han Jo Kim, MD

14:50 - 15:00 Q & A

15:00 - 15:15 Panel: Neurosurgical vs. Orthopaedic Acceptance of New Patient Specific Technology
Han Jo Kim, MD, Tyler Koski, MD, Rajiv K. Sethi, MD, & Eric O. Klineberg, MD

15:15 - 15:45

Refreshment Break & Exhibit Viewing
The Forum

15:45 - 16:55

Concurrent Sessions 3A-B | Abstract Sessions

Session 3A: Miscellaneous (Tumor, Infection, Non-op, Other)
The Liffey A

Moderators: *Christopher P. Ames, MD & Rajiv K. Sethi, MD*

15:45 - 15:49 Paper #16: Validation of Traditional Prognosis Scoring Systems and SORG Nomogram for Predicting Survival of Spinal Metastasis Patients Undergoing Surgery
Pongsthorn Chanplakorn, MD; Chanthong Budsayavilaimas, MD; Pilan Jaipanya, MD; Chaiwat Kriwattanapong, MD; Gun Keorochana, MD; Pittavat Leelapattana, MD; Thamrong Lertudomphonwanit, MD

15:49 - 15:53 Paper #17: Survivorship Prediction in Spinal Oncology Patients by Oncologists is Reliable: Data from a Quaternary Metastatic Spinal Cord Compression MDT
Hassam Ahmed, BS; Kofi Cox, BS; Priyanshu Saha, MBBS, BS; Zion Hwang, MBBS, BS; Emily Tsang; Mehran Afshar, MBBS; Wing-Kin Liu, MBBS; Erlick Pereira, MBBS; Thamer Hamdan, MBBS; Bisola Ajayi, PA-R; Tesfaldet Kurban; Mohamed Abdalla, MBBS; Varinder Singh Alg, MBBS; Ursalan Khan, MBBS; Tim Bishop, FRCS; Jason Bernard, MD, FRCS; Darren F. Lui, FRCS

15:53 - 15:57 Paper #18: Can the SORG Machine Learning Algorithms Predict Rural Cohort Spinal Metastatic Disease Survival?
James Hall, MD; Michael Garneau, BS; Trevor Gulbrandsen, MD; Alex Coffman, BS; Cassim Igram, MD; Andrew Pugely, MD; Catherine Olinger, MD; Joseph Schwab, MD

15:57 - 16:08 Discussion

16:08 - 16:12 Paper #19: The Use of Carbon Fibre Implants in En Bloc Surgery and Separation Surgery for Radical Oncological Treatment of Spinal Oligometastatic Disease
Priyanshu Saha, MBBS, BS; Kofi Cox, BS; Emily Tsang; Zion Hwang, MBBS, BS; Disola Ajayi, PA-R; Mohamed Abdalla, MBBS; Varinder Singh Alg, MBBS; Ursalan Khan, MBBS; Tesfaldet Kurban, BSc; Shahnawaz Haleem, MBBS; Tim Bishop, FRCS; Jason Bernard, MD, FRCS; Darren F. Lui, FRCS

16:12 - 16:16 Paper #20: Experience of Spinal Oligometastatic Disease at a Quaternary Level 1 Spine Centre
Priyanshu Saha, MBBS, BS; Emily Tsang; Zion Hwang, MBBS, BS; Bisola Ajayi, PA-R; Tesfaldet Kurban; Mohamed Abdalla, MBBS; Varinder Singh Alg, MBBS; Ursalan Khan, MBBS; Shahnawaz Haleem, MBBS; Jason Bernard, MD, FRCS; Tim Bishop, FRCS; Darren F. Lui, FRCS

16:16 - 16:20 Paper #21: Pedagogy in Spine Surgery: Developing a Free and Open-access Virtual Simulator for Lumbar Pedicle Screws Placement.
Léonard Chatelain, MD; Marc Khalifeé, MD, MS; Guillame Riouallon, MD; Pierre Guigui, MD; Emmanuelle Ferrero, MD, PhD

16:20 - 16:31 Discussion

16:31 - 16:35 Paper #22: Clinical and Radiological Outcomes Between Anterior Lumbar Interbody Fusion with Percutaneous Pedicle Screw Fixation and Transforaminal Lumbar Interbody Fusion in the Treatment of High-Grade Isthmic Spondylolisthesis
Daniel Coban, MD; Stuart Changoor, MD; Conor J. Dunn, MD; Neil Patel, MD; Kumar Sinha, MD; Ki S. Hwang, MD; Michael J. Faloon, MD; Arash Emami, MD

16:35 - 16:39 Paper #23: Women in Spine Surgery
Kathryn Jurenovich, DO; Lisa Cannada, MD; Melissa Erickson, MD; Hania Shahzad, MBBS; Nazihah S. Bhatti, BS; Elizabeth Yu, MD

16:39 - 16:43 Paper #24: Assessing the Effects of Prehabilitation Protocols on Post-Operative Outcomes in Adult Cervical Deformity Surgery: Does Early Optimization Lead to Optimal Clinical Outcomes?
Peter Tretiakov, BS; Bailey Imbo, BA; Kimberly McFarland, BS; Pooja Dave, BS; Rachel Joujon-Roche, BS; Tyler K. Williamson, MS, BS; Jamshaid Mir, MD; Stephane Owusu-Sarpong, MD; Bassel G. Diebo, MD; Shaleen Vira, MD; Peter G. Passias, MD; Pawel P. Jankowski, MD

16:43 - 16:55 Discussion

Session 3B: Cervical Spine, Kyphosis and Lumbar Degenerative
The Liffey B

Moderators: *Praveen V. Mummaneni, MD, MBA & Tyler Koski, MD*

15:45 - 15:49 Paper #25: Can Baseline Disability Limit Clinical Improvement After Surgical Correction of Cervical Deformity?
Peter G. Passias, MD; Rachel Joujon-Roche, BS; Pooja Dave, BS; Peter Tretiakov, BS; Kimberly McFarland, BS; Jamshaid Mir, MD; Stephane Owusu-Sarpong, MD; Jordan Lebovic, MBA

15:49 - 15:53 Paper #26: Addressing Thoracic Secondary Drivers at the Onset of Corrective Realignment Surgery for Adult Cervical Deformities Allows for Maintained Alignment and Clinical Gains at Two Years
Peter G. Passias, MD; Peter Tretiakov, BS; Bailey Imbo, BA; Rachel Joujon-Roche, BS; Tyler K. Williamson, MS, BS; Pooja Dave, BS; Kimberly McFarland, BS; Jamshaid Mir, MD; Tomi Lanre-Amos, MD; Bassel G. Diebo, MD; Shaleen Vira, MD

15:53 - 15:57 Paper #27: Cervical Laminoplasty Versus Laminectomy and Posterior Spinal Fusion for Cervical Myelopathy: Propensity Matched Analysis of 24-Month Outcomes from the Quality Outcomes Database
Andrew K. Chan, MD; Christopher I. Shaffrey, MD; Christine Park, BA; Oren Gottfried, MD; Erica F. Bisson, MPH; Mohamad Bydon, MD; Anthony L. Asher, MD; Domagoj Coric, MD; Eric A. Potts, MD; Kevin T. Foley, MD; Michael Y. Wang, MD; Kai-Ming G. Fu, MD, PhD; Michael S. Virk, MD, PhD; John J. Knightly, MD; Scott Meyer, MD; Paul Park, MD; Cheerag D. Upadhyaya, MSc; Mark E. Shaffrey, MD; Luis M. Tumialán, MD; Jay D. Turner, MD; Giorgos Michalopoulos, MD; Brandon Sherrod, MD; Nitin Agarwal, MD; Dean Chou, MD; Regis W. Haid Jr., MD; Praveen V. Mummaneni, MBA

15:57 - 16:08 Discussion

16:08 - 16:12 Paper #28: The Impact of C3 Laminectomy on Cervical Sagittal Alignment in Cervical Laminoplasty: A Prospective, Randomized Controlled Trial Comparing Clinical and Radiological Outcomes between C3 Laminectomy with C4-C6 Laminoplasty and C3-C6 Laminoplasty
Jun-Hoe Kim, MD; Junghoon Han, MD; Taeshin Kim, MD; Chang-Hyun Lee, MD, MS; Chi Heon Kim, MD, PhD; Chun Kee Chung, MD, PhD

16:12 - 16:16 Paper #29: Proposal for a Treatment-oriented Classification System for Congenital Kyphosis in Children
Ziming Yao, PhD; Xue Jun Zhang, MD

16:16 - 16:20 Paper #30: Severe Kyphoscoliosis Patients with MRI Type III Spinal Cord at Apex: Does Preoperative Traction Improve Surgical Safety?
Wanyou Liu, MS; Benlong Shi, MD, PhD; Zhen Liu, PhD; Xu Sun, MD; Zezhang Zhu, PhD; Yong Qiu, PhD

16:20 - 16:31 Discussion

16:31 - 16:35 Paper #31: Nutrient Delivery by Controlled-release Microparticles Improves Autograft Performance in Rat Posterolateral Lumbar Spinal Fusion
Ting Cong, MD; Kyle W. Morse, MD; Janice Havasy, MD; Max Korsun, BS; Alexander Koo, BA; Sheeraz Qureshi, MD; Matthew E. Cunningham, MD, PhD

16:35 - 16:39 Paper #33: Effect of Systemic Teriparatide (PTH1-34) versus Placebo on Bone Mineral Density (BMD) after Lumbar Spinal Arthrodesis: A Secondary Analysis of a Randomized Clinical Trial
Astrid H. Gimbel, BS; Mikkel î Andersen, MD; Pernille Hermann, MD, PhD; Annette Bennedsgaard Jespersen, MD, PhD; Leah Y. Carreon, MD, MS

16:39 - 16:55 Discussion

16:55 - 17:15

Exhibit Viewing
The Forum

17:15 - 18:45

Session 4: 30 Years of Innovation: What Stuck and What Didn't?
The Liffey B
Moderators: *Stefan Parent, MD, PhD & Ahmet Alanay, MD*

17:15 - 17:20 Introduction
Stefan Parent, MD, PhD

17:20 - 17:30 Clinical Outcomes of Posterior VCR for Severe Deformity; What and for What Indications Should This Procedure be Reserved?
Lawrence G. Lenke, MD

17:30 - 17:34 Discussion

17:34 - 17:44 Five-year Clinical Results of Cervical Total Disc Replacement Compared with Anterior Discectomy and Fusion
Todd J. Albert, MD

17:44 - 17:48	Discussion
17:48 - 17:58	Outcomes of a Randomized Clinical Trial in Adults with Symptomatic Lumbar Scoliosis (ASLS); Should We Offer Surgical Treatment to Symptomatic Adults with Lumbar Scoliosis? *Justin Smith, MD, PhD*
17:58 - 18:02	Discussion
18:02 - 18:12	Use of MIS in Posterior Fusion for AIS- What Made Me Move Away From This Procedure? *Firoz Miyanji, MD*
18:12 - 18:16	Discussion
18:16 - 18:26	Sacro-Iliac Joint Fusions- Current Indications and Clinical Outcomes *Robert K. Eastlack, MD*
18:26 - 18:30	Discussion
18:30 - 18:40	Anterior vs. Posterior Approaches to the Spine: Is the Anterior Approach Finally Making a Comeback with VBT? *Randal R. Betz, MD*
18:40 - 18:44	Discussion
18:44 - 18:45	Conclusion/Final Words *Stefan Parent, MD, PhD*

08:00 - 17:00

Registration Open
The Forum Lobby

08:30 - 16:00

Exhibit Hall Open
The Forum

08:30 - 09:00

Refreshment Break & Exhibit Viewing
The Forum

09:00 - 11:00

Concurrent Sessions 5A-B | Abstract Sessions

Session 5A: AIS, Motion Preservation, Innovative Methods and Neuromuscular
The Liffey A

Moderators: *Lindsay M. Andras, MD & Laurel C. Blakemore, MD*

09:00 - 09:04 Paper #34: Adolescent Idiopathic Scoliosis (AIS) Surgery: Comparison between Adolescence and Adulthood in a Cohort of 495 Patients
Emmanuelle Ferrero, MD, PhD; Marc Khalifeé, MD, MS; Pierre Guigui, MD

09:04 - 09:08 Paper #35: Single-Stage Implant Exchange Provides Less Correction Loss with Better Patient-Reported Outcomes than Implant Removal Only Following Late Infections after Posterior Spinal Fusion for AIS
Gregory Benes, BS; Harry L. Shufflebarger, MD; Suken A. Shah, MD; Burt Yaszay, MD; Michelle Claire Marks, PT, MA; Peter O. Newton, MD; Paul D. Sponseller, MD, MBA

09:08 - 09:12 Paper #36: Anterior vs Posterior Spinal Fusion in Lenke Type 5 AIS Curves: Comparison of Health Related Quality of Life, Radiologic Outcomes and Assessment of the Degeneration of Unfused Segments (MRI Study) - Mean 13 Years Follow up
Hamisi M. Mraja, MD; Baris Peker, MD; Halil Gok, MD; Celaleddin Bildik, MD; Ayhan Mutlu, MD; Onur Levent Ulusoy, MD; Tunay Sanli, MA; Selhan Karadereler, MD; Meric Enercan, MD; Azmi Hamzaoglu, MD

09:12 - 09:24 Discussion

09:24 - 09:28 Paper #37: Vertebral Body Tethering in Lenke 5 and 6 AIS: Radiographic Outcomes in Selective Vs. Non-Selective VBT
Noor Maza, MD; Lily Q. Eaker, BA; Baron S. Lonner, MD

09:28 - 09:32 Paper #38: Unilateral Thoracic Spinal Nerve Resection Causes Idiopathic-Like Thoracic Scoliosis in an Immature Porcine Model
Hong Zhang, MD; Daniel J. Sucato, MD, MS

09:32 - 09:36 Paper #39: Assessment of Cessation of Growth in Idiopathic Scoliosis: Radiographic Measures, Biologic Measures and More
Michelle C. Welborn, MD; Amer F. Samdani, MD; James O. Sanders, MD; Vishwas R. Talwalkar, MD; Robert H. Cho, MD; Selina C. Poon, MD; Ryan Coghlan, MS; Joseph D. Stone, MD; Susan Sienko, PhD

09:36 - 09:48 Discussion

09:48 - 09:52 Paper #40: Three-Dimensional Spine Growth is Maintained 5 Years Post-Operative Thoracic Vertebral Body Tethering Surgery in Idiopathic Scoliosis
Sharan T. Achar, MS; Umesh P. Kanade, MS; Harith B. Reddy, MS; Vigneshwara M. Badikillaya, MD; Sajan K. Hegde, MD; Mathieu Boulet, MD

09:52 - 09:56 Paper #41: Comparison of of Free-hand Technique and Use of Intraoperative Navigation for Pedicle Screw Placement in the Lumbar Spine: A Prospective, Randomized Controlled Trial
Bhavuk Garg, MS; Nishank Mehta, MS; Shubhankar Shekhar, MBBS; Shrijith MB, MD; Tungish Bansal, MS; Namith Rangaswamy, MS

09:56 - 10:12 Discussion

10:12 - 10:16 Paper #43: Mortality in Cerebral Palsy Patients with Scoliosis With and Without Spinal Deformity Surgery - A Registry-based Investigation
Matti Ahonen, MD, PhD; Ilkka J. Helenius, MD, PhD; Mika Gissler, PhD; Ira Jeglinsky-Kankainen, PhD

10:16 - 10:20 Paper #44: Mid-term Outcome of Multimodal Treatment for Severe Spinal Deformity in Osteogenesis Imperfecta: Minimum Two Years Follow-up
Yusuke Hori, MD, PhD; Tyler C. McDonald, MD; Kenneth J. Rogers, PhD; Petya Yorgova; Irene Li, MS; Michael Bober, MD; Richard Kruse, MD; Jeanne M. Franzone, MD; Suken A. Shah, MD

10:20 - 10:24 Paper #45: Why are we Fixing the Spine? Surgeon and Caregiver Answers on the Goals of Surgery for Patients with CP Scoliosis
Ali Asma, MD; Armagan C. Ulusaloglu, MD; Petya Yorgova; Irene Li, MS; Patrick J. Cahill, MD; Keith Baldwin, MD, MPH, MSPT; Paul D. Sponseller, MD, MBA; Burt Yaszay, MD; M. Wade Shrader, MD; Harms Study Group; Suken A. Shah, MD

10:24 - 10:36 Discussion

10:36 - 10:40 Paper #46: Minimally Invasive Surgery in Patients with Adolescent Idiopathic Scoliosis is Safer, Less Expensive with Better Restoration of Kyphosis
Vishal Sarwahi, MD; Sayyida Hasan, BS; Jesse M. Galina, BS; Aaron M. Atlas, BS; Alexandre Ansorge, MD; Charlotte De Bodman, MD; Yungtai Lo, PhD; Terry D. Amaral, MD; Romain Dayer, MD

10:40 - 10:44 Paper #47: The Learning Curve of Minimally Invasive Surgery (MIS) in Adolescent Idiopathic Scoliosis (AIS)
Vishal Sarwahi, MD; Sayyida Hasan, BS; Keshin Visahan, BS; Alexandre Ansorge, MD; Charlotte De Bodman, MD; Yungtai Lo, PhD; Terry D. Amaral, MD; Romain Dayer, MD

10:44 - 10:48 Paper #48: Which is Better: Percutaneous or Open Robot-Assisted Spine Surgery? Prospective, Multicenter Study of 2,524 Screws in 336 patients
Nathan J. Lee, MD; Lindsay Orosz, MS, PA-C; Christopher R. Good, MD; Greg Poulter, MD; Ehsan Jazini, MD; Colin Haines, MD; Jeffrey L. Gum, MD; Ronald A. Lehman, MD

10:48 - 11:00 Discussion

Session 5B: Adult Spinal Deformity and Quality, Safety, Value, Complications
The Liffey B

Moderators: *Ferran Pellise, MD, PhD & Justin S. Smith, MD, PhD*

09:00 - 09:04 Paper #49: A Parameter Fixed to Poor Outcomes?: A Detailed Analysis of High Pelvic Incidence in Adult Spinal Deformity Surgery
Peter G. Passias, MD; Bailey Imbo, BA; Jamshaid Mir, MD; Kimberly McFarland, BS; Peter Tretiakov, BS; Pooja Dave, BS; Rachel Joujon-Roche, BS; Stephane Owusu-Sarpong, MD; Tyler K. Williamson, MS, BS; Jordan Lebovic, MBA; Bassel G. Diebo, MD; Shaleen Vira, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Justin S. Smith, MD, PhD

09:04 - 09:08 Paper #50: Maintenance of Pelvic Tilt Normalization following Adult Spinal Deformity Corrective Surgery: Analysis of Prevalence, Timing, and Predictors Influencing Occurrence
Peter G. Passias, MD; Pooja Dave, BS; Peter Tretiakov, BS; Jamshaid Mir, MD; Kimberly McFarland, BS; Stephane Owusu-Sarpong, MD; Jordan Lebovic, MBA; Andrew J. Schoenfeld, MD

09:08 - 09:12 Paper #51: What's Next: A Hierarchical Order to Surgical Planning for Age-Adjusted Correction of Adult Spinal Deformity
Peter G. Passias, MD; Tyler K. Williamson, MS, BS; Stephane Owusu-Sarpong, MD; Rachel Joujon-Roche, BS; Pooja Dave, BS; Peter Tretiakov, BS; Bailey Imbo, BA; Jamshaid Mir, MD; Kimberly McFarland, BS; Jordan Lebovic, MBA; Shaleen Vira, MD; Bassel G. Diebo, MD; Renaud Lafage, MS; Virginie Lafage, PhD

09:12 - 09:24 Discussion

09:24 - 09:28 Paper #52: Adult Spinal Deformity Surgery Associated with Thromboembolic Disease: An Analysis of Over 8,500 Spinal Deformity Patients
Daniel O. Gallagher, BS; Takashi Hirase, MD; Kevin Bondar, MD; Jacob Harris, BS; Philip K. Louie, MD; Arya G. Varthi, MD; Comron Saifi, MD

09:28 - 09:32 Paper #53: Failure of Nonoperative Care in Adult Symptomatic Lumbar Scoliosis: Incidence, Timing, and Risk Factors for Conversion from Nonoperative to Operative Treatment
John C. Clohisy, MD; Michael P. Kelly, MD; Elizabeth L. Yanik, PhD; Vy Pham, MD; Justin S. Smith, MD, PhD; Han Jo Kim, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Christine Baldus, RN; Keith H. Bridwell, MD

09:32 - 09:36 Paper #54: An Analysis of the Capabilities and Utilization of Artificial Intelligence in Adult Spinal Deformity Surgery
Peter G. Passias, MD; Bailey Imbo, BA; Kimberly McFarland, BS; Pooja Dave, BS; Jamshaid Mir, MD; Peter Tretiakov, BS; Tyler K. Williamson, MS, BS; Rachel Joujon-Roche, BS; Lara Passfall, BS; Oscar Krol, BS; Bassel G. Diebo, MD; Shaleen Vira, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Alan H. Daniels, MD; Andrew J. Schoenfeld, MD; Stephane Owusu-Sarpong, MD; Jordan Lebovic, MBA; Justin S. Smith, MD, PhD; Pawel P. Jankowski, MD

09:36 - 09:48 Discussion

09:48 - 09:52 Paper #55: Persistent Lower Extremity Compensation for Sagittal Imbalance Following Surgical Correction of Complex Adult Spinal Deformity: A Radiographic Analysis of Early Impact
Tyler K. Williamson, MS, BS; Peter G. Passias, MD; Justin S. Smith, MD, PhD; Renaud Lafage, MS; Breton G. Line, BS; Rachel Joujon-Roche, BS; Peter Tretiakov, BS; Oscar Krol, BS; Bassel G. Diebo, MD; Alan H. Daniels, MD; Jeffrey L. Gum, MD; Themistocles S. Protopsaltis, MD; D. Kojo Hamilton, FAANS; Alex Soroceanu, MPH; Justin K. Scheer, MD; Robert K. Eastlack, MD; Gregory M. Mundis Jr., MD; Michael P. Kelly, MD; Pierce D. Nunley, MD; Eric O. Klineberg, MD; Han Jo Kim, MD; Khaled M. Kebaish, MD; Stephen J. Lewis, MD, FRCS(C); Richard Hostin, MD; Munish C. Gupta, MD; Lawrence G. Lenke, MD; Christopher P. Ames, MD; Douglas C. Burton, MD; Christopher I. Shaffrey, MD; Virginie Lafage, PhD; Frank J. Schwab, MD; Shay Bess, MD; International Spine Study

09:52 - 09:56 Paper #56: 90-Day Complication and Revision Surgery Rates Using Navigated Robotics in Thoracolumbar Spine Surgery
Lindsay Orosz, MS, PA-C; Nathan J. Lee, MD; Tarek Yamout, MD; Jeffrey L. Gum, MD; Ronald A. Lehman, MD; Greg Poulter, MD; Colin Haines, MD; Ehsan Jazini, MD; Christopher R. Good, MD

09:56 - 10:00 Paper #57: The Cranial Sagittal Vertical Axis to the Hip (CrSVA-H) is the Best Sagittal Alignment Predictor of Patient Reported Outcomes at 2 Years Postoperative in Adult Spinal Deformity Surgery
Christopher Lai, BS; Sarthak Mohanty, BS; Fthimnir Hassan, MPH; Caroline Taber, BS; Jaques Williams, MD; Nathan J. Lee, MD; Zeeshan M. Sardar, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

10:00 - 10:12 Discussion

10:12 - 10:16 Paper #58: Impact of Smoking Status on Early and Late Outcomes after Adult Spinal Deformity Surgery
Tina Raman, MD; Themistocles S. Protopsaltis, MD

10:16 - 10:20 Paper #59: Factors Associated with Sagittal Malalignment Reoccurrence after Pedicle Subtraction Osteotomy
Tina Raman, MD; Themistocles S. Protopsaltis, MD

10:20 - 10:24 Paper #60: Propensity Score Matched (PSM) Study Comparing Patient Reported (PROs) and Clinical Outcomes Among Patients who Achieved PI-LL(PILL)<10 versus PI-LL>10
Sarthak Mohanty, BS; Christopher Lai, BS; Fthimnir Hassan, MPH; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

10:24 - 10:36 Discussion

10:36 - 10:40 Paper #61: Frailty Stratification Using the Modified 5-item Frailty Index: Significant Variation within Frailty Patients in Elective Spine Surgery.
Gaston Camino-Willhuber, MD; Henryk Haffer, MD; Maximilian Muellner, MD; yusuke dodo, MD; Soji Tani, MD, PhD; Erika Chiapparelli, MD; Michele Sarin, MS; Jennifer Shue; Ellen M. Soffin, MD, PhD; William Zelenty, MD; Gbolabo Sokunbi, MD; Darren R. Lebl, MD; Federico P. Girardi, MD; Frank P. Cammisa Jr, MD; Alexander P. Hughes, MD; Andrew A. Sama, MD

10:40 - 10:44 Paper #62: PROMIS Anxiety and Sleep Scores are Associated with High Barriers to Proper Opioid Use After Adult Spinal Deformity
Kevin C. Mo, BS; Oscar Covarrubius, BS; Arjun Gupta, BS; Christa LiBrizzi, MD; Farah Musharbash, MD; Micheal Raad, MD; Lee Riley, MD; Khaled M. Kebaish, MD; Brian J. Neuman, MD

10:44 - 10:48 Paper #63: A Multidisciplinary Approach Does not Discriminate Based on Socioeconomic Factors for Patients with Adult Spinal Deformity
Caroline E. Drolet, PhD; Jesse Shen, MD, PhD; Venu M. Nemani, MD, PhD; Comron Saifi, MD; Jean-Christophe A. Leveque, MD; Rajiv K. Sethi, MD; Philip K. Louie, MD

10:48 - 11:00 Discussion

11:15 - 11:30

Lunch Pick-Up
The Forum

11:30 - 12:30

Hands-On Workshops *(lunch pick-up available inside HOW rooms)*
Liffey Hall 1, Liffey Hall 2, Wicklow Hall 2A, Wicklow Hall 2B
For the full schedule, please refer to page 173.

12:30 - 12:45

Exhibit Viewing
The Forum

12:45 - 14:15

Concurrent Sessions 6A-B | Education Sessions
Session 6A: Non-Fusion Surgical Treatment for AIS: Expanding the Portfolio
The Liffey A

Moderator: *Per D. Trobisch, MD*

12:45 - 12:48 Introduction from Chair
Per D. Trobisch, MD

12:48 - 12:58 What are the Optimal Indications for Growth Modulation to Work?
Michelle C. Welborn, MD

12:58 - 13:08 Still Pushing The Limits, Or Normal Evolution of a New Technique?
Baron S. Lonner, MD

13:08 - 13:18 The Optimal Indications Based on My Clinical Practice – Lessons Learned From 10 Years of Performing VBT?
Hee-Kit Wong, FRCS

13:18 - 13:30 Discussion

13:30 - 13:40 Self-Distracting Posterior-Based Devices; Indications, Early Results, and Pearls
Ron El-Hawary, MD

13:40 - 13:50 Selective PSF and Lumbar VBT? What are the Early Clinical Outcomes?
Firoz Miyanji, MD

13:50 - 14:00 Revision Strategies Following VBT
Per D. Trobisch, MD

14:00 - 14:12 Discussion

14:12 - 14:15 Final Words from Chair
Michelle C. Welborn, MD

Session 6B: Patient-Focused MIS
The Liffey B

Moderators: *Peter G. Passias, MD, Robert K. Eastlack, MD, Corey T. Walker, MD & Michael J. Faloon, MD*

12:45 - 12:54 Using An Algorithmic Approach to Tackle Minimally Invasive Deformity Operations
Praveen V. Mummaneni, MD, MBA

12:54 - 13:03 MIS Deformity Home Runs and Strikeouts
Robert K. Eastlack, MD

13:03 - 13:08 Discussion

13:08 - 13:17 Identification of the Ideal Candidate for Prone Lateral Single-Position Circumferential Fusion
Corey T. Walker, MD

13:17 - 13:26 Lumbosacral Junction Options and Approaches for Optimal Sagittal Correction
Ferran Pellisé, MD, PhD

13:26 - 13:35 But What About the Long-Term Complications? Will we see more PJK, Rod Fractures, and/or Mechanical Complications?
Elizabeth L. Lord, MD

13:35 - 13:40 Discussion

13:40 - 13:43 Case Presentation Debate: Severe Coronal Plane Imbalance (Type C Curve With Coronal Shift)
Corey T. Walker, MD

13:43 - 13:52 Debater 1: MIS Gets It Done
Neel Anand, MD

13:52 - 14:01 Debater 2: Open Gets It Done
Gregory M. Mundis Jr., MD

14:01 - 14:15 Discussion

14:15 - 14:30

Exhibit Viewing
The Forum

14:30 - 15:30

Hands-On Workshops *(with snacks & coffee)*
Liffey Hall 1, Wicklow Hall 2B
For the full schedule, please refer to page 173.

15:30 - 16:00

Exhibit Viewing & Refreshment Break
The Forum

16:00 - 17:35

Session 7: Expert Techniques
The Liffey B

Moderator: *Stefan Parent, MD, PhD*

16:00 - 16:05 Presentation of the Whitecloud Award Winning Paper

16:05 - 16:10 Introduction
Stefan Parent, MD, PhD

16:10 - 16:20 How I Perform a VBT? Tips, Tricks, and Master Techniques
Amer F. Samdani, MD

16:20 - 16:25	Discussion
16:25 - 16:35	Cervico-Thoracic VCR *Christopher P. Ames, MD*
16:35 - 16:40	Discussion
16:40 - 16:50	Cervical Pedicle Screws *Kota Watanabe, MD, PhD*
16:50 - 16:55	Discussion
16:55 - 17:05	High-Grade Spondylolisthesis Reduction *Daniel J. Sucato, MD, MS*
17:05 - 17:15	MIS Anterior Scoliosis Correction- Combined All Prone *Jason Cheung*
17:15 - 17:20	Discussion
17:20 - 17:35	Conclusion *Stefan Parent, MD, PhD*

19:00 - 21:00

Innovation Celebration

A reception offering food & beverages to celebrate the conclusion of sessions and lead attendees into Innovation Day on Saturday hosted by SRS Industry Supporters. The celebration will take place at *EPIC: The Irish Emigration Museum* and will offer all attendees an opportunity to connect with peers, reflect on the meeting, celebrate innovation and explore the museum. Open to all registered attendees and guests of registered attendees. Registration is required and tickets must be purchased in advance. Tickets are $10 USD for registered attendees and guest tickets may be purchased for $175 USD, per guest. A limited number of tickets may be available onsite. If you have already registered and would like to add the Innovation Celebration and/or purchase guest ticket(s), please visit the Registration Desk located in The Forum Lobby.

SATURDAY, MARCH 25, 2023

INNOVATION DAY

Hosted by SRS Industry Partners. Please refer to the IMAST website

PODIUM PRESENTATION ABSTRACTS

1. INCIDENCE OF TETHER BREAKAGE IN ANTERIOR VERTEBRAL BODY TETHERING

Patrick J. Cahill, MD; Firoz Miyanji, MD; Brett Lullo, MD; Amer F. Samdani, MD; Baron S. Lonner, MD; Joshua M. Pahys, MD; Steven W. Hwang, MD; Lawrence L. Haber, MD; Ahmet Alanay, MD; Suken A. Shah, MD; Stefan Parent, MD, PhD; Laurel C. Blakemore, MD; Dan Hoernschemeyer, MD; Kevin M. Neal, MD; Harms Study Group; Peter O. Newton, MD

Hypothesis
The incidence of tether breakage in AVBT is hypothesized to be high and increase with time postoperatively.

Design
Retrospective review of a retrospective, multi-center database

Introduction
AVBT is an emerging treatment for AIS. Limited evidence exists regarding complications of AVBT. Specifically, tether breakage is a known complication with unknown incidence. We aim to define the incidence of tether breakage in AIS patients that undergo AVBT.

Methods
All patients with right-sided, thoracic curves who underwent AVBT with at least 2 and up to 3 years of radiographic follow-up were included. The screw angulation at each instrumented vertebra was used to calculate the adjacent screw angle between each level. Any increase in adjacent screw angle > 5° from the minimum over the period of available radiographic follow-up signified a tether breakage between two levels. Presence and timing of tether breakage was noted for each level. The lowest segment was not analyzed as this level is often purposely left untensioned. Comparisons were made between identified breakages using our method and surgeon reported suspected breakages within the database. A Kaplan-Meier survival analysis was performed to calculate expected tether breakage up to 36 months.

Results
208 patients from 10 centers were included in our review. The overall incidence of tether breakage was 36% (75 cases). Surgeons reported suspected breakage within the database in only 28 of 75 (37%) cases identified using our method. Of these 28 cases of suspected breakage, 21 were treated with observation (75%), 4 with tether revision (14%), and 3 with conversion to PSF (11%). Of patients with tether breakage, 76% had breakage identified at only 1 level, 21% at 2 levels, and 3% at 3 levels. The level of the initial breakage occurred most commonly at T9-T10 (29%) and below the apex (72%). The timing of the initial break occurred most commonly at or beyond 24 months. The cumulative rate of expected tether breakage was 19% at 24 months and increased to 50% at 36 months. Cases with identified tether breakage ultimately required conversion to PSF for any reason more often than cases without (12% vs 2%; p = 0.004).

Conclusion
The incidence of tether breakage in AVBT is high, expected to occur in 50% of patients by 36 months post-op, yet the breakage is unreported 63% of the time. Patients with tether breakage required conversion to PSF for any reason more often than those without (p=0.003).

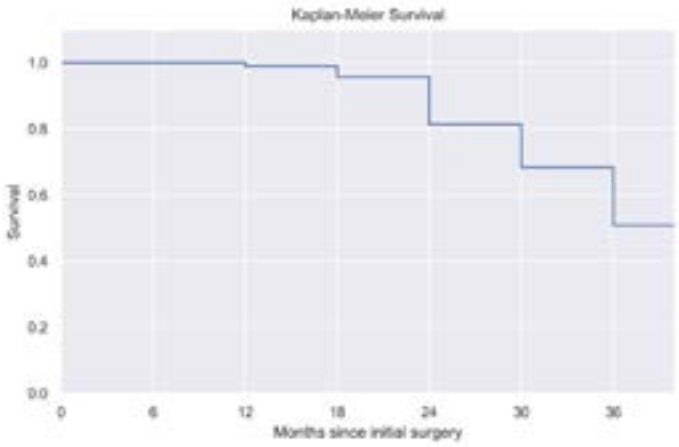


Figure 1: Kaplan-Meier survival analysis estimating expected tether breakage.

2. CORONAL DECOMPENSATION FOLLOWING VERTEBRAL TETHERING IN IDIOPATHIC SCOLIOSIS

Yoji Ogura, MD; Michelle C. Welborn, MD; A. Noelle Larson, MD; Laurel C. Blakemore, MD; Firoz Miyanji, MD; Lindsay M. Andras, MD; Stefan Parent, MD, PhD; Ron El-Hawary, MD

Hypothesis
The purpose of this study is to evaluate changes in the thoracic and thoracolumbar curves and truncal balance in patients treated with selective thoracic AVBT and the risk of CD at minimum of 2-year follow-up

Design
Retrospective review of prospective multicenter database from a large pediatric spine registry

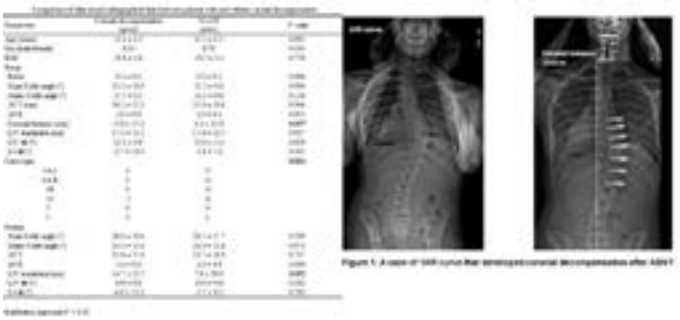
Introduction
Post-operative CD continues to be a challenge in the treatment of Lenke 1A-R curves. When treated with

thoracic fusion, Lenke 1AR curves are 2x more likely to add on than 1A-L curves. Because fusion to the last substantially touched level typically requires extension into the upper lumbar spine, patients with Lenke 1A-R curves may be better candidates for motion preserving surgeries such as Anterior Vertebral Body Tethering (AVBT). However, there is currently little information regarding level selection in AVBT. This lack of consensus on level selection may be contributing to the current reoperation rates of 16-44%, often due to adding on and lumbar curve progression. Thus, the goal of this study is to better understand the risk factors for CD after AVBT.

Methods
Radiographic parameters including Cobb angle, LIV tilt, LIV translation, L4 tilt, coronal balance were measured. CD was defined as the distance between C7PL and CSVL >2cm. Multiple logistic regression model yielding odds ratios (ORs) and 95% confidence intervals (CIs) was used to identify significant predictors of CD. Variables with a P value <.05 in univariate analyses were entered into the multiple logistic regression model. Inclusion criteria were >2 year follow-up, LIV was L1 or above, skeletally immature Risser 1 or less, preoperative and final follow-up AP and lateral upright radiographs were available.

Results
Out of 136 pts undergoing AVBT, 94 (86 female and 6 male) met the inclusion criteria. Mean age at surgery was 12.1 and mean follow-up was 41.0 months. Major and minor curves, AVR, coronal balance, LIV translation, LIV tilt, L4 tilt were significantly improved after surgery (Table). CD occurred in 11%.Preop coronal balance was significantly different between pts with and without CD. Lenke 1A-R (27%) and 1C (26%) curves had greater incidence of CD compared to 1A-L (4%), 2 (0%), and 3 (0%). LIV selection was not significantly different between pts with and without CD.

Conclusion
Lenke 1A-R and 1C curve types were risk factors for CD which occurred in 11% of our AVBT pts. There were no other preoperative predictors associated with CD.



3. FOLLOW-UP REPORT ON PROSPECTIVE FDA IDE STUDY ON VERTEBRAL BODY TETHERING FOR IDIOPATHIC SCOLIOSIS

Amer F. Samdani, MD; Joshua M. Pahys, MD; Harsh Grewal, MD; Jason Woloff, BS; Alejandro Quinonez, BS; Emily Nice, BS; Solomon Samuel, D. Eng.; Steven W. Hwang, MD

Hypothesis
VBT is safe and effective

Design
Retrospective review of a prospective data set

Introduction
Vertebral body tethering (VBT) is an alternative treatment option for patients with idiopathic scoliosis. We present the latest results from the first prospective U.S. Food and Drug Administration (FDA) Investigational Device Exemption (IDE) study on VBT.

Methods
Eligible patients underwent VBT at a single center from August 2011 to July 2015. Inclusion criteria included skeletally immature patients with Lenke type 1A or 1B curves between 30° and 65°. Clinical, radiographic, and reoperation data were collected. An independent reviewer measured the radiographic parameters.

Results
57 subjects (49 girls and 8 boys, age 12.4 ± 1.3 years), were followed for an average of 71.7 months (range, 43.6 to 115.2). The main thoracic coronal curve angle was a mean of 40.4° ± 6.8° preoperatively and was corrected to 21.2° ± 14° at the most recent follow-up. In the sagittal plane, T5-T12 kyphosis measured 15.5° ± 10.0° preoperatively, 17.0° ± 10.1° postoperatively, and 18.9° ± 13° at the most recent follow-up. 78.5% of patients (44 out of 56) had curves of ≤30° at the most recent follow-up. The mean Risser grade was 4.96 ± 0.19 at the time of the latest follow-up. The most recent SRS scores averaged 4.5 ± 0.4, and scores on the self-image questionnaire averaged 4.4 ± 0.7. No major neurologic or pulmonary complications occurred. 10/57 patients (17.5%) had a revision or

reoperation: 5 were done for overcorrection, 3 for adding-on, 1 for spondylolisthesis, and 1 for bone screw migration. 42 subjects had both pre-op and ≥2 year post-op follow-up pulmonary function data. The mean % predicted FEV1 and % predicted FVC for pre-op were 84.7% and 87.0%. The mean % predicted FEV1 and % predicted FVC for follow-up >2 years post-op were 79.5% and 80.6%, respectively.

Conclusion
VBT has emerged as a treatment option for patients with immature idiopathic scoliosis. We present updated results from the first FDA-approved IDE study on VBT, which formed the basis for the eventual Humanitarian Device Exemption approval. The continued findings affirm the safety and efficacy of VBT and suggest opportunities for improvement, particularly with respect to reoperation rates.

4. WHAT IS THE RATE OF MRI-IDENTIFIED DEGENERATIVE DISC DISEASE IN ADOLESCENT IDIOPATHIC SCOLIOSIS? DOES IT IMPACT SRS-22 SCORES? A REVIEW OF 968 CASES

Conor T. Boylan, MD, BS; Ravindra Thimmaiah, FRCS Tr & Orth; George McKay, FRCS; Adrian C. Gardner, FRCS Tr & Orth; Matthew P. Newton Ede, FRCS Tr & Orth; Jwalant S. Mehta, FRCS (Orth), MCh (Orth), MS (Orth), D Orth; Jonathan Spilsbury, FRCS Tr & Orth; David S. Marks, FRCSOrth; Morgan Jones, FRCS

Hypothesis
We hypothesise that rates of degenerative disc disease (DDD) in non-operative patients will be lower than those post-surgery and that DDD will adversely affect SRS-22 scores.

Design
Retrospective chart and MRI review at a single tertiary centre.

Introduction
There remains uncertainty regarding the long-term impact of spinal fusion on intervertebral disc degeneration rates and DDD in unfused caudal spinal segments in adolescent idiopathic scoliosis (AIS). Several studies report the rate of DDD to be high after corrective surgery, but no studies provide a reliable baseline of its prevalence in non-operative patients. Additionally, few studies satisfactorily correlate DDD with patient-reported outcome scores. We aimed to report the rate and severity of MRI findings of DDD in non-surgical AIS patients and correlate these findings with SRS-22 scores. Additionally, we aimed to quantify the rate of concurrent pathological radiological findings in this group.

Methods
All AIS patients aged 10-16 who had received a whole spine MRI between September 2007 and January 2019 and who had not received surgical intervention to their spine were included. MRI scans identifying DDD were reviewed by a blinded second reviewer who graded every disc using the Pfirrmann grading system. SRS-22 scores were extracted and correlated with MRI findings. Univariable analysis used independent two-tailed Mann-Whitney U test for continuous data and Fisher exact tests for nominal and ordinal data. Multivariable analysis was performed using simple linear regression.

Results
In total, 968 participants were included in the study. Of these, 93 (9.6%) had evidence of DDD, which was Pfirrmann grade ≥3 in 28 (2.9%). The most commonly affected level was L5/S1 (59.1% of DDD cases). A total of 55 patients (5.7%) had evidence of syringomyelia, 41 (3.4%) had evidence of spondylolisthesis (all L5/S1), 14 (1.4%) had bilateral L5 pars defects, and 5 (0.5%) had facet joint degeneration. SRS-22 scores were available in 580 cases at the time of scan. Function (p=0.04), pain (p=0.04) and self-image (p=0.04) SRS-22 scores were worse in patients with DDD.

Conclusion
We found that 9.6% of non-operative AIS patients had at least some evidence of disc degeneration identified on MRI, most often at the L5/S1 level. Presence of DDD negatively impacts SRS-22 pain, function and self-image domains.

5. ROTATIONAL CHANGES FOLLOWING USE OF DIRECT VERTEBRAL ROTATION IN ADOLESCENT IDIOPATHIC SCOLIOSIS: A LONG TERM RADIOGRAPHIC AND COMPUTED TOMOGRAPHY EVALUATION.

Dong-Gune Chang, MD, PhD; Javier Pizones, MD, PhD; René M. Castelein, MD, PhD; Lawrence G. Lenke, MD; Se-Il Suk, MD, PhD; Hong Jin Kim, MD; Jae Hyuk Yang, MD, PhD; Seoung Woo Suh, MD, PhD; Yunjin Nam, MD; Sung Cheol Park, MD; Anne Christopher, MD

Hypothesis
The vertebra morphology which underwent DVR procedures will be changes as AIS patients grow.

Design
A retrospective study.

Introduction
Adding the DVR maneuver in pedicle screw instrumentation (PSI) through posterior approach provides sufficient three-dimensional correction in surgical treatment of AIS. However, there are still

unknown long-term follow-up results. Therefore, this study longitudinally evaluates the long-term morphological changes in vertebral rotation in AIS patents who underwent deformity correction with the DVR maneuver.

Methods
A total of 45 patients with AIS who underwent deformity correction using pedicle screw instrumentation with rod derotation and DVR were retrospectively, longitudinally assessed for vertebral rotation (135 vertebrae with a minimum five-year follow-up). Apical vertebral rotation (AVR) was measured by computed tomography (CT) using the rotational angle to the sacrum (RAsac) and the Aaro and Dahlborn method.

Results
The mean follow-up period in this study was 10.1 years. The main curve correction rate and loss of correction were 75.8% and 0.1°, respectively. On the Nash-Moe scale, the proximal EV scores at the preoperative, postoperative, and last follow-up exams were 0.6, 0.6, and 0.4, respectively, with no statistical significance (P = 0.279). The preoperative, postoperative, and last follow-up of apical vertebra were 1.3, 1.1, and 1.0, respectively, with statistical insignificance (P = 0.658). The distal EV showed statistically significant differences between the preoperative, postoperative, and last follow-up values (P = 0.001), except between the postoperative and last follow-up values, in a Bonferroni post-hoc analysis. The last follow-up RAsac (P = 0.515) and AVR (P = 0.376) values did not differ significantly from preoperative RAsac and AVR, respectively.

Conclusion
Although DVR is an effective rotational maneuver during surgical treatment of AIS, it does not maintain the corrected AVR as AIS patients grow for 10 years.

6. CONCAVE AND CONVEX GROWTH DO NOT DIFFER OVER TETHERED VERTEBRAL SEGMENTS, EVEN WITH OPEN TRI-RADIATE CARTILAGE

Daniel Farivar, BS; Michael J. Heffernan, MD; Ron El-Hawary, MD; A. Noelle Larson, MD; Firoz Miyanji, MD; Stefan Parent, MD, PhD; Lindsay M. Andras, MD; Pediatric Spine Study Group; *David L. Skaggs, MMM*

Hypothesis
1. Vertebral body tethering (VBT) is associated with asymmetric increases in height over instrumented vertebrae. 2. The instrumented Cobb angle improves following VBT with growth.

Design
Retrospective case series of a multicenter registry.

Introduction
In theory, growth following VBT corrects scoliosis over time.

Methods
Inclusion criteria were patients with idiopathic scoliosis receiving VBT with standing radiographs at < 4 months and ≥ 2 years after surgery. Patients with suspected broken tethers were excluded. The distances between the superior endplate of the upper instrumented vertebrae (UIV) and the inferior endplate of the lower instrumented vertebra (LIV) were measured at the concave corner, mid-point, and convex corner of the endplates. The instrumented Cobb angle (UIV-LIV angle) was recorded. Subgroup analyses included comparing different Risser scores and tri-radiate cartilage (TRC) closed versus open. Student t-tests assessed statistical significance.

Results
83 patients met inclusion criteria (92% female; age at time of surgery 12.5±1.4 years) with a mean follow-up time of 3.8±1.4 years. Risser scores at time of surgery were: 0 (n=33), 1 (n=12), 2 (n=10), 3 (n=11), 4 (n=12), and 5 (n=5). Of the 33 Risser 0 patients, 17 had an open TRC, 16 had a closed TRC. At final follow-up, the mean number of instrumented levels was 7.5±0.8. The UIV-LIV distance at concave, middle, and convex points significantly increased from immediate post-op to final-follow-up for Risser 0 patients, but not for Risser 1-5 patients. Increases in UIV-LIV distance were not significantly different between concave, middle, and convex points for all groups. There were no significant changes in UIV-LIV angle in any group. Risser 0, TRC open patients had a non-significant decrease of 4.0° (22.1° to 18.1°) (p=0.316), while Risser 2-5 patients had a non-significant increase of 1.9° (24.0° to 25.9°) (P=0.435).

Conclusion
At a mean of 3.8 years following VBT, 33 Risser 0 patients demonstrated significant growth in the instrumented segment, though there was no difference between concave or convex growth, even for patients with open TRC. The UIV-LIV angle in patients with open TRC had an insignificant improvement of 4o; and those Risser 2-5 had an insignificant worsening of 2o.

(A) Changes in UIV-LIV Distance			
Average Difference in UIV-LIV distance: Immediate Post-Op to Final Follow-Up	Concave	Middle	Convex
Risser 0: TRC Open (n=17) P=0.449 (concave vs. convex)	**+15.8 mm (11.9%) (P<0.009)**	**+15.2 mm (10.5%) (P<0.014)**	**+12.2 mm (8.1%) (P<0.048)**
Risser 0: TRC Closed (n=16) P=0.890 (concave vs. convex)	**+16.8 mm (12.4%) (P<0.044)**	**+17.0 mm (12.2%) (P<0.024)**	**+17.6 mm (12.2%) (P<0.016)**
Risser 1 (n=12) P=0.884 (concave vs. convex)	+10.7 mm (7.6%) (P=0.169)	+10.8 mm (7.4%) (P=0.169)	+10.2 mm (6.7%) (P=0.197)
Risser 2-5 (n=38) P=0.681 (concave vs. convex)	+8.9 mm (6.6%) (P=0.101)	+9.8 mm (6.8%) (P=0.124)	+9.9mm (6.9%) (P=0.097)
(B) Changes in UIV-LIV Angle			
UIV-LIV Angle	Immediate Post-Op	Final Follow-Up	Difference
Risser 0: TRC Open (n=17)	22.1±10.3°	18.1±12.5°	-4.0° (P<0.316)
Risser 0: TRC Closed (n=16)	22.1±11.0°	22.5±14.3°	+0.4° (P<0.929)
Risser 1 (n=12)	23.7±9.9°	21.2±13.0°	-2.5° (P<0.601)
Risser 2-5 (n=38)	24.0±9.0°	25.9±11.9°	+1.9° (P<0.435)

UIV-LIV distance and angle by Risser and TRC

7. WHAT ARE WE TRANSFUSING? A PROSPECTIVE TRIAL EVALUATING THE QUALITY OF INTRAOPERATIVELY SALVAGED RED BLOOD CELLS IN SPINAL DEFORMITY SURGERY

David Kurland, MD, PhD; Daniel Alber, BS; *Darryl Lau, MD*

Hypothesis

We postulate that factors inherent to modern spine surgery cause irreversible cellular injury that decreases RBC survivability and suitability for transfusion.

Design

This is a prospective clinical trial.

Introduction

Intraoperative RBC salvage (aka Cell Saver) is widely employed in spinal deformity surgery. Unlike other surgical subspecialities wherein blood is immediately salvaged (with low potential RBC injury), modern approaches to spine surgery inherently result in collection of blood exposed to high-heat electrocautery, prolonged stasis, and abrasive pharmaceuticals, potentially resulting in RBC injury. However, this has not been studied in a scientific manner. We present preliminary results of a prospective study defining the quality of RBC salvage in spinal deformity surgery.

Methods

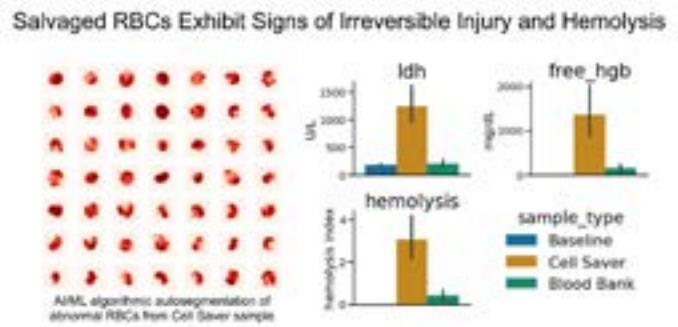
Patients undergoing spinal deformity surgery with Cell Saver were prospectively enrolled (N = 35). Comparison blood samples include baseline (arterial-line), allogenic (blood bank), and salvage (Cell Saver transfusate). Qualitative laboratory measures of RBC health and hemolysis were collected. Morphological assessment utilized Stimulated Raman Histology (SRH) and artificial intelligence based machine-learning algorithm.

Results

Salvage blood differed significantly from baseline and allogenic blood, including an unpredictable range of RBC density (2.11-9.52 x1000/uL), and significantly lower MCV (smaller RBCs) vs. baseline and allogenic samples (p = 0.015 and 4.05E-8, respectively). SRH revealed a high proportion (30.7%) of often irreversibly injured acanthocytes (shrunken and irregularly spiculated RBCs). Salvage blood samples had significantly higher intracellular components indicating active lysis: potassium (p = 0.019 and 8.2E-16), LDH (p = 3.3E-11 and 1.66E-6), and free-hemoglobin (p = 4.87E-7 and 0.001). The salvage blood mean hemolysis index (HI) was significantly higher than baseline (155x, p = 1.1E-10) and allogenic blood (7.23x, p = 2.29E-5).

Conclusion

Intraoperative salvaged blood is composed of high proportions of irreversibly injured RBCs with HI even exceeding levels suitable for transfusion by US FDA and Council of Europe standards, properties that may decrease the suitability of salvaged RBCs as a blood replacement. Collection of postoperative laboratory data, perioperative outcomes, and ex-vivo mechanical fragility and rheological profiles are currently underway.



8. REOPERATION RATE AFTER PSF VARIES SIGNIFICANTLY BY LENKE TYPE

Peter Boufadel, BS; Baron S. Lonner, MD; Amer F. Samdani, MD; Joshua M. Pahys, MD; Suken A. Shah, MD; Paul D. Sponseller, MBA

Hypothesis
Reoperation rates vary by Lenke curve types.

Design
Retrospective review of prospectively collected data from a multicenter AIS database.

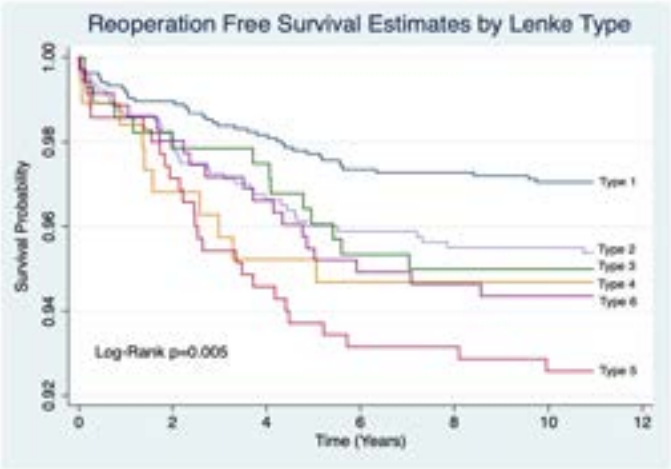
Introduction
Lenke curve types vary in frequency and response to treatment. There is no literature currently available that explores the potential difference in reoperation rate between Lenke types. With current availability of different surgical options for certain curve types, rates of reoperation are important for decision-making.

Methods
We studied a multicenter database of 3332 patients with adolescent idiopathic scoliosis who underwent initial fusion at ≤ 21 years with a minimum follow up period of two years. We collected data on patient's age, sex, SRS-22 total score, major curve magnitude, lumbar modifiers, surgical approach, and causes of reoperation. We determined and compared the rate of reoperation and risk factors of each Lenke curve type.

Results
148 patients who required reoperation were identified. Reoperation rate varied by Lenke type (p=0.018): type 5 had the highest reoperation rate (7.43%); type 1 had the lowest (3.01%). Both type 5 (OR 2.58, p=0.000) and type 6 (OR 1.93, p=0.019) curves had significantly greater reoperation rates compared to type 1. The two most common causes of reoperation were instrumentation complications and surgical site infection requiring implant removal. Reoperation due to non-infectious etiologies (p=0.005) and reoperation due to instrumentation complications (p=0.013) varied by Lenke type. A higher major curve magnitude was associated with a higher risk of reoperation in Lenke type 3 (p=0.005) and type 5 (p=0.000). Patients with Lenke type 1 curves with LIV at or above L1 had a higher reoperation rate (3.83%) compared to those with LIV below L1 (1.72%; p=0.027).

Conclusion
With availability of vertebral body tethering and other options, knowledge of reoperation rates after posterior spinal fusion by curve types is important. This study found that reoperation rate varies by Lenke type. Patients with type 5 curves are more likely to have instrumentation complications and have the highest reoperation rate. Patients with type 1 curves have the lowest reoperation rate.

Lenke Type	No. of Subjects	Mean Follow Up (Years)	Total Percentage Rate (%)	Non-SSI Percentage Rate (%)
Type 1	1,360	4.25	3.01*	1.99*
Type 1A	794	4.25	2.64*	1.89*
Type 1B	284	4.34	4.23	2.11*
Type 1C	282	4.18	2.84*	2.13*
Type 2	801	4.13	4.62*	3.00*
Type 3	279	4.40	5.02	4.66*
Type 4	188	3.98	5.32	2.66
Type 5	350	4.49	7.43*	6.29*
Type 6	354	4.08	5.65*	3.39
			P=0.018	**P=0.005**



Reoperation Rate and Survival, by Lenke Type

9. DECOMPRESSION WITH OR WITHOUT FUSION FOR GRADE 1 DEGENERATIVE LUMBAR SPONDYLOLISTHESIS: 60-MONTH OUTCOMES FROM THE QOD

Andrew K. Chan, MD; Erica F. Bisson, MPH; Mohamad Bydon, MD; Steven D. Glassman, MD; Kevin T. Foley, MD; Christopher I. Shaffrey, MD; Eric A. Potts, MD; Mark E. Shaffrey, MD; Domagoj Coric, MD; John J. Knightly, MD; Paul Park, MD; Michael Y. Wang, MD; Kai-Ming G. Fu, MD, PhD; Jonathan R. Slotkin, MD; Anthony L. Asher, MD; Michael S. Virk, MD, PhD; Vivian Le, MPH; Dean Chou, MD; Regis W. Haid Jr., MD; Praveen V. Mummaneni, MBA

Hypothesis
Patients undergoing decompression alone and decompression with fusion will have similar outcomes at 60 months.

Design
Retrospective analysis of prospectively-collected data

Introduction
When comparing decompression alone versus decompression with fusion for degenerative lumbar spondylolisthesis, long-term outcomes are unclear.

Methods
We conducted a retrospective analysis of prospectively-collected data from the QOD Spondylolisthesis module. Patients were enrolled who received single-segment surgery for Meyerding grade 1 degenerative lumbar spondylolisthesis. Sixty-month outcomes—Oswestry Disability Index (ODI), reaching ODI minimum clinically important difference (MCID) (defined as an ODI improvement of 12.8), Numeric Rating Scale (NRS) Back Pain (NRS-BP), NRS Leg Pain (NRS-LP), EQ-5D, NASS Satisfaction, and cumulative reoperation rate—were compared for patients receiving decompression alone versus decompression with fusion. Multivariable analyses were conducted, adjusting for variables reaching p<0.20 on univariate comparisons.

Results
Overall, 608 patients were enrolled: 140 decompression alone (23.0%) and 468 (77.0%) decompression with fusion. The 60-month follow-up rate was 73.2%. In multivariable analyses, fusion was associated with a higher odds of reaching ODI MCID (OR=1.9, 95%CI{1.2-3.1}, p=0.01), lower NRS-LP (β=-0.7, 95%CI{-1.3- -0.1}, p=0.01), and higher NASS satisfaction (OR=1.9, 95%CI{1.2-3.0}, p=0.01). Fusion was associated with similar NRS-BP (β=-0.3, 95%CI{-0.8-0.3}, p=0.36), ODI (β=-2.5, 95%CI{-6.2-1.2}, p=0.18), and EQ-5D (β=0.02, 95%CI{-0.02-0.06}, p=0.27) compared to decompression alone. The difference in 5-year cumulative reoperation rates was not statistically significant (decompression alone: 14.3% vs. fusion: 10.7%, p=0.24).

Conclusion
In a long-term, 60-month comparison of outcomes, the addition of fusion to decompression was associated with superior outcomes for leg pain and satisfaction and nearly twice the odds of achieving ODI MCID. Both procedures performed similarly for back pain, quality of life, and reoperation.

Univariate (unadjusted) comparisons between decompression alone and decompression with fusion at 60 months.

Variables	Decompression alone (n=140)	Decompression with fusion (n=468)	*Unadjusted p value*
ODI, baseline, mean ± SD	39.7 ± 18.0	48.8 ± 16.4	<0.001**
ODI, 60 months, mean ± SD	19.2 ± 17.9	24.2 ± 19.9	0.02**
ODI MCID, 60 months, n (%)	52 of 90 (57.8)	243 of 351 (69.2)	0.04**
NRS-BP, baseline, mean ± SD	5.5 ± 3.3	7.1 ± 2.5	<0.001**
NRS-BP, 60 months, mean ± SD	2.9 ± 2.7	3.5 ± 3.1	0.02**
NRS-LP, baseline, mean ± SD	6.3 ± 2.9	6.6 ± 2.8	0.24
NRS-LP, 60 months, mean ± SD	2.6 ± 2.9	2.5 ± 3.1	0.43
EQ-5D, baseline, mean ± SD	0.59 ± 0.21	0.52 ± 0.23	0.001**
EQ-5D, 60 months, mean ± SD	0.75 ± 0.22	0.75 ± 0.22	0.13
NASS Satisfaction 1 or 2 (i.e., satisfied), 60 months, n (%)	73 of 89 (82.0)	282 of 329 (85.7)	0.39

**statistically significant, $p<0.05$

10. THE INCIDENCE OF FOETAL SCOLIOSIS AND THE CHANCES OF SUCCESSFUL DELIVERY

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Hypothesis
Foetal scoliosis is a poorly understood diagnosis which requires more evidence to allow accurate counselling of patients with this finding.

Design
Retrospective, Cohort Study

Introduction
Foetal scoliosis can be detected on antenatal ultrasound, and may be associated with other spinal abnormalities such as hemivertebrae. Little is known regarding its incidence and implications.

Methods
The computerised foetal medicine ultrasound database at a tertiary hospital was retrospectively analysed using the search terms “spine” and “scoliosis”, between 1997 and 2021. The reports were manually reviewed and patients removed that showed no abnormalities. Demographics of the mother, pregnancy and outcome data were collated.

Results
During the 24-year study period, 600,000 antenatal ultrasound scans were available. A duplicate rate was calculated, resulting in a total population of 378,000 foetuses. Initial results yielded 195 scans, and after removal of duplicates and manual checking of reports,

there were 123 cases of confirmed spinal deformities, with an incidence of approximately 0.33 per 1000 foetuses (1 in 3000).Of the 123, there were 59 (48%) that reached term and 64 (52%) which did not. Of those that survived to term, 36/59 (61%) had normal development and no other concerns. The remaining patients had other non-fatal abnormalities, including VACTERL association in 5 cases (8.4%). Of those that did not survive, only one patient did not have other significant abnormalities. In most cases, there were multiple significant abnormalities and the decision was taken for termination of pregnancy (52 cases, 81%).

Conclusion
This study represents the largest database review of antenatal scans for spinal abnormalities. The incidence of foetal spinal deformity is approximately 1 in 3000, and prognosis is generally determined by the presence of other significant abnormalities.

11. GREATER THAN 70% OF LIV SELECTION IS AT L3 OR BELOW IN EARLY ONSET SCOLIOSIS. IS THERE ANY ROLE FOR A MORE SELECTIVE APPROACH?

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Hypothesis
We hypothesized that implant type and patient size would inform LIV selection.

Design
Retrospective, study-group

Introduction
This purpose of this study was to assess the impact of patient and implant characteristics on LIV selection in ambulatory children with EOS and to assess the relationship between the touched vertebrae (TV) and the LIV.

Methods
An international pediatric spine database was queried for patients ages 2-10 years treated by growth friendly instrumentation with at least 2-year follow up. Non-ambulatory patients, those with a LIV below L5, and those with prior spine surgery were excluded. The relationship between the LIV and preoperative spinal height, curve magnitude, and implant type were assessed. The relationship between the TV (defined as the most cephalad vertebrae touched by the center sacral vertical line) and the LIV was also evaluated.

Results
Overall, 281 patients met inclusion criteria. The LIV was L3 or below in 71% of patients: T10-T12 (1%), L1 (9%), L2 (19%), L3 (40%), L4 (29%), L5 (2%). Smaller T1-T12 spinal length was associated with a more caudal LIV selection (p=0.001). Larger curve magnitudes were similarly associated with more caudal LIV selection (p=<0.0001): L1 (61±11°), L2 (67±18°), L3 (75±21°), L4 (82±22°). Implant type (MCGR/TGR/VEPTR) was not associated with LIV selection (p=0.32) including MCGR actuator length (p=0.829). The majority (64%) of patients exhibited TV-LIV incongruence. The LIV was caudal to the TV in 78% of patients with a TV at L2 or above compared to only 17% of patients with a TV at L3 or below (p<0.0001).

Conclusion
Larger curve magnitude and smaller spinal height were associated with more caudal LIV selection, while implant type was not. Although selective thoracic surgery is an area of focus in adolescent idiopathic scoliosis, it is rare in EOS. As 50% of patients had an LIV caudal to the TV, this may represent an area for improved clinical decision making.

12. DOES A DEDICATED "SCOLIOSIS TEAM" AND SURGICAL STANDARDIZATION IMPROVE OUTCOMES IN ADOLESCENT IDIOPATHIC SCOLIOSIS SURGERY AND IS IT REPRODUCIBLE?

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Hypothesis
Standardizing protocols has been shown to improve outcomes in orthopedic surgery, thus we hypothesize that reproducing these protocols in different institutions would continue to yield superior results.

Design
Retrospective review

Introduction
In 2011, we implemented a standardized approach including a "scoliosis team". We also implemented a standardized pre-operative work-up, specific intraoperative protocols including the use of anti-fibrinolytics and intrathecal morphine, and a multi-disciplinary postoperative care model. The purpose of this study is to determine if standardization improves AIS surgery outcomes and whether it is transferrable between institutions.

Methods
A retrospective review was conducted of a prospective AIS database from 2009-2018 at 2 institutions (IA and

IB). In each institution, a non-standardized group (NST) and a standardized group (ST), were compared. Demographics and perioperative outcomes were recorded. In 2015, the surgeons changed institutions (to IB). Reproducibility was determined between institutions (IA vs. IB). Median (IQR), Kruskal-Wallis, and Fisher's exact test were used.

Results
The non-standardized group (NST) included 44 patients, while the standardized group (ST) included 281 patients. Age (p=0.21), BMI (p=0.48), preoperative Cobb angle (p=0.48), levels fused (p=0.42), and correction percentage (p=0.39) were all similar. Standardized protocol patients had lower estimated blood loss (EBL) (700 ml vs 325 ml, p<0.001), shorter anesthesia time (437 min vs 384 min, p=0.004), shorter surgical time (310 min vs 248 min, p<0.001), and shorter length of stay (LOS) (7 days vs 5 days, p<0.001). IA (n=101) and IB (n=105) were compared. Age (p=0.21), BMI (p=0.48) and preoperative Cobb angle (p=0.48) were similar. EBL (p<0.001), anesthesia time (p<0.001), surgical time (p<0.001), and LOS (p<0.001) were significantly lower in IB.

Conclusion
Standardization of perioperative approach for AIS correction with a dedicated team resulted in significantly decreased blood loss, surgical time, and length of stay. These results occurred as the team continued to refine the protocol over the study duration. The ability to implement these changes across multiple institutions while continuing to improve outcomes demonstrates the reproducibility of this protocol.

13. EFFECTS ON CLINICAL OUTCOMES AND ANALYSIS ON CULTURE POSITIVE PATIENTS WHO UNDERWENT PRIMARY LUMBAR FUSION

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Hypothesis
We hypothesize that standard surgical skin preparation nor preoperative antibiotics properly access and eradicate these organisms prior to primary spine surgery.

Design
This prospective, consecutive cohort of fifty-four patients undergoing primary lumbar spine surgery at a single tertiary center. All patients met the inclusion/exclusion criteria which included between the ages of 18 and 80, undergoing a posterior approach with pedicle screw instrumentation with no evidence of a prior or current fracture, trauma, tumor, or an active systemic or local infection.

Introduction
Occult bacteria have been linked to deep and chronic infections in spine surgery. These organisms are commensal to dermal and deeper tissue layers, including the intervertebral disc and bone. These organisms can potentially adhere to the biofilm surrounding the hardware and limit bone formation.

Methods
Culture samples were subsequently obtained from the superficial skin, dermal wound-edge following incision, hypodermis, and the vertebral pedicle prior to instrumentation implantation. Control culture samples were taken from scalpel, tap, and suction prior to incision. The primary outcome was the rate of positive culture samples from the various layers traversed during standard surgical spine exposure. Clinical outcomes of fusion status and revision rate were collected.

Results
A total of 525 culture samples were obtained, and samples were positive in 33.3% of patients (18/54). Culture-positive patients had on average 3.1 positive samples per case. Superficial skin samples were positive in 13.0% (n=7), dermal layer samples in 16.7% (n=9), hypodermis samples in 13.0% (n=7), and vertebral samples in 20.4% (n=11) of cases. All control samples taken were culture-negative. C. acnes was the most common organism isolated, in 83.3% of culture-positive cases. Significantly more males were culture-positive than females. Patients with positive cultures were treated with antibiotics. At one year post-op, patients in culture-positive group had similar fusion rates to culture-negative groups. However, delayed fusion was observed at a higher rate in the culture-positive group.

Conclusion
Occult bacteria was detected in one third of patients undergoing primary instrumented posterior spine surgery. Deep culture samples of the vertebral pedicle were more often positive than dermal layer samples.

14. TRENDS AND RATES OF REPORTING OF GENDER, RACE, ETHNICITY, AND OTHER SOCIOECONOMIC DETERMINANTS OF HEALTH IN SPINE SURGERY RANDOMIZED CLINICAL TRIALS

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BS; Valentina Battistoni, BS; Miguel Cartagena Reyes, BS; Juan Silva Aponte, BS; *Hamid Hassanzadeh, MD*

Hypothesis
Rates of socioeconomic parameter reporting in RCTs will be low, and may be significantly different over the study period.

Design
Systematic Review

Introduction
Although numerous institutions maintain guidelines and recommendations regarding the appropriate inclusion and reporting of age, sex, race, ethnicity, and other variables in randomized clinical trials (RCTs), the proportion of studies that ultimately include and clearly report such information is unknown.

Methods
The MEDLINE PubMed and Embase databases were searched for RCTs from 2002-2022. Data was collected from studies screened according to prespecified inclusion criteria regarding reporting and analysis of socio-economic covariates. Multivariable logistic regression was used to find predictors of whether racial or ethnic data was reported and analyzed.

Results
Of 432 included studies, 94.2% and 90.3% reported age and sex, respectively, whereas only 7.4% reported demographic data regarding race, and 4.2% included information on ethnicity. Of the other social determinants studied, 14.4%, 6.5%, 0.2%, 0.9%, and 1.2% included baseline information for employment, education, insurance status, income, and housing/living situation, respectively. On multivariable analysis, location in Europe and Asia was significantly associated with lower odds ratio of reporting racial or ethnic data compared to North America (P<0.001 and P=0.004, respectively); similarly, study size under 75 (P=0.018) and 76-250 participants (P=0.031) was associated with lower odds of reporting racial or ethnic data compared to larger studies. No other factors, including year of publication, were found to be significantly associated (Table 1).

Conclusion
Among randomized clinical trials in spine surgery, rates of reporting of social covariates including race, ethnicity, education, income, employment status, insurance status, and housing/living situation were relatively low compared to gender and age. Rates of reporting data did not improve over the study period. Smaller trial sizes and location outside of North America was significantly associated with decreased odds of reporting racial and ethnic data.

Parameter	Adjusted OR	P-value
Study size		
0-75	**0.253 [0.081, 0.788]**	**0.018**
76-250	**0.329 [0.119, 0.905]**	**0.031**
251+	1 [reference]	
Region		
North America	1 [reference]	
Asia	**0.05 [0.005, 0.364]**	**0.004**
Europe	**0.077 [0.022, 0.270]**	**<0.001**
Other	0	0.999
Single vs Multi Center		
Single	0.407 [0.155, 1.075]	0.070
Multi	1 [reference]	
Subject		
Degenerative	2.80 [0.305, 25.65]	0.362
Trauma	1 [reference]	
Infectious	7.68 [0.263, 224.13]	0.236

Table 1: Multivariable analysis of parameters associated with reporting of race and/or ethnicity data in RCTs in spine surgery from 2002-2022

15. COST-EFFECTIVENESS ANALYSIS OF WEIGHT-LOSS PROGRAMS USE IN OBESE PATIENTS UNDERGOING SPINAL DEFORMITY SURGERY

Juan Silva Aponte, BS; Miguel Cartagena Reyes, BS; Micheal Raad, MD; *Amit Jain, MD*

Hypothesis
Weight-Loss Programs will be a cost-effective and optimal strategy for the reduction of postoperative surgical-site infection readmission in obese adult spinal deformity patients.

Design
Cost-effectiveness analysis

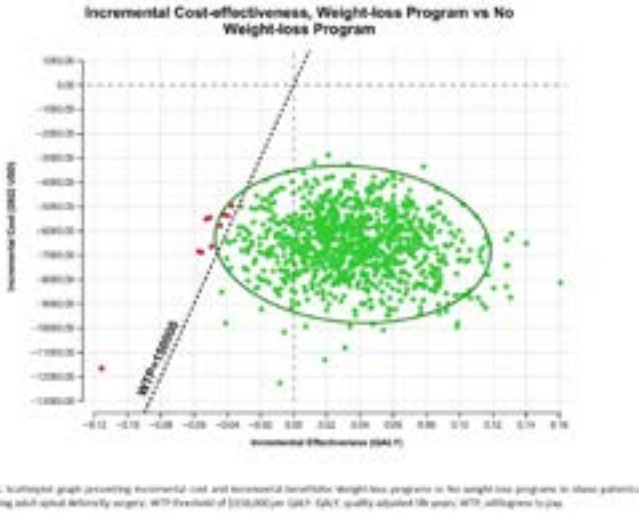
Introduction
Obesity has been described as an independent risk factor for postoperative surgical-site infections in ASD patients. Previous literature has highlighted postoperative infection as a principal reason for readmissions following spine surgery, with costs of up to $100,000. To our knowledge, the cost-effectiveness of implementing a weight-loss program for obese adult spinal deformity patients prior to undergoing spine deformity surgery has not been previously reported.

Methods
A decision-analysis model was built for a hypothetical obese adult patient with spinal deformity with plans of undergoing surgical intervention. A comprehensive review of the literature was performed to obtain event probabilities, costs and health utilities at each node. Health utilities were utilized to calculate Quality-

Adjusted Life Years (QALYs). A base-case analysis was carried out to obtain the incremental cost and effectiveness (QALYs) of weight loss program prior to spine surgery. Probabilistic sensitivity analysis was performed to evaluate uncertainty in our model and obtain mean incremental costs, effectiveness, and net monetary benefits. One-way sensitivity analyses were also performed to identify the variables with the most impact on our model.

Results
Use of weight loss program was favored as a strategy in 99% of the iterations. The mean incremental utility ratio for the weight loss strategy demonstrated higher benefit and lower cost while being lower than the willingness-to-pay threshold set at $150,000 per quality adjusted life years. Weigh loss program was associated with a mean incremental net monetary benefit of $61,240. One-way sensitivity analysis reported cost of readmission and QALY of readmission to have the greatest impact on the model.

Conclusion
Use of weight loss programs is a cost-effective strategy to reduce postoperative wound infection readmissions and its economic burden in obese patients undergoing ASD surgery.



Incremental Cost-effectiveness Graph, Weight-loss vs No weight-loss

16. VALIDATION OF TRADITIONAL PROGNOSIS SCORING SYSTEMS AND SORG NOMOGRAM FOR PREDICTING SURVIVAL OF SPINAL METASTASIS PATIENTS UNDERGOING SURGERY

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Hypothesis
The hypothesis is that traditional prognostic scoring systems has limit ability to predict patient survival and the tumor specific predictive scoring scheme may be necessary for better survival prediction in spinal metastasis patients.

Design
Retrospective study

Introduction
Many scoring systems that predict overall patient survival are based on clinical parameters and primary tumor type. To date, no consensus exists regarding which scoring system has the greatest predictive survival accuracy, especially when applied to specific primary tumors. Additionally, such scores usually not include modern treatment modalities, which influence patient survival.

Methods
A retrospective review on spinal metastasis patients, aged more than 18 years old and who had undergone surgical treatment, between October 2008 and August 2018. Patients were scored based on data before the time of surgery. A survival probability was calculated for each patient using the given scoring systems. The predictive ability of each scoring system was assessed using receiver operating characteristic (ROC) analysis at post-surgery time points; area under the curve (AUC) was then calculated to quantify predictive accuracy.

Results
A total of 186 patients were included in this analysis: 101 were males and the mean age was 57.1 years. Primary tumors were lung, breast, prostate, hematologic malignancy, thyroid, gastrointestinal tumor, and other malignancies. The primary tumor was unidentified in 10 patients. The overall survival was 201 days. For survival prediction, the Skeletal Oncology Research Group (SORG) nomogram showed the highest performance when compared to other prognosis scores in all tumor metastasis but a lower performance to predict survival with lung cancer. The revised Katagiri score demonstrated acceptable performance to predict death for breast cancer metastasis but had variable performance for death predictions in other primary tumors. The Tomita and revised Tokuhashi scores revealed acceptable performance only in lung cancer metastasis. SORG nomogram demonstrated acceptable performance for predicting death in hematologic malignancy metastasis at all time points.

Conclusion
The results were inconsistent among the prediction models for the specific primary tumor types. The SORG nomogram, revealed the highest predictive performance when compared to previous survival prediction models.

17. SURVIVORSHIP PREDICTION IN SPINAL ONCOLOGY PATIENTS BY ONCOLOGISTS IS RELIABLE: DATA FROM A QUATERNARY METASTATIC SPINAL CORD COMPRESSION MDT

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Hypothesis
We hypothesise that the oncologist's prognostic estimates are accurate, and we postulate that centring the oncologist's prognosis within an MDT approach to MSCC patients is superior to using established scoring systems to ascertain the prognosis and determine management

Design
Retrospective data analysis

Introduction
MSCC is the second most common neuro-oncological complication of cancer. Prognostic scoring systems such as the revised Tokuhashi, Bauer and Tomita scores are widely used to help guide treatment. Recent advances in treatment have dramatically changed the prognosis of certain cancers. This is resulting in a worsening disconnect between the prognosis provided by scoring systems and the reality of patient survival in the current era. As treatment direction is largely guided by prognosis, using these scoring systems may impact patient care. We propose that oncologists are accurate in their prognostic predictions and should be the primary source of prognostic estimates. This oncologist-led MDT system is central to approaches such as the Neurological, Oncological, Mechanical and Systemic (NOMS) framework, which aims to solve the shortcomings of a prognostic tool-based approach by dynamically assessing patients in an MDT.

Methods
Retrospective data captured between January 2015 and December 2018 was reviewed for 1,572 patients referred with MSCC, and 829 patients were included in the study. We compared Group 1 (patient prognosis assigned as <6months survival) versus Group 2 (patient prognosis assigned as >6 months survival). Median overall survival (mOS) and hazard ratio for death (HR) was assessed. Receiver operator curve (ROC) analysis was performed to assess the accuracy of the oncologist's prognosis.

Results
mOS in Group 1 was 5.8 months (95%CI 4.2-7.4m), and in Group 2 mOS was not reached. Log rank test gave a Chi2 of 131 ($p<0.001$). Cox regression analysis revealed a HR of 0.30 ($p<0.001$). Area under the ROC curve was 78%.

Conclusion
Prognosis given by oncologists is accurate for this cohort of unselected, consecutive real-world patients. The prognosis provided by oncologists works in tandem with the NOMS framework and guides the treatment of MSCC, enabling a higher quality of life for patients. Therefore, the importance of the oncologist-given prognosis should be reflected in both national and international guidelines relating to the management of MSCC.

18. CAN THE SORG MACHINE LEARNING ALGORITHMS PREDICT RURAL COHORT SPINAL METASTATIC DISEASE SURVIVAL?

James Hall, MD; Michael Garneau, BS; Trevor Gulbrandsen, MD; Alex Coffman, BS; Cassim Igram, MD; Andrew Pugely, MD; *Catherine Olinger, MD*; Joseph Schwab, MD

Hypothesis
The SORG machine learning algorithm will accurately predict 90-day and 1-year survival in patients undergoing surgery for spinal metastatic disease in a rural midwestern cohort.

Design
Retrospective review

Introduction
To determine the value of invasive surgical procedures, the Skeletal Oncology Research Group (SORG) machine learning algorithm was developed to predict 90-day and 1-year survival in spinal metastatic disease. Prior studies showed good performance of the algorithms based on a single region patient cohort but this has not been validated in a rural population.

Methods
A retrospective review of spinal metastatic disease patients receiving surgery from 2010 to 2022 at the University of Iowa Hospitals and Clinics was

performed. The validation and developmental cohorts baseline characteristics were compared. Discrimination, calibration, overall performance, and decision curve analysis were used to evaluate the SORG machine learning algorithm in this external cohort.

Results

249 patients were included in this study. 90-day and 1-year mortality rates were 63 (25%) and 134 (54%), respectively. The validation and developmental cohorts differed significantly in primary tumor histology, presence of visceral metastasis, and pre-operative hemoglobin levels. The SORG algorithm for 90-day and 1-year mortality showed strong discrimination (AUC 85 [95% confidence interval [CI] 0.74-0.94] and 0.82 [95% CI 0.71-0.91] respectively), decision curve analysis, calibration, and Brier score. The 90-day and 1-year mortality showed almost perfect calibration confirmed by a calibration intercept of 0.06 (95% CI -0.09 – 0.21) and 0.02 (95% CI -0.12 – 0.16).

Conclusion

This external validation study demonstrated that the SORG machine learning algorithm utilized in predicting 90-day and 1-year survival of patient with spinal metastatic disease exhibited strong performance in a rural, midwestern US cohort. More multi-center studies are needed to further validate the algorithms in varying populations.

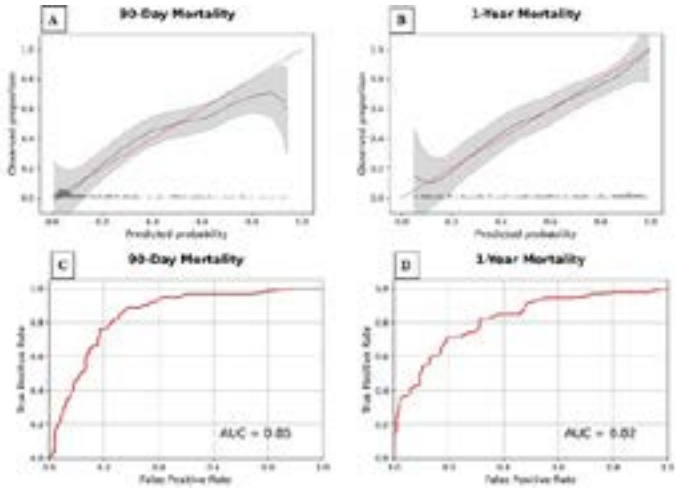

Figure 1. A-B: SORG-MLA 90-day and 1-year mortality Calibration plots. C-D: SORG-MLA 90-day and 1-year mortality receiver operating characteristic curve.

19. THE USE OF CARBON FIBRE IMPLANTS IN EN BLOC SURGERY AND SEPARATION SURGERY FOR RADICAL ONCOLOGICAL TREATMENT OF SPINAL OLIGOMETASTATIC DISEASE

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Hypothesis

Carbon fiber instrumentation provides a great alternative to traditional titanium instrumentation in radical oncological surgery that requires planned stereotactic ablative radiotherapy.

Design

Retrospective Review

Introduction

Radical treatment for Spinal Oligometastatic Disease (OMD) was often done with highly morbid Tomita En Bloc Spondylectomy. Now, Stereotactic Ablative Radiosurgery (SABR) provides curative tumour ablation without open surgery, reduced cord toxicity and better pain management. SABR delivered postoperatively to Separation Surgery (SS) has shown excellent mortality rates, infection control, maximum local-control, and better pain management. Carbon fibre instrumentation (CFI) compared to Titanium Implants (TI) possess high resistance to ionizing radiation and low wear particles, which is better suited for postoperative SABR planning and surveillance imaging.

Methods

Retrospective analysis of spinal oncology database between February 2017- December 2022 at quaternary level-1 spinal centre. Patient demographics, surgical method, radio-oncological characteristics, local recurrence, hardware malfunction, infection rates, and mortality were investigated with 24-month follow up.

Results

79 patients (55% male) were part of the OMD pathway. CFI cases included 5 En bloc spondylectomy cases and 24 separation surgeries. 2 intended cases failed to have post operative SBRT demoting it to palliative decompressions. TI cases included 4 En Bloc Surgeries and 20 Separation surgeries. Mean inpatient stay was 35 days (4-187); En Bloc (n=5) mean hospital length of stay was 77 days; SS with CFI (n=24) mean hospital length of stay was 30 days. SS with TI±SABR: 30-day

mortality-10%, 12-month mortality-15% 12-month LR-0%. TI: Infection-4%. SS with CFI±SABR: 30-day mortality-6%, 3-year mortality-12.5% SS with CFI+SABR: 30-day and 12-month mortality-0%, 12-month LR-0% CFI: Infection-0%. Pain was associated with PD cases only.

Conclusion
The use of CF pedicle screws, rods and VBR to treat OMD is safe and efficacious. It has excellent prevention rates of infections, local recurrence, and mortality. It has the advantage of producing no artefact on interval MRI scans, which is an important consideration in neoplastic disease. When postoperative SABR is absent from the treatment regime, that is when patients have met complications and have been demoted to palliative decompression and neurological symptom management.

20. EXPERIENCE OF SPINAL OLIGOMETASTATIC DISEASE AT A QUATERNARY LEVEL 1 SPINE CENTRE

Priyanshu Saha, MBBS, BS; Emily Tsang; Zion Hwang, MBBS, BS; Bisola Ajayi, PA-R; Tesfaldet Kurban, BSc; Mohamed Abdalla, MBBS; Varinder Singh Alg, MBBS; Ursalan Khan, MBBS; Shahnawaz Haleem, MBBS; Jason Bernard, MD, FRCS; Tim Bishop, FRCS; *Darren F. Lui, FRCS*

Hypothesis
Recognition of OMD and OPD pathway enables patients to become disease free as appropriate treatment will be delivered.

Design
Retrospective Review

Introduction
Treatment paradigms for spinal oligometastatic disease (OMD) have evolved. Oncological radical treatment can lead to disease free state in patients. Traditionally this was achieved with Tomita En Bloc spondylectomy. Stereotactic ablative radiotherapy (SABR) as a primary treatment modality can deliver radical treatment without open surgery. In separation surgery, postoperative SABR can be indicated in metachronous OMD for Maximum Local Control. Other novel methods include radiofrequency ablation (RFA) which can be combined with the techniques described above.

Methods
A retrospective review of spinal OMD management at a quaternary level-1 spinal centre between 01/01/2017-28/02/2022. Demographic data, tumour type, surgical type (En Bloc, Separation Surgery (SS), RFA, Palliative Decompression (PD)), cases with local recurrence and mortality data were examined.

Results
79 patients were identified with OMD or OPD, 66 radical surgical patients: (84%), 55% had separation surgery, 14% had En Bloc Surgery, RFA ± Cement alone was 10%; SABR alone (radiosurgery) (4%) and Intensity-modulated radiation therapy alone (3%); other/no treatment: (9%) Of the separation surgery (n=36), 5 patients also had undergone RFA and cement for enhanced MLC and infection control. The difference in use of titanium and carbon fibre instrumentation was analysed to investigate differences in outcomes. Mortality: 1 year mortality for radical surgery is 1.5% and 0% for separation surgery + SABR. Including palliative surgery: 30-day mortality – 7.5% (n=5; 2 COVID, 1 encephalopathy, 1 T1RF), none of the deceased patients had post adjuvant radiotherapy and no hardware related issues. 2 patients had PD. 1 year mortality – 9 % (n=6, 2 additional patients: patient 5: SS converted to PD as no SABR was administered; patient 6: PD) Infection: 30-day infection rate – 1.5%, 1 yr infection rate 3%. Local Recurrence (LR): 1-year: 0%, 2-year: 1.5% 3-year: 3%

Conclusion
Our data shows excellent 3-year local recurrence rates of 3%- and 1-year infection rate of 3%. Failure to deliver radical treatment in OMD shows higher 1 year mortality compared to palliative treatment (1.5% versus 7.5%). In carefully selected patients, non-surgical methods can also be indicated such as primary treatment modality such as SABR.

21. PEDAGOGY IN SPINE SURGERY: DEVELOPING A FREE AND OPEN-ACCESS VIRTUAL SIMULATOR FOR LUMBAR PEDICLE SCREWS PLACEMENT.

Léonard Chatelain, MD; Marc Khalifeé, MD, MS; Guillame Riouallon, MD; Pierre Guigui, MD; Emmanuelle Ferrero, MD, PhD

Hypothesis
The goal was to design a freely accessible web-based tool for training in lumbar pedicle screws placement.

Design
Development of a simulator, and validation study with students.

Introduction
Many surgical simulators, both physical and virtual, have been developed in recent years. Those available for pedicle screws placement are various, ranging from simple sawbones to virtual reality. Yet, they

remain expensive and often require specific devices. No free online virtual simulator has yet been developed. The goal was to design a freely accessible web-based tool for training in lumbar pedicle screws placement. A validation study with students was carried out.

Methods
The computer simulator consisted of a lumbar spine and a red box hiding the pedicles. The box simulated a conventional posterior approach (Figure 1). Five pairs of pedicle screws could be navigated. The red box was then removed to assess their position. A validation study was conducted. Twenty-four medical students were randomized into a simulation group and a control group. All had a basic course on pedicle screws placement. The 12 simulation group students performed two simulation sessions on computer. The control group had only the basic course without simulation. All 24 students then conducted a final common step on sawbones. Each screw was graded (I: no breach, II: breach < 10%, III: breach > 10%). Grade III screws were considered to be misplaced. The number of misplaced screws, the type of breaches and the time to run the simulation were analyzed.

Results
In the final sawbones simulation, 96 real screws were studied. The control group misplaced 50% of their screws (N=24/48), compared with only 20.8% in the simulation group (N=10/48, p<0.05). On average, students in the simulation group mispositioned less than one pedicle screw per person (0.83 screw, 20.8%), versus two out of four screws in the control group (50%, p < 0.05). Simulation group was slower to insert their real screws. Over the two computer simulations, the rate of misplaced screws decreased (12.5%, 15/120; versus 38.3%; 46/120). Of the 61 misplaced virtual screws, 24 were in the spinal canal.

Conclusion
This tool is the first free online lumbar pedicle screws simulator. The validation on sawbones indicated better results in the group that benefited from the simulation.

Figure 1. The lumbar spine model hidden in the box.

22. CLINICAL AND RADIOLOGICAL OUTCOMES BETWEEN ANTERIOR LUMBAR INTERBODY FUSION WITH PERCUTANEOUS PEDICLE SCREW FIXATION AND TRANSFORAMINAL LUMBAR INTERBODY FUSION IN THE TREATMENT OF HIGH-GRADE ISTHMIC SPONDYLOLISTHESIS

Daniel Coban, MD; Stuart Changoor, MD; Conor J. Dunn, MD; Neil Patel, MD; Kumar Sinha, MD; Ki S. Hwang, MD; *Michael J. Faloon, MD*; Arash Emami, MD

Hypothesis
ALIF PPF and TLIF will have similar outcomes in the treatment of high-grade IS in adult patients.

Design
Retrospective Cohort Study

Introduction
Treatment of low-grade spondylolisthesis utilizing ALIF PPF or TLIF has been well described in the literature; however, there is a paucity of reports comparing the long-term outcomes between these techniques in the setting of high-grade IS. The aim of this study was to assess the overall revision rates and average time to revision, pelvic incidence (PI)-lumbar lordosis (LL) mismatch correction, and functional clinical outcomes of ALIF PPF and TLIF in the treatment of high-grade IS.

Methods
A retrospective review was performed to identify all adult patients between 2009-2018 who underwent ALIF PPF or TLIF for high-grade isthmic spondylolisthesis with a minimum follow-up of 2 years. Demographic data, revision rates and average time to revision in each group were compared. PI-LL mismatch was calculated from both pre-and post-operative radiographs and degree of correction was compared. Complications were reviewed. Functional outcomes were assessed with the Oswestry Disability Index (ODI) and Visual Analog Scale for back (VAS-b) and leg (VAS-l) pain measurements at follow-up visits.

Results
A total of 65 patients were included, 35 in the ALIF PPF cohort and 30 in the TLIF cohort. The overall revision rates were 10.0% and 11.4% for the TLIF and ALIF PPF groups, respectively (p= 0.853). Average time to revision was 425.5 ± 426.1 days for the ALIF PPF group and 203.0 ± 280.3 days for the TLIF group (p= 0.675). One patient in the TLIF group required a durotomy repair and one patient in the ALIF PPF group required repair of the common iliac vein due to incidental transection. Each cohort achieved a similar proportion of PI-LL mismatch correction, 86% in the ALIF PPF group and 83% in the TLIF group (p= 0.790).

Both cohorts experienced significant improvements in their functional outcome scores compared to their pre-operative values; however, the magnitude of improvement was not statistically significant.

Conclusion
After long-term follow-up, there were less revisions in the TLIF cohort, however the difference was not statistically significant. Both procedures demonstrated similar improvements in clinical and radiographic outcomes.

23. WOMEN IN SPINE SURGERY

Kathryn Jurenovich, DO; Lisa Cannada, MD; Melissa Erickson, MD; Hania Shahzad, MBBS; Nazihah S. Bhatti, BS; Elizabeth Yu, MD

Hypothesis
Why is there such a low percentage of women in spine surgery?

Design
37 question survey

Introduction
The influences on a female orthopedic surgeon differ from males with the choices they must make regarding work/life balance, pregnancy, and family. Based on previous work, it was found spine had one of the lowest percentages (2%), of women completing a fellowship in that specialty for orthopedics. By exploring possible reasons for having the lowest percentage of women amongst all orthopedic specialties, ideas to improve the diversity in orthopedic spine surgery can be formulated.

Methods
A 37-question survey was developed and focused on exploring the reasons for pursuing spine surgery, the influence of a role model and their associated gender, physical aspects, and discrimination during the interview process. Additionally, a GRIT Scale was included at the end of the survey for participants to complete. The survey was disseminated to all the members of AO Spine, orthopedic spine fellowship programs, and distributed on social media to both orthopedic surgeons and neurosurgeons. The survey was emailed and posted to social media starting in January 2022 for three months.

Results
A total of 62 responses were received in which 63% were female and 37% were male. Overall, 16% of the respondents were discouraged to do a spine fellowship by an attending or a program director. Among the respondents, 10% were women and 6% were men. 22% of the women were discriminated against during their fellowship interview, while none of the men felt they were discriminated against during their interview. Twenty-four of the responders were asked negative questions during their fellowship interview of which 16% were male while 84% of them were females. The negative questions included age, pregnancy plans, and marital status/significant other. Eleven answered yes to feeling discriminated against during their fellowship year. Of these individuals, 78% were women and 22% were men who felt they were discriminated against during their fellowship by being bullied, harassed, sexually harassed, or being a DO.

Conclusion
The low percentage of women in spine surgery may be attributable to a lack of role models, the interview process, and experiences during their fellowship year. This study demonstrates how mentorship can play a large influence in pursuing a spine specialty. The results from this survey also bring to light the discouragement and discrimination females face pursuing a spine fellowship.

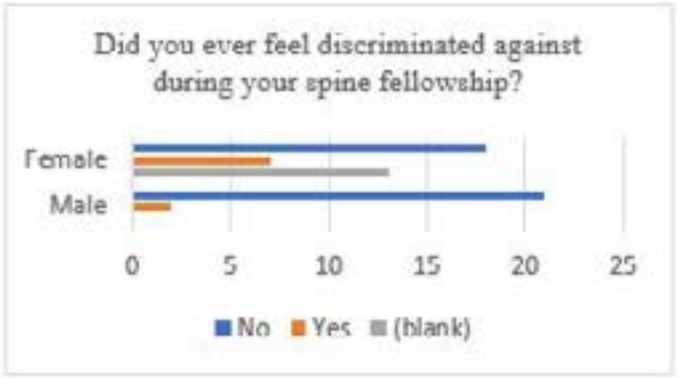


Figure 2

24. ASSESSING THE EFFECTS OF PREHABILITATION PROTOCOLS ON POST-OPERATIVE OUTCOMES IN ADULT CERVICAL DEFORMITY SURGERY: DOES EARLY OPTIMIZATION LEAD TO OPTIMAL CLINICAL OUTCOMES?

Peter Tretiakov, BS; Bailey Imbo, BA; Kimberly McFarland, BS; Pooja Dave, BS; Rachel Joujon-Roche, BS; Tyler K. Williamson, MS, BS; Jamshaid Mir, MD; Stephane Owusu-Sarpong, MD; Bassel G. Diebo, MD; Shaleen Vira, MD; Peter G. Passias, MD; *Pawel P. Jankowski, MD*

Hypothesis
Prehabilitation improves peri- and post-operative outcomes in adult cervical deformity surgery.

Design
Retrospective cohort review

Introduction
Previous studies have demonstrated that pre-operative rehabilitation (prehab) may be beneficial in adult cervical deformity surgery. Though protocols vary widely, general overlap exist in terms of inclusion of mental and physical modalities in order to optimize patient outcomes. However, there remains a paucity of literature in regards to assessing outcomes in a controlled setting.

Methods
Operative CD patients ≥18yrs with complete pre-(BL) and 2-year(2Y) data were stratified by enrollment in prehabilitation beginning in 2019, consisting of physical therapy, nutritional counseling, and/or psychological counseling. Patients were stratified as having underwent prehabilitation (Prehab+) or not (Prehab-). Differences in pre and post-op factors were assessed via means comparison analysis. Costs were calculated using PearlDiver database estimates from Medicare pay-scales. QALY was calculated via NDI mapped to SF6D using validated methods.

Results
115 patients were included (56.37±8.90 years, 38% female, 29.84±6.19 kg/m2). Of these patients, 57 (49.6%) were classified as Prehab+. At baseline, groups were comparable in age, gender, BMI, CCI, and frailty. Surgically, Prehab+ were able to undergo longer procedures (p=.017) with equivalent EBL (p=.627), and shorter SICU stay (p<.001). Post-operatively, Prehab+ patients reported greater reduction in neck pain overall, and reported with lower NSR-Neck scores at both 1Y and 2Y than Prehab- patients (all p<.05). Prehab+ patients reported significantly less complications overall, as well as less need for reoperation (all p<.05). Cost analysis revealed that Prehab+ patients had similar overall 2Y cost than Prehab- patients (40715 vs 42197 USD, p>.05).

Conclusion
Introducing prehabilitation protocols in adult cervical deformity surgery may aid in improving patient physiological status, enabling patients to undergo longer surgeries with lessened risk of peri- and post-operative complications. Though cost-effectiveness of such programs should be further assessed, prehabilitation should be considered for eligible patients to assist in optimizing recovery and reducing complications or reoperations.

25. CAN BASELINE DISABILITY LIMIT CLINICAL IMPROVEMENT AFTER SURGICAL CORRECTION OF CERVICAL DEFORMITY?

Peter G. Passias, MD; Rachel Joujon-Roche, BS; *Pooja Dave, BS*; Peter Tretiakov, BS; Kimberly McFarland, BS; Jamshaid Mir, MD; Stephane Owusu-Sarpong, MD; Jordan Lebovic, MBA; Matthew E. Cunningham, MD, PhD; Chris Gilligan, MD; Pawel P. Jankowski, MD

Hypothesis
Although patients with higher baseline disability have more room for improvement, there may be a threshold beyond which greater disability limits HRQL improvement due to elevated risks and a point of no return.

Design
Retrospective analysis of a single center CD database

Introduction
Surgical intervention has been shown to be an effective treatment modality for adult cervical deformity (CD), yet patient reported outcomes vary greatly even when patients are optimally realigned.

Methods
CD patients with 2-year data included. Cohort was ranked into quartiles by baseline NDI, from lowest/best score (Q1) to highest/worst score (Q4). Means comparison tests analyzed differences between disability groups. Multivariable Analyses (MVA) assessed differences in outcomes of interest controlling for covariates including baseline deformity, demographics, HRQLs, surgical details, surgical realignment and complications.

Results
: 89 patients were included. Mean BL NDI by disability group were: Q1: 24±8, Q2: 40±3, Q3: 53±5, and Q4: 68±8. MVA accounting for the aforementioned covariates found that patients in Q2 demonstrated the greatest improvement in NRS Neck at 2Y (-3.5, p=.039). Additionally, patients in Q2 achieved ≥1 MCID in NRS Neck at higher rates than patients in Q4, p=.014. Furthermore, MVA found that patients in Q2 also demonstrated greatest improvement in NRS Back at 2Y (-1.71), and improvement was superior to those in Q4 (+0.84) who deteriorated on average, p=.010. Finally, MVA found that patients in Q2 demonstrated the greatest improvement in EQ5D (+0.74, p=.042). Compared to patients in Q1, MVA found patients in Q2 were 12.0x more likely to reach MCID in EQ5D, (p=.015) whereas odds were not significantly different for Q3 or Q4.

Conclusion
Moderately disabled CD patients consistently demonstrated the greatest improvement in HRQLs whereas those with severe or complete disability, saw the least improvement. We propose that a baseline NDI of 40 may represent a disability "Sweet Spot," within which operative intervention maximizes patient reported outcomes. Furthermore, delaying intervention until patients are severely disabled, may limit benefits of surgical correction in cervical deformity patients.

26. ADDRESSING THORACIC SECONDARY DRIVERS AT THE ONSET OF CORRECTIVE REALIGNMENT SURGERY FOR ADULT CERVICAL DEFORMITIES ALLOWS FOR MAINTAINED ALIGNMENT AND CLINICAL GAINS AT TWO YEARS

Peter G. Passias, MD; Peter Tretiakov, BS; Bailey Imbo, BA; Rachel Joujon-Roche, BS; Tyler K. Williamson, MS, BS; *Pooja Dave, BS*; Kimberly McFarland, BS; Jamshaid Mir, MD; Tomi Lanre-Amos, MD; Bassel G. Diebo, MD; Shaleen Vira, MD

Hypothesis
Extending the fusion construct past the thoracic secondary driver will reduce post-operative complications and improvement in patient outcomes by 2Y in ACD surgery.

Design
Retrospective cohort review

Introduction
There is a paucity in the literature regarding the clinical and radiographic outcomes of patients with secondary drivers with fusion constructs extending to or past the thoracic apex. Comparative analyses of including or excluding secondary deformity drivers have yet to be conducted.

Methods
Operative CD patients with baseline (BL) and 2 year (2Y) HRQL and radiographic data were included and characterized by the presence of secondary thoracic driver (SD). Patients with a SD were divided based on the inclusion (IN) or exclusion (EX) of the thoracic driver apex in the fusion. Means comparison tests assessed differences between groups. Backstep binary regression controlling for Passias et al. frailty scores and history of prior fusion assessed the effect of secondary driver exclusion on postoperative outcomes.

Results
94 patients (62.1yrs, 65%F, 27.6kg/m2) were included. 20.2% of patients were categorized as SD+IN. Controlling for BL age, sex, and presence of symptomatic deformity requiring operation, BL SD+LF pts had a significantly lower mean BMI (p=.006), significantly lower mean TS-CL (p=.048), and were significantly more likely to be categorized as cSVA-Moderate by Ames et al. criteria (p=.019) than SD+EX patients. In terms of surgical differences, SD+LF patients were more likely to undergo any osteotomy (p=.002), SPO (p=.045), or VCR (p=.005). At 1Y post-op, SD+ IN patients had significantly higher mean EQ5D VAS scores (p<.001). Additionally, if the location of the secondary driver was not included in the fusion construct, patients were significantly more likely to be reoperated for DJK (p=.030). Binary risk analysis revealed that SD+EX patients were at significantly increased risk of severe DJK by 1Y (p=.010) and 2Y (p=.010), and having short construct alone was associated with significantly increased risk of reoperation by 2Y (p=.043).

Conclusion
Despite the more severe radiographic and neurological markers noted and more invasive surgeries undertaken, patients whose fusions extended past the thoracic driver demonstrated significantly lowered risk of distal junctional kyphosis (DJK) or subsequent reoperation.

27. CERVICAL LAMINOPLASTY VERSUS LAMINECTOMY AND POSTERIOR SPINAL FUSION FOR CERVICAL MYELOPATHY: PROPENSITY MATCHED ANALYSIS OF 24-MONTH OUTCOMES FROM THE QUALITY OUTCOMES DATABASE

Andrew K. Chan, MD; Christopher I. Shaffrey, MD; Christine Park, BA; Oren Gottfried, MD; Erica F. Bisson, MPH; Mohamad Bydon, MD; Anthony L. Asher, MD; Domagoj Coric, MD; Eric A. Potts, MD; Kevin T. Foley, MD; Michael Y. Wang, MD; Kai-Ming G. Fu, MD, PhD; Michael S. Virk, MD, PhD; John J. Knightly, MD; Scott Meyer, MD; Paul Park, MD; Cheerag D. Upadhyaya, MSc; Mark E. Shaffrey, MD; Luis M. Tumialán, MD; Jay D. Turner, MD; Giorgos Michalopoulos, MD; Brandon Sherrod, MD; Nitin Agarwal, MD; Dean Chou, MD; Regis W. Haid Jr., MD; Praveen V. Mummaneni, MBA

Hypothesis
CL and PCF have similar outcomes at 24 months.

Design
Retrospective analysis of prospectively-collected data

Introduction
Compared to PCF, CL may result in different outcomes for those operated for CSM.

Methods
Patients undergoing CL and PCF for CSM were included. Cases involving the thoracic spine were excluded. 1:1 propensity matching (nearest neighbor method) was based on age, operated levels, and baseline mJOA and VAS neck pain.

Results
Overall, 1,141 patients were prospectively enrolled with 946 (82.9%) reaching 2Y follow up. 45 CL and 187 PCF met prespecified inclusion criteria. CL was associated with similar blood loss (p>0.05) and length of stay (p>0.05), but a higher rate of routine discharge (88.9 vs 66.7%, p=0.01). CL demonstrated superior mJOA at 3 months (14.0 vs 12.8, p=0.04) but this difference was no longer apparent at 2Y (14.3 vs 14.0, p=0.61). CL had a higher rate of 2Y return to baseline activities (85.7 vs 54.5%, p=0.04). There were no differences for 2Y NASS satisfaction, VAS neck pain, VAS arm pain, NDI, EQ VAS, and EQ-5D (p>0.05). Compared to baseline, both procedures were associated with significant mean improvements in all 2Y PROs (p<0.05). There were no differences in 30-day readmission (CL: 0 vs PCF:2.2%, p>0.99) and 2Y cumulative reoperation (CL: 6.7 vs PCF: 2.2%, p=0.31). 2Y return to work (RTW) rates were similar (CL: 45.0 vs PCF:54.5%, p=0.61).

Conclusion
Compared to PCF for CSM, CL was associated with a higher rate of discharge to home. mJOA improved more rapidly for CL, but initial 3-month superiority was no longer evident at 2 years. CL patients more often returned to baseline activities at 2 years. Quality of life, RTW, and satisfaction were similar for both groups.

Matched Dataset	Laminoplasty (n=45)		PCF (n=45)		p
	Mean / Freq	SD / %	Mean / Freq	SD / %	
Age, yrs	62.4	12.7	61.6	13.3	0.76
BMI, kg/m^2	29.7	6.7	28.5	7.8	0.46
Female	24	53.3	20	44.4	0.40
ASA grade 1 or 2	20	45.5	17	40.5	0.64
Preop mJOA	11.6	3.2	11.6	2.8	0.97
Preop VAS Neck Pain	5.0	3.1	4.8	3.3	0.77
Preop VAS Arm Pain	4.1	3.5	4.5	3.7	0.52
Preop EQ-5D	0.6	0.2	0.5	0.2	0.51
Preop EQ-5D VAS	56.9	24.1	58.7	24.6	0.74
Preop NDI	37.3	18.5	38.1	24.0	0.86
Symptom Duration > 12 months	21	60.0	23	66.1	0.84
Independent Ambulation	33	73.3	31	68.9	0.64
Motor Deficit	26	66.6	24	53.3	0.83
Surgical Characteristics and Perioperative Parameters					
Mean levels	4	1.0	4	1.1	0.47
EBL, ml	107.4	108.7	137.9	144.5	0.27
LOS, days	3.0	1.6	3.4	2.3	0.30
Discharged to home	40	88.9	30	66.7	0.01**
Clinical Outcomes					
mJOA					
3 months	14.0	2.6	12.8	2.6	0.04**
2 years	14.3	2.5	14.0	2.7	0.61
VAS Neck Pain					
3 months	3.4	2.9	3.2	2.9	0.73
2 years	2.5	2.6	2.3	2.9	0.76
VAS Arm Pain					
3 months	1.9	2.8	3.3	3.4	0.06
2 years	2.6	3.1	3.1	3.3	0.55
EQ-5D					
3 months	0.7	0.2	0.6	0.2	0.06
2 years	0.7	0.3	0.7	0.3	0.45
EQ-5D VAS					
3 months	68.0	20.8	65.4	23.4	0.61
2 years	67.5	24.7	70.4	20.8	0.66
NDI					
3 months	23.5	20.2	25.8	21.1	0.65
2 years	18.7	20.6	21.2	21.4	0.35
NASS Satisfaction 1 or 2[1]					
3 months	33	84.6	29	76.3	0.56
2 years	33	82.5	29	82.9	0.85
Return to Work					
3 months	5	50.0	10	71.4	0.29
2 years	9	45.0	6	54.5	0.61
Return to Activities					
3 months	18	47.4	11	29.7	0.12
2 years	24	85.7	6	54.5	0.04**
30-Day Readmission	0	0	1	2.2	>0.99
2 Year Reoperation	3[2]	6.7	1[3]	2.2	0.31

[1] 1 or 2 indicates patient would have surgery again
[2] 3 patients underwent subsequent ACDF
[3] 1 patient with surgical site infection/wound dehiscence
**Asterisk indicates statistical significance.
Values may not add up to 100% where data is missing.

28. THE IMPACT OF C3 LAMINECTOMY ON CERVICAL SAGITTAL ALIGNMENT IN CERVICAL LAMINOPLASTY: A PROSPECTIVE, RANDOMIZED CONTROLLED TRIAL COMPARING CLINICAL AND RADIOLOGICAL OUTCOMES BETWEEN C3 LAMINECTOMY WITH C4-C6 LAMINOPLASTY AND C3-C6 LAMINOPLASTY

Jun-Hoe Kim, MD; Junghoon Han, MD; Taeshin Kim, MD; Chan-Hyun Lee, MD, PhD; Chi Heon Kim, MD, PhD; Chun Kee Chung, MD, PhD

Hypothesis
C3 laminectomy in cervical laminoplasty may cause unbalanced cervical lordosis due to C2-C3 segmental hyper-lordosis

Design
A prospective randomized controlled trial

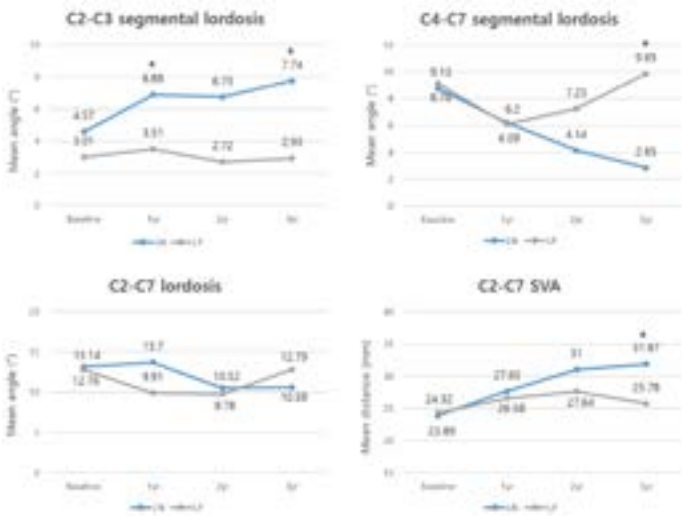
Introduction
C3 laminectomy in cervical lamnoplasty is a modified laminoplasty technique preserving semispinalis cervicis muscle attached to the C2 spinous process.

Several previous studies showed this technique promotes better outcomes of postoperative neck pain and C2-C3 range of motion(ROM) compared to conventional cervical laminoplasty. However, there is still a lack of understanding of total and proportional postoperative cervical sagittal alignment outcomes.

Methods
We conducted a single-center, prospective randomized controlled trial in patients with cervical spondylotic myelopathy (CSM) or ossification of posterior longitudinal ligament (OPLL) from March 2017 to January 2020. One hundred twenty two (122) patients were randomly assigned to either C3 laminectomy with C4-C6 laminopalsty group (LN group, n=62) or C3-C6 laminoplasty group (LP group, n=60). The primary outcomes were C2-C3 segmental lordosis and the Neck Disability Index (NDI). Secondary outcomes included other clinical outcomes and radiographic parameters until postoperative 3-year period.

Results
C2-C3 segmental lorodosis was significantly greater at 1-year and 3-year postoperatively in the LN group than in the LP group (7.74 ± 4.90 ° in the LN group and 2.93 ± 3.55 ° in the LP group at 3-year postoperatively, $p < 0.01$). On the other hand, C4-C7 segmental lordosis was significantly smaller at 3-year postoperatively in the LN group (2.85 ± 8.94 ° in the LN group and 9.85 ± 8.69 ° in the LP group, $p < 0.01$). C2-C7 SVA was significantly greater at 3-year postoperatively in the LN group than in the LP group (31.87 ± 13.07 mm in the LN group and 25.78 ± 13.29 mm in the LP group, $p = 0.04$). The rate of C2-C3 fusion was 10.6 % in LN group and 39.6 % in LP group ($p < 0.01$). NDI was significantly better at 3-year postoperatively in the LP group than in the LN group ($P < 0.05$).

Conclusion
Laminoplasty with C3 laminectomy for CSM or OPLL may cause positive cervical sagittal malalignment due to unbalanced cervical lordosis.



Mean values of radiologic parameters. *, there was a statistically significant difference between the groups.

29. PROPOSAL FOR A TREATMENT-ORIENTED CLASSIFICATION SYSTEM FOR CONGENITAL KYPHOSIS IN CHILDREN

Ziming Yao, PhD; Xue Jun Zhang, MD

Hypothesis
A new classification system can provide clear descriptions and surgical options for various types of pediatric congenital kyphotic deformities..

Design
Proposal of a new classification system for pediatric congenital kyphosis.

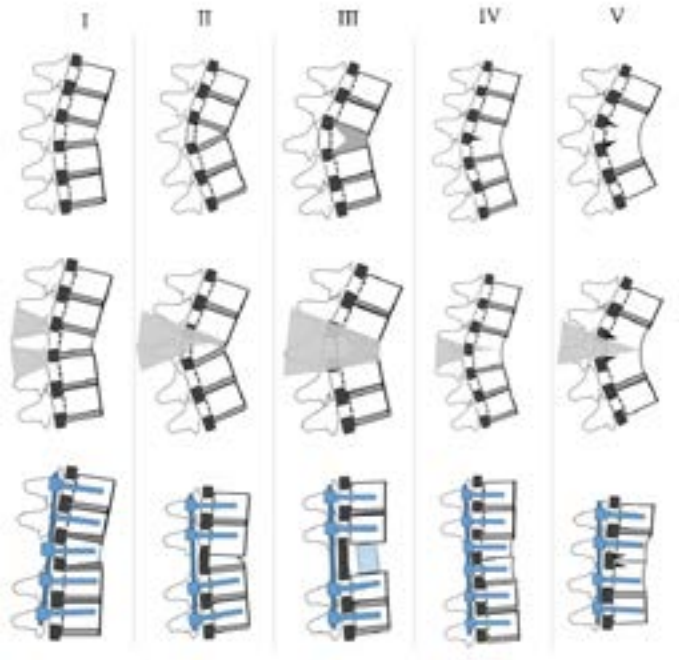
Introduction
The classification of congenital kyphosis described by Winter is the one most commonly used. However, this classification of congenital kyphosis cannot direct the surgical options and the treatment choices remain controversial. The objective of this study is to propose a new treatment-oriented classification system for pediatric congenital kyphosis based on radiographic findings and evaluates the reliability of this new classification system.

Methods
For each type of congenital kyphosis, we propose a set of radiological criteria that are suggestive for diagnosis as well as the corresponding surgical options. To evaluate the reliability of this new classification system, 35 patients with congenital kyphosis were reviewed and classified by four attending spine surgeons and five spine fellows.

Results
Our new classification system divides congenital kyphosis into five types, and each types' characteristics

has been illustrated detailedly. The overall Fleiss kappa coefficient (k) value for the new classification system was 0.755, which indicates significant agreement. The interobserver and intraob- server k values were 0.755 and 0.828, respectively, and there were no significant differences in the k values between the attending spine surgeons and spine fellows.

Conclusion
The proposed classification system provides clear descriptions and surgical options for various types of pediatric congenital kyphotic deformities. The reliability study confirmed that the classification system is both simple and consistent, although further research may be needed to validate the system.



30. SEVERE KYPHOSCOLIOSIS PATIENTS WITH MRI TYPE Ⅲ SPINAL CORD AT APEX: DOES PREOPERATIVE TRACTION IMPROVE SURGICAL SAFETY?

Wanyou Liu, MS; Benlong Shi, MD, PhD; Zhen Liu, PhD; Xu Sun, MD; *Zezhang Zhu, PhD*; Yong Qiu, PhD

Hypothesis
HGT could effectively correct the deformity and improve neurological function for patients with type Ⅲ spinal cords.

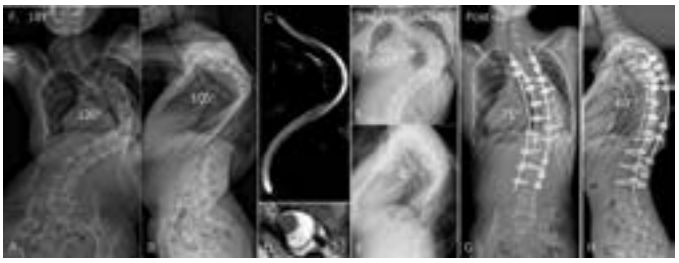
Design
Retrospective study

Introduction
Thoracic kyphoscoliosis patients with type Ⅲ spinal cords had a higher incidence of intraoperative neurological complications, the current study was designed to analyze the radiographic improvements after HGT in those patients, and to assess the clinical outcomes and surgical safety of HGT in this cohort.

Methods
A total of 47 severe thoracic kyphoscoliosis patients with type Ⅲ spinal cords on preoperative apex MRI who underwent preoperative HGT followed by one-stage posterior spinal fusion from February 2019 to June 2021 in our hospital were retrospectively analyzed. There were 18 males and 29 females with an average age of 22.5±12.8 (9-60) years. The average duration of traction was 7.4±3.9 (4-16) weeks. Radiographic parameters were measured including the coronal Cobb angle, C7PL-CSVL, GK and SVA at pre-traction, post-traction and post-operation, respectively. The Frankel scoring system was used for the evaluation of neurological status at at pre-traction, post-traction and post-operation.

Results
The initial coronal Cobb angle, C7PL-CSVL, GK and SVA of 47 patients before HGT was 116.0±17.5°, 35.7±16.9mm, 110.9±22.1° and 43.8±19.5mm, respectively. After HGT, the coronal cobb angle and GK were improved to 87.9±16.5° (t=9.096, P<0.001) and 84.1±19.9° (t=8.842, P<0.001), the improvement rate were 22.4±10.3% and 23.7±8.9%, respectively. At post-operation, the coronal cobb angle, C7PL-CSVL, GK and SVA were improved to 69.1±21.0° (t=15.185, P<0.001), 22.0±13.7mm (t=13.745, P<0.001), 65.3±19.3° (t=10.626, P<0.001) and 21.1±14.9mm (t=10.321, P<0.001), the improvement rate were 41.3±14.5%, 39.9±15.5%, 40.1±20.7% and 53.1±27.0%, respectively. A total of 14 patients showed neurological deficits of lower limbs at pre-traction. Neurological improvement were observed after HGT in 8 patients and after surgery in 3. No new neurological deficits were observed after HGT traction or surgery.

Conclusion
For severe thoracic kyphoscoliosis patients with type Ⅲ spinal cord on preoperative apex MRI, the HGT could effectively correct the deformity, improve neurological function, enhance the tolerance of spinal cord to surgery and reduce the risk of intraoperative iatrogenic neurological deficit.



A 18 year girl dignosed with neuromuscular kyphoscoliosis

31. NUTRIENT DELIVERY BY CONTROLLED-RELEASE MICROPARTICLES IMPROVES AUTOGRAFT PERFORMANCE IN RAT POSTEROLATERAL LUMBAR SPINAL FUSION

Ting Cong, MD; Kyle W. Morse, MD; *Janice Havasy, MD*; Max Korsun, BS; Alexander Koo, BA; Sheeraz Qureshi, MD; Matthew E. Cunningham, MD, PhD

Hypothesis
We hypothesize that surgical implantation of tissue-sustaining factors, such as salts, macronutrients and sugars, can improve graft viability and increase the posterolateral spine fusion rate in a rat model.

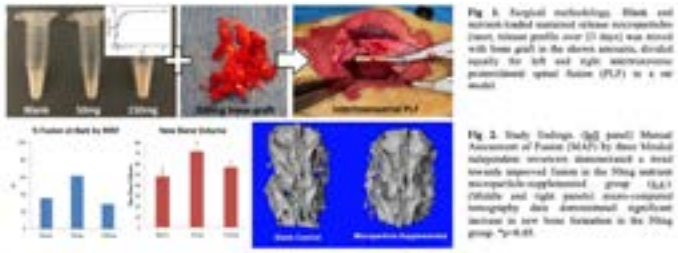
Design
A blinded, randomized trial of Sprague-Dawley rats undergoing L4-L5 intertransverse fusion.

Introduction
Tissue grafting in orthopaedic surgery occurs in areas heavily affected by electrocautery and periosteal stripping. Postoperatively, neovascularization and bony ingrowth take weeks to occur, during which exists a non-optimal host environment for cell survival and ingrowth. Due to variable cellular or bony graft handling during surgery and implantation into atrophic/biology-poor host sites, it follows that poor cellular viability, and/or the inability to trigger a cellular healing response, can contribute to imperfect fusion rates seen in graft-augmented spine surgery.

Methods
This was an Institutional Animal Care and Use Committee-approved study. Nutrient-loaded microparticles of 100-200um in diameter were manufactured by mechanical wax coating to effect sustained release. 50 Sprague-Dawley rats (12 weeks old, male only) were divided into three surgical groups: blank microparticles (control n=15), 50mg microparticle supplementation (50mg group n=15), and 150mg microparticle supplementation (150mg group n=15). All animals underwent L4-L5 single-level posterolateral spinal fusion by autologous bone grafting (Figure 1). At 8 weeks, all animals were sacrificed and lumbar spine specimens were collected. All specimens immediately underwent blinded manual assessment of fusion (MAF) with three independent reviewers (4). Finally, specimens underwent micro-computed tomography (μCT) analysis to evaluate for new bone formation (BV).

Results
At 8 weeks, 62% of the 50mg group was deemed fused by MAF, as compared to 36% of the control group and 29% of the 150mg group. Analysis of new bone formation by μCT demonstrated a statistically significant increase ($p < 0.05$) in new bone formation in the 50mg group (71.6±6.7 voxels) as compared to the control (48.4±18.6 voxels) and 150mg groups (57.0±15.7 voxels) (Figure 2).

Conclusion
Our findings suggest that nutrient delivery may improve bone graft performance, primarily informed by μCT data demonstrating increase new bone formation in groups that received a moderate amount (50mg) of nutrient.



Figure

32. USE OF DEXAMETHASONE IN THE IMMEDIATE POST-OPERATIVE PERIOD IS ASSOCIATED WITH INCREASED RISK OF INSTRUMENTATION AND SURGICAL SITE COMPLICATIONS IN DIABETIC PATIENTS UNDERGOING LUMBAR SPINAL FUSION

Douglass Johnson, MD; Brian McCormick, MD; Joseph Ferguson, MD; Bryan W. Cunningham, PhD; Paul C. McAfee, MBA

Hypothesis
Dexamethasone in the immediate post-operative period increases surgical site and instrumentation complications at all time points.

Design
Retrospective cross-sectional study

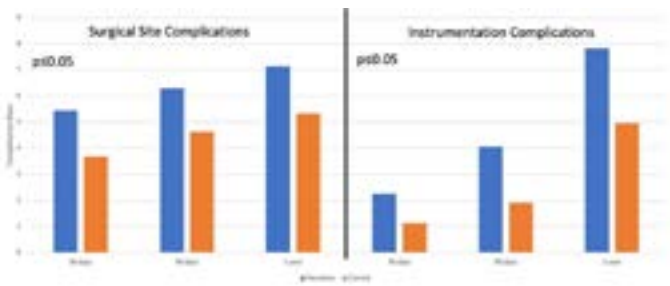
Introduction
Dexamethasone is widely used in post-operative spine patients, and there are few studies investigating the effects in a diabetic population that is more at risk when receiving the medication. This study aims to determine the effects of dexamethasone on post-

operative complications.

Methods
Patients undergoing 1- or 2-level posterior lumbar fusions with a diagnosis of diabetes mellitus who received dexamethasone within three days post-operatively were identified using the PearlDiver database. Patients were propensity-matched in a 1:10 ratio to diabetic patients undergoing the same procedure who did not receive dexamethasone. Medical complications including DVT, UTI, AKI, pneumonia, and transfusion were assessed at 90 days. Surgical site and instrumentation complications were assessed at 30 days, 90 days, and 1 year.

Results
A total of 7,865 patients comprise the basis of this analysis and were included in this study. 715 patients in the test group (female=372, male=343) received dexamethasone post-operatively. 7150 patients who did not receive dexamethasone were included in the control group. Patients in the test group had a significantly higher risk of DVT at 90 days (OR: 1.9 [1.2-3.0], p= 0.0068). There was no difference in UTI, AKI, pneumonia, or transfusion at 90 days (p>0.05). Surgical site complications were significantly elevated in the test group at 30 days (OR: 1.51 [1.01-2.13], p=0.019), 90 days (OR: 1.38 [1.00-1.91], p=0.047), and 1 year (OR: 1.36 [1.01-1.84], p=0.046). Instrumentation complications were also significantly elevated in the test group at all time points: 30 day (OR: 2.0 [1.16-3.43], p=0.012), 90 day (OR: 2.18 [1.45-3.28], p=0.0002), 1 year (OR: 1.63 [1.22-2.19], p=0.001). Length of stay was shorter in the test group, 3.29 days versus 3.48 days respectively (p= 0.0259).

Conclusion
Administration of decadron in the post-operative period after lumbar fusion is associated with higher risk of surgical site and instrumentation complications at 30 days, 90 days, and 1 year in patients undergoing elective one- or two-level lumbar fusions.



Complication rates between dexamethasone and control group at all time points

33. EFFECT OF SYSTEMIC TERIPARATIDE (PTH1-34) VERSUS PLACEBO ON BONE MINERAL DENSITY (BMD) AFTER LUMBAR SPINAL ARTHRODESIS: A SECONDARY ANALYSIS OF A RANDOMIZED CLINICAL TRIAL

Astrid H. Gimbel, BS; Mikkel î Andersen, MD; Pernille Hermann, MD, PhD; Annette Bennedsgaard Jespersen, MD, PhD; *Leah Y. Carreon, MD, MS*

Hypothesis
Systemic administration of PTH will have a beneficial effect on hip and spine BMD compared to placebo in patients aged > 60 undergoing decompression and non-instrumented lumbar arthrodesis.

Design
Secondary analysis of data from a randomized, double-blind placebo-controlled trial.

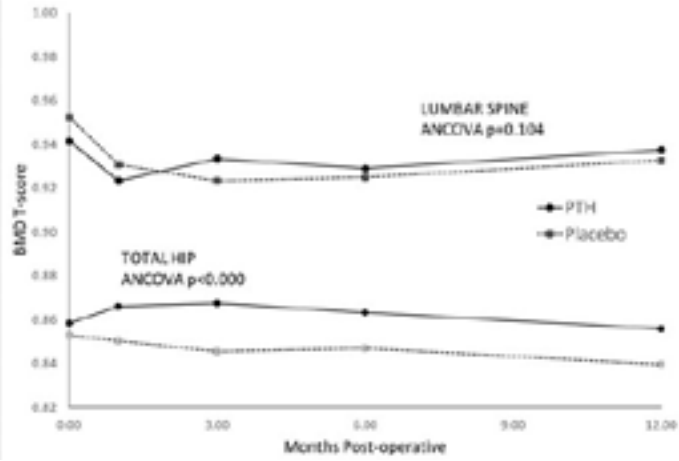
Introduction
Patients undergoing decompression and non-instrumented lumbar arthrodesis may have initial bone loss after surgery, increasing their fracture risk. The aim of this analysis is to determine whether short term systemic Teriparatide has a beneficial effect on Bone Mineral Density (BMD) in patients 60 years and older undergoing non-instrumented lumbar arthrodesis.

Methods
Patients were 87 Danish patients eligible for spinal decompression and non-instrumented arthrodesis, who received either 20 micrograms Teriparatide (N=43) or placebo (N=44) daily for 3 months starting prior to surgery. Randomization and allocation were computer-generated. Outcome measures were BMD and Patient reported Outcome measures (PROs) containing Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) for leg pain. DXA scans were performed preoperatively and at 1,3,6 and 12 months after surgery. PROs were collected at the same time points aside at 1 month after surgery. ANCOVA comparing Lumbar Spine BMD and Hip BMD in Teriparatide vs Placebo with gender, weight, age and baseline BMD as covariates were performed.

Results
There was some improvement in BMD in the Teriparatide group compared to placebo at 3 months after surgery, but not sustained at 6 and 12 months. There was a loss of Lumbar Spine BMD at 1 month after surgery in both groups.

Conclusion
Systemic Teriparatide provided a short term beneficial effect on BMD compared to placebo in patients

undergoing decompression and non instrumented lumbar arthrodesis. There was an initial rapid bone loss 1 month after surgery in both groups.



Hip: A significant difference at 3 months after surgery between Teriparatide group (BMD: 0,876 g/cm2) and the placebo group (BMD: 0,845 g/cm2) (P-value:0,0). This difference was not maintained at 6 and 12 months after surgery. There was a significant bone loss at 12 months after surgery in both Lumbar spine (Placebo: 2,1 %) and Total Hip (Placebo: 1,6%).

34. ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS) SURGERY: COMPARISON BETWEEN ADOLESCENCE AND ADULTHOOD IN A COHORT OF 495 PATIENTS

Emmanuelle Ferrero, MD, PhD; Marc Khalifeé, MD, MS; Pierre Guigui, MD

Hypothesis
AIS Surgery is associated with better long term quality of life and deformity correction when it is performed in adolescence

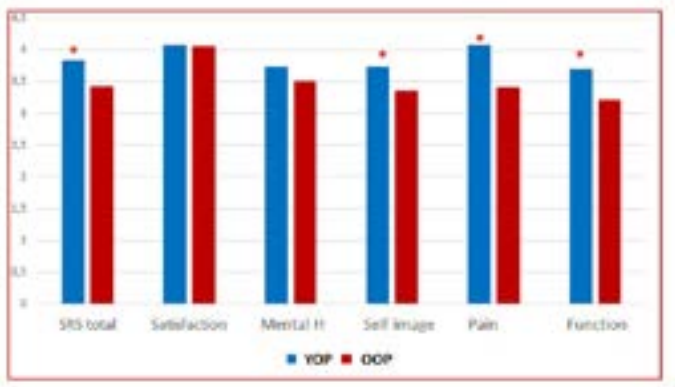
Design
retrospective multicenter

Introduction
Idiopathic scoliosis is a frequent pathology. It is also a chronic disease during patient's life. In case of a moderate deformity in a well aligned adolescent, it's a big concern to decide when to do the surgery. Objective of this study was to compare clinical, radiological and surgical data of AIS patients operated in adolescence and those operated adults.

Methods
Inclusion period extended from 2010 to 2017. Two groups were defined, those operated on before 20 years (YOP), and those operated on after 35 years (OOP). Demographic and radiographic data were collected preoperatively. At follow-up, radiographic data and functional outcomes (VAS, SRS, SF12, Oswestry) were analyzed. Minimum follow-up was 5 years for YOP (mean 84+/-7months)and 2 years for OOP (mean 49+/-6months).

Results
The population consisted of 495 patients (80% women). There were 364 YOP and 131 OOP. In the 2 groups, deformity was important with mean Cobb angle of 63°+/-19 without significant difference btw the groups. Preoperative global sagittal and coronal alignment was preserved in all groups (SVA <3cm and C7 coronal plumbline < 2.5cm). 3 column osteotomies were more frequent (6 vs 0), postop complications were more common (12% vs 7%), fusions length (17+/-3 vs 12+/-4) and length of stay (11+/-9 vs 6+/-3) were longer for old than young patients (all p <0.05). Main Cobb correction was better in young than old (30+/-10° vs 22+/-13°,p=0.03). Results were stable at FU. Functional outcomes at FU were better for YOP than for OOP (SF12 PCS 50+/-7 vs 39+/-6, p=0.02). SRS score was better for YOP than OOP (table). The same trends were observed at maximum follow-up.

Conclusion
Surgery for idiopathic scoliosis, when performed at adolescence, is associated with a better deformity correction and quality of life at long term follow-up. After 35 years, surgery remains an acceptable therapeutic option, despite higher complication rate and worse alignment.



Histogram of SRS scores comparison between YOP and OOP at follow-up.

35. SINGLE-STAGE IMPLANT EXCHANGE PROVIDES LESS CORRECTION LOSS WITH BETTER PATIENT-REPORTED OUTCOMES THAN IMPLANT REMOVAL ONLY FOLLOWING LATE INFECTIONS AFTER POSTERIOR SPINAL FUSION FOR AIS

Gregory Benes, BS; Harry L. Shufflebarger, MD; Suken A. Shah, MD; Burt Yaszay, MD; Michelle Claire Marks, PT, MA; Peter O. Newton, MD; Paul D. Sponseller, MBA

Hypothesis
Infection cure rates will be equivalent, but single-stage implant exchange (SSE) will provide better deformity correction and patient-reported outcomes than implant removal only (IR).

Design
Retrospective review of a multicenter, prospectively maintained AIS database

Introduction
Late infections after posterior spinal fusion (PSF) for AIS represent the leading cause of late revision. While the exact mechanism is unknown, late-developing SSI present major medical and surgical burdens. Implant removal and antibiotic therapy are curative; however, patients may experience deformity progression.

Methods
We compared radiographic (major curve, thoracic kyphosis, lumbar lordosis), surgical (EBL, operative time, implant properties), clinical (LOS, causative organisms), and patient-reported outcomes (SRS-22) at latest follow-up for all patients who developed a late SSI after PSF from 2005 to 2021. Delayed deep SSI were defined as those occurring >1 year after the initial procedure.

Results
47 patients developed late SSI at a mean 3.8 ± 2.2 years (range: 1-9.7 years) after index surgery. The average follow-up was 6 years with 2.1 years of follow-up after revision surgery. 26 patients were treated with IR and 21 with SSE. At latest follow-up, major curve loss of correction was less in the SSE group (mean change, 1.13°) than in the IR group (mean change, 9.3°) (p=<0.001), as well as thoracic kyphosis (mean change 1.2° for SSE vs. 8.8° for IR; p=0.04). Patients who underwent SSE had higher SRS-22 total scores (4.38 vs. 3.81, p=0.02) as well as better subscores regarding self-image, function, and satisfaction at latest follow-up compared to those who underwent IR only. 27 out of 42 patients (64%) had negative culture results. Most isolated organisms were gram-positive. No differences were observed by treatment group for operative time, estimated blood loss, length of hospital stay or change in SRS-22 total scores. No patient had a subsequent infection during the follow-up period. 2 IR patients underwent reinstrumentation for curve progression.

Conclusion
Although IR was curative in our cohort at latest follow-up, SSE offered better maintenance of correction, improved sagittal profile, and improved overall health-related quality-of-life outcomes with equivalent reinfection risk.

trends in total SRS-22 scores over time by IR and SSE cohorts

36. ANTERIOR VS POSTERIOR SPINAL FUSION IN LENKE TYPE 5 AIS CURVES: COMPARISON OF HEALTH RELATED QUALITY OF LIFE, RADIOLOGIC OUTCOMES AND ASSESSMENT OF THE DEGENERATION OF UNFUSED SEGMENTS (MRI STUDY) - MEAN 13 YEARS FOLLOW UP

Hamisi M. Mraja, MD; Baris Peker, MD; Halil Gok, MD; Celaleddin Bildik, MD; Ayhan Mutlu, MD; Onur Levent Ulusoy, MD; Tunay Sanli, MA; Selhan Karadereler, MD; *Meric Enercan, MD*; Azmi Hamzaoglu, MD

Hypothesis
Anterior Spinal Fusion (ASF) and Posterior Spinal Fusion (PSF) may demonstrate different clinical and radiological outcomes in the long term f/up.

Design
Retrospective.

Introduction
Selective lumbar fusion (Cobb to Cobb) was accepted as standard treatment for AIS with Lenke Type 5 curves, but the choice of surgical approach is still controversial. The aim of this study is to compare the long-term clinical, radiological outcomes and assess the disc degeneration (DD) and facet joint degeneration (FJD) at unfused lumbosacral spine with MRI in surgically treated Lenke type 5 AIS pts.

Methods
43 (15 ASF, 28 PSF) Lenke type 5 AIS pts treated with ASF or PSF between Cobb levels with more than 10 yrs f/up performed by single surgeon were included. Preop, postop, f/up coronal & sagittal parameters were analysed. DD and FJD at unfused segments distal to the fusion were assessed with lumbar MRIs at the

final f/up. Clinical outcomes were evaluated with SRS22r

Results
ASF group included 15 pts with 18,7(12-23) yrs f/up. PSF group included 28 pts with 13(10-17) yrs f/up. The mean age at the time of surgery was 15 for both groups. LIV levels were similar for both groups (L3; 80% ASF vs 78% PSF). Mean TL/L curve correction rate was 76% in ASF and 85% in PSF group without any correction loss at latest f/up. Magnitude of residual lumbar curves were similar and stable over time (ASF;6.4° vs PSF;5.8°). Spontaneous upper thoracic curve corrections were similar (59% ASF vs 57% PSF). DD and FJD grades of distal unfused segments were similar for both groups despite the longer f/up period and higher mean age at the time of f/up (ASF;18yrs f/up, age:34yrs vs PSF; 13yrs f/up, age:28yrs). DD and FJD were significant at LIV+1 level in both groups. SRS22r all domain scores were higher in ASF group. Revision surgery was performed only in 1(1.9%) patient for pseudoarthrosis in PSF group.

Conclusion
ASF and PSF provided satisfactory clinical and radiologic outcomes in the long term f/up. Although mean length of f/up and mean age was at least 5 years greater in ASF pts compared to PSF patients, in the unfused lumbosacral spine below the fusion level, both groups had similar grades of disc and facet joint degeneration. Patient satisfaction(4,7/5) and SRS22r scores are higher in ASF pts at the end mean 13 years f/up.

37. VERTEBRAL BODY TETHERING IN LENKE 5 AND 6 AIS: RADIOGRAPHIC OUTCOMES IN SELECTIVE VS. NON-SELECTIVE VBT

Noor Maza, MD; Lily Q. Eaker, BA; *Baron S. Lonner, MD*

Hypothesis
There is no difference in radiographic outcomes between Lenke 5 and 6 AIS patients managed with selective vs. nonselective VBT.

Design
Single surgeon retrospective review

Introduction
Anterior vertebral body tethering (VBT) is a non-fusion alternative for skeletally immature patients with AIS. There is a paucity of data on TL major curvatures treated with VBT. We sought to compare the outcomes of selective (S) versus non-selective (NS) VBT instrumentation in Lenke 5 and 6 AIS.

Methods
Inclusion criteria were Lenke 5/6, Risser 0-4, and min. 2 yr. FU. 17 S (only TL/L curvature instrumented) patients were compared to 13 NS patients (both T and TL/L curves are instrumented with bilateral approach). Sub-analysis was performed between Lenke 5 S vs NS instrumentation. Continuous variables were compared using Mann Whitney U tests and student t-tests. Categorical variables were compared using Chi-square and Fisher Exact tests.

Results
At baseline, S patients were older at index surgery (14.5±1.4 vs. 13.3±1.7, p = 0.0508), had fewer Lenke 6 curves (6% vs. 54%), smaller pre-op T (29.5±6.1 vs. 48.2±6.7, p <0.0001) and TL curves (47.8±5.5 vs. 54.9±7.8, p = 0.0065). While there were significant differences in pre-op T inclinometer measurements (3.3±3.0 vs. 8.5±4.1, p = 0.001), there were no differences in TL. There were no between group differences in TL curve correction (S 62.6±29.1% vs. NS 59.0±18.1%; p>0.999). However, the S group had less T curve (S 51.0±46.2% vs. NS 58.5±16.5%; p=0.0120) correction although similar residual curvature. In both the S (6%) and NS (8%) groups, 1 patient had a residual TL curve >35°.T5-T12 kyphosis increased and lumbar lordosis was maintained in both groups. There were no differences in T (3.7±3.7 vs 4.0±1.0; p=0.8852) or TL (4.5±2.8 vs 3.7±1.5; p=0.6403) inclinometer measurements at latest FU. 47% of patients experienced tether breakage (33% at a single level; 13% at 2 or more). There were 4 major complications including 1 revision due to overcorrection and adding on, 1 revision due to curve progression resulting in fusion of the T spine and revision of TL implants in S group, 1 screw revision due to radiculopathy.

Conclusion
Both S and NS VBT for treatment of TL major curvatures result in reliable correction of the TL major curvature and similar residual T curvature. S patients have lesser baseline T and TL deformity.

Lenke 5 & 6 Curves				
		Lumbar Instrumented Curve (S) (N=17)	**Both Curves Instrumented (NS) (N=13)**	**P Value**
Demographics	Gender (F)	15 (88%)	11 (85%)	0.3671
	Age	14.5±1.4	13.3±1.7	0.0705
	Risser 0/1/2/3/4	2 | 9 | 2 | 4 | 7	2 | 2 | 2 | 3 | 3	**0.0051**
	PRISM* 3A | 3B | 4	5 | 5 | 7	4 | 1 | 8	**0.0486**
	Mean RO	35.6±9.6	34.0±11.2	0.6147
T (°)	Pre	29.5±6.1	48.2±6.7	**<0.0001**
	Latest FU	14.7±12.2 (51.8±40.2%)	19.8±7.4 (59.3±16.5%)	0.2755 (0.0129)
TL (°)	Pre	47.8±5.5	54.9±7.8	**0.0065**
	Latest FU	18.8±12.7 (62.6±29.1%)	22.0±9.5 (59.8±18.1%)	0.4893 (>0.999)
T5-T12 Kyphosis (°)	Pre	17.3±8.1	25.5±12.7	0.0526
	Latest FU	23.3±15.1	30.7±17.4	0.1319
Lumbar Lordosis (°)	Pre	53.3±11.9	61.8±14.0	0.0933
	Latest FU	52.7±12.0	60.1±15.6	0.1615
T Inclinometer (°)	Pre (Latest FU)	3.3±3.0 (3.7±3.2)	8.5±4.1 (4.4±1.5)	**0.001** (0.6125)
TL Inclinometer (°)	Pre (Latest FU)	15.8±4.0 (4.4±2.7)	16.2±4.4 (3.4±1.8)	0.7635 (0.4235)
Lenke 5 Curves				
T (°)	Pre	28.8±5.7	45.5±5.1	**<0.0001**
	Latest FU	14.3±12.7 (51.6±47.6%)	22.0±8.1 (51.2±19.7%)	0.1749 (0.2944)
TL (°)	Pre	47.4±5.5	49.5±4.5	0.4241
	Latest FU	17.9±13.1 (62.5±30.1%)	26.0±4.6 (47.2±9.6%)	0.0804 (0.1369)
Lumbar Lordosis (°)	Pre	53.4±12.3	59.4±12.3	0.3768
	Latest FU	52.8±12.4	61.8±20.7	0.2245
T Inclinometer (°)	Pre (Latest FU)	3.4±3.3 (3.7±3.7)	8.0±4.0 (4.0±1.0)	**0.0096** (0.8852)
TL Inclinometer (°)	Pre (Latest FU)	15.4±3.9 (4.5±2.8)	17.5±4.4 (3.7±1.5)	0.2962 (0.6403)

*PRISM: Proximal humeral evaluation system

Table. Comparison of S and NS instrumented VBT patients.

38. UNILATERAL THORACIC SPINAL NERVE RESECTION CAUSES IDIOPATHIC-LIKE THORACIC SCOLIOSIS IN AN IMMATURE PORCINE MODEL

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

Hypothesis

A unilateral thoracic spinal nerves (TSN) disturbance would interrupt the normal reflex arc to remain the efferent supply to the intercostal muscle (ICM) resulting in the muscular denervation and weakness on the ipsilateral side which would result in imbalance thoracic muscular support inducing the rib cage deformity to cause the thoracic scoliosis.

Design

To test whether multiple-level unilateral TSN resection can induce the initial thoracic cage deformity to cause idiopathic-like thoracic scoliosis in an immature porcine model.

Introduction

The cause of adolescent idiopathic scoliosis is still unknown. A proportion of studies have centered on the possibility of a neurogenic theory for idiopathic scoliosis and additional research is needed in this area.

Methods

Seventeen one-month-old pigs were assigned to 3 groups. In group 1 (n=6), eight-level right TSN were resected from T7 to T14 with bilateral paraspinal muscle stripping. In group 2 (n=5), the animals were treated in the same way except the contralateral (left) side was intact. In group 3 (n=6), bilateral eight-level TSN were resected from T7 to T14. All animals were followed up for 17-weeks. Radiographs and pathology were measured and analyzed the correlation between the Cobb angle and thoracic cage deformity. A histological examination of ICM was performed.

Results

An overt rig cage deformity toward the TSN resection side produced thoracic scoliosis immediately after the surgery in every animal of the unilateral TSN resection group (FIG. 1). In groups 1 and 2, an average 62±12° and 42±15° right thoracic scoliosis with apical hypokyphosis of a mean -5.2±16° and -1.8±9° were created in 17-weeks follow up. Statistical analysis demonstrated that the thoracic deformities were strongly correlated with the Cobb angle. No scoliosis was seen in any animal of the bilateral TSN resection group. The histological examination showed ICM denervation on the TSN resection side.

Conclusion

Unilateral TSN resection induced initial thoracic deformity toward the TSN resection side resulting in idiopathic-like thoracic hypokyphotic scoliosis in an immature pig model. These data suggest that neurogenic thorax muscular imbalance may have some role in initiating scoliosis.

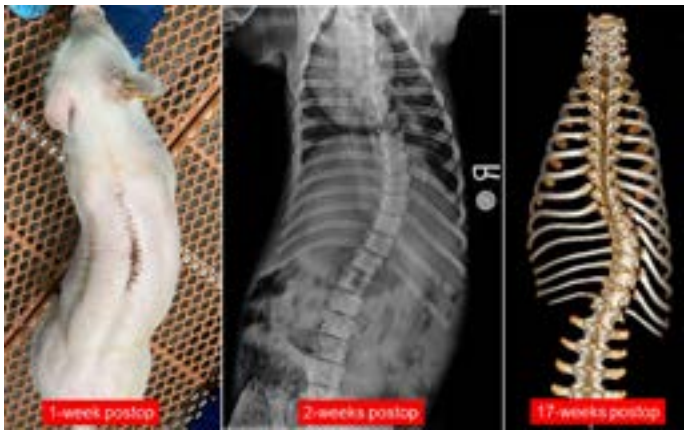


Fig-1

39. ASSESSMENT OF CESSATION OF GROWTH IN IDIOPATHIC SCOLIOSIS: RADIOGRAPHIC MEASURES, BIOLOGIC MEASURES AND MORE

Michelle C. Welborn, MD; Amer F. Samdani, MD; James O. Sanders, MD; Vishwas R. Talwalkar, MD; Robert H. Cho, MD; Selina C. Poon, MD; Ryan Coghlan, MS; Joseph D. Stone, MD; Susan Sienko, PhD

Hypothesis
We hypothesized that the combination of biologic and radiographic data would improve our ability to accurately assess cessation of growth.

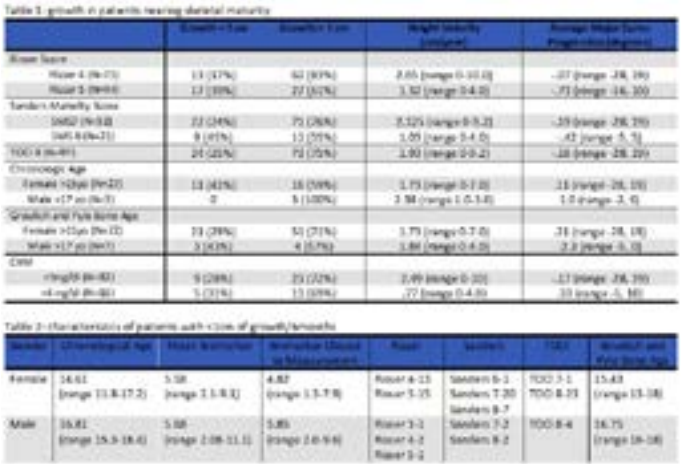
Design
IRB approved Prospective Comparative Study

Introduction
Assessment of cessation of growth for is critical for determining surgical and brace treatment of scoliosis patients. Risser score (RS) was the gold standard but has been shown it can result in the mistreatment of 1/4 braced patients with AIS. Subsequent studies showed over 20% of Sanders Maturity Stage (SMS) 7 pts had curve progression at cessation of bracing. Type X collagen (COLX) is produced in the growing physes during enchondral ossification. CXM is a breakdown product of COLX and has been shown to be a direct measure of enchondral ossification and longitudinal bone growth. We theorized that the combination of CXM and radiographic or clinical measures may allow for accurate prediction of cessation of growth.

Methods
Q6mo anthropometrics and spine PA biplanar slot scanner images including the hand were assessed for major curve magnitude, RS, triradiate cartilage status (TRC), Greulich and Pyle bone age (BA), and SS. Serial Dried Blood Spots (DBS) to obtain CXM levels were collected 3 consecutive days Q1-2months based on SS. Inclusion criteria included Risser 4 or 5, SMS 7 or 8, TOCI 8, chronologic age (CA) or bone age (BA) >15 in girls and >17 in boys, cxm <5ng/dl.

Results
Over 250 patients with idiopathic scoliosis with Cobb ≥20 were enrolled between 2018-2022. Of those patients, 97 patients reached a measure that would meet at least one criteria for cessation of bracing and were included in this sub-analysis. RS 5, SMS 8, and CXM <4 showed the lowest rates of continued growth. Patients with CXM<4ng/dl showed the lowest height velocity at <.77cm/year. Despite that, there were patients in each group that continued to grow.

Conclusion
Assessment of the cessation of growth remains challenging. The current metrics for cessation of bracing are inadequate with 20-25% of patients experiencing curve progression and upwards of 75-100% of patients will have significant remaining growth when RS, SMS, TOCI, CA or BA are used alone. It is only be combining biologic, clinical and radiographic parameters that we have the potential to accurately determine cessation of growth which is critically important for determining timing of cessation of bracing and surgical intervention in patients with scoliosis.



40. THREE-DIMENSIONAL SPINE GROWTH IS MAINTAINED 5 YEARS POST-OPERATIVE THORACIC VERTEBRAL BODY TETHERING SURGERY IN IDIOPATHIC SCOLIOSIS

Mathieu Boulet, MD; Jennifer K. Hurry, MASc; David L. Skaggs, MMM; Michelle C. Welborn, MD; Lindsay M. Andras, MD; Craig R. Louer, MD; A. Noelle Larson, MD; Firoz Miyanji, MD; Stefan Parent, MD, PhD; Pediatric Spine Study Group; Ron El-Hawary, MD

Hypothesis
The instrumented levels of VBT continue to grow over time.

Design
Radiographic analysis of VBT patients from an international, multi-center pediatric spine registry.

Introduction
Scoliosis can be treated with VBT as a growth-friendly and motion-sparing procedure. However, the knowledge of how growth is affected by a tether spanning multiple levels is unclear in the literature. Three-dimensional true spine length (3D-TSL) is a novel assessment technique that accounts for the shape of the spine in both the coronal and sagittal planes. Previous studies* have demonstrated that 3D-TSL is more accurate than simple coronal plane height measurements. This study aimed to assess if 3D-TSL increases over a five-year period after VBT implantation. *DOI 10.1097/BPO.0000000000001031

Methods
Prospectively collected radiographic data from an international pediatric spine registry was analyzed.

Complete radiographic data over three visits (post-operative, 2 years, and 5 years) was available for 60 patients who underwent VBT.

Results
The mean age of this cohort was 12.2 (9 – 15) years at instrumentation. The average number of vertebrae instrumented was 7.3 (SD 0.8). Major Cobb angles were 50.1° pre-operative; 27.3° post-operative and 34.1° at 5 years ($p<0.05$). An accentuation was seen in global kyphosis from 28.8° pre-operative to 42.9° at 5 years ($p<0.05$). Immediate mean post-operative 3D-TSL of the tethered segments (top of UIV to top of LIV) was 13.74 (SE 0.23) cm; two-year length was 14.31 (SE 0.22) cm; and five-year length was 14.70 (SE 0.22) cm ($p<0.05$; Fig 1). The global spine length (T1-S1 3D-TSL) started at 40.61 (SE 0,38) cm; measured 42.86 (SE 0.34) cm at 2 years; and 44.13 (SE 0.31) cm at the final visit ($p<0.05$). Over the instrumented levels, 40/60 (66.7%) patients had greater than 0.5 cm of 3D growth at 2 years and 25/60 (41.7%) patients had more than 1 cm of gain at 5 years. Subgroup analyses were not significant for age, Cobb angles or number of spanned vertebrae between these patients and those who had less significant growth through the follow-up.

Conclusion
This series demonstrates that 3D-TSL can increase over the instrumented levels after VBT surgery. At 5 years, this average 3D growth of 0.96 cm or 0.13 cm per instrumented level lends support to the theory that VBT surgery is a growth friendly fusionless technique.

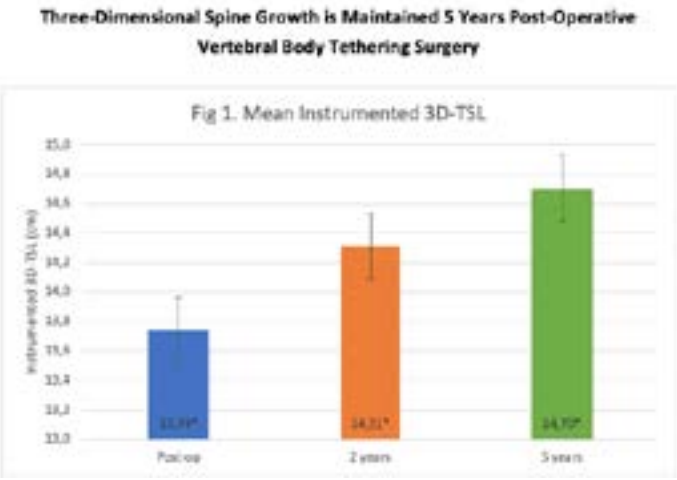


Fig 1. Mean Instrumented 3D-TSL

41. COMPARISON OF FREE-HAND TECHNIQUE AND USE OF INTRAOPERATIVE NAVIGATION FOR PEDICLE SCREW PLACEMENT IN THE LUMBAR SPINE: A PROSPECTIVE, RANDOMIZED CONTROLLED TRIAL

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Hypothesis
O-arm navigation offers better accuracy than conventional free hand placement of screws

Design
Randomised control trial. Adult patients undergoing single-level lumbar interbody fusion by an open, posterior approach were prospectively recruited and randomly assigned to free-hand (FH) or O-arm navigation guided (ON) pedicle screw placement

Introduction
Navigation over the last two decades have been revolutionary in the field of spine surgery . Though O-arm–based navigation (ON) is considered a better choice than the conventional freehand (FH) technique for spine surgery, literature evidence showing the accuracy of ON compared with the FH technique is limited. The objective of the randomized control study is to compare free-hand (FH) and O-arm navigation guided (ON) pedicle screw placement in the lumbar spine.

Methods
Adult patients undergoing single-level lumbar interbody fusion by an open, posterior approach were prospectively recruited and randomly assigned to free-hand (FH) or O-arm navigation guided (ON) pedicle screw placement. The outcome measures compared were: i) accuracy of pedicle screw placement – using Gertzbein-Robbins classification and angular deviation from the 'ideal' coaxial intrapedicular trajectory (in degrees), ii) surgical time taken exclusively for pedicle screw placement (minutes), iii) radiation exposure (seconds fluoroscopy), iv) incidence of cranial facet violation (%) and, v) clinical complications.

Results
Forty patients (80, in total) were randomly allocated to each group; a total of 160 pedicle screws were inserted by each of the two techniques. Although the accuracy of screw placement (ON: 97% v/s FH: 93%) and incidence of cranial facet violation (ON: 12% v/s FH: 22%) was better in ON group, this difference was not statistically significant. Placement of screws in FH group deviated significantly more (FH: 11.8° v/s ON:

3.6°) from the ideal coaxial intrapedicular trajectory. Both the surgical time for screw placement (ON: 28 ± 14.4 minutes v/s FH: 15.6 ± 7.5 minutes) and radiation exposure (ON: 54.2 seconds v/s FH: 32.2 seconds) were significantly more in the ON group.

Conclusion
In the hands of an experienced surgeon, O-arm navigation guided pedicle screw placement in the lumbar spine provides no added advantage over free-hand technique, while increasing the surgical time and the radiation exposure to the patient.

43. MORTALITY IN CEREBRAL PALSY PATIENTS WITH SCOLIOSIS WITH AND WITHOUT SPINAL DEFORMITY SURGERY – A REGISTRY-BASED INVESTIGATION

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Hypothesis
We hypothesized that scoliosis surgery affects survival of cerebral palsy patients with scoliosis.

Design
Registry-based retrospective cohort study.

Introduction
Scoliosis is common in children with cerebral palsy (CP). Severe scoliosis leads to decreased health related quality of life (HRQoL) and pulmonary compromise. Scoliosis surgery in CP patients increases HRQoL and reduces caregiver burden, but effects of scoliosis surgery on pulmonary function and mortality remain obscure. The purpose of this study was to compare mortality and primary causes of deaths in scoliotic children with CP with and without spinal deformity surgery.

Methods
We identified 4571 children born between 1987 and 2020 who had been diagnosed with CP between 1996 and 2022 from national registries, of these 474 CP patients had been diagnosed with scoliosis. Two hundred and thirty-six had not been operated and 238 were operated for scoliosis during the follow-up median 17.8 (IQR 11.7-25.7) and 23.0 (IQR 18.4-28.2)) years, respectively. Associated co-morbidities, demographic data, mortality and causes of death were analyzed between non-surgically and surgically treated children with CP and scoliosis.

Results
Children with CP and scoliosis with non-surgical and surgical treatment were diagnosed with scoliosis at the age of 12.1 and 12.5 years, respectively. Length of gestation and birth weight was similar in both groups. Both groups had similar rate of pneumonias, epilepsy, and gastrostomy. During the follow-up mortality was higher in the non-surgically treated group than in the surgically treated group (n=38/236, 16% vs. n=29/238, 12%, p=0.047) (Fig. 1.). Cause of death was respiratory in 76.3% (29/38) in patients with non-surgical treatment and 37.9% (11/29) surgical treatment of scoliosis (p=0.002). Neurological causes of death were significantly more common in surgically treated patients than in non-surgically treated patients, 44.8% (13/29) and 15.8% (6/38), respectively (p=0.009).

Conclusion
Surgical treatment of scoliosis associates to reduced mortality due to respiratory causes in children with cerebral palsy and scoliosis.

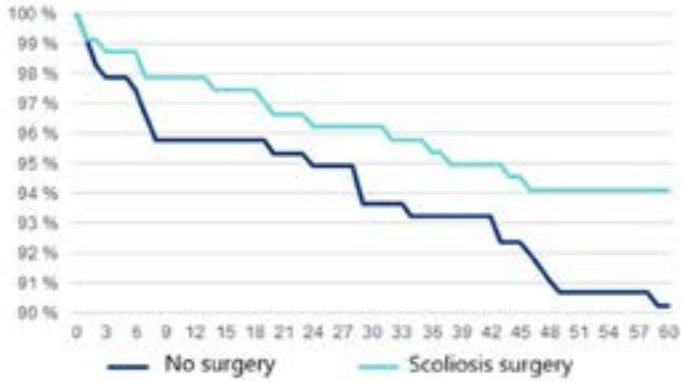

Figure 1. Survival function in showing the risk of death in non-surgically treated and surgically treated CP patients with scoliosis starting at the age of surgery (median 12.8 (IQR 9.2-15.2)) years of age (p=0.047).

44. MID-TERM OUTCOME OF MULTIMODAL TREATMENT FOR SEVERE SPINAL DEFORMITY IN OSTEOGENESIS IMPERFECTA: MINIMUM TWO YEARS FOLLOW-UP

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Hypothesis
Posterior spinal fusion (PSF) with segmental pedicle screw instrumentation and cement augmentation combined with preoperative bisphosphonate therapy will bring favorable scoliosis surgical outcomes for patients with osteogenesis imperfecta (OI).

Design
Retrospective case series

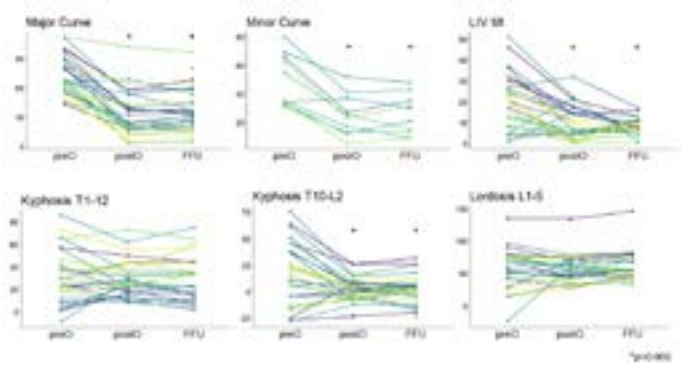
Introduction
The surgical treatment for scoliosis in patients with

OI is challenging because of curve rigidity, small stature, and bone fragility. Previous surgical methods and instrumentation had limited correction and high complication rates. Current instrumentation, including pedicle screws with cement augmentation, has improved scoliosis outcomes in this population, but few reports have been published.

Methods
We evaluated 28 patients (average age 14.2±2.1 years; 16 females) with OI and thoracolumbar scoliosis who underwent PSF between 2008-2019 and completed a minimum two-year follow-up. Two patients were OI type I, 18 were type III, six were type IV, and two were others (type V and VIII). Radiographic parameters were measured at preoperative, postoperative, and latest follow-up (FFU) visits. In addition, incidences of the following complications were reviewed; surgical site infection (SSI), neurologic deficit, implant failure, cement extravasation, and unplanned return to the OR (UPROR). A mixed effect model was used to evaluate changes in radiographic parameters from preoperative to FFU.

Results
Fourteen had thoracic, 11 had double major, and 3 had lumbar/thoracolumbar curves. A mean follow-up of 69 months (range 24 – 148 months). Figure 1 shows significant improvement of the major curve, persistent at final follow-up (pre; post; final = 74; 35; 37°, p<0.001) with a 51% correction rate, as well as the minor curve (50; 25; 25°, p<0.001) and lowest instrumented vertebra (LIV) tilt (13; 8; 4°, p<0.001). While thoracic kyphosis (T1-12) and lumbar lordosis (L1-5) remained unchanged, thoracolumbar kyphosis (T10-L2) significantly improved (17; 3; 2°, p<0.001). Two patients had proximal junctional kyphosis with screw pullout, one of which underwent UPROR. One patient had superficial SSI treated with antibiotics. No patients had neurologic deficits or cement extravasation.

Conclusion
Our contemporary multimodal approach provided favorable outcomes to patients with OI and scoliosis with a 51% correction of the major curve and low complication rates at a minimum 2-year follow-up.



Change in radiographic parameters

45. WHY ARE WE FIXING THE SPINE? SURGEON AND CAREGIVER ANSWERS ON THE GOALS OF SURGERY FOR PATIENTS WITH CP SCOLIOSIS

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Hypothesis
The alignment of caregiver and surgeon goals and expectations will improve HRQOL outcomes.

Design
Retrospective cohort

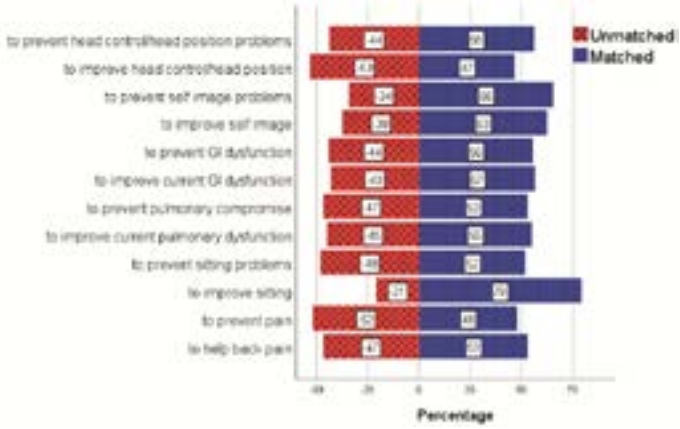
Introduction
The decision to perform an instrumented spinal fusion is not straightforward. A shared decision-making process involving the caregiver/patient with the surgeon is optimal. One objective of shared decision-making is to assure that caregiver/patient and surgeon expectations and goals for surgery are aligned. With this study we want to identify the different expectations caregivers and surgeons have for instrumentation of spinal deformities (scoliosis) in children with cerebral palsy and to assess the effect of agreement/disagreement on perceived health-related quality-of-life outcomes

Methods
A multicenter cohort of patients with cerebral palsy who underwent spinal fusion with minimum 2-year follow-up was retrospectively reviewed from a prospectively collected database registry. Questions related to “indication for spinal fusion” were answered prior to surgery by caregivers and surgeons(Fig). Descriptive statistics were used to show frequencies for surgeon/caregiver goals for spinal fusion. Matched/unmatched answer pattern groups were compared with independent t-test for Caregiver Priorities & Child

Health Index of Life with Disabilities(CPCHILD) domain scores at 2- and 5-year follow-up

Results
312 patients were included for analysis. The most common goal for caregivers and surgeons was "to improve sitting" and the least important goal was "to prevent self-image problems." (Fig) When the two groups matched answers on "help back pain," there was improvement in 2- and 5-year follow-up on the comfort domain of the CPCHILD questionnaire. Significant unmatched answers in goals to prevent back pain and improve current pulmonary and gastrointestinal dysfunction correlated with deterioration in overall quality-of-life perception by parents at 2-year follow-up.

Conclusion
Improving sitting is a common expectation of both surgeons and caregivers. To prevent self-image problems is not a common expectation for surgeons and caregivers. Disagreement to prevent back pain correlated with deteriorated QOL perception by caregivers. Disagreement to improve pulmonary dysfunction correlated with deteriorated QOL perception by caregivers. Disagreement to improve gastrointestinal dysfunction correlated with deteriorated QOL perception by caregivers.



46. MINIMALLY INVASIVE SURGERY IN PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS IS SAFER, LESS EXPENSIVE WITH BETTER RESTORATION OF KYPHOSIS

Vishal Sarwahi, MD; Sayyida Hasan, BS; Jesse M. Galina, BS; Aaron M. Atlas, BS; Alexandre Ansorge, MD; Charlotte De Bodman, MD; Yungtai Lo, PhD; Terry D. Amaral, MD; Romain Dayer, MD

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.

47. THE LEARNING CURVE OF MINIMALLY INVASIVE SURGERY (MIS) IN ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS)

Vishal Sarwahi, MD; Sayyida Hasan, BS; Keshin Visahan, BS; Alexandre Ansorge, MD; Charlotte De Bodman, MD; Yungtai Lo, PhD; Terry D. Amaral, MD; Romain Dayer, MD

Hypothesis
Perioperative outcomes improve over time for MIS in AIS

Design
Ambispective review

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

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

Results
Group 1 (n=21), Group 2(n=19), Group 3(n=21), and Group 4(n=30) were similar in demo data(p>0.05). Preop Cobb was similar between Group 1 and 2 (48 vs 50.5,p=0.49) as was kyphosis (28.6 vs 21,p=0.15). Levels fused was similar (10 vs 11, p=0.19) as was fixation points (23.5 vs 16.7,p=0.13). Postop Cobb was similar between Group 1 and 2 (15.5 vs 13.6,p=0.60), however postop kyphosis was significantly higher in Group 1 (31.4 vs 19.9,p=0.014). Surgical time(min) was significantly less in Group 2 (456 vs 285,p<0.001). EBL(ml) was similar between groups(400 vs 300,p=0.88). Hospital stay(days) was significantly less in Group 2(5 vs 6,p =0.028). In Group 3 and 4, preop Cobb(53 vs 61,p=0.070) and kyphosis(28 vs 25,p=0.503) were similar. Percent cobb correction was similar(72 vs 72.2,p=0.829) but postop kyphosis was significantly less in Group 4(33 vs 28,p=0.024). EBL was similar between groups(350vs350,p=0.272). Surgical time was significantly less for Group 4(444 vs 303,p=0.002). Hospital stay was similar (5 vs 5,p=0.074).

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

48. WHICH IS BETTER: PERCUTANEOUS OR OPEN ROBOT-ASSISTED SPINE SURGERY? PROSPECTIVE, MULTICENTER STUDY OF 2,524 SCREWS IN 336 PATIENTS

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Hypothesis
Percutaneous and open robot-assisted cases have similar outcomes

Design
Prospective multicenter cohort

Introduction
There is limited literature on the comparison of percutaneous robot-assisted spine surgery to open robot-assisted techniques. Determining the clinical differences between these cohorts can better inform surgeons and patients during their preoperative planning phase of care. A large, prospective, multicenter study was performed to further elucidate the outcomes and complications between these two approaches

Methods
This is a prospective study of adult patients(≥18 years) who underwent spine surgery with a bone mounted robotic assist with navigation confirmation from 2020-2022 at 4 independent institutions, among 6 spine surgeons. A propensity score matching(PSM) algorithm was employed to control for potential selection bias between percutaneous and open surgery. The minimum f/u was 90 days.

Results
After PSM, 336 patients with 2,524 robot-assisted screws remained with no significant differences in demographics/comorbidities, diagnoses, and operative factors. The mean ASA 2.3±0.6, BMI 29.8±5.5, current nicotine use 9%, and mean length of stay 3.1±1.8 days. Most common diagnoses included unstable spondylolisthesis(40%), lumbar stenosis(21%), and deformity(15%) with the mean # levels fused 4.0±3.1. Although no difference was found for operative time(open:195±88min vs percutaneous:197±120,p=0.839), robot time/screw was significantly lower for open vs percutaneous (4.3±2.5 vs 8.3±8.3±3.8,p<0.001). There was no difference in robot abandonment(2.1% vs 0%,p=0.081) and screw accuracy(99.1% vs 98.6%, p=0.307); however, open was associated with a higher number of screws not executed due to registration/unreachability issues(1%

vs 0%, p=0.001). Intraop blood loss was greater for open vs percutaneous(EBL:301mL vs 108mL,p<0.001). No difference was observed for intraop complications, length of stay, 90day surgical/medical complications, and revision surgery.

Conclusion
In the first prospective, multicenter study on robot-assisted spine surgery, open approach was associated with shorter robot time/screw, but higher robot-related registration/unreachability issues and greater intraop blood loss. The overall screw accuracy was high(99%) and no difference was observed in robot abandonment, screw accuracy, LOS, revision surgery, and intraop/90 day postop complications between groups.

49. A PARAMETER FIXED TO POOR OUTCOMES?: A DETAILED ANALYSIS OF HIGH PELVIC INCIDENCE IN ADULT SPINAL DEFORMITY SURGERY

Peter G. Passias, MD; Bailey Imbo, BA; Jamshaid Mir, MD; Kimberly McFarland, BS; Peter Tretiakov, BS; Pooja Dave, BS; Rachel Joujon-Roche, BS; Stephane Owusu-Sarpong, MD; Tyler K. Williamson, MS, BS; Jordan Lebovic, MBA; Bassel G. Diebo, MD; Shaleen Vira, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Justin S. Smith, MD, PhD

Hypothesis
Patients with high pelvic incidence have increased risk for complications and poor clinical outcomes following ASD surgery.

Design
Retrospective

Introduction
Pelvic incidence (PI) serves as the cornerstone for realignment schema to create a more individualized realignment target. Yet, previous literature has linked high PI to problematic outcomes following corrective surgery, including mechanical complications and hip pathologies.

Methods
ASD pts with 2Y data included. Groups: PI >65° (HighPI) versus PI < 65° (NormPI). Means comparison tests assessed differences in demographics and surgical details between groups. Multivariate analysis controlling for BL age and frailty analyzed complication rates and clinical improvement between groups.

Results
Included: 445 ASD pts. 21% presented with a PI >65° (HighPI). HighPI pts were older (63 yrs), shorter, with higher BMI and frailty (all p<.05). HighPI were more likely to have had a prior fusion (OR: 1.9, [1.2-3.1]). HighPI were also more likely to present with lower physical functioning scores, and severe pelvic compensation (OR: 5.5, [3.4-8.9]) and global deformity (OR: 3.5, [2.2-5.6]). HighPI underwent more 3COs (OR: 1.8,[1.1-3.1]) and fusion to pelvis (OR: 2.1,[1.1-3.9]). HighPI were more likely to be undercorrected in each age-adjusted parameter compared to NormPI (OR: 4.8, [2.9-7.8]). Yet, HighPI were less likely to deteriorate within in-construct PI-based alignment (relative lordosis and lordosis distribution) (OR: 0.3,[0.1-0.9]). While not different at six weeks, HighPI were more likely to deteriorate in PI-based global alignment and pelvic compensation from six weeks to two years (OR: 3.2, [1.6-6.5]). This translated to a higher likelihood of developing a major or mechanical complication (OR: 1.6, [1.04-2.6]). Additionally, adjusted analysis revealed HighPI had less improvement in patient-reported physical and mental component scores by 2Y (both p<.05).

Conclusion
High pelvic incidence is associated with increased frailty, decreased physical functioning, and more severe lumbopelvic and global deformity in patients presenting for adult spinal deformity correction. These patients are more often undercorrected by age-adjusted standards and deteriorate in out-of-construct alignment over time even when adequately corrected, leading to higher mechanical complications and less clinical improvement by two years.

50. MAINTENANCE OF PELVIC TILT NORMALIZATION FOLLOWING ADULT SPINAL DEFORMITY CORRECTIVE SURGERY: ANALYSIS OF PREVALENCE, TIMING, AND PREDICTORS INFLUENCING OCCURRENCE

Peter G. Passias, MD; *Pooja Dave, BS*; Peter Tretiakov, BS; Jamshaid Mir, MD; Kimberly McFarland, BS; Stephane Owusu-Sarpong, MD; Jordan Lebovic, MBA; Andrew J. Schoenfeld, MD

Hypothesis
To determine the surgical and radiographic parameters associated with and predict maintaining PT normalization after ASD corrective surgery

Design
: Single-center retrospective cohort study

Introduction
Increasing pelvic tilt (PT) is a primary compensatory mechanism in adult spinal deformity (ASD). Some ASD patients improve their PT following ASD correction,

while others do not. The driving forces behind this lack of PT-response are not well defined.

Methods
Operative ASD patients fused to S1/pelvis were included. Patients stratified into four groups: Early Normalization PT <20° 6 weeks (PTNorm6w); Delayed Normalization PT <20° 2 years (PTNorm2y); Non-normalized PT >20° 2 years (Non); Reversal Normalization PT <20° 6 weeks and PT >20° 2 years (RevNorm). Univariate analyses were used to compare normalized and non-normalized by postoperative alignment (PI-LL, SVA, and GAP score) and clinical outcomes (complication rates, HRQL). Multivariable logistic regression and ROC curve develop a model consisting of significant predictors.

Results
253 met inclusion criteria (64.6±9.06 years, 79% female, BMI 27.9±5.57 kg/m2, CCI: 1.9±1.6, levels fused 11.8±4.4, EBL: 1841.6mL, op time: 449.6min). mean PT was: BL: 30.5°, 6W: 22.5°, 2Y: 25°. By SRS-Schwab, 56.5% (n=143) had a moderate pelvic tilt at baseline and 43.5% (n=110) had severe pelvic tilt at baseline. 37.9% (n=96) were normalized at 6W and 6.3% (n=16) normalized between 6 weeks and 2 years, with 43.1% (n=109) were normalized by 2Y. PT6WNorm and PT2YNorm were more likely to be overcorrected at 6W (p<.05). GAP score 6W became greater for non-normalized patients (.55 vs 1.34, p=0.08) and 2Y (.93 vs 1.4, p=.49). PT2YNorm had lower implant failure (8.9% vs 19.5%, p<.05), rod breakage (1.3% vs 13.8%, p<.05) and pseudoarthrosis (0% vs 4.6%, p<.05). Total complication rate was significantly lower for normalization (56.7% vs 66.1%, p=.02). 88% achieved significantly greater normalization with baseline PI-LL and PI-LL at 6 weeks (OR .82 [.7 - .95], p<.05).

Conclusion
PT normalization following ASD correction occurred in almost 40% of patients by 6 weeks postop. Normalization is more likely to occur in patients where reconstruction addresses lumbopelvic mismatch, extends above the apex of the thoracic kyphosis, and has adequate surgical invasiveness to achieve full alignment correction.

51. WHAT'S NEXT: A HIERARCHICAL ORDER TO SURGICAL PLANNING FOR AGE-ADJUSTED CORRECTION OF ADULT SPINAL DEFORMITY

Peter G. Passias, MD; Tyler K. Williamson, MS, BS; Stephane Owusu-Sarpong, MD; Rachel Joujon-Roche, BS; Pooja Dave, BS; Peter Tretiakov, BS; Bailey Imbo, BA; Jamshaid Mir, MD; Kimberly McFarland, BS; Jordan Lebovic, MBA; Shaleen Vira, MD; Bassel G. Diebo, MD; *Renaud Lafage, MS*; Virginie Lafage, PhD

Hypothesis
An individualized order for spinopelvic realignment produces better 2-year HRQL metrics and decreases the risk of mechanical complications and junctional failure following ASD surgery.

Design
Retrospective

Introduction
Research has been concentrated on ASD realignment thresholds for achieving desired clinical outcomes while decreasing complications. However, patients present in differing patterns at unequitable starting points.

Methods
Included: ASD pts with 2Y data. Good Outcome(GO) defined as no proximal junctional failure(PJF), major mechanical complication, or reoperation and meeting Smith et al Best Clinical Outcome(ODI<15 and SRS-Total>4.5) or SCB in ODI(18.8) by 2Y. Patients stratified into Not Frail and Frail, then ranked and categorized by Low and High PI(pelvic incidence). Hierarchical Approach: for each deformity group, using conditional inference tree(CIT) analysis, thresholds for PI-LL were derived based on meeting GO. Patients meeting PI-LL threshold were isolated, and realignment in each remaining parameter(age-adjusted PT, SVA, T1PA and preoperative UIV inclination angle) was examined to identify which had the greatest effect on meeting GO. ANCOVA and multivariable logistic regression analysis, controlling for age, comorbidities, BL deformity and disability, and surgical factors assessed outcome rates for the hierarchical approach of each deformity group.

Results
445 ASD pts included. Deformity groups: 29% Not Frail Low PI, 26% Not Frail High PI, 25% Frail Low PI, 21% Frail High PI. Not Frail Low PI less likely developed major mechanical complications(OR:0.1,[0.1-0.9]) and more often achieved GO(OR: 2.6,[1.1-6.3]) with correction of T1PA. Choosing an optimal UIV inclination best aided Not Frail High PI, increasing likelihood of meeting GO(OR: 3.6,[1.3-10.2]). Matching age-adjusted SVA in Frail Low PI after correcting PI-LL led to lower rates of PJF(0% vs 12%,p=.001), reoperation(OR:0.11,[0.01-0.84]) and higher odds of meeting GO(OR:4.0,[1.1-15.6]). Frail High PI was more likely to meet GO(OR:12.7,[3.3-49.1]) when correcting PI-LL and matching age-adjusted PT, with lower rates

of PJF (0% vs. 13%,p<.001).

Conclusion
Tailored correction goals demonstrated robust clinical improvement while minimizing radiographic and mechanical complications. This analysis of realignment outcomes enables surgeons to plan individualized corrections based on the presentation of spinal deformity patients.

Table 1. Hierarchical Approach to Age-Adjusted Correction in Adult Spinal Deformity Surgery

Hierarchical Approach to Not Frail-Low PI	1) Correct PI-LL between -5° and 15° 2) Next, correct T1PA below 17°
Hierarchical Approach to Low Global-High PI	1) Correct PI-LL between -6° and 12° 2) Next, choose a UIV with inclination angle below 20°
Hierarchical Approach to High Global-Low PI	1) Correct PI-LL between 5° and 25° 2) Next, correct to age-adjusted SVA range
Hierarchical Approach to High Global-High PI	1) Correct PI-LL between 0° and 15° 2) Next, correct to age-adjusted PT range

52. ADULT SPINAL DEFORMITY SURGERY ASSOCIATED WITH THROMBOEMBOLIC DISEASE: AN ANALYSIS OF OVER 8,500 SPINAL DEFORMITY PATIENTS

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Hypothesis
We hypothesized that bleeding disorders and low preoperative hematocrit are risk factors for deep venous thrombosis and pulmonary embolism.

Design
A retrospective observational study

Introduction
The annual frequency of primary and revision multi-level adult spine deformity (ASD) surgeries has increased in the past two decades. Studies evaluating the incidence of deep venous thrombosis (DVT) and pulmonary embolism (PE) following these operations, as well as their risk factors, are limited by sample size. The objective of the present study was to describe the risk factors for and incidence of DVT and PE within 30 days following ASD surgery with ≥7 vertebral levels of posterior instrumentation.

Methods
The American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) database was queried for patients undergoing ASD surgery from 2010 to 2019. Through Current Procedural Terminology (CPT) codes 22843 and 22844, 8,533 adult patients who underwent surgical correction of ASD with ≥7 levels of posterior instrumentation were included. Occurrence of and risk factors for DVT and PE following ASD surgery with ≥7 levels of posterior instrumentation were determined. Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines were followed.

Results
Postoperative venous thromboembolism (VTE) was identified in 325 (3.81%) cases. Of these, 201 (2.36%) involved DVTs, and 157 (1.84%) involved PEs. Independent predictors of postoperative DVT identified by multivariate logistic regression included disseminated cancer (Odds Ratio [OR]: 2.23, 95% Confidence Interval [CI]: 1.41-3.53), steroid or immunosuppressant use for a chronic condition (OR: 2.46, 95% CI: 1.59-3.80), and preoperative hematocrit (OR: 0.96, 95% CI: 0.934-0.990). Independent predictors of postoperative PE identified by multivariate logistic regression included female patients (OR: 1.53, 95%CI: 1.04-2.25), black patients (OR: 1.65, 95% CI: 1.01-2.68), and disseminated cancer (OR: 1.92, 95% CI: 1.10-3.35).

Conclusion
DVT and PE represent major postoperative complications after complex ASD surgery. Black patients, patients with disseminated cancer, patients on chronic steroid or immunosuppressive therapies, and patients with lower preoperative hematocrit levels were at increased risk for VTE following ASD surgery with ≥7 levels of posterior instrumentation.

53. FAILURE OF NONOPERATIVE CARE IN ADULT SYMPTOMATIC LUMBAR SCOLIOSIS: INCIDENCE, TIMING, AND RISK FACTORS FOR CONVERSION FROM NONOPERATIVE TO OPERATIVE TREATMENT

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Hypothesis
Certain radiographic factors, disease-specific factors, and patient-reported outcomes are associated with conversion from nonoperative to operative treatment in patients with ASLS.

Design
Post-hoc analysis of dual-arm, prospective study

Introduction
It is unclear why some patients with adult spinal deformity fail to improve with nonoperative care and convert to surgery, and what factors may relate to conversion to surgery.

Methods
Patients from the ASLS trial who initially received at least 6 months of nonoperative treatment were followed for up to 8 years after trial enrollment. Baseline PROMs (SRS-22 and Oswestry Disability Index [ODI]), radiographic data, and other clinical characteristics were compared for patients who did and did not convert to operative treatment during follow-up. Incidence of operative treatment was calculated and independent predictors of operative treatment were identified with multivariate regression.

Results
Of 135 nonoperative patients, 42 (31%) crossed over to operative treatment after 6 months and 93 (69%) received only nonoperative treatment. In the observational cohort, 23/106 (22%) of nonoperative patients crossed over to surgery. In the randomized cohort, 19/29 (66%) randomized to nonoperative treatment crossed over to surgery. The most impactful factors associated with crossover from nonoperative to operative treatment were enrollment in the randomized cohort, SRS-Subscore less than 3.5, and lumbar lordosis less than 30 degrees. Each 1-point decrease in baseline SRS-subscore was associated with a 233% higher risk of conversion to surgery (HR=2.33, 95%CI=1.14-4.76, p=0.0212). Each 10-degree decrease in lumbar lordosis was associated with a 24% increased risk of operative treatment (HR=1.24, 95%CI=1.03-1.49, p=0.0232). Enrollment in the observational cohort was associated with a 70% lower probability of proceeding with operative treatment (HR=0.30, 95%CI=0.14-0.65, p=0.0024).

Conclusion
Enrollment in the randomized cohort, a lower SRS-Subscore, and lower lumbar lordosis were associated with conversion from nonoperative treatment to surgery in patients (observational and randomized) who were initially managed nonoperatively in the ASLS trial.

54. AN ANALYSIS OF THE CAPABILITIES AND UTILIZATION OF ARTIFICIAL INTELLIGENCE IN ADULT SPINAL DEFORMITY SURGERY

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Hypothesis
Artificial intelligence (AI) will have a beneficial impact on the peri- and post-operative course in adult spinal deformity (ASD) corrective surgery.

Design
Retrospective

Introduction
AI has enhanced the orthopedic surgical tool kit by introducing a broad range of analytical advances that may offer enhanced preoperative planning, intraoperative robotic or navigational guidance, and prediction of post-operative complications. However, there remains a paucity of literature in regards to the utility of AI in ASD-corrective surgery.

Methods
Operative ASD patients with complete baseline (BL) and 2-year (2Y) radiographic/HRQL data were stratified by AI-based utilization and robotic or navigational assistance in pre- and peri-operative course (AI+) or not (AI-). Corrections were based on AI models linked to age, proportional alignment and frailty status algorithms to predict outcomes, junctional failure and thoracic compensations Means comparison tests and regression analysis assessed differences between patient groups.

Results
158 patients were included (57 AI+, 101 AI-). The cohort was 50% female, mean age of 58.8 yrs, BMI 31.6 kg/m2, CCI 3.9, and 6.6 levels fused. At baseline, patient groups were comparable in terms of BL radiographic parameters, all $p < .05$. Surgically, AI+ had significantly shorter operative times and EBL than AI-, both $p < .05$. AI+ had more combined approaches and less osteotomies overall, both $p < .05$. Post-operatively, AI+ patients were noted to have significantly improved segmental alignment in terms of decreased PT (p=.006), and improved global alignment per decreased TPA and SVA by 2Y, both $p < .05$. Compared to AI-, AI+ patints had a lower overall complication rate by 2Y (28.1% vs 47.5%), $p < .05$. in a multivariate analysis controlling for age, CCI, and invasiveness, AI+ patietnts were 61.6% less likely to experience a perioperative complication (OR .384 [CI .149-.989], p=.047).

Conclusion
This study demonstrates that when using artificial intelligence-based technologies, patients demonstrated lower intra-operative invasiveness, increased likelihood of reaching radiographic alignment targets, and decreased complication rates specifically in the perioperative period.

55. PERSISTENT LOWER EXTREMITY COMPENSATION FOR SAGITTAL IMBALANCE FOLLOWING SURGICAL CORRECTION OF COMPLEX ADULT SPINAL DEFORMITY: A RADIOGRAPHIC ANALYSIS OF EARLY IMPACT

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Hypothesis
Residual lower extremity compensation portends poor outcomes and surgical correction of spinal deformity can alleviate these mechanisms.

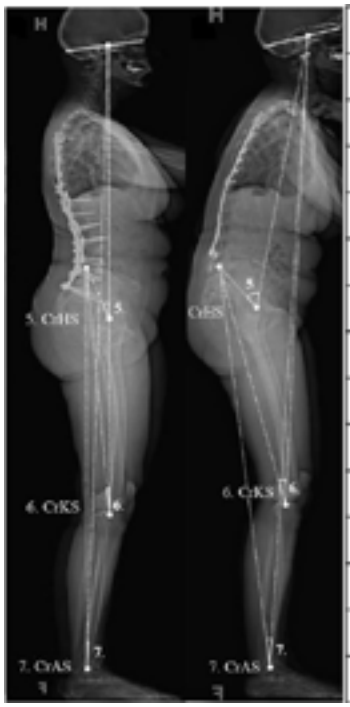
Design
Retrospective

Introduction
Achieving ideal spinopelvic realignment during adult spinal deformity corrective surgery does not always produce ideal outcomes. Little is known whether compensation in the lower extremities (LE) plays a role in this disassociation.

Methods
Included: surgical complex ASD pts with six-week(6W) data. 6W outcomes: SAAS (Sagittal Age-Adjusted Score). LE parameters assessed (Figure): Cranial-Hip-Sacrum angle (Cr-H-S; Hip Compensation), Cranial-Knee-Sacrum angle (Cr-K-S; Knee Compensation), Cranial-Ankle-Sacrum angle (Cr-A-S; Ankle Compensation). Compensation designated as the upper tertile at 6W for each parameter. Multivariate analysis controlling for BL PT and history of TKA or THA evaluated outcomes between groups.

Results
167 complex ASD pts (22% previous THA/TKA, Levels fused: 13.1±3.8) included. At baseline, 71% were compensating in LE: 56% at the hips, 53% knees, 63% ankles. After correction, 50% were compensating in at least one LE joint (37% retained from baseline). Matching age-adjusted alignment did not eliminate compensation at any joint. However, undercorrection led to higher rates of LE compensation in all joints (all p<.01). When examining pts matched in SAAS, 50% were compensating in LE and displaying persistent LE motor weakness. Adjusted analysis showed pts matched in age-adjusted with LE compensation were more likely to be globally undercorrected (20% vs 0%, p<.001). Additionally, patients corrected to age-adjusted were more likely to develop PJK when compensating in LE (OR: 2.2; p=.039). Overall, correcting PI-LL to low deformity (<10°) had the greatest odds of resolving LE compensation (OR: 10, p<.001).

Conclusion
Perioperative lower extremity compensation was often the product of undercorrecting complex adult spinal deformity. Even in the setting of age-adjusted realignment, compensation in the lower extremities was associated with global undercorrection and junctional kyphosis. Consideration of the lower extremities during surgical planning is vital to avoid adverse outcomes in the perioperative course following complex adult spinal deformity surgery.



Parameter	Overall Cohort	Compensating
Baseline		
PT	24.3±12.4	28.3±12.9
PI-LL	15.1±22.8	21.8±22.3
SVA	63.2±66.0	87.3±69.0
Cr-H-S	31.4±13.5	37.3±13.3
Cr-K-S	7.4±5.6	10.1±5.8
Cr-A-S	4.0±3.2	5.6±3.3
Six Weeks		
PT	21.7±10.7	25.9±10.8
PI-LL	3.6±13.6	9.4±13.3
SVA	22.2±40.3	42.8±41.5
Cr-H-S	27.0±9.8	32.8±8.4
Cr-K-S	5.4±4.1	8.3±3.5
Cr-A-S	2.6±2.4	4.2±2.1

56. 90-DAY COMPLICATION AND REVISION SURGERY RATES USING NAVIGATED ROBOTICS IN THORACOLUMBAR SPINE SURGERY

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Hypothesis
Navigated robotic thoracolumbar spine surgery results in low rates of complications and revision surgeries at 90 days.

Design
Prospective, Multi-Center Cohort Study

Introduction
Technology in spine surgery has evolved over three decades; the integration of robotics with navigation being among the more recent innovations. With the rapidly advancing field, platform upgrades, and growing interest, quality data is needed to demonstrate the validity of the technology's use. This study determined 90-day complication and revision rates using one bone-mounted robotic with navigation confirmation platform.

Methods
Adults undergoing navigated robotic thoracolumbar surgery from 2020-2022 were prospectively enrolled by 6 surgeons at 4 distinct centers spanning 3 US regions. Each surgeon's experience using navigation and robotics was advanced. Medical, surgical, and robot related complications and revision surgeries were collected to 90 days. Demographics and outcomes were analyzed for means and frequencies.

Results
Of 411 surgeries, 3,469 screws were implanted (82.9% pedicle, 17.1% cortical). The majority (93.4%) underwent interbody fusion, 56.2% staged and 43.8% single day (52.8% posterior, 40.6% AP flip, 6.7% AP single position). Mean levels fused were 4.4 ± 3.7 and revision cases were 6.3%. Most frequent diagnoses were spondylolisthesis (37.2%) and spinal deformity (22.1%). Average ASA score was 2.3 ± 0.6, CCI was 0.49 ± 1.0, BMI was 29.6 ± 5.7 kg/m^2, and 11.9% were nicotine users. Intraoperative adverse events occurred in 4.1%, 0.5% robot related (1 durotomy, 1 implant-related). The frequency of patients with at least one postoperative complication was 21.7%. Unique complications were: 6.6% surgical (19.4% before discharge, 38.7% within 2 weeks, 41.9% by 90 days), 18.2% medical (36.1% before discharge, 43.3% within 2 weeks, and 20.6% by 90 days), and 0% robot related. Revision surgery rate at 90-days was 1.5%, none being robot related.

Conclusion
This large, prospective, multicenter study demonstrates that experienced users of an integrated navigation and robotic spine platform achieve low complication and revision surgery rates during thoracolumbar spine surgery. We found 4.1% intraoperative complications (0.5% robot related), 21.7% with any postoperative complication (6.6% unique surgical, 0% robot related), and 1.5% revision surgeries (0% robot related).

57. THE CRANIAL SAGITTAL VERTICAL AXIS TO THE HIP (CRSVA-H) IS THE BEST SAGITTAL ALIGNMENT PREDICTOR OF PATIENT REPORTED OUTCOMES AT 2 YEARS POSTOPERATIVE IN ADULT SPINAL DEFORMITY SURGERY

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Hypothesis
CrSVA-H is a better predictor than established measures of sagittal alignment of patient-reported outcomes 2 years after adult spinal deformity surgery.

Design
Single Center, Retrospective Cohort

Introduction
Radiographic sagittal alignment measures like C7SVA and PI-LL drive outcomes in ASD. More consideration is now given to total body sagittal alignment including the head and lower extremities. Recent evidence suggests that the novel CrSVA measurement is a better predictor of preop PROs. This study sought to evaluate CrSVA as a predictor of PROs at 2 years postop.

Methods
165 ASD patients with 2yr follow-up were included. CrSVA to the sacrum(S), hip(H), knee(K), and ankle(A) were the horizontal distance to the vertical plumbline from the nasion-inion midpoint, with positive values indicating an anterior cranium. Standard sagittal alignment parameters were also collected. Univariate and multivariable linear regression models evaluated radiographic predictors of 2yr PROs as measured by SRS total/subdomains. Significance was set as p-value <0.05.

Results
On univariate regression, older age, greater ASA score, and lower baseline total SRS as well as pre/postop sagittal alignment were significantly associated with worse 2yr SRS scores (Table 1). In multivariable regression, after adjusting for baseline SRS scores, greater preop C7SVA was found to be the only independent predictor of 2yr total SRS score (β=1.62, P=0.02) when considered with alignment only relative to C2. However, in the subsequent model including

CrSVA-H, C7SVA no longer remained an independent predictor and instead, postop CrSVA-H (β=-2.08, P=0.004) independently drove postop SRS scores. That is, when the model included alignment relative to the cranium, C2, and C7, greater or more anterior CrSVA-H drove worse SRS scores while lesser CrSVA-H had better scores. Similar models for subdomains again found CrSVA-H to be the best predictor of function (β=-0.13, P=0.0007), pain (β=-0.12, P=0.016), and self-image (β=-0.12, P=0.006).

Conclusion

Multivariable regression found that C7SVA is supplanted by CrSVA-H alignment as a significant, independent driver of two-year SRS scores in patients with ASD and should be considered the new gold standard of postoperative sagittal alignment target goal.

Table 1. Univariate and Multivariate Regression Models for 2-Year Total SRS Score

	2 Year Total SRS Score		
	Univariate Model	Multivariable Model 1 Adjusted R^2 = 0.349	Multivariable Model 2 Adjusted R^2 = 0.431
	β (SEM, p-value)	β (SEM, p-value)	β (SEM, p-value)
Demographic Characteristics			
Age (Per Year Increase)	-0.19 (0.08, 0.021)		
Gender			
Female (vs. male reference)	-0.87 (1.23, 0.2484)		
ASA Class			
Per Unit Increase in ASA Score	-3.05 (1.43, 0.0032)		
Pre-Operative SRS Score			
Per Unit Increase in Pre-SRS Score	0.56 (0.07, <0.0001)	0.53 (0.08, <0.0001)	0.52 (0.08, <0.0001)
Pre-Operative Alignment			
PI-LL	-0.12 (0.04, 0.0474)		
C2-S SVA	-0.62 (0.22, 0.0055)	-1.14 (0.68, 0.0955)	-1.4 (0.8, 0.0825)
C2-H SVA	-0.59 (0.25, 0.0199)		
C2-K SVA	-0.28 (0.31, 0.4061)		
C2-A SVA	-0.86 (0.34, 0.0134)		
C7 SVA	-0.67 (0.25, 0.004)	1.62 (0.65, 0.0201)	1.16 (0.75, 0.1228)
CrSVA-S	-0.61 (0.22, 0.0063)		
CrSVA-H	-0.58 (0.26, 0.0292)		0.88 (0.57, 0.1247)
CrSVA-K	-0.25 (0.32, 0.4818)		
CrSVA-A	-0.79 (0.34, 0.0226)		
Post-Operative Alignment			
PI-LL	-0.21 (0.1, 0.0138)		
C2-S SVA	-1.14 (0.51, 0.0063)	-0.55 (0.64, 0.7088)	1.26 (0.82, 0.1295)
C2-H SVA	-1.23 (0.34, 0.0005)		
C2-K SVA	-0.1 (0.39, 0.7949)		
C2-A SVA	-1.52 (0.44, 0.0064)		
C7 SVA	-1.25 (0.39, 0.0018)	-0.75 (0.77, 0.3312)	-0.69 (0.74, 0.3533)
CrSVA-S	-0.61 (0.22, 0.0063)		
CrSVA-H	-1.43 (0.32, <0.0001)		-1.08 (0.71, 0.0614)
CrSVA-K	-0.35 (0.41, 0.3973)		
CrSVA-A	-1.79 (0.45, <0.0001)		

Table 1

58. IMPACT OF SMOKING STATUS ON EARLY AND LATE OUTCOMES AFTER ADULT SPINAL DEFORMITY SURGERY

Tina Raman, MD; *Themistocles S. Protopsaltis, MD*

Hypothesis

Smoking is an independent risk factor for 90-day complications after ASD surgery as well as pseudarthrosis and unplanned revision at long term follow up.

Design

Retrospective review of prospectively collected database.

Introduction

There is limited data on the impact of smoking status on both short- and long-term outcomes after ASD surgery. We sought to analyze a large single center cohort to add more to our understanding of the effect of smoking on outcomes and postoperative complications.

Methods

1013 ASD patients (Age: 46 ± 23 years; mFI: 0.44 ± 0.70; Levels: 10.1 ± 4.2) were stratified based on smoking status into three groups. Current smokers (n = 72) included all patients who were active smokers. Former smokers (n = 265) included all patients who quit smoking more than 4 weeks before surgery. Nonsmokers (n = 676) included all patients who had never smoked. Outcome measures studied included perioperative complications, and revision surgery rates.

Results

The readmission rate at 90 days was significantly higher in current (12.7%) and former smokers (12.0%), compared with nonsmokers (6.1%) (p=0.007). There was a significantly higher rate of postoperative epidural hematoma in smokers (5%), compared to former and nonsmokers (0%) (p<0.001). There was a higher rate of postoperative pneumonia in smokers (4.5%) compared to former smokers (1.4%) and nonsmokers (0.07%) (p=0.038). There was no significant difference in length of stay between the groups. At minimum one year follow up, there was a significantly higher rate of pseudarthrosis (smokers: 15.6%, former: 6.7%, non: 4.5%, p=0.041) with no significant difference in rate of revision surgery for pseudarthrosis. Smokers had a significantly higher rate of neurologic complications (29% versus 18.5%, p=0.001) compared to nonsmokers. Smokers who did not experience any resolution of the neurologic injury had greater pack year history (28.5 ± 22 pack year) versus smokers who experienced complete resolution of the motor and/or sensory deficit (21.2 ± 19.3 pack year) (p=0.02).

Conclusion

Smoking is associated with higher 90-day readmission rate, and higher rates of epidural hematoma, neurologic complications, and postoperative pneumonia after ASD surgery. At one year, smokers have a higher rate of pseudarthrosis. Patients with

greater pack year history were less likely to experience resolution of a neurologic injury sustained at the index surgery.

59. FACTORS ASSOCIATED WITH SAGITTAL MALALIGNMENT REOCCURRENCE AFTER PEDICLE SUBTRACTION OSTEOTOMY

Tina Raman, MD; *Themistocles S. Protopsaltis, MD*

Hypothesis
Preoperative radiographic criteria and patient characteristics predict risk for recurrence of sagittal malalignment during long term follow up after PSO.

Design
Retrospective review of prospectively collected single center database.

Introduction
PSO procedure in adult spinal deformity (ASD) surgery are commonly performed for severe or rigid deformities. We sought to report the incidence of PSO site failure, defined as pseudarthrosis or rod fracture at the PSO site, as well as evaluate radiographic risk factors.

Methods
ASD patients undergoing PSO from 2011-2018 were included. Demographics, surgical variables, and long standing radiographic measurements were assessed preoperatively, immediately postoperatively, and at final follow-up. The rate of recurrence of sagittal malalignment was assessed, as well as risk factors.

Results
117 patients (Age: 59 ± 14; Levels fused 11.7 ± 4.5) who underwent 3CO were included. The average follow-up time was 44.7 ± 20.1 months. Lumbar lordosis increased from 20.7° to 37.1° ($p < 0.0001$) and remained stable at 36.5° ($p=0.76$). There was no significant change in pelvic tilt (Pre: 32.8°, Immediate Post: 27.6°, Final: 28.9°, $p=0.45$). SVA C7 decreased from 147.9 to 87.4 mm ($p < 0.0001$) and remained stable at 87.4 mm ($p = 0.99$). Twenty-three patients (19.7%) had an SVA C7 increase of more than 50 mm in the postoperative course: recurrence group. Patients who developed recurrence of sagittal malalignment had significantly greater preoperative SVA (191.1° vs 140.3°, 0.014), less preoperative lumbar lordosis (12.1 vs 22.1, $p=0.02$), greater initial correction of SVA (92.1 vs 47.4, $p=0.013$), and significantly greater increase in sacral slope (11.9 vs 3.7, $p=0.019$). Patients who developed recurrence of sagittal malalignment more commonly had developed a pseudarthrosis (47.8 vs. 15.7, $p=0.042$). By regression analysis, greater preoperative SVA (OR 1.009, 0.035), and age over 65 (OR 1.3, $p=0.04$) were predictive of recurrence of sagittal malalignment at final follow-up.

Conclusion
Recurrence of sagittal malalignment may occur after PSO at a rate of 19.7%. Patients over 65 years of age are at risk of recurrence. Greater preoperative SVA, less preoperative lumbar lordosis, and greater initial correction of SVA were associated with recurrence of sagittal malalignment at final follow-up. Patients who developed a lumbar pseudarthrosis were more likely to develop recurrence of sagittal malalignment.

60. PROPENSITY SCORE MATCHED(PSM) STUDY COMPARING PATIENT REPORTED(PROS) AND CLINICAL OUTCOMES AMONG PATIENTS WHO ACHIEVED PI-LL(PILL)<10 VERSUS PI-LL>10

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Hypothesis
Patients(pts) found to have spinopelvic mismatch(PI-LL>10) report worse PROs.

Design
Retrospective, PSM study of pts undergoing PSF for deformity defined by any following criteria: PI-LL≥25°, TPA≥30°, SVA≥15cm, thoracic scoliosis≥70°, thoracolumbar scoliosis ≥50°, coronal malalignment≥7cm, or undergoing 3-CO or fusion≥12 levels.

Introduction
Studies have highlighted correlations between radiographic parameters and PROs. Regional mismatch between the lumbar lordosis(LL) and pelvic incidence(PI), has well defined goals in literature(~10°).

Methods
All pts. had 2 yr PROs. Key outcomes were total SRS, ODI(PROs),and reoperation at 1 and 2 yr. postop. Two cohorts were created based on 2yr. alignment: PILL>10°, PILL<10°. A multivariable logistic regression model was built to discern factors associated with achieving PILL<10°. Independent predictors on the multivariable model were matched using PSM. Within PSM cohorts, binary outcomes were evaluated using McNemar test; continuous outcomes used the Wilcoxon rank-sum test.

Results
164 pts had 2 yr follow up. Average(avg) age was 50.49(1.38), avg BMI was 18.67(1.01), and avg 13.54(0.32) operative levels. 84(51.2%) had PILL<10 and 80(48.8%) had PILL>10 at 2yr. postop. B/l pelvic

tilt(PT)[0.96(0.92 – 0.99)] and b/l PI-LL[0.95(0.9 - 0.99)] independently predicted achieving PILL<10 at 2Yr. Between the 38 PSM pairs, there were no significant differences in demographic variables or plethora of b/l alignment metrics including b/l PT[24.5(1.43) vs 27.1(1.19), P=0.1685] and PILL[15.57(2.17) vs 16.06(2.07),P=0.87]. Between PSM matched pairs, there were no significant differences in b/l SRS/ODI PROs. At 1 and 2Yr, PROS on SRS scale were near identical(2Yr. PROs shown): Function[4.07(0.14) vs 4.01(0.12), P=0.75],Pain[3.89(0.18) vs 3.93(0.15),P=0.86], Appearance[4.21(0.15) vs 3.82(0.16), 0.08],Mental Health[4.08(0.15)vs 4.09(0.12), 0.96], Satisfaction[4.43(0.15) vs 4.35(0.17), P=0.72], and Total [90.17(2.54) vs 88.14(2.51),0.57]. Similarly, 2Yr. ODI was comparable [18.1(2.9) vs 22.4(2.95),P=0.30]. 90D reoperation rate was 2.63%(1pt) in both PSM cohorts(P>0.99). However, 2yr. reoperation rate was lower in the PILL<10° group[5.26% vs 18.4%,P=0.04]

Conclusion

Pts that maintain PI-LL<10 at 2Yr postop following ASD surgery have near-identical SRS/ODI PROs but lower 2yr reoperation rate compared to pts. who have PI-LL>10 at 2Yr postop.

61. FRAILTY STRATIFICATION USING THE MODIFIED 5-ITEM FRAILTY INDEX: SIGNIFICANT VARIATION WITHIN FRAILTY PATIENTS IN ELECTIVE SPINE SURGERY.

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Hypothesis

Our Hypothesis is that not all frailty patients have similar risk of complications after spine surgery, some combinations of comorbidities could have higher risk of complications than others

Design

Retrospective nationwide database study

Introduction

Frailty patients have a higher rate of postoperative complications, however, not all frailty patients have the same risk. Our objective was to analyze and compare the combinations of variables that compose the modified 5-factor frailty index score (mFI-5) based on the number of comorbidities in terms of complications, reoperation, readmission, and mortality after elective spine surgery.

Methods

The American College of Surgeons - National Surgical Quality Improvement Program (ACS-NSQIP) Database was used to identify patients who underwent elective spine surgery. The mFI-5 item score was calculated Multivariable analysis was used to assess the independent impact of each combination of comorbidities in the mFI-5 score on the risk of complications, reoperation, readmission, and mortality.

Results

A total of 167, 630 patients were included with a mean age of 59.9 ± 13.6 years. A total of 15,515 patients were reported to suffer any complication (9.3%), 3,020 suffered surgical complications (1.8%), 4,608 required reoperations (2.7%), 7,892 were readmitted (4.7%), and 383 died (0.2%) within 30 days after surgery. The risk of complications was the lowest in patients with diabetes + hypertension (OR=1.3) and highest in those with the combination of CHF, diabetes, COPD, and dependent status (OR=7.6); there was a high variation in complication rate based on specific combinations.

Conclusion

There is high variability in terms of relative risk of complications based on the number and combination of different comorbidities, especially with some comorbidities such as CHF and dependent status. Therefore, frailty status encompasses a heterogeneous group and sub-stratification of frailty status considering the type of comorbidity involved can be useful in determining a subgroup of frailty patients with significantly higher risk of complications.

62. PROMIS ANXIETY AND SLEEP SCORES ARE ASSOCIATED WITH HIGH BARRIERS TO PROPER OPIOID USE AFTER ADULT SPINAL DEFORMITY

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Hypothesis

Socioeconomic differences will predict patients with high barriers to proper opioid use.

Design

Retrospective Review

Introduction

Inappropriate opioid use in the United States

continues to be a health crisis. Previous studies have shown that patient reported outcomes questionnaires can identify barriers to proper opioid use. The aim of this study is to identify whether preoperative PROMIS scores are associated with high barriers to proper, as prescribed, opioid use.

Methods
ASD patients with at least four levels fused were identified in a single-institution database. Barriers to opioid use were measured with a previously validated Barriers Questionnaire-Taiwan (S-BQT) with total scores ranging from 0-35. The top 25% (>17) were identified as patients with high barriers to proper opioid use. Threshold linear regression with Bayesian Information Criteria was utilized to identify thresholds associated with high barriers to proper opioid use. Multivariable analysis was employed controlling for age, gender, comorbidity, income, and education level.

Results
106 total patients were included in this study. 23 (22%) had high barriers to proper opioid use. Mean age was 51 with 72 (68%) female. On bivariate analysis, patients with high barriers to proper opioid use were: more likely to be older (61.1 vs. 48.2); be less comorbid (0.544); be living with others (22% vs 54%); have more fatigue (PROMIS fatigue 57.2 vs. 52.2); have more anxiety (57.2 vs. 52.2); have more sleep (58.3 vs. 52.8); and have less social satisfaction (PROMIS 39.4 vs. 43.9) ($P<0.05$ for all). Threshold regression identified cut-offs of ≥59.5 for PROMIS Anxiety and ≥ 61.7 for PROMIS sleep. On multivariable logistic regression, patients with of ≥59.5 for PROMIS Anxiety (OR 3.85; P=0.018) and ≥ 61.7 for PROMIS sleep (OR 6.04; P=0.006) had greater odds of high barriers to proper opioid use.

Conclusion
Thresholds of preoperative PROMIS ≥59.5 for Anxiety and ≥ 61.7 for Sleep can be utilized to counsel patients undergoing ASD surgery who may be more likely to have higher barriers to proper opioid utilization. These thresholds correspond to at least mild anxiety and sleep disturbance. This can aid in shared decision making and patient counseling to ensure more responsible use of narcotics in the ASD patient population.

63. A MULTIDISCIPLINARY APPROACH DOES NOT DISCRIMINATE BASED ON SOCIOECONOMIC FACTORS FOR PATIENTS WITH ADULT SPINAL DEFORMITY

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Hypothesis
A multidisciplinary approach does not discriminate based on socioeconomic factors for patients with adult spinal deformity

Design
Retrospective case series

Introduction
Adult spinal deformity surgery (ASD) is partly a high-risk procedure due to the comorbid aging population it often affects. Multidisciplinary approaches were developed to improve outcomes and decrease complications and have shown their efficacy in optimizing and screening patients. However, socioeconomically disadvantaged populations are more burdened with comorbidities. Is there a bias towards healthier and more socioeconomically advantaged patients? We sought to assess whether patients received surgery following a multidisciplinary conference review will differ by socioeconomic status, as defined by the area deprivation index.

Methods
A single-center retrospective analysis of patients operated for ASD was performed. Patients presented at a multidisciplinary conference for surgical clearance between August 2015 and March 2021 were reviewed. Patients were categorized based on their operative status. Each patient's residence was ranked using the Area Deprivation Index based on the Neighborhood Atlas. This index ranks every zip code based on deciles, with one being the least disadvantaged and ten being the most disadvantaged within a state. Using logistic regression, we examined whether demographic variables, ADI rank for Washington (median split into low/advantaged and high/disadvantaged), distance from the hospital, and the interactions predicted whether patients received surgery after the conference.

Results
Our analysis identified 330 patients (209 female, 121 male; 19-86 years old, M = 64.6, SD = 12.1). Patients with a history of psychiatric disorders were less likely to receive surgery, p = .02. No other main effects approached significance. There was a significant

interaction between ADI and distance, p = .04. More advantaged patients were less likely to receive surgery if they were closer than farther from the hospital, p = .03. Distance did not significantly affect whether more disadvantaged patients received surgery, p = .51.

Conclusion

This analysis suggests that a multidisciplinary approach does not discriminate based on socioeconomic status. Further investigation is needed to understand the relationship between distance and ADI, and their interactive effect on surgery.

101. GUIDED POSTERIOR VERTEBRAL MODULATION (GPVM): A NEW FUSIONLESS TECHNIQUE FOR CORRECTION OF ADOLESCENT IDIOPATHIC SCOLIOSIS

Gonzalo Mariscal, MD; Jesus Burgos Flores, MD; Luis Miguel Anton Rodrigalvarez, MD; Eduardo Hevia, MD; Carlos Barrios, PhD

Hypothesis
The correction of adolescent idiopathic scoliosis by posterior vertebral modulation using pedicle screws achieves complete correction of the deformity, maintaining the vertebral mobility of the spine once the instrumentation is removed and without significant loss of correction.

Design
Retrospective analysis of prospectively collected data.

Introduction
Current techniques of anterior vertebral growth modulation by vertebral body stapling or tethering provide only an incomplete and unpredictable correction of the deformity in addition to the disadvantages of the required thoracotomy. The purpose of this study was to report the correction ability of a vertebral modulation technique throughout a posterior approach without fusion in AIS patients.

Methods
A series of 36 AIS patients (Risser 3 or less) underwent surgical correction by posterior pedicle screws without fusion. Instrumentation was removed once the maturity stage was advanced. Most of the cases were main thoracic Lenke-1 curves. Coronal and sagittal curve correction was assessed by conventional standing X-rays at pre and postoperative, before instrumentation removal, just post removal (3-years follow-up), and 2-years follow-up after the removal surgery. A coronal wedging ratio (WR) was also calculated between the height of the apex vertebra at the concave and the convex side of the main curve (MC).

Results
Mean preoperative coronal Cobb of the MC was 53.7°±7.5 (95% CI: 50.7-56.6) and was corrected to 5.5°±7.5° (89.7%). Before removal of the instrumentation, there was a loss of correction of 3.4°. In the 2-year check-up after removal of the implants the mean MC was 13.1°. T5–T12 kyphosis showed a significant improvement from a mean angle of 19.0° (95% CI:13.3–24.8) to 27.1° (95% CI:20.1–26.1) 2 years after implants removal (29.9% increase) ($p<0.05$). Before surgery, WR was 0.71±0.06, and 2 years after removal WR was 0.98± 0.08 ($p<0.001$). At last follow-up, the mean sagittal ROM of the T12-S1 segment was 51.2±21.0°. SRS-22 scores improved from 3.31±0.25 to 3.68±0.25 at final assessment ($p<0.001$).

Conclusion
Vertebral growth modulation through a fusionless posterior approach using pedicle screws correct satisfactory scoliotic main curves in AIS patients. After removal of the instrumentation, there was a non-significant loss of correction. This technique permits conservation of an acceptable ROM of the lower instrumented segments.

103. CHANGE OF CERVICAL SAGITTAL ALIGNMENT AFTER SURGERY FOR ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS): COMPARISON OF VERTEBRAL BODY TETHERING (VBT) VERSUS POSTERIOR SPINAL FUSION (PSF)

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Hypothesis
Cervical sagittal alignment parameters following VBT for correction of AIS are similar to what is observed following PSF.

Design
Multi-center retrospective review.

Introduction
PSF constructs have been shown to improve cervical deformity however, to date, these relationships have not been described in patients treated with VBT.

Methods
AIS correction surgeries with LIV in the lumbar spine from 2013 to 2021 with pre and 2-year postop standing full body plain films available were included. Patients were grouped as VBT or fusion. Outcome measures: Age, height, weight, BMI, Risser score, LIV and levels instrumented. Radiographic analysis included pre and postop C2 to C7 sagittal vertical axis (cSVA), cervical lordosis angle (CL), T1 slope and thoracic kyphosis (TK). Measures were compared using independent samples t-tests; significance set at $p<0.05$.

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Results
99 patients: 49 VBT, 50 fusions. There were no differences in age or levels instrumented between groups. The VBT cohort Lenke class breakdown is 23% 1A, 13% 1C, 31% 3C. 18% 5C, and 15% 6C, while the PSF cohort consisted of 42% 1A, 6% 1B, 2% 2C, 2% 3B, 12% 3C, 2% 5B, 24% 5C, and 10% 6C. There were no significant differences in patient age or number of levels instrumented. VBT patients had a lower level of bone maturity as defined by Risser class (1.6±0.9 vs 2.6±1.8, p=0.001). The VBT cohort had higher baseline cSVA (3.4mm±1.6 vs -1.0mm±3.1, 0.001) and less CL (-0.6°±18.2 vs 11.6°±12.8, p=0.001) than PSF cohort. No differences in baseline T1 slope or Thoracic Kyphosis was observed. VBT patients also had higher 2-year cSVA (3.4mm±1.4 vs -3.7mm±2.1, p=0.001) and less CL (-4.0±18.5 vs 7.0±12.2, p=0.001) compared to PSF. The PSF group had a significantly greater correction in cSVA than VBT group (2.8mm±4.0 vs 0mm±1.6, p=0.001). Both groups displayed improvement in radiographic parameters of cervical and thoracic alignment including CL (VBT 3.3° vs 4.3°, p=0.74), T1 slope (VBT -4.3° vs -4.9°, p=0.81) and TK (VBT -6.1° vs -3.9°, p=0.47). After PSM for Lenke classification, 66 patients remained: 33 VBT, 33 PSF. The PSF group continued to demonstrate greater improvement in cSVA than VBT group (3.2mm±3.0 vs -0.3±1.8, p=0.001.

Conclusion
VBT and PSF both improve radiographic parameters of cervical alignment in AIS patients; however, PSF showed greater correction of cSVA at 2-year follow-up.

Cervical Comparison of Vertebral Body Tethering versus Posterior Spinal Fusion in AIS with 2-year follow-up

		Tether	Fusion	P value
Demographics	N=99	49	50	
	Age	13.6 ± 1.4	13.2 ± 1.9	0.31
	Risser score	1.6 ± 0.8	2.6 ± 1.8	0.001
	mean UIV	T6	T5	
	Levels Instrumented	9.3 ± 2.0	9.6 ± 2.3	0.43
	Lenke Classification			
	1A	23%	42%	
	1B	0%	6%	
	1C	13%	0%	
	2C	0%	2%	
	3B	0%	2%	
	3C	31%	12%	
	5B	0%	2%	
	5C	18%	24%	
	6C	15%	10%	
Baseline	cSVA (mm)	3.4 ± 1.6	-1.0 ± 3.1	0.001
	CL (°)	-0.6 ± 18.2	11.6 ± 12.8	0.001
	T1 Slope (°)	15.9 ± 12.8	15.9 ± 9.3	1
	TK (°)	21.7 ± 18.4	25.2 ± 12.7	0.3
2-year	cSVA (mm)	3.4 ± 1.4	-3.7 ± 2.1	0.001
	CL (°)	-4.0 ± 18.5	7.0 ± 12.2	0.001
	T1 Slope (°)	20.4 ± 11.4	20.6 ± 10.3	0.95
	TK (°)	27.5 ± 16.0	28.5 ± 11.8	0.72
difference from baseline to 2-year	Δ cSVA (mm)	0 ± 1.6	2.8 ± 4.0	0.001
	Δ CL (°)	3.3 ± 20.1	4.3 ± 13.4	0.8
	Δ T1 Slope (°)	-4.7 ± 14.5	-4.9 ± 10.1	0.93
	Δ TK (°)	-6.2 ± 17.4	-3.9 ± 12.0	0.46

104. MINIMALLY INVASIVE SURGERY VS STANDARD POSTERIOR APPROACH IN THE TREATMENT OF IDIOPATHIC SCOLIOSIS: A TWO YEARS FOLLOW-UP RETROSPECTIVE STUDY

Francesco Vommaro, MD; *Giovanni Ciani, MD*; Chiara Cini, MD; bruna maccaferri, MD; Luca Boriani, MD; Alessandro Gasbarrini, MD

Hypothesis
To compare the safety and efficacy of posterior minimally invasive surgery(MIS) to standard posterior spinal fusion(PSF) surgery in adolescent idiopathic scoliosis

Design
Monocenter retrospective control study

Introduction
Minimal invasive approach could be a feasible option in patients with AIS. In the literature, MIS has been

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shown to reduce blood loss, postoperative pain while allowing earlier mobilization and discharge. Nevertheless,there are significant technical challenges of performing MIS on this patient population

Methods
We collected 111 AIS patients with Cobb angle curve ≤70° who treated with MIS(n=47)or PSF(n=64) from February 2018 to June 2020. All of them attempted an outpatient follow-up consisting of clinical and radiological evaluation for at least two years from surgery. We collected values of Cobb angles degrees to study the correction rate of the structural curve. The data collected included level of apical and distal fusion, operative time, preop and postop hemoglobin and length of hospitalization. NRS medium score was assessed during the whole hospitalization. Complications recorded included: nerve lesions, fever, surgical infection, mechanical complication and postoperative pain assessment

Results
There was no significant difference between the 2 groups in terms of radiographic and clinical features. The correction rates of the structural curve were not significantly different between MIS and PSF group (64.6vs60.9%) as for the correction rate of secondary curve (59.1vs59.2%). The two groups had non significantly longer operative time (209.9vs215min). The average number of fusion segments in MIS group was lower than in PSF group (9,1vs10,2).The MIS group had a significantly lower decrease of postoperative hemoglobin in comparison to PSF group (2.8vs4.3)(p< 0,001). The evaluation of pain showed a lower NRS score in MIS group (1,8vs3,8). PSF group was observed to have significantly lengthier time of hospitalization (4.9vs6.3days)(p= 0,02). Complications were more frequent in PSF group rather than in MFS group (11vs3),with no infectious complication in MIS group

Conclusion
MIS is a safe and capable alternative to standard open approach for AIS patients with curves ≤70°. Even though there were no difference in term of operative time between MIS and PSF, our results showed that MIS had the advantages of less blood loss and pain

105. THE SANDERS CLASSIFICATION AND OBESITY: DO OBESE KIDS WITH AIS PRESENT WITH MORE ADVANCED SKELETAL MATURITY?

Jeffrey M. Henstenburg, MD; Jeremy Heard, BS; Hamdi Sukkarieh, MD; *Suken A. Shah, MD*; Jaysson T. Brooks, MD; Tyler C. McDonald, MD

Hypothesis
We hypothesize that in patients with AIS, obese and overweight patients will have a higher Sander's Maturity Score on initial presentation when compared to normal weight patients.

Design
Retrospective case-control

Introduction
Obese and overweight (OOW) patients with adolescent idiopathic scoliosis (AIS) have been shown to initially present to the spine clinic with a more advanced Risser score compared to normal weight (NW) patients. The Sander's Maturity Scale (SMS) is now more commonly used by surgeons to make treatment decisions because it more reliably predicts skeletal maturity. However, the relationship between SMS and obesity has not been described.

Methods
Billing data from two different institutions were used to identify patients with AIS presenting to a pediatric orthopedic spine surgeon for an initial visit between July 2012 and March 2020. We excluded subjects without height/weight data, spine radiographs, or left hand radiographs for measuring SMS stage. BMI-for-age percentiles were calculated and used to group patients into NW (<85th percentile) or OOW (85th percentile and above) per CDC guidelines. After collecting preliminary data, a power analysis was performed using average SMS scores between NW and OOW patients with an alpha of 0.5 and we determined we would need approximately 300 male and 300 female subjects.

Results
590 patients (296 female, 294 male) were identified. The SMS stage at presentation was significantly greater in OOW compared to NW patients for both females (5.9±1.8 vs 5.2±1.7; P=.003) and males (4.9±1.9 vs 4.1±1.8; P=.002). The cobb angle for OOW females were significantly different from NW females at 36.1 ± 15.5 degrees and 29.8 ± 15.6 degrees respectively (P=0.004). The cobb angle was not different for OOW and NW males (P=0.341).

Conclusion
At initial presentation, OOW patients present at a

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greater skeletal maturity as measured by the SMS compared with NW patients. OOW female patients present with a greater major curve magnitudes than NW female patients. This highlights the impact of the pediatric obesity epidemic on the AIS population. These findings can be used to counsel families and provide anticipatory guidance for the AIS treatment plan.

106. RESTORATION OF IDEAL SAGITTAL ALIGNMENT IN AIS WITH THORACIC HYPOKYPHOSIS /LORDOSIS WITH HYBRID TECHNIQUE: COMBINATION OF POSTERIOR THORACIC FUSION WITH NON-FUSION THORACOLUMBAR/LUMBAR VBT

Meric Enercan, MD; Hamisi M. Mraja, MD; Baris Peker, MD; Halil Gok, MD; Celaleddin Bildik, MD; Tunay Sanli, MA; Ayhan Mutlu, MD; Onur Levent Ulusoy, MD; Selhan Karadereler, MD; Azmi Hamzaoglu, MD

Hypothesis
Thoracic VBT may not be powerful enough to restore the ideal thoracic sagittal alignment in pts with thoracic hypokyphosis(THK)/lordosis(TL). Hybrid technique including posterior thoracic fusion with or without Ponte Osteotomy will restore ideal thoracic kyphosis and ideal sagittal alignment, TL/L VBT will preserve spinal flexibility & motion of the lumbar spine in double major AIS curves with THK/TL

Design
Retrospective

Introduction
Restoration of the ideal sagittal alignment is essential in AIS deformity correction. We introduced Hybrid technique including posterior surgery w/o Ponte osteotomy in order to restore sagittal alignment better and TL/L VBT with Double Screw-Double Cord(DS-DC) fixation in order to preserve lumbar flexibility and motion. The aim of this study to evaluate the efficacy of hybrid technique for the restoration ideal sagittal alignment in pts with double major curves with THK/TL

Methods
24 AIS pts who had double major curves with THK/TL treated with hybrid technique were included. Coronal and sagittal parameters were measured on preop, first erect & f/up x-rays and lumbar ROM were compared. SRS-22r was used for clinical assessment

Results
Mean age 14(11-18) yrs & f/up was 28(24-62) months. Mean MT 48° was corrected to 8° at f/up (84%). Mean TL/L of 52° was corrected to 8,5° at f/up (83,5%). 20 pts with THK of 13° restored to 33°. 4 pts with TL of -7° restored to 25° TK. Ponte osteotomy was performed in 11 (45%) pts (7 pts with THK, 4 pts with TL). 17 (70%) pts with preop. cervical kyphosis had improved cervical alignment postoperatively (11 pts straight, 6 pts cervical lordosis). ROC analysis showed TK restoration > 30° and T1 slope > 25° was correlated with improved cervical lordosis restoration (area=0.77). According to TL/L sagittal alignment, ant.or post.cord was tightened first to restore TL/L alignment. 12 pts with TL kyphosis of 16° was restored to 2.3°. There was no cord rupture. Preop lumbar ROM was preserved at f/up

Conclusion
Hybrid technique provided satisfactory corrections on both planes.Posterior surgery w/o Ponte osteotomy enables restoration of the TK. Cervical alignment improved better when TK was restored > 30° and T1 slope > 25°. TL/L VBT with DS-DC fixation provided deformity correction,restored TL/L alignment,preserved flexibility and motion of lumbar spine without cord rupture

107. MRI-BASED CLASSIFICATION OF SPINAL CORD MORPHOLOGY TO ASSESS RISK OF INTRAOPERATIVE NEUROMONITORING ALERTS IN ADOLESCENT IDIOPATHIC SCOLIOSIS PATIENTS

Sara Van Nortwick, MD; Richard Jones, MD; Matthew Dow, MD; Hayley Fowler, BS; William R. Barfield, PhD; Robert F. Murphy, MD

Hypothesis
Spinal cord morphology classification can predict intraoperative neuromonitoring (IONM) alerts in adolescent idiopathic scoliosis (AIS) patients.

Design
Retrospective review.

Introduction
A spinal cord morphology classification can predict intraoperative neuromonitoring (IONM) alerts in adult patients undergoing spinal deformity correction. To our knowledge, this is the first study to apply that classification to AIS patients. Our purpose was to stratify spinal cord morphology on preoperative MRIs as a risk factor for IONM alerts in AIS patients.

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Methods
AIS patients over a 3-year study period with pre-operative MRIs of the neural axis who underwent spinal fusion were included in the study. Using T2-weighted axial MRI from the apex of the deformity, spinal cord morphology was designated into 3 categories. Type 1 is an oval cord enclosed in cerebrospinal fluid (CSF); Type 2 is an oval cord pressed against the pedicle with no interceding CSF between pedicle and cord; Type 3 is a cord that is deformed/compressed by the pedicle with no interceding CSF. Cord morphology was compared as a function of Cobb angle and risk of IONM alert.

Results
Sixty-three patients qualified for inclusion: 15 were Type 1 (24%), 41 were Type 2 (65%), and 7 were Type 3 (11%). Patients with a Type 3 spinal cord on average had a larger Cobb angle (71°) than Type 1 (49°) or Type 2 (61°) patients (p=0.01). There were 12 total cases (19%) with IONM alerts: 2 (13%) in Type 1, 7 (17%) in Type 2, and 3 (43%) in Type 3. The odds an IONM alert occurring were 0.21x higher with a Type 3 cord versus a Type 1 cord.

Conclusion
In this series of AIS patient undergoing spinal fusion, a Type 2 spinal cord morphology was the most common on preoperative MRI. Patients with Type 3 spinal cords had significantly larger Cobb angles. There were no significant association between spinal cord morphology type and risk of an IONM alert.

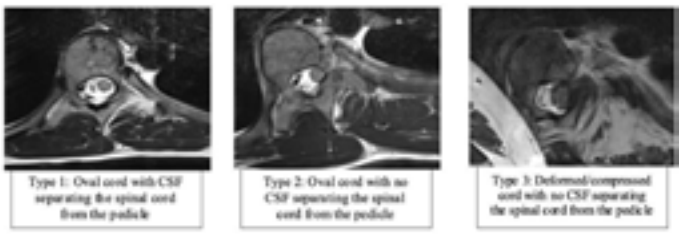

Figure 1: Three types of Spinal Cord Morphology

108. IMPLANT DENSITY AND TYPE OF CONSTRUCT PROVIDE A COMPARABLE CORRECTION IN SINGLE THORACIC AIS

Leonardo Oggiano, MD; Sergio De Salvatore, MD; Sergio Sessa, MD; Cloe Curri, MD; Pier Francesco Costici, MD

Hypothesis
The hypothesis is to demonstrate that different implant densities and types of construct provide similar correction rate

Design
Retrospective single center study, Level of evidence III

Introduction
Single thoracic curve is the most common form of scoliosis in the adolescent population. The goal of surgical treatment is to balance the spine both in the coronal and sagittal planes. Different types of instrumentations can be performed. In this study, we report our results on 100 patients affected by thoracic adolescent idiopathic scoliosis (AIS) and treated by different types of constructs.

Methods
From 2016 to 2019 one hundred consecutive patients affected by Lenke 1 type scoliosis were surgically treated. Based on the instrumentation performed we divided patients into 4 groups: group 1, all-level concave instrumentation; group 2, all-level convex instrumentation; group 3, all-level bilateral instrumentation; group 4, skip instrumentation. Groups were homogeneous in terms of the number of patients (20-25), age (13-14 years), sex (F:M 9:1) and preoperative Cobb angle (50-80°). In all cases, we used pedicle screws instrumentation

Results
Results were substantially similar in all groups, with a small difference between the all-level one-side instrumentation and the bilateral all-level and skip instrumentation. The average of Cobb angle correction was about 72% in groups 1 and 2, 79% in group 3 and 75% in group 4. Operative time was faster in groups 2 and 4 (mean 180 minutes), a little less fast in group 3 (mean 200 minutes) and slower in group 3 (mean 220 minutes). Intraoperative blood loss had the same trend (from 500 ml to 800 ml). A very low rate of complications was reported, slightly more in group 3 (3 cases of dural tear, 2 cases of transient neuromonitoring signal loss during a correction) and in group 1 (one case of dural tear) with respect to groups 2 and 4 (one case of transient neuromonitoring signal loss). Postoperative hyperkyphosis and loss of correction at 2 years follow-up were similar in all groups

Conclusion
In our experience, all kinds of construct substantially provide a comparable correction in single thoracic AIS. Moreover, the increase in implant density gives a greater deformity correction at the expense

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of a longer operative time and slightly greater complications. We believe that having at least one anchor for each vertebra included in the arthrodesis area may be enough.

109. POSTERIOR CORRECTION OF LENKE TYPE 1 SCOLIOSIS: MINI-OPEN TECHNIQUE COMPARED TO OPEN SURGERY

Leonardo Oggiano, MD; Sergio De Salvatore, MD; Cloe Curri, MD; Sergio Sessa, MD; Pier Francesco Costici, MD

Hypothesis
We hypothesize that MS could provide similar results in curve correction in patients with Lenke 1 compared to the standard open technique.

Design
Retrospective single centre study, Level of evidence III

Introduction
Open posterior spinal instrumentation and fusion (OS) is the most used option in AIS. Nevertheless, this technique leads to significant soft tissue disruption and paravertebral muscle detachment. In the era of mini-invasive (MS) procedures, the possibility of using less invasive techniques to reduce surgical trauma, muscular disruption, and skin incision, with the same potential for correction of deformity, could be a favourable option. The study was designed to compare results and complications in patients affected by Lenke type 1 adolescent idiopathic scoliosis treated by posterior MS versus the standard open posterior approach

Methods
Twenty consecutive patients (mean age 13 years, 17 F- 3 M) with a single thoracic curve (pre-operative Cobb angle: 45°-70°) planned for posterior correction, were divided into two groups: 10 were treated by MS and 10 by OS. In the MS group the classical skin incision has been modified to three non-contiguous midline incisions, through which 2-4 levels can be fused utilizing a muscle-splitting approach. Time of surgery, intra-operative blood loss, number of fusion levels, post-operative Cobb angle, post-operative pain evaluated by Visual Analog Scale (VAS) and discharge times were noted. The last follow-up was at 1 year after the surgical procedure.

Results
The operation time in the MS group was shorter, but not statistically significant, than the control group on average 235 min ± 23.4 versus 255 min ± 22.5 (p>0,05). The coronal curve correction in the MS group was similar to the control group (69,5%±7,2 vs. 72,9%±8,8, p>0.05). A significant reduction of intraoperative blood loss (p=0,019), shorter hospital stays (p=0.045) and better results on VAS scale (p=0,048) were reported in patients treated with MS technique. No loss in deformity correction was reported at 1-year follow-up.

Conclusion
The mini-open approach for AIS surgery is a promising technique, that grants the same results as standard OS in deformity correction. However, MS allows lower intraoperative blood loss, reduces the length of hospital stay and postoperative pain compared to standard OS, with smaller skin scars and a consequent greater compliance of both patient and parents

110. EFFICACY OF LIPOSOMAL BUPIVACAINE FOR PAIN CONTROL IN PEDIATRIC PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS UNDERGOING INSTRUMENTED POSTERIOR SPINAL FUSION

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Hypothesis
We hypothesize that liposomal bupivacaine would reduce pain outcomes while maintaining similar outcomes for AIS patients undergoing standard fusion.

Design
Retrospective cohort study

Introduction
LB has been touted to have increased longevity for pain control compared with standard formulations. Several studies in adult spine populations have been carried out with variable results. Narcotic use and pain control have not yet been examined in the pediatric deformity population.

Methods
Pediatric patients undergoing elective primary spinal fusion for scoliosis between 2018 – 2020 by three senior attending physicians were selected for inclusion. Starting early 2020, patients began receiving peri-incisional injections of LB by plastic surgeons during PSF closure. These patients were compared to those that did not receive any injections. Maximum pain scores, time to ambulation (OOB), length of

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stay (LOS), narcotic refills, and complications were recorded and analyzed.

Results
A total of 241 patients met inclusion criteria. No differences were noted in demographics. There were no significant differences between maximum pain score at activity (5.5 vs 6.0, p = 0.36), time to ambulation (by POD 1: 75.3% vs 75.0%, p = 0.96; by POD 2: 94.1% vs 93.6%, p = 0.87), and complications (2.4% vs 6.4%, p = 0.17). LOS was 0.7 days shorter in the LB group (3.0 vs 3.7, p<0.01). Narcotic refills were also found to be utilized less frequently in the LB group (2.4% vs 6.4%, p = 0.17).

Conclusion
Although there were no observed differences in pain scores and time to ambulation, patients who received LB were discharged from the hospital sooner and requested less narcotics refills. Therefore, there may be a clinical benefit in using a long acting local anesthetic formulation in this subset of patients.

111. MOBILE DEVICE BASED 3D SCANNING PREDICTS COBB ANGLE IN PATIENTS WITH AIS

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Hypothesis
Mobile device-based 3D scanning can accurately predict cobb angle in a population of patients being screened for AIS.

Design
Cross-sectional, single center study

Introduction
Non-radiographic screening and diagnosis in adolescent idiopathic scoliosis (AIS) currently relies on scoliometer. We hypothesized that white-light based 3D scanning could generate high quality 3D representations of surface anatomy using a mobile device would provide better deformity assessments compared to scoliometers

Methods
Patients 10 to 18 years old presenting to an outpatient clinic for spinal deformity evaluation with radiographs within 30 days were enrolled. 3D scans were taken in the upright and forward bend positions. Image processing software was used to make 3D measurements of trunk shift(TS), coronal balance(CB), and clavicle angle(CL) in upright position and largest angle of trunk rotation(ATR) in bending position. 3D Measurements were compared to radiographic counterparts. We compared multivariable regression models predicting the likelihood of cobb angle>20° based on BMI and 3D measurements vs BMI and scoliometer using Akaike information criterion (AIC).

Results
312 visits representing 258 patients were included. Mean age =was 13.7 years mean coronal MCM was 19.8+/- 13.0° for lumbar curves and 22.1+/-15.3° for thoracic curves. There was a significant correlation between 3D and radiographic CL (r = 0.65), TS (r = 0.8), and CB (r = 0.8) (p < 0.001). Correlations between cobb angle and ATR were higher for 3D lumbar ATR (r = 0.63) than scoliometer lumbar ATR (r = 0.39). Similarly, correlations between cobb angle and ATR were higher for 3D thoracic ATR (r = 0.65) than scoliometer thoracic ATR (r = 0.46). A Multivariable regression model predicting cobb>20 including 3D data outperformed a model based on scolimeter data (AIC=206 vs 237).

Conclusion
Mobile device-based 3D scanning identifies clinically relevant scoliotic deformity and is a better predictor of major curve magnitude than scoliometer measurements.

112. FEASIBILITY AND OUTCOMES OF MINI OPEN CORRECTION AND FUSION FOR ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS): 2-5 YEARS FOLLOW-UP

Matthew J. Geck, MD; *Devender Singh, PhD*; Ashley Duncan, RN; John Stokes, MD; Eeric Truumees, MD

Hypothesis
Minimally invasive surgery (MIS) provides effective treatment option for Adolescent Idiopathic Scoliosis (AIS) reconstruction

Design
Retrospective study

Introduction
This study reports 2 years follow-up surgical outcome scores on patients undergoing MIS for AIS and to provide ongoing evidence of the feasibility and outcomes of this innovative treatment.

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Methods
Medical records on 61 patients with MIS correction of AIS were reviewed. Age, operative time, estimated blood loss (EBL), length of hospital stays (LOS), Lenke curve, preoperative (pre-op) and postoperative (post-op) Cobb angles, Scoliosis Research Society-22r (SRS-22r), Oswestry Disability Index (ODI) and Visual Analogue Scale (VAS) were evaluated. Surgical technique was uniform in all patients using two or three midline incisions.

Results
Mean patient age was 16.5 years (11–47 yrs.). Curves were classified as: 36 Lenke 1A, 13 Lenke 1B, 3 Lenke 1C; 9 Lenke 5C. Mean flexibility index of the main curve was 54.6%. Post-op follow-up landmarks of our cohort were 49 patients with 2 years and 12 with 5 years follow ups. Mean pre-op, 2 and 5 years follow-up Cobb angles were 54.2° (±3.5°), 12.8° (±3.1°), and 11.1 ° (±2.3°), respectively. Mean corrections at 2 and 5 years were 76% (±7.6%) and 82% (±7.4%), respectively. This difference was statistically significant ($p<0.001$). Mean loss of correction on follow-ups was less than 5°. Mean operative time was 321 minutes with mean EBL of 147 mls (±67.7 mls). Mean LOS was 3.2 days (±1.2 days). Pre-op mean VAS and ODI scores were 22 and 17.4, respectively; 11.6 and 8.0 at 2 years and 9.4 and 6.6 at 5 years post-op, which were statistically significantly improved ($p<0.001$). The mean SRS-22r score at 2 and 5 years were 4.58 (±0.5) and 4.65(±0.6), respectively. The radiographic evaluation showed solid fusion rates in all patients at 2 years. At 5 years, 2 patients underwent revisions for L3-L4 non-unions. No other complications or revisions were observed in our cohort.

Conclusion
Based on our cohort's 2-5 years follow-up data we conclude that MIS provides an effective treatment option for AIS reconstruction. Our study indicates that MIS can achieve adequate deformity correction and positive clinical outcomes over long run as indicated by cobb angle, VAS, ODI and SRS-22r scores during follow-ups. If the goals of AIS surgery can be achieved, consideration should be given to less invasive techniques.

113. NOVEL ALGORITHM BASED ON ARTIFICIAL INTELLIGENCE FOR AUTOMATED COMPUTATION OF CORONAL PARAMETERS VALIDATED ON PREOPERATIVE AP X-RAYS OF 100 PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS

Clara Berlin, MD; Sonja Adomeit, MS; Priyanka Grover, MS; Marcel Dreischarf, PhD; Henry Halm, MD; Peter M. Obid, MD

Hypothesis
Artificial Intelligence (AI) algorithm provides measurements with excellent reliability compared to human experts.

Design
Retrospective, mono-centric cohort research study comparing the reliability of a novel AI algorithm in predicting coronal parameters with measurements of two experienced physicians.

Introduction
Accurate measurements of coronal parameters are crucial for preoperative planning of patients with adolescent idiopathic scoliosis (AIS). For reasons of time efficiency and accuracy, there is a growing need for automated determination of parameters. Advanced algorithms based on AI may independently determine essential radiographic parameters and improve workflows in clinical practice and research.

Methods
Preoperative images of 100 AIS patients (mean age/BMI: 14.5 yrs/20.4 kg/m², ♀/♂: 80/20) were measured independently by two physicians and compared with AI. Repeated measurements of one physician were used to analyze intra-rater reliability. An AI algorithm was developed and trained to detect anatomic regions of interest in AP full spine X-rays (cervical, thoracic, lumbar spine and sacrum). The resulting spinal curvature is used for the fully automated measurement of T1-tilt, coronal balance, and Cobb angles in the proximal thoracic (PT), thoracic, and thoracolumbar regions. To evaluate the performance of AI algorithm, mean error, standard deviation and intra/inter-rater reliability were assessed using single measure Intraclass Correlation Coefficients (ICC, absolute agreement). ICC>0.75 was considered excellent (Ciccetti, Psychol. Assess. 1994).

Results
ICC values for inter- (range: 0.85-0.99) and intra-rater (0.98-1) reliability demonstrate excellent agreement

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between physicians. AI algorithm can compute parameters in all 100 images yielding in excellent ICC values ranging from 0.77 (PT Cobb angle) to 0.92 (T1-tilt) compared to human raters. Mean error is smallest for T1-tilt (-0.8°) and largest for thoracic Cobb angle (8.4°).

Conclusion
This study demonstrates high reliability between the measurements of physicians and AI algorithm. Hence, the algorithm could support surgeons in the radiographic assessment of spinal deformities and facilitate the analysis of large datasets (e.g., registry studies) for research purposes.

surgeons in clinical practice and facilitate the analysis of large datasets (e.g., registry studies) for research purposes.

114. CHOOSING DISTAL LEVEL SELECTION FOR THORACIC VERTEBRAL BODY TETHERING: BEWARE OF GOING SHORT OF THE LAST SUBSTANTIALLY TOUCHED VERTEBRA

Stephen Plachta, MD; *Amer F. Samdani, MD*; Joshua M. Pahys, MD; Alejandro Quinonez, BS; Maureen McGarry, BBE; Steven W. Hwang, MD

Hypothesis
Curves of patients undergoing thoracic VBT are more likely to add on if instrumented short of the last substantially touched vertebra (LSTV).

Design
Single-center retrospective review

Introduction
Several papers have reported outcomes following thoracic anterior vertebral body tethering, yet few advise on distal level selection. We sought to determine the impact of lowest instrumented vertebra (LIV) selection and risk for adding-on.

Methods
All AIS patients with Lenke 1A/B curves who underwent VBT with minimum 2 year follow-up (f/u) were identified. Radiographic and clinical data were retrospectively reviewed. Adding on was defined as distalization of the end vertebra (EV) or change from first erect to latest x-ray >5°. The LIV was stratified based on location relative to the EV and LSTV.

Results
121 patients (100 girls, 21 boys) with mean 49.6 ± 21.3 mos f/u were included; all were skeletally immature (median Risser=0). Pre-op thoracic coronal curve of 49.9 ± 8.4° corrected to 22.4 ± 10.6° (55 ± 21% correction) at most recent f/u. Adding on occurred in 28.1% of patients (34/121). Lenke 1A curves had 3.1 times higher risk of adding on compared to Lenke 1B curves (25/66 [37.9%] vs. 9/55 [16.4%], p=0.014). LIV was EV or distal in all patients. The rate of adding on was 41.9% (18/43) when LIV was proximal to LSTV (OR= 3.0), 21.7% (13/60) when LIV=LSTV, and 11.1% (2/18) when LIV was LSTV +1 (p = 0.01). Further analysis revealed that the rate of adding on was 41.6% when LIV=EV (but EV was cephalad to LSTV), compared to 14.7% when LIV=EV (EV at or caudal to LSTV). In addition, adding on leading to revision surgery appeared highest in those patients who had been instrumented short of the LSTV (5/43 [11.6%] vs. 4/78 [5.1%], p=0.27), although sample size precluded statistical significance.

Conclusion
Adding on occurs in a significant number of patients after thoracic VBT. Surgeons should consider tethering to the LSTV to decrease the incidence of adding on in these growing patients.

116. RADIOGRAPHIC MOTION BEFORE AND AFTER VERTEBRAL BODY TETHERING COMPARED TO POSTERIOR SPINAL FUSION FOR THORACIC SCOLIOSIS.

Michelle Claire Marks, PT, MA; Maty Petcharaporn, BS; Tracey P. Bastrom, MA; Firoz Miyanji, MD; Patrick J. Cahill, MD; John (Jack) M. Flynn, MD; Baron S. Lonner, MD; Harms Study Group; Peter O. Newton, MD

Hypothesis
Patients have more spinal motion following Vertebral Body Tethering compared to Posterior Spinal Fusion.

Design
Prospective, multi-center, controlled comparative study

Introduction
The amount of motion preservation with Vertebral Body Tethering (VBT) compared to Posterior Spinal Fusion (PSF) remains unknown. We aim to define radiographic spinal motion and compare changes thereof in AIS patients 2-3years following both procedures.

Methods
Patients with major right thoracic AIS who underwent

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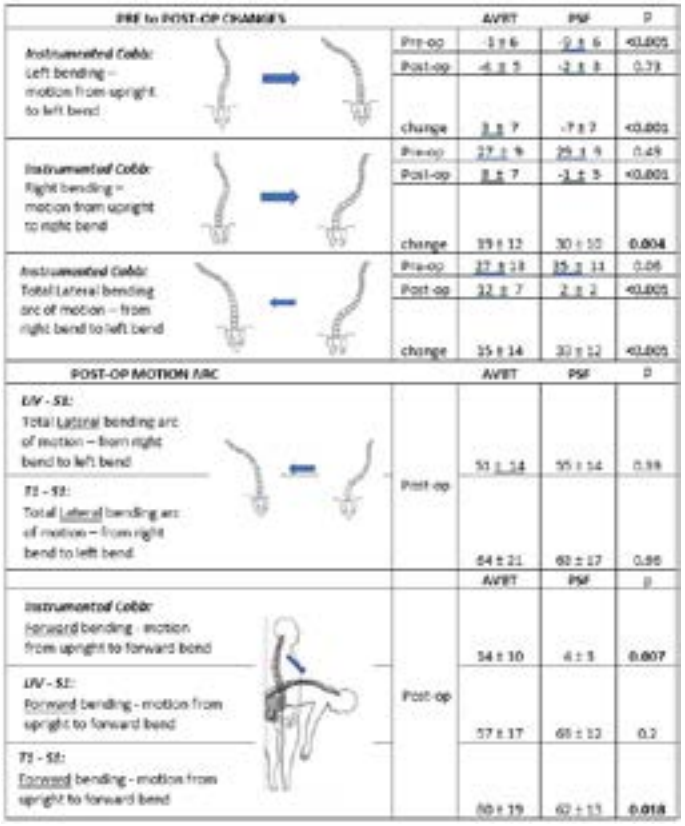
thoracic VBT (LIV: T11-L1) and presented between 2-3 years post-op were included. Pre-operative upright, and right and left coronal bend films for both cohorts were measured (no forward bend preop). Postop radiographs were acquired in neutral, maximum right, left, and forward bending positions. The VBT patients were matched 1:1 with patients treated with PSF, for whom similar bending radiographs were captured. Matching criteria included: curve pattern and lowest instrumented vertebra (LIV).

Results

There were 24 patients in each cohort similar in age (VBT 13±1, PSF 14±2,p=0.09), preop Cobb (VBT 48±7, PSF 49±6,p=0.5), and LIV (p=0.9). Postoperative Cobb was significantly lower in the PSF cohort (VBT 24±10, PSF 19±7,p=0.02). The loss from pre to post-op in side bending total arc of motion within the instrumented segments was 15° in the VBT cohort (12° postop) versus 33° in the PSF cohort (2° postop) (p<0.001). Despite this difference, the postop total lateral bending arc of motion from T1-S1 (64°vs63°) and from LIV-S1 (51°vs55°) was not different between VBT or PSF, respectively. Analysis of the forward bending arc of motion at the post-operative time point demonstrated significantly greater flexion in the instrumented region (14°vs4°) as well as globally from T1-S1 (80°vs62°) for the VBT cohort compared to PSF (p=0.007,p=0.018), but no difference below the LIV.

Conclusion

In a cohort of thoracic scoliosis patients, VBT patients had ~10 degrees greater side bending and flexion within the instrumented segments. At 2-3 year post-op, global motion from T1-S1 in forward bending was greater with VBT, but not in overall side bending. Additionally, there were no differences in regional motion below the LIV between the approaches. Motion preservation after thoracic VBT tethering is modest and appears primarily limited to sagittal plane bending.



Radiographic motion: region measured is bold.

117. A COMPREHENSIVE ANALYSIS OF OUTCOMES AND TREATMENT SUCCESS OF THORACIC, THORACOLUMBAR AND BILATERAL VERTEBRAL BODY TETHERING SURGERY

Caglar Yilgor, MD; Altug Yucekul, MD; Nuri Demirci; Feyzi Kilic, MD; Suha Aktas, MD; Ludovica Pallotta, MD; Gokhan Ergene, MD; Sahin Senay, MD; Sule Turgut Balci, MD; Pinar Yalinay Dikmen, MD; Tais Zulemyan, MSc; Yasemin Yavuz, PhD; Ahmet Alanay, MD

Hypothesis

Curve type, surgical technique and remaining growth affects VBT treatment success

Design

Retrospective analysis of prospectively collected data

Introduction

As VBT treatment for scoliosis evolves, it is important to be able to objectively classify results to allow to look at clinical and radiographic predictors for outcomes and treatment success. Aim was to determine the treatment success rates, and possible factors affecting outcomes.

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Methods
Coronal alignment (C7-CSVL), final follow-up proximal thoracic, main thoracic and thoracolumbar/lumbar curve magnitudes, changes in the sagittal plane and re-operations were used to formulate a 3-category radiographic outcome scheme. "Excellent" and "acceptable" outcomes were classified as "treatment success", while "poor" outcomes denoted "treatment failure". Lenke curve patterns, thoracic, thoracolumbar and bilateral surgeries, and anticipated remaining growth (TRC closure & Sanders stages) potential of patients were compared using Chi-Squared and Exact tests, and ANCOVA.

Results
46 patients (43F, 3M, mean age: 12.7±1.7 years, mean follow-up: 56.5±10.6 (48-93) months) were included. Thoracic VBT (with or without lumbar extension) demonstrated higher success (85%) compared with thoracolumbar (40%) and bilateral (57%) VBT surgeries (p=0.030). Lenke 1 Curves demonstrated higher success (86%; in detail 90%, 90%, 83% and 78% for 1A, 1B, 1C and 1Ar curves, respectively) compared with Lenke 2-3 (33%) and Lenke 5-6 (50%) curves (p=0.022). TRC closed patients demonstrated higher success (82%) compared to TRC open (43%) patients (p=0.028). Success rates for Sanders 1-2 (66%), Sanders 3-4 (88%) and Sanders 5-6-7 (71%) patients were similar (p=0.384). Patients with treatment success demonstrated better mean SRS-22 satisfaction (4.71 vs 3.85, p=0.010) scores compared with patients with treatment failure at latest follow-up, although each domain and the subtotal score were similar (p>0.05 for all comparisons).

Conclusion
Although, theoretically, motion preservation is more desirable at the lumbar spine, at its current state, outcomes of thoracic VBT surgery are more favorable. Despite concerns in this regard, outcomes of Lenke 1C and 1Ar curves are not inferior to that of Lenke 1A and 1B curves. A sweet spot in regards to remaining growth for superior outcomes is still to be discovered. Radiographic results reflect into patient-reported satisfaction.

118. INFLUENCES OF POSTOPERATIVE PELVIC TILT CORRECTION IN PROXIMAL JUNCTIONAL KYPHOSIS OCCURRENCE

Emmanuelle Ferrero, MD, PhD; Marc Khalifeé, MD, MS

Hypothesis
Excessive pelvic retroversion correction is associated with Proximal Junctional kyphosis (PJK) occurrence

Design
Retrospective monocenter study

Introduction
Adult spinal deformity is a common disease, responsible for poor functional outcomes. Surgical correction enables radiographic and clinical improvement but is associated with important complications rate (up to 60%), especially mechanical with PJK. Aim of this study was to analyze the role of pelvic retroversion correction in the occurrence of PJK and to determine risk factor for PJK.

Methods
All ASD patients, older than 45 yo, operated between 2014 and 2018 were included. Fusion should include a UIV between T9 and L1 and fusion to the sacrum or iliac. Demographic and surgical data were recorded. On fullspine X-rays, coronal and sagittal radiographic parameters were measured preoperatively, postoperatively and at final follow-up. Occurrence of radiological PJK corresponding to a 10° increase in the sagittal Cobb angle, measured between the upper instrumented vertebra (UIV) and UIV + 2, between postoperative and 2-years follow-up X-rays, was reported. First, parameters were compared between "PJK" and "non PJK patients". Then, in the PJK group, patients who had revision for PJK "R- PJK" were compared to patients without revision "non R-PJK".

Results
76 patients were included. Preoperatively, PJK patients had lower lumbar lordosis (LL) with similar pelvic tilt (PT), thoracic kyphosis (TK) and SVA than non-PJK patients. Demographic data were similar between groups. Preoperative UIV slope was smaller in PJK than non-PJK patients (0°+/-2 vs 2°+/-3; p=0.004). Postoperatively, PJK patients had higher LL and TK correction than non PJK patients (p>.03 and p<0.001). Pelvic tilt correction was greater in PJK patients (31% of correction) than non-PJK (16%), (-8° +/-11 vs -4°+/-7, p=0.03). At FU, upper LL was greater in PJK patients. PJK patients who had revision for PJK were more malaligned with larger SVA, greater UIV slope (p=0.002), larger PT than non-R PJK patients

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Conclusion
PJK patients had greater lordosis improvement and retroversion correction than non-PJK. Surgeon must be careful not to overcorrect LL and to avoid UIV choice at the apex of kyphosis. LL correction LL might be associated with retroversion hyper-correction in some patients. Then UIV is posteriorly projected and PJK may occured. Surgeon must be careful to avoid UIV choice at kyphosis apex.

119. VALIDATION OF INTER-SCREW DISTANCE FOR IDENTIFYING RADIOGRAPHIC TETHER BREAKAGE IN VERTEBRAL BODY TETHERING: A CROSS-CENTRE COMPARISON OF CLINICALLY PROVEN BREAKAGES

Sandra H. Wan; *Stephanie Da Paz, MD*; Sheryl Z. Saw; Per D. Trobisch, MD; Kenneth M. Cheung, MD, MBBS, FRCS

Hypothesis
Increase in inter-screw distance can better identify radiographic tether breakages.

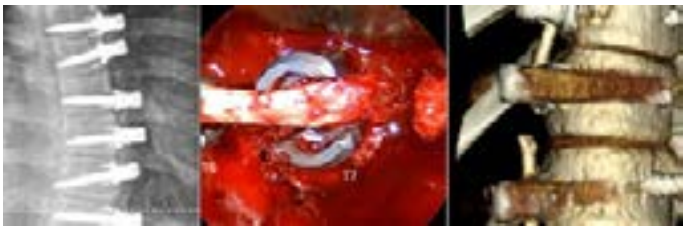
Design
Two-centre retrospective analyses

Introduction
Tether breakage in Vertebral Body Tethering (VBT) has been arbitrarily defined as a 5° increase in inter-screw angulation. However, it was previously found that only 56% of tether breakages could be identified using the 5° rule. As tensile tests by Guldeniz et al. have suggested that tether breakage occurs when it elongates more than 10-13% of its original length, we propose that an increase in distance between the 2 screw heads of > 10% of their original length is a better indicator of tether breakage.

Methods
23 subjects with Adolescent Idiopathic Scoliosis who underwent VBT with a minimum of 1-year follow-up from two centres were analysed. Inter-screw angles and distances at each of the instrumented levels between post-operative radiographs and at the latest follow-up visit were measured by two independent observers blinded to the tether status. Sensitivity was compared to true tether breakages from re-operation records and CT reconstruction.

Results
14 subjects from Germany had 45 breakages out of 130 segments, while 9 subjects from Hong Kong had 15 breakages out of 63 segments from CT reconstruction. Mean number of instrumented levels were 9 ± 3 and 7 ± 2 from Germany and Hong Kong respectively. The mean pre-op major Cobb was 52 ± 13° and at post-op was 28 ± 9°. Inter-screw distance correctly identified 44 out of 60 breakages (SN=73%), while inter-screw angle only correctly identified 35 (SN=58%).

Conclusion
Tether can break without a loss of correction and therefore an increase in angle. Inter-screw distance allows us to identify such breaks as well. While this may not affect overall clinical management, identifying the true incidence of tether breakages allow us to better understand the natural history of VBT and the consequences of long-term implantation.



Inter-screw distance and angle were measured from plain radiographs (left) and compared to true tether breakages from re-operative findings (centre) and CT scans (right).

120. POSTOPERATIVE SHOULDER BALANCE IN LENKE TYPE 1 ADOLESCENT IDIOPATHIC SCOLIOSIS PATIENTS WITH LARGE THORACIC CURVE (COBB ANGLE ≥ 70 DEGREES): A RADIOGRAPHIC STUDY

Jun Jiang, MD; Yong Qiu, PhD; *Zezhang Zhu, PhD*

Hypothesis
Severe MT curve is not a risk factor for postoperative shoulder imbalance in Lenke type 1 AIS patients. Large MT curve correction will not lead to residual left-elevated shoulder if the correction rate of MT curve is proper in these patients.

Design
A retrospective study

Introduction
To date, there was no study specifically concerning on the influence of magnitude of preoperative thoracic curve on postoperative shoulder balance in these patients.

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Methods
A total of 47 Lenke type 1 AIS patients underwent posterior correction surgery between Sept. 2016 to Nov. 2018 in our institution were included. All these patient were divided into 2 groups based on the severity of MT curve. Group A consisted of 25 cases with MT curve equal to or more than 70 degree while Group B consisted of 22 cases with MT curve less than 70 degree. Proximal thoracic (PT) Cobb angle, MT Cobb angle, MT apical vertebral translation (AVT), T2-T5 kyphosis, T5-T12 kyphosis, and radiographic shoulder height (RSH) were compared preoperatively, immediately after surgery, and at a minimum of two-year follow-up.

Results
Although all the correction of PT Cobb angle, that of MT Cobb angle and that of MT AVT were significantly larger in Group A when compared with Group B ($P<0.05$), the RSH was comparable between these 2 groups both immediately after surgery and at last follow up ($P>0.05$). Both the correction of MT Cobb angle and that of MT AVT had significantly positive associations with the change of RSH in all these patients ($P<0.05$).

Conclusion
Severe MT curve is not a risk factor for postoperative shoulder imbalance in Lenke type 1 AIS patients. Large MT curve correction will not lead to residual left-elevated shoulder if the correction rate of MT curve is proper in these patients.

121. IS THE MORPHOLOGY OF THE APICAL PEDICLES INFLUENCED BY APICAL ROTATION OR THE CORONAL CURVE MAGNITUDE IN ADOLESCENT IDIOPATHIC SCOLIOSIS: A RADIOGRAPHIC ASSESSMENT

Bhavuk Garg, MS; Tungish Bansal, MS; Nishank Mehta, MS; Jwalant S. Mehta, FRCS (Orth), MCh (Orth), MS (Orth), D Orth; Shubhankar Shekhar, MBBS; Namith Rangaswamy, MS; *Rajesh Malhotra, MD*

Hypothesis
To establish whether pedicle dysmorphism is linked to curve magnitude CCA and the AVR in adolescent idiopathic scoliosis (AIS)

Design
Observational Study

Introduction
The correlation of pedicle dysmorphia with apical vertebral rotation (AVR) and Coronal Cobb angle (CCA) has not been studied

Methods
Preoperative radiographs and CT scans of 25 AIS patients operated at a single centre from 2013-2019 were retrospectively reviewed CCA was noted on the standing radiograph whereas the AVR was measured on the axial cuts of CT scan. Pedicle morphometric measurements were performed at apical vertebra (when present), 2 vertebrae above (U1 and U2) and below (B1 and B2) the apex vertebra/disc on CT scan. We assessed the transverse pedicle diameter, transverse cancellous channel diameter, sagittal pedicle diameter, pedicle length and pedicle axis length. Pearson Correlation tests between pedicle morphometric measurements, AVR and the curve magnitude (Cobb angle) were studied.

Results
Curve was main thoracic,thoracolumbar/lumbar (TL/L) curves and double major in 17, 4 and 4 patients respectively. The mean Cobb angle was 61.5 ± 9.3° and the mean AVR was 28.4 ± 17.8°. A positive correlation was noted with the AVR for U1 concave pedicle length ($r=0.45$ $p=0.03$), pedicle axis length of the U2 concave pedicle ($r=0.6$, $p=0.04$), transverse pedicle diameter of the convex apical vertebrae($r=0.82p=0.00009$) and the convex apex pedicle ($r=0.80,p=0.002$) A negative correlation with the AVR was noted for U2 convex pedicle length ($r=-0.51,p=0009$), transverse cancellous channel diameter of the U2 concave pedicle ($r=-0.42,p=0.04$) and apical concave pedicle ($r=-0.78,p=0.002$) and the sagittal pedicle diameter for the convex pedicle of U2 ($r=-0.45,p=0.03$) and apex($r=-0.59,p=0.04$). The Cobb angle did not show a significant correlation with any of the pedicle measurements at any of the levels on the convex and the concave sides.

Conclusion
Pedicle asymmetry and dysmorphism demonstrates a morphometric association with the apical vertebral rotation than the curve magnitude. The pedicle length and pedicle axis length increase on the concave apical and periapical region with increase in AVR. The transverse cancellous channel diameter significantly decreases on the concave apical region with increase in AVR. The sagittal pedicle diameter decreases on the convex side with increase in AVR.

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122. INFLUENCE OF THE THORACOLUMBAR JUNCTION FLEXIBILITY ON THE RISK OF ADDING-ON AFTER POSTERIOR VERTEBRAL ARTHRODESIS FOR THORACIC IDIOPATHIC ADOLESCENT SCOLIOSIS.

Thierry A. Odent, MD, PhD; Emilie ANDRE, MD

Hypothesis
The objective of the study was to analyze the role of the thoracolumbar sagittal flexibility on the outcome after posterior spinal fusion of Lenke 1 and 2 adolescent idiopathic scoliosis with last touched vertebra (LTV) as lowest instrumented vertebra. The results were then analyzed according to the Roussouly sagittal spinal alignment classification.

Design
Single-center retrospective study

Introduction
The choice of the LIV for AIS surgery remains a highly debated topic. Using the LTV as the Lowest intrumented vertebra is a common choice but is still associated with a risk of distal adding on and unsatisfactory clinical outcome. In the literature, no studies consider flexibility in the sagittal plane of the thoracolumbar junction.

Methods
We included 105 thoracic AIS patients who had a posterior spinal fusion with LTV chosen as the LIV with a 2 years minimum follow-up. Thoracolumbar junction flexibility was assessed on dynamic sagittal X-rays (maximal flexion and extension) and compared to the standing position. Adding-on was defined according to radiographic Wang criteria's. Then, according to the Roussouly morphotypes, we determined which thoracolumbar junction flexibility parameters (flexion and/or extension) were important.

Results
Mean age of the patients was 14± 2 years. The preoperative mean Cobb angle was 61± 12.7° and 27.5± 7.7° after surgery. Mean follow-up was 3.1 years. Twenty-nine patients (28%) developed an adding-on. Thoracolumbar junction range of motion between flexion and extension was higher (p= 0,008) with higher flexibility in flexion (p< 0,001) than in the adding-on group. In no adding-on group, 53 patients (70%) had a flexible thoracolumbar junction and 23 patients (30%) had a stiff thoracolumbar junction in flexion and flexible in extension. In adding-on group, 27 patients (93%) had a stiff thoracolumbar junction and 2 patients (7%) had a flexible junction in flexion and stiff in extension. Regarding the Roussouly classification, the reserve of flexibility necessary (extension or/and flexion) was different according to the type of back.

Conclusion
The flexibility of the thoracolumbar junction is a determining factor in the surgical outcome after posterior spine fusion for AIS and should be considered in correlation with the frontal and sagittal alignment of the spine.

123. CAN WE STOP DISTALLY AT LSTV-1 FOR ADOLESCENT IDIOPATHIC SCOLIOSIS WITH LENKE 1A/2A CURVES? A MINIMUM OF 2 YEARS FOLLOW-UP STUDY

Xiaodong Qin, PhD; Zhen Liu, PhD; Yong Qiu, PhD; *Zezhang Zhu, PhD*

Hypothesis
In some cases, selecting LSTV-1 as LIV could achieve similar outcomes to LSTV.

Design
Retrospective study

Introduction
Posterior thoracic fusion to save more lumbar mobile segments has become the mainstay of operative treatment for AIS with Lenke 1A/2A curves. Although previous studies have recommended selecting the LSTV as LIV, good outcomes could still be achieved in some cases when LSTV-1 was selected as LIV. The purpose of the study is to determine in which case LSTV-1 could be a valid LIV, in which case distal fusion should extend to LSTV, and to identify risk factors for distal adding-on.

Methods
Ninety-four patients were included in the study with a minimum of 2-year follow-up after posterior thoracic instrumentation, in which LSTV-1 was selected as LIV. Patients were identified with distal adding-on between first erect radiographs and 2-year follow-up based on previously defined parameters. Factors associated with the incidence of adding-on were analyzed.

Results
The mean follow-up duration was 37.7±15.8 months. Forty patients (42.6%) with LSTV-1 selected as LIV achieved good outcomes at the last follow-up. Several preoperative risk factors significantly associated with

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distal adding-on were identified, including lower Risser (p=0.001), longer thoracic curve length (p=0.005), larger rotation and deviation of LSTV-1 (p<0.001) and preoperative coronal imbalance (p=0.013).

Conclusion
Skeletally immature patients with long thoracic curve, preoperative coronal imbalance, large rotation and deviation of LSTV-1 are at increased risk of distal adding-on when selecting LSTV-1 as LIV. Under this condition, distal fusion level should extend to LSTV; While in other case, LSTV-1 could be a valid LIV.

124. ATYPICAL APEX LOCATION MAY BE THE INDICATION FOR COBB+1 TO COBB FUSION IN LENKE 5C ADOLESCENT IDIOPATHIC SCOLIOSIS PATIENTS

Shibin Shu, PhD; Hongda Bao, MD; Xin Zhang, MD; Zhen Liu, PhD; *Zezhang Zhu, PhD*; Yong Qiu, MD

Hypothesis
Cobb+1 to Cobb fusion is not a contraindication with atypical apex location in Lenke 5C patients.

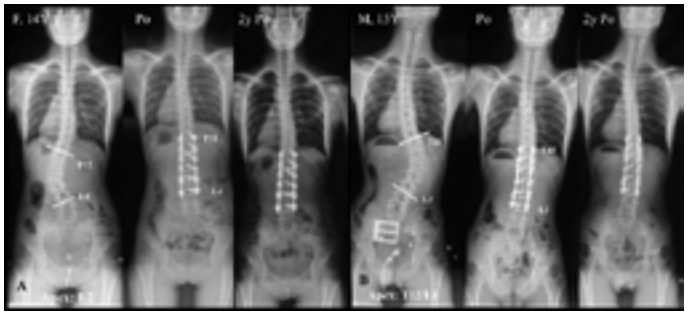
Design
A retrospective study

Introduction
The indication of Cobb+1 to Cobb fusion and the clinical outcome has not been investigated.

Methods
Lenke 5C AIS patients with a minimum follow-up of 2 years and selecting Cobb+1 to Cobb fusion were included. They were divided into the typical group (apex location of the main curve is between T12 and L1) and the atypical group (apex location of the main curve is below the disc of L1/L2). Radiographic parameters and SRS-22 scores were compared.

Results
52 patients (19 in typical group and 33 in atypical group) were included with mean follow-up of 30.8 months. 6 patients (31.58%) in the typical group and 5 (15.15%) in the atypical group showed proximal decompensation during follow-up, and the incidence was significantly higher in the typical group (p=0.043). Within the atypical group, the patients with proximal decompensation showed similar Risser grade, baseline thoracic Cobb angle, and main Cobb angle. However, the baseline thoracic/lumbar apical vertebra translation (AVT) ratio was significantly larger in patients with proximal decompensation (p=0.016). Meanwhile, patients with proximal decompensation in the typical group showed significantly larger pre-operative UIV translation and lumbar AVT but similar post-operative UIV tilt.

Conclusion
Cobb+1 to Cobb fusion strategy, selecting UIV at 1 level above UEV, could be performed in Lenke 5C patients with atypical apex location. In addition, when with small baseline thoracic curve represented by smaller baseline thoracic-lumbar AVT ratio, UIV could be selected at UEV+1.



125. OPTIMIZING HEALTH PRIOR TO ADULT SPINAL DEFORMITY SURGERY: ARE COSTS OUTWEIGHED BY PERIOPERATIVE BENEFITS?

Peter G. Passias, MD; Pooja Dave, BS; Rachel Joujon-Roche, BS; Peter Tretiakov, BS; Jamshaid Mir, MD; Kimberly McFarland, BS; Jordan Lebovic, MBA; Renaud Lafage, MS; Virginie Lafage, PhD

Hypothesis
Optimization of modifiable health conditions prior to surgical correction of Adult Spinal Deformity (ASD) minimizes perioperative complications and reduces overall cost.

Design
Retrospective study of a single center ASD database.

Introduction
Operative ASD patients are particularly vulnerable to the deleterious impact of comorbidities on surgical outcomes (Yagi et. al).

Methods
ASD patients with perioperative data were included. Optimization of diabetes (DM), osteoporosis, and nutritional status was assessed. Patients with DM were considered optimized (Opt) if pre-op HbA1c≤7%. Those with osteoporosis were Opt if treated with an FDA approved drug prior to surgery. In contrast, nutritional status was assessed by ranking patients

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into quartiles (Q1-Q4) by baseline BMI. Q1 (low BMI) and Q4 (high BMI) were considered N-Opt. Total Costs (TC) were calculated from average Medicare DRG reimbursement. Where applicable, pre-op (≤90 days) costs incurred that were directly related to optimization (e.g. drugs) were added to TC. Multivariable analyses assessed perioperative outcomes while accounting for surgical and demographic differences between groups.

Results
269 patients were included (24.2% DM; 15.2% osteoporotic). Of diabetics (70.8% Opt; 29.2% N-Opt), Opt patients had 94.1% lower odds of wound infection (OR: 0.059 [0.007, 0.491], p=.009) and 89.3% lower odds of 90-day readmission (OR: 0.107 [0.033, 0.352], p< .001). Accordingly, Opt patients had significantly lower TC ($27,385 vs. $35,955, p<.001). For osteoporosis (85.4% Opt; 14.6% N-Opt), Opt patients had 79.3% lower odds of peri-op complications (OR: 0.207, [0.086, 0.498], p<.001) and lower TC ($28,053 vs. $33,171, p=.002). For nutritional status (50.2% Opt; 49.8% N-Opt), mean BMI of N-Op quartiles were 21.4 kg/m2 (Q1) and 39.1 kg/m2 (Q4). Compared to N-Opt quartiles (p>.05), odds of peri-op complications were significantly reduced for patients in Q2 (OR: 0.354 [0.200, 0.625], p<.001) and Q3 (OR: 0:380 [0.193, 0.751], p=.005) and TC were significantly lower in Opt quartiles (all p<.001, Figure 1).

Conclusion
Despite accounting for surgical differences and costs of preoperative interventions, total costs were significantly lower in optimized patients. Thus, optimizing modifiable health conditions prior to surgery may benefit ASD patients by reducing perioperative complications while also minimizing utilization of hospital resources and lowing total costs.

126. COMPARISON OF MULTI-LEVEL LOW-GRADE TECHNIQUES VERSUS THREE-COLUMN OSTEOTOMIES IN ADULT SPINAL DEFORMITY SURGERY: DOES HARMONIOUS CORRECTION MATTER?

Peter G. Passias, MD; Tyler K. Williamson, MS, BS; Stephane Owusu-Sarpong, MD; Rachel Joujon-Roche, BS; Pooja Dave, BS; Peter Tretiakov, BS; Jamshaid Mir, MD; Kimberly McFarland, BS; Jordan Lebovic, MBA; Shaleen Vira, MD; Bassel G. Diebo, MD

Hypothesis
There is benefit to achieving harmonious correction of severe lumbopelvic deformity with multi-level low-grade (MLG) techniques.

Design
Retrospective

Introduction
Recent debate has arisen between whether to use a three-column osteotomy(3CO) or multiple low-grade techniques(MLG) to treat more rigid deformities in adult spinal deformity(ASD) surgery. High-intensity 3CO may increase the risk of complications, while MLG approaches may be less effective.

Methods
ASD patients with baseline(BL) PI-LL>30° and two-year(2Y) data included. Groups: 1) 3CO or 2) MLG[3+ SPOs or 3+ ALIFs with no 3CO]. Groups were propensity score matched(PSM) for BL PI-LL and prior fusion. Segmental Utility Ratio(SU Ratio) assessed relative segmental correction[segmental correction divided by overall correction in lordosis divided by number of thoracolumbar interventions(IBF,SPO,3CO)]. Paired t-test assessed lordotic distribution by differences in lordosis between adjacent lumbar disc spaces(i.e.L1-L2 to L2-L3,etc). Multivariable analysis, controlling for age, gender, CCI, and baseline PI, evaluated the complication rates, radiographic and patient-reported outcomes between groups.

Results
108 patients included. 45% underwent MLG, 41% 3CO. MLG had higher CCI and lower BMI(both p<.05). MLG patients had less previous fusions than 3COs(31% vs. 80%,p<.001). MLG patients accrued 24% less blood loss, but 22% greater operative time(565 min vs. 419,p=.009). Upon PSM, 3COs had greater segmental and relative correction at each level(SU Ratio means: 3CO:69% vs. MLG:23%,p<.001). However, 3COs had lordotic differences between two adjacent lumbar disc pairs(range: -0.5-9.0°,p=.009), while MLG was more harmonious(range: 2.2-6.5°,p>0.4). MLG were more often realigned to age-adjusted standards(OR: 5.6,[1.2-46.4];p=.033). MLG were less likely to develop neurological complications or undergo reoperation(OR: 0.4,[0.1-0.9];p=.041). Adjusted analysis revealed MLG patients more often met SCB in ODI(OR: 5.3,[1.1-26.8]; p=.043).

Conclusion
Multi-level low-grade techniques showed better

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utility in lumbar distribution and age-adjusted global correction, while minimizing neurological complications and reoperation rates by two years. In selective instances, these techniques may offer the spine deformity surgeon a safer alternative when correcting severe adult spinal deformity.

	MLG	3CO	p-value	MLG	3CO	p-value
	Preoperative			Correction		
PI	57.7 ± 12.3	61.2 ± 15.6	.409	0.3 ± 1.4	-0.2 ± 2.9	.503
PI-LL	47.4 ± 13.8	43.2 ± 12.1	.289	-39.1 ± 15.0	-38.3 ± 11.8	.845
PT	35.5 ± 7.5	34.8 ± 7.3	.740	-14.2 ± 8.5	-12.6 ± 7.1	.477
SVA	143.4 ± 64.9	148.3 ± 60.9	.793	-109.4 ± 73.0	-113.3 ± 62.4	.847
TIPA	39.6 ± 8.4	39.7 ± 10.1	.943	-21.7 ± 10.7	-21.0 ± 8.8	.798
T4-T12	-16.5 ± 13.8	-24.9 ± 18.0	.085	-19.2 ± 12.0	-14.5 ± 12.0	.195
GAP Score	11.9 ± 0.8	11.7 ± 0.9	.327	-5.8 ± 4.0	-6.8 ± 2.8	.372
	MLG		3CO		p-value	
Realignment Strategies						
Age-Adjusted SVA	40.8%		29.6%		.260	
Age-Adjusted TIPA	44.9%		29.6%		.128	
Age-Adjusted PI-LL	28.6%		13.9%		.144	
Age-Adjusted PT	30.6%		27.3%		.727	
Matched in SAAS	42.7%		29.6%		.135	
Proportioned in GAP	18.4%		7.3%		.077	
Segmental Correction						
L1-L2	10.2 ± 10.5		-		-	
L2-L3	11.8 ± 8.4		26.2 ± 3.7		.029*	
L3-L4	11.7 ± 7.7		22.0 ± 11.6		.003*	
L4-L5	11.5 ± 9.5		24.2 ± 8.5		.000*	
L5-S1	5.3 ± 11.3		8.9 ± 19.9		.711	

127. WHAT IS THE AMOUNT OF CORONAL CORRECTION REQUIRED IN ADULT SPINAL DEFORMITY PATIENTS TO ACHIEVE OPTIMAL OUTCOMES IN PATIENTS WITH VARYING DEGREES OF SAGITTAL TO CORONAL DEFORMITY?

Peter G. Passias, MD; Oscar Krol, BS; Jamshaid Mir, MD; Pooja Dave, BS; Peter Tretiakov, BS; Kimberly McFarland, BS; Tyler K. Williamson, MS, BS; Rachel Joujon-Roche, BS; Bailey Imbo, BA

Hypothesis
To determine what degree of coronal correction is needed for best clinical and radiographic outcomes.

Design
Retrospective review

Introduction
Adult spinal deformity (ASD) is a debilitating condition that is increasing in prevalence as the elderly population continues to grow. Surgery has been shown as an effective treatment modality for correcting malalignment, however, the degree of coronal correction needed in the case of a suitable sagittal alignment is still unclear.

Methods
379 operative ASD pts with available baseline(BL) and 2-year radiographic and HRQL data were included. Patients were ranked into 4 quartiles(Q) by SVA to C7PL deformity, with 1st being the lowest C7PL. Conditional inference tree analysis(CIT) was used to develop threshold cutoffs for target coronal alignment. Persistent sagittal/coronal deformity was defined as a 2Y C7PL above 50th percentile and a + or ++ SRS-Schwab deformity in 2Y SVA.

Results
Mean coronal measurements: C7PL: 3.5±3.2cm, Max Cobb Angle: 44.4±20.9. Mean correction in C7PL was 2.3±2.8cm, Max Cobb 22.7±16 and 5.1±6cm in SVA. 94 patients (Q1) were considered pure coronal deformity, with a mean SVA .7cm ± 2.3cm and mean coronal 4.3cm ± 3.3cm and 95 patients were considered pure sagittal deformity with a mean SVA 7.9cm ± 6.8cm and mean coronal 1.1cm ± 1.1cm. Table 1. In patients with a pure coronal deformity, a 2Y C7PL <3.4cm showed lower PJK (OR: .24, 95% CI: .095, p=.003) with a significant relationship between degree of correction with SF-36 PCS (r=.320) and SRS-22 Pain (r=.240, both p<0.05). When analyzing Q2, Q3, and Q4 there were no significant relationships with post-operative C7PL and development of PJK, PJF, or HRQL measures. In patients with persistent sagittal and coronal deformity (n=122 [mean SVA: 8.1±3.3cm, mean C7PL: 4.3±2.1cm]), patients with a 2Y C7PL greater than 3.8cm were less likely to meet MCID for SRS-Pain (OR: .18, 95% CI: .08- .40, p<.001).

Conclusion
When stratifying by degree of sagittal to coronal deformity, results show patients with a pure coronal deformity have a significant benefit from correction below 3.4cm. With increasing sagittal deformity, coronal realignment has a lower impact on outcomes. Patients with a persistent coronal and sagittal deformity were more likely to have decreased pain when coronal deformity was below 3.8cm.

128. WHEN DOES THE GAP SCORE FAIL?: COMPREHENSIVE ASSESSMENT OF MECHANICAL AND JUNCTIONAL FAILURE IN PATIENTS MEETING POST-OPERATIVE GLOBAL ALIGNMENT AND PROPORTIONALITY TARGETS

Peter Tretiakov, BS; Pooja Dave, BS; Kimberly McFarland, BS; Jamshaid Mir, MD; Tomi Lanre-Amos, MD; Bassel G. Diebo, MD; Shaleen Vira, MD; *Peter G. Passias, MD*

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Hypothesis
In patients considered matched by SRS-Schwab and age-adjusted criteria, increasing post-operative GAP score is associated with increasing risk of mechanical or junctional complications.

Design
Retrospective

Introduction
Setting surgical goals according to the GAP score may decrease the prevalence of mechanical complications. However, addressing these targets does not always prevent high mechanical complication or revision rates. This study aimed to elucidate factors associated with failure despite GAP score adherence.

Methods
ASD patients ≥18Y with baseline (BL) radiographic data at baseline (BL) and 1-year (1Y) were isolated in the single-center database. Patients were stratified by GAP category primarily: Proportioned (GAP-P), Moderately Disproportioned (GAP-MD), and Severely Disproportioned (GAP-SD). Secondarily, failure rates within each category were established for patients meeting Age-Adjusted and SRS-Schwab targets by 6W. Logistic regression analysis and CIT analysis then determined factors associated with failure in each subgroup.

Results
331 patients (63.0yrs, 67% F) were isolated. Of the total cohort, 56.2% had ≥1 age-adjusted match at 6W postop (Match). By GAP proportionality: 48.5% of patients were considered GAP-P by 6W, 38.8% were considered GAP-MD, and 12.7% were considered GAP-SD by 6W post-op. Of patients considered GAP. In terms of gross failure, 7.4% of the cohort developed PJK by 1Y despite meeting GAP targets, though no patients developed radiographic PJF. No matched patients developed signs of instrumentation failure or malposition by 1Y. By failure rate, significant correlations were observed with increasing GAP score and mechanical failure rates by 6W (p=.004), however no correlations were observed with junctional failure rates within the peri-operative period (p>.05). By GAP category, differences were observed in terms of mechanical failure, with matched GAP-MD and GAP-SD patients being 1.6 times (p=.026) and 1.9 times (p<.005) more likely to suffer failure versus their matched GAP-P counterparts.

Conclusion
In patients considered matched by SRS-Schwab and age-adjusted criteria, significant correlations between increasing post-operative GAP score and mechanical failure within the early-post operative period. These findings suggest stricter adherence to GAP planning may be necessary to avoid adverse outcomes.

129. THE IMPACT OF SAGITTAL ALIGNMENT ON DISABILITY DECREASES AFTER SURGERY AS OTHER FACTORS BECOME MORE INFLUENTIAL: SERIES OF 925 PATIENTS WITH 2-YR FOLLOW UP

Justin K. Scheer, MD; Virginie Lafage, PhD; Justin S. Smith, MD, PhD; Renaud Lafage, MS; Peter G. Passias, MD; Eric O. Klineberg, MD; Douglas C. Burton, MD; Breton G. Line, BS; Shay Bess, MD; Christopher I. Shaffrey, MD; Frank J. Schwab, MD; Munish C. Gupta, MD; *Christopher P. Ames, MD*; International Spine Study Group

Hypothesis
Postop health-related quality of life (HRQOL) is not correlated to sagittal alignment

Design
Retrospective analysis of a prospective multicenter Adult Spinal Deformity (ASD) database.

Introduction
The relationship of sagittal malalignment to outcomes has been emphasized in adult deformity surgery and it is known that sagittal parameters have some correlation to HRQOL measures overall. However, the specific relationship of HRQOL to postop sagittal alignment and changes in the strength of the relationship from preop to post op for deformity surgery has not been well defined.

Methods
Adult(≥18yrs), Cobb angle ≥20deg, SVA≥5cm, PT≥25deg, and/or thoracic kyphosis≥60deg, 2-yr follow up. Pts grouped by having met 2/3 of the sagittal alignment thresholds (SVA,PT, and/or PI-LL) at 2yrs postop for either the SRS-Schwab values(+SS0) or age-adjusted values(+AGE). Age-adjusted values calculated within +/-10yrs of actual age. Pts that didn't meet 2/3 of the SRS-Schwab were labeled –SS0 and age-adjusted values(–AGE). Baseline/2yr HRQOL Linear regression preformed for all groups for baseline 2yr HRQOL.

Results
Total 925 pts. Mean age 60.1±14.2yrs, 602(65.1%)+SS0,

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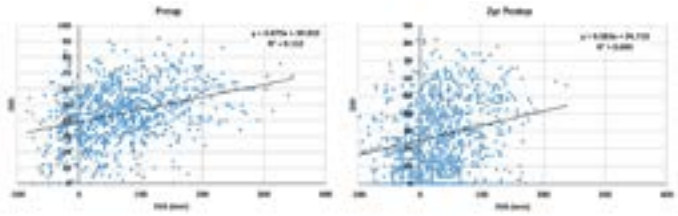
323(35.9%)-SS0, 199(21.5%)+AGE, and 283(30.6%)–AGE pts. The remaining age-adjusted pts were either overcorrected or did not have 2/3 sagittal values matched (n=443). All pts had significant improvement in all HRQOL at 2yrs (p<0.001 for all). Overall baseline R2 values for all pts for SVA, PI-LL and PT with ODI were (0.110, 0.072, 0.043, respectively) and at 2yrs they were lower (0.049, 0.016, 0.008, respectively). This same trend of low R2 was in +/-SS0 and +/-AGE pts. However, the R2 for 2yr ODI vs. MCS, SRS appearance, and SRS Mental, increased postop (0.19, 0.43, 0.22, vs. 0.17, 0.25, 0.17, respectively) compared with preop.

Conclusion
Sagittal alignment correlates weakly with preop HRQOL and postop HRQOL is improved. Preop SVA explains only 11% of preop ODI scores based on the R2 value and this decreases postop to 5%. After alignment correction, other patient factors become increasingly important such as the relationship between ODI and SRS Appearance, SRS Mental, and MCS. More work is necessary to better understand the postop HRQOL relationships including the possibility of a better measurement tool for surgical success.



130. HIGH SURGICAL INVASIVENESS COMBINED WITH FRAILTY IS ASSOCIATED WITH GREATER IMPROVEMENT THROUGHOUT LONG-TERM RECOVERY AFTER ASD SURGERY WITH MINIMUM 5-YEAR FOLLOW-UP

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Hypothesis
Patients who are both frail and have invasive surgeries will have adverse post-operative recovery kinetics

Design
Retrospective Review

Introduction
Evidence on long-term surgical recovery in adult spinal deformity (ASD) patients who are both frail and have an invasive procedure is limited. This study aims to evaluate frail and invasive patients with 5-year recovery kinetics.

Methods
ASD-FI scores were used to stratify non-frail (<0.3) and frail (>0.3) patients. ASD-SR scores were used to stratify low invasive (<90) from high invasive (>90) surgeries. Using ASD-FI and ASD-SR, patients were separated into four cohorts: non-frail low invasive (NFLI), frail low invasive (FLI), non-frail high invasive (NFHI), and frail high invasive (FHI). HRQOLs at 1-year, 2-year, and 5-years were normalized against preoperative values. AUC was calculated across time points to generate an integrated health state score (IHS). Multivariable linear regression was used to compare IHS scores of FLI, NFHI, and FHI to NFLI while controlling for age, gender, comorbidity, and radiographic alignment.

Results
There were 633 eligible ASD patients and 339 had 5-year follow-up. Of those, 125 patients with complete HRQOL data at pre-operative, 1-year, 2-year, and 5-year visits were included. 27.2% (34) were NFLI, 20.0% (25) were FLI, 26.4% (33) were NFHI, and 26.4% (33) were FHI. Using NFLI as the referent, FLI and NFHI did not have differences in ODI, MCS, PCS, or SRS-22r IHS scores (P>0.05). On multivariable analysis of integrated health scores, FHI had higher MCS (7.6 vs. 5.47; P=0.0188), SRS Activity (6.97 vs. 5.67; P=0.0004), SRS Pain (8.49 vs. 6.4; P=0.001), SRS Appearance (8.97 vs. 6.81; P=0.0014), SRS Satisfaction (11.71 vs. 7.97; P=0.0033), and SRS Total (7.49 vs. 6.09; P=0.0002), indicating more improved recovery over a 5-year period. Patients who were FHI had higher rates of complications (P<0.05).

Conclusion
Despite having more complications, patients who were frail and underwent more invasive surgeries were more likely to have greater overall improvement

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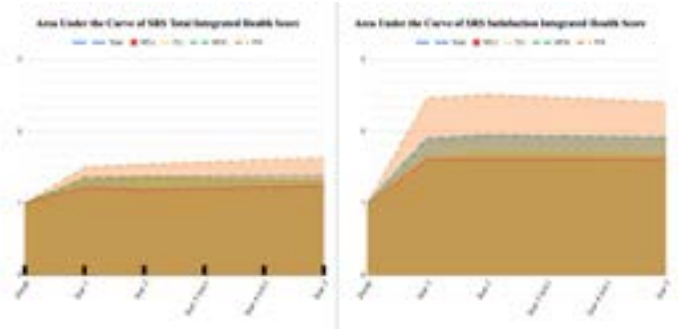
in activity, pain, and satisfaction over a 5-year period relative to preoperative baseline. Our results suggest that frailty in combination with invasiveness do not hinder long-term postoperative recovery kinetics, in comparison to frailty or invasiveness alone.



131. DETERMINING THE UTILITY OF 3-COLUMN OSTEOTOMIES IN REVISION SURGERY COMPARED TO PRIMARY SURGERIES IN THE FLEXIBLE THORACOLUMBAR SPINE

Peter G. Passias, MD; Tyler K. Williamson, MS, BS; Stephane Owusu-Sarpong, MD; Rachel Joujon-Roche, BS; Pooja Dave, BS; Peter Tretiakov, BS; Kimberly McFarland, BS; Jamshaid Mir, MD; Bailey Imbo, BA; Jordan Lebovic, MBA; Bassel G. Diebo, MD; Shaleen Vira, MD

Hypothesis
Despite higher complication rates, three-column osteotomies demonstrate tremendous global and segmental correction with generous clinical improvement across primary and revisions.

Design
Retrospective

Introduction
It would helpful to identify the presence and performance of the three column osteotomy(3CO) in adult spinal deformity(ASD) patients undergoing either revision or primary corrective surgery.

Methods
ASD patients with 2Y data. Groups: 3CO and non-3CO(remaining ASD cohort). For subanalysis, patients were stratified based upon undergoing primary(P3CO) or revision(R3CO) surgery. Non-3COs and 3COs were propensity score-matched(PSM) for baseline(BL) PI-LL and number of levels fused. Multivariate analysis controlling for age, CCI, BMI, and BL PI evaluated the complication rates, radiographic and patient-reported outcomes.

Results
436 patients included. 20% had 3CO. 3CO was performed in 16% of primaries(P3CO), 51% of revisions(R3CO). Both 3CO groups had greater severity in deformity and disability at baseline, but only revisions improved more than PSM-matched non-3COs. Despite greater segmental correction, 3COs had much lower rates of aligning in Lumbar Distribution Index(LDI), higher mechanical complications, and more reoperations when performed below L3. When comparing P3CO and R3CO, groups differed in baseline lumbopelvic and global alignment, as well as disability. R3CO group had greater clinical improvement and global correction(both p<.04), although P3CO achieved alignment in LDI more often(OR: 3.9,[1.3-6.2];p=.006). P3CO had more neurological complications(30% vs. 13%,p=.042), while R3CO was trended towards higher mechanical complications(25% vs. 15%,p=.2).

Conclusion
Primary and revision surgeries incorporating a three-column osteotomy showed greater improvement in realignment by two years compared to the use of other osteotomies. Primaries failed to demonstrate the same improvement as primaries without a 3CO. While three-column osteotomies offer similar utility for realignment across primary and revision surgeries, its use in revision ASD correction provides far greater clinical benefit.

Table 3. Focal and Overall Correction by Revision Status

Level	Intervention	# of pts	Segmental Correction	Relative Correction (SUR)	Overall Lordosis BL	Overall Lordosis 6W	Overall Lordosis Correction
L1	3CO Primary	1	34.2	72%	8.2	55.4	47.2
	3CO Rev	-	-	-	-	-	-
L2	3CO Primary	3	39.0	116%	37.3	64.9	33.9
	3CO Rev	7	16.2	35%	21.8	55.1	28.9
L3	3CO Primary	11	18.4	56%	29.2	60.4	32.8
	3CO Rev	25	22.5	62%	23.7	57.2	32.6
L4	3CO Primary	3	18.3	48%	16.3	54.7	38.4
	3CO Rev	17	23.4	71%	21.7	56.9	36.0
L5	3CO Primary	1	23.0	67%	19.0	53.3	34.3
	3CO Rev	3	7.0	33%	28.4	49.6	21.3
Total	3CO Primary	27	22.7	54%			31.5
	3CO Rev	61	21.7	56%			31.0

132. MECHANISMS OF LUMBAR SPINE "FLATTENING" IN ADULT SPINAL DEFORMITY: DEFINING CHANGES IN SHAPE THAT OCCUR RELATIVE TO A NORMATIVE POPULATION

Renaud Lafage, MS; Jonathan Elysee, MS; Themistocles S. Protopsaltis, MD; Peter G. Passias, MD; Han Jo

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Kim, MD; Alex Soroceanu, MPH; Breton G. Line, BS; Gregory M. Mundis Jr., MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; Eric O. Klineberg, MD; Munish C. Gupta, MD; Douglas C. Burton, MD; Lawrence G. Lenke, MD; Shay Bess, MD; Justin S. Smith, MD, PhD; Frank J. Schwab, MD; Virginie Lafage, PhD; International Spine Study Group

Hypothesis
The shape of the lumbar spine in ASD patients will deviate from its normative counterpart.

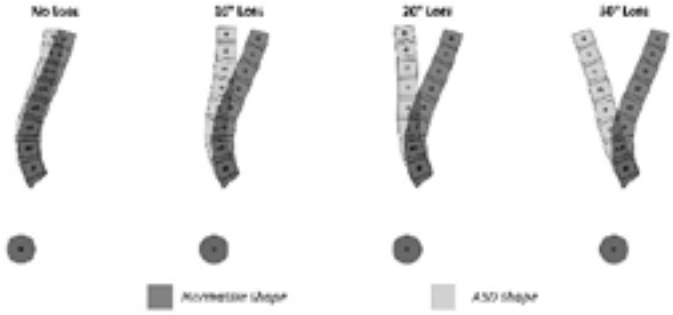
Design
Retrospective review of an ASD registry

Introduction
Previous work comparing ASD to normative population demonstrated that, contrary to general belief, a large proportion of the curvature is lost proximally (L1-L4). This study is a follow-up looking not only at regional angles but also at the spinal contour collectively.

Methods
119 asymptomatic volunteers with full-body free-standing radiographs were used to identify age-and-PI models of each Vertebra Pelvic Angle (VPA) from L5 to T10. These formulas were then applied to a cohort of primary surgical ASD patients without coronal malalignment (SRS-Schwab Type=N). Loss of lumbar lordosis was defined as the offset between age-and-PI normative value and pre-operative spino-pelvic alignment. Spine shapes, defined by VPAs, were compared and analyzed using paired t-test.

Results
"362 primary ASD patients were identified (age=64.4±13, 57.1% F). Preop alignment demonstrated a large variability with a mean PI-LL of 15°±21, distal LL=31°±15, and PI=55°±13. Compared to their age-and-PI normative values, ASD patients had a significant loss in lordosis of 17°±19 in following distribution: 14.1% had "no loss" (mean: 0.1±2.3), 22.9% with 10° loss (mean: 9.9±2.9), 22.1% with 20° loss (mean: 20.0±2.8), and 29.3% with 30° loss (mean:33.8±6.0). Comparison of the VPAs between each LL group and the normative shape demonstrated that the ""no Loss"" patients had a lumbar spine slightly anterior to the normative shape from L4 to T10 (VPA difference of 2°). The shape of the ""small deformity"" group (10°) superimposed with the normative one from L5 to L2 (VPA with p>0.1) and became anterior at the L1 level. As the loss in lordosis increased, the offset between ASD and normative shapes started to propagate to the distal levels and became significant extending caudally to L3 for the ""20° loss"" group and further down to L4 for the more severe group."

Conclusion
As the deformity progresses and the loss of lordosis increases, the difference between ASD shape and normative shape happens first proximally and then progresses incrementally caudally with increasing deformity. Understanding the spinal contour and the location of this loss may be key to achieving a sustainable correction by identifying optimal and personalized post-operative shape.



133. ARE COMPLICATIONS DIFFERENT BETWEEN UNSTAGED OPEN VS. UNSTAGED CIRCUMFERENTIAL MIS IN ADULT SPINAL DEFORMITY SURGERY?

Pierce D. Nunley, MD; Paul Park, MD; Peter G. Passias, MD; Richard G. Fessler, MD, PhD; Juan S. Uribe, MD; Jay D. Turner, MD; Vivian Le, MPH; *Robert K. Eastlack, MD*; Dean Chou, MD; Michael Y. Wang, MD; Adam S. Kanter, MD; David O. Okonkwo, MD, PhD; Neel Anand, MD; Gregory M. Mundis Jr., MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Praveen V. Mummaneni, MBA; International Spine Study Group

Hypothesis
Complication profile will favor CMIS vs OPEN.

Design
Retrospective Analysis of Propensity Matched Prospective Cohorts

Introduction
Circumferential Minimally Invasive Surgery (CMIS) for Adult Spinal deformity (ASD) has continued to evolve.

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There remains a paucity of data comparing CMIS vs OPEN techniques for ASD. We analyze two propensity matched prospectively collected data groups comparing single-day unstaged OPEN to single-day unstaged CMIS to discover differences in complication profile between the two groups.

Methods
58 single-day unstaged CMIS patients were propensity matched (SVA, LL-PI, BMI, PT) with 58 single-day unstaged OPEN patients. Min 2-yr follow-up.

Results
The mean age for OPEN was 63 yrs vs 69 yrs for CMIS patients. No differences in prior surgery, smoking, BMI, Charlston, frailty index or baseline PROMS between the groups except for NRS leg OPEN 3.62 vs CMIS 5.98. However, Max Cobb 40 vs 24.86 and CVA 37.0 vs 26.0 was greater for OPEN vs CMIS. All CMIS cases were Ant/Post procedures done in one day. 48 of the OPEN cases were A/P and 10 were posterior only-all were done in one day. Interbody levels fused were not different between CMIS and OPEN (2.59 vs 3.10) however posterior levels fused were greater in OPEN vs CMIS (11.1 vs 3.45). There were no differences in 2 yr postop CVA, Max Cobb, PI, or PT, however there were differences in OPEN vs CMIS for PI-LL, -1.49 vs 6.22 and SVA, 21.58 vs 43.69. 2-year PROMS revealed an improvement in CMIS over OPEN for ΔNRS leg -3.02 vs -0.65 and SRS-22 3.31 vs 3.68. There was a significant difference in the EBL(OPEN 1514cc vs CMIS 215cc) and LOS Days (OPEN 8.3 vs CMIS 4.2). CMIS significantly favored OPEN for Complications by event (30 vs 47), Major Comp(9 vs 18) and minor comp(12 vs 33) and Reops (8 vs 21).

Conclusion
Our cohort of Single-Day Unstaged OPEN vs Single-Day Unstaged CMIS patients reveals that CMIS outperforms OPEN for EBL, LOS, Complications (major and minor), and reoperations. There are differences in number of levels fused likely due to MIS group philosophy of minimizing fusion levels based on the MISDEF 2 algorithm. While it is important to continue to study the differences between these two approaches, this study provides evidence to support utilizing CMIS techniques in treating ASD.

134. AGE-ADJUSTED FRAILTY IS INDEPENDENTLY ASSOCIATED WITH AN INCREASE IN MEDICAL COMPLICATIONS BUT NOT REOPERATION AFTER 3-COLUMN OSTEOTOMY FOR SPINAL DEFORMITY

Christopher L. McDonald, MD; Rodrigo Saad-Berreta, MD; *Daniel Alsoof, MBBS*; George Anderson, BS; Michael Kutschke, MD; Bassel G. Diebo, MD; Eren Kuris, MD; Alan H. Daniels, MD

Hypothesis
Frail patients have increased complications and reoperations after 3-column osteotomies.

Design
Retrospective cohort study.

Introduction
3-column osteotomies (3-CO) are a powerful tool for spinal deformity correction. Complication rates for these procedures are high, and patient selection is paramount to appropriate implementation. While frailty has been accepted as a risk factor for complications after for adult spinal deformity surgery, it has incompletely understood how it affects 3-column osteotomy patients.

Methods
The PearlDiver Mariner database was utilized for CPT codes defining 3-CO between 2010-2020. All patients aged 18 and older were retained in the study with ICD codes used to identify frailty. Outcomes included reoperation rate, surgical complications, and medical complications. Bivariate analysis included chi squared tests and Welsh T test between frail and non-frail patients. Logistic regression was employed to account for potential confounding variables in the relationship between these two cohorts and complications. Frail and non-frail cohorts were matched in a 1:1 ratio for age range, sex, and region.

Results
A total of 1,460 patients with frailty and 1,411 patients without frailty undergoing 3-CO were included in the study. Frail patients were older and had more medical comorbidities ($p < 0.001$). In matched regression, there were no differences in reoperation rates at 30-days, 1-year, and 5-years ($p>0.05$ for all). In examination of surgical complications, frail patients were more likely to suffer bowel and bladder dysfunction at both 30-days (OR 1.98, $p = 0.014$) and 2-years (OR = 1.49, $p = 0.028$). This cohort was also more likely to become septic at 2-years (OR = 1.41, $p = 0.33$). In examination

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of medical complications, frail patients were more likely to have post-operative acute kidney injury (OR = 1.62, p = 0.018), cardiac complications at 30-days (OR = 1.83, p = 0.006) and 2-years (OR = 1.67, p < 0.001), deep vein thrombosis at 2-years (OR = 1.47, p = 0.027), and pneumonia (OR = 1.55, p = 0.039).

Conclusion
In age-matched patients undergoing 3-CO for adult spinal deformity, frail patients are more likely to suffer medical complications, but had similar overall costs and re-operation risks. Due to their comorbidities, less invasive deformity correction strategies can be considered to aid in risk reduction post-operatively.

135. RELATIONSHIP BETWEEN PELVIC INCIDENCE-BASED RELATIVE SPINOPELVIC PARAMETERS, GLOBAL SAGITTAL ALIGNMENT AND LOWER EXTREMITY COMPENSATIONS

Altug Yucekul, MD; Alp Ozpinar, MD; Duhan Kilickan; Mohamed Dalla; Nallammai Muthiah; Tais Zulemyan, MSc; Yasemin Yavuz, PhD; Javier Pizones, MD, PhD; Ibrahim Obeid, MD; Frank Kleinstuck, MD; Francisco Javier S. Perez-Grueso, MD; Ferran Pellisé, MD, PhD; Caglar Yilgor, MD; Ahmet Alanay, MD; European Spine Study Group

Hypothesis
Pelvic incidence-adjusted relative spinopelvic parameters significantly correlate to measurements of the lower extremity compensation

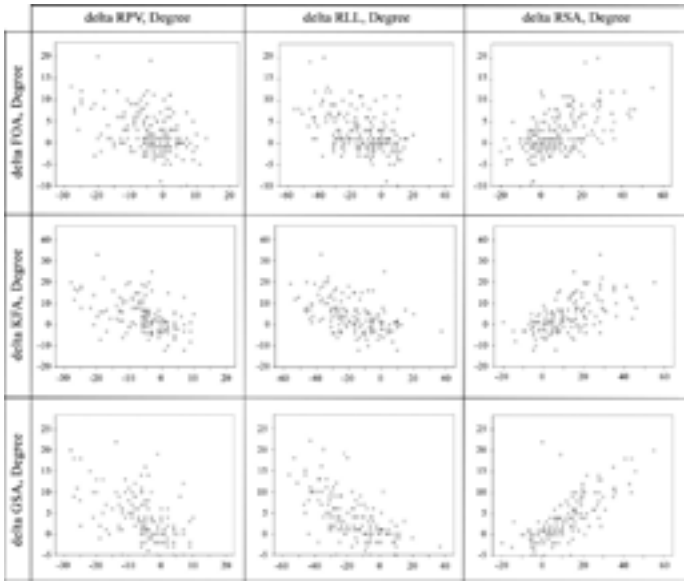
Design
Retrospective analysis of prospectively collected data

Introduction
In response to sagittal malalignment, compensatory spinal and lower extremity mechanisms are recruited. Thoracolumbar realignment surgery has been shown to yield reciprocal changes in these compensations. Thus, whole-body radiographic assessment has come to the fore. This study aimed to evaluate the relationship between spinopelvic parameters and lower extremity compensation angles, and to examine their coupled change with deformity correction.

Methods
This was a multicenter retrospective analysis of patients who had ≥4 levels posterior fusion, whole-body radiographs, and ≥2 years follow-up. Relative Pelvic Version (RPV), Relative Lumbar Lordosis (RLL), Relative Spinopelvic Alignment (RSA), Femoral Obliquity Angle (FOA), Knee Flexion Angle (KFA) and Global Sagittal Axis (GSA) were measured preoperatively and at 6th week postoperative scans. Kruskal-Wallis tests were performed to assess the preoperative relation of relative spinopelvic parameters to global sagittal alignment and lower extremity compensation angles. Spearman's correlations were performed to assess correlations of preoperative to postoperative radiographic changes.

Results
193 patients (156F, 37M) were included. The mean age was 57.2±16.6 years. The mean follow-up duration was 50.6 (24-90) months. A mean of 10.3±3.8 levels were fused. Among the cohort, 124 (64.2%) had a sacral or sacroiliac fixation, 63 (32.6%) had posterior-column osteotomies and 43 (22.3%) had 3-column osteotomies. Preoperative FOA, KFA and GSA were found to be statistically different between different RPV, RLL and RSA categories (p <0.05 for all analyses). Significant weak-to-strong correlations were observed between PI-adjusted spinopelvic parameters, global sagittal alignment and lower extremity compensation angles (rho range: -0,351 to 0,767).

Conclusion
PI-adjusted relative spinopelvic parameters that form the GAP score significantly correlate to measurements of the lower extremity compensation. Preoperative to postoperative changes in RPV, RLL and RSA reflected changes in FOA, KFA and GSA. This information may serve as a valuable proxy for surgical planning when whole-body imaging is not available.



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136. HIGH COMPLICATION RATES IN THE SURGICAL STRAIGHTENING OF PARKINSON'S PATIENTS WITH SEVERE SPINAL IMBALANCE

Stefan Krebs, MD; Thomas Pfandlsteiner, MD; Moritz Brielmaier, MD

Hypothesis
Adult deformity correction in patients with Parkinson´s disease is associated with high complication rates.

Design
Single center retrospective cohort study

Introduction
Patients with Parkinson´s disease often suffer from spinal deformity. To treat these patients is challenging. This study shows the different types of complications and revision surgery rates.

Methods
40 patients with Parkinson's disease and severe spinal deformity/imbalance underwent long-term surgical correction. 25 women, 15 men, Ø 71 years. "FU" Ø 34 months (6-108). 34 patients with severe deformity and imbalance, 6 patients post-traumatic kyphosis. SPO was performed in all patients. Anterior release in 20 patients, PSO in 15 patients or combination. Ø 2.7 operations per patient, Ø 14.8 segments. Dropped-head-sign: 1/3, camptocormia: 1/3, Pisa syndrome: 75%, osteoporosis: 100%.

Results
Average correction of sagittal deformity 71% and sagittal balance 76%. FU: 36 out of 40 patients very satisfied. Visual analog scale preoperatively 8.2, Ø FU 3.8, Ø scoliosis correction exit 68° (50-85°), postop. 26° (10-29°), complications: 1 psychotic derailment. Lengthening cranially with dropped-head-sign and implant avulsion in 6 patients. Residual imbalance frontal and sagittal with reoperation in 5 patients. 3 lumbosacral decompensations with revision. PJK without subsequent surgery in 3 patients. Deep wound infection, implant failure, multiple revisions resulting in death in 1 patient. Hemorrhage in marcumarization 3 months postop. 1 patient.

Conclusion
The surgical treatment of spinal deformities in Parkinson's patients is complex and risky, and even with primarily long-term care, follow-up operations are often necessary. Considering the progression without surgery and the overall good surgical results, however, there is a clearly positive risk-benefit ratio.

137. IS SEXUAL DYSFUNCTION AN ISSUE AFTER UNDERGOING A C2-SACRUM POSTERIOR SPINAL FUSION?

Justin Mathew, MD; Joseph M. Lombardi, MD; Hannah Lin, BS; Nathan J. Lee, MD; Venkat Boddapati, MD; Zeeshan M. Sardar, MD; Lawrence G. Lenke, MD; Ronald A. Lehman, MD

Hypothesis
Patients who have undergone C2-sacrum PSF experience postoperative sexual dysfunction.

Design
Consecutive case series of open posterior spinal instrumented fusion from C2-sacrum.

Introduction
Patient who have undergone C2-sacrum posterior spinal fusion (PSF) comprise a poorly studied population. Limitations in sexual function are unreported in the literature among those with any major spinal reconstruction. While many of these patients resume hobbies and activities, they will often query surgeons preoperatively about their postoperative sexual function. The ability to adequately counsel this patient population is hampered by the dearth of literature on this subject.

Methods
25 patients who had undergone C2-sacrum PSF at a single institution were contacted by email and telephone. A standardized, validated questionnaire (ASEX) was administered, as well as specific questions addressing arousal, physical limitations during sex, and sexual satisfaction. Responses were assigned numerical values and assessed using descriptive statistics and student's t test. Sexual dysfunction was defined as an ASEX score >19.

Results
Of 25 patients who had undergone C2-sacrum PSF, 52% (13/25) responded. 40% (10/25) were able to complete to the questionnaire. 8% (2/25) had never had sex (before or after surgery) and were excluded. 4% (1/25) had an underlying medical condition and felt unable to answer the questionnaire. The average follow up time was 3.1 ±1.1years. Over 90% of respondents had more than two years follow up since their C2-sacrum PSF. Of those who responded, 40% (4/10) experience sexual dysfunction as defined by

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ASEX >19. Though the ASEX questionnaire generally addresses arousal, the responses did not differ significantly from the responses to our tailored questions (p=0.165). Of the patients who reported being in the upper quartile of difficulty with physical limitations (discomfort, muscle tightness, or motion restriction), only one had sexual dysfunction. 90% of the respondents report return to sexual activity following C2-sacrum PSF.

Conclusion
This is the first study to evaluate sexual dysfunction after a C2-sacrum fusion. Interestingly, 90% of those who underwent C2-sacrum PSF report a return to sexual activity, with only 40% demonstrating sexual dysfunction.

140. PERIOPERATIVE OUTCOMES AND COST EFFECTIVENESS OF SINGLE POSITION ROBOTIC ADULT SPINAL DEFORMITY SURGERY

Peter G. Passias, MD; Pooja Dave, BS; Peter Tretiakov, BS; Jamshaid Mir, MD; Kimberly McFarland, BS; Jordan Lebovic, MBA; Stephane Owusu-Sarpong, MD

Hypothesis
To assess cost utility and perioperative complications of robotic-assistance in thoracolumbar spine surgery.

Design
retrospective analysis of prospective single center database.

Introduction
Spine surgery has technological advancements including the incorporation of robotic assistance and navigation. Given the relative novelty and increasing prevalence of robotic-assistance, there is a paucity of literature examining clinical, operative, and cost outcomes in patients undergoing thoracolumbar spine surgery utilizing robotic assisted intraoperative navigation and screw placement.

Methods
Inclusion criteria were operative ASD patients (coronal Cobb angle≥20°, SVA≥50mm, PT≥25°, and/or thoracic kyphosis>60°) >18yrs with complete baseline (BL) and 2-year (2Y) data. Patients were grouped by utilization of robotic assistance: Robotic vs. Non-Robotic. ANCOVA and logistic regressions were utilized to assess differences in outcomes, including complications, reoperations, and HQRLs, while accounting for covariates as appropriate. Cost data was based on average Medicare reimbursement by DRG. Utility was calculated using ODI converted to SF-6D. Utility was then used to assess QALYs gained and cost/QALY within the 90d perioperative period.

Results
222 included (63% Robotic vs. 37% Non-Robotic). Cohort mean baseline SVA was 15.45±34.40mm, PI-LL 1.41±12.17°, and PT 16.24±8.80°. Robotic patients had significantly lower CCI vs. Non-Robotic patients (2.67±1.58 vs. 1.80±1.26, p<.001). There were no differences in BL age, gender, BMI, or BL deformity between groups (Table 1). Surgically, MVA Found Robotic patients had significantly lower EBL (p=.033) and lower rates of overall complications (21.4% vs. 37.9%, p=.016), reoperations (2.90% vs. 19.0%, p <.005), and readmissions (2.1% vs. 8.6%, p=.035). Mean utility gained at 90d was 0.101 for Non-Robotic patients vs. 0.132 for Robotic and mean QALYs gained at 90d was 0.885 for Non-Robotic patients vs. 0.915 for Robotic. Mean cost at 90d was $51,120 for Non-Robotic vs. $47,189 for Robotic patients, mean cost/QALY at 90d of $260,647 for Non-Robotic vs. $183,858 Robotic.

Conclusion
Robotic patients demonstrated lower rates of readmissions and reoperations than non-robotic counterparts. These outcomes suggest that use of robotic assistance in thoracolumbar spine surgery has the potential to minimize patient complications in the perioperative period and improve cost effectiveness.

141. HOW GOOD ARE SURGEONS AT ACHIEVING THEIR GOAL SAGITTAL ALIGNMENT FOLLOWING ADULT DEFORMITY SURGERY?

Justin S. Smith, MD, PhD; Elias Elias, MD, MS; Breton G. Line, BS; Virginie Lafage, PhD; Renaud Lafage, MS; Eric O. Klineberg, MD; Han Jo Kim, MD; Peter G. Passias, MD; Jeffrey L. Gum, MD; Khaled M. Kebaish, MD; Robert K. Eastlack, MD; Alan H. Daniels, MD; Gregory M. Mundis Jr., MD; Richard Hostin, MD; Themistocles S. Protopsaltis, MD; D. Kojo Hamilton, FAANS; Michael P. Kelly, MD; Munish C. Gupta, MD; Frank J. Schwab, MD; Douglas C. Burton, MD; Christopher P. Ames, MD; Lawrence G. Lenke, MD; Christopher I. Shaffrey, MD; Shay Bess, MD; International Spine Study Group

Hypothesis
Preop goals for sagittal alignment following adult spinal deformity (ASD) surgery will not be consistently achieved.

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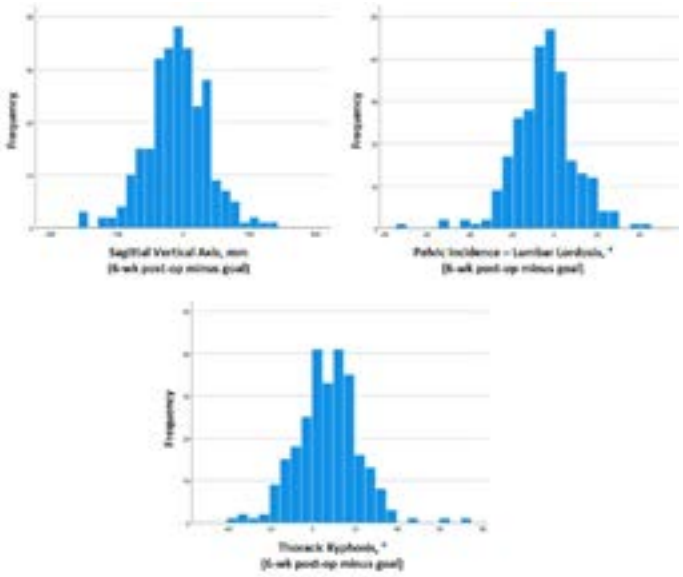
Design
Multicenter, prospective cohort

Introduction
Malalignment following ASD surgery can impact outcomes and increase mechanical complications. Despite improved definition of ideal alignment for ASD surgery and preop alignment planning tools, it remains unclear whether preop goals for alignment are achieved with surgery.

Methods
ASD patients were enrolled based on 3 criteria: deformity severity (PI-LL>25°, TPA>30°, SVA>15cm, TCobb>70° or TLCobb>50°), procedure complexity (>12 levels fused, 3CO or ACR) and/or age (>65 and >7 levels fused). The surgeon documented sagittal alignment goals prior to surgery. Goals were compared with achieved alignment (6 wks) and overall mean and SD were calculated for the offset (achieved minus goal) for each measure. Goal alignment was considered attained if the offset was within +/-1 SD of the goal. Regression analysis was performed using demographic, surgical, and baseline radiographic measures.

Results
The 266 enrolled patients had a mean age of 61 yrs (SD=15 yrs) and 68% were women. Mean instrumented levels was 14 (SD=4) and 24% had a 3CO. Mean (SD) offsets were: SVA=-8.5 mm (45.6 mm), PI-LL=-4.6° (14.6°), TK=7.2° (14.7°), reflecting tendencies to undercorrect SVA and PI-LL and increase TK (Figure). Goals were achieved for SVA, PI-LL, and TK in 74%, 71%, and 69% of cases, respectively. On regression analysis: goal SVA was more likely to be achieved with lower baseline SVA (OR=0.993, 95%CI=0.988-0.997, p=0.001) and greater baseline TK (OR=1.016, 95%CI=1.002-1.031, p=0.029); goal PI-LL was more likely to be achieved with greater patient age (OR=1.021, 95%CI=1.002-1.039, p=0.026) and previous TL spine surgery (OR=2.028, 95% CI=1.136-3.621, p=0.017); and goal TK was more likely to be achieved with lower baseline SVA (OR=0.995, 95%CI=0.991-0.999; p=0.014). Notably, patient-specific rods were used in 21 patients and were not associated with greater achievement of goal alignment for any parameter (p>0.8).

Conclusion
Surgeons failed to achieve goal alignment of each sagittal parameter in ~25% of ASD pts, with tendencies to undercorrect SVA and PI-LL and increase TK. Patients at greatest risk were those with more severe deformity. Further advancements are needed to enable more consistent translation of preop alignment goals to the operating room.



142. THE EFFECT OF PREOPERATIVE REHABILITATION ON ADULT SPINAL DEFORMITY PATIENT OUTCOMES

Peter G. Passias, MD; Bailey Imbo, BA; Kimberly McFarland, BS; Jamshaid Mir, MD; Peter Tretiakov, BS; Pooja Dave, BS; Rachel Joujon-Roche, BS; Oscar Krol, BS; Bassel G. Diebo, MD; Shaleen Vira, MD; Carl B. Paulino, MD; Themistocles S. Protopsaltis, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Jeffrey L. Gum, MD; Rafael De la Garza Ramos, MD; Andrew J. Schoenfeld, MD; Kevin Moattari, BS; Tomi Lanre-Amos, MD

Hypothesis
Identify if preoperative rehabilitation influences patient outcomes following adult spinal deformity (ASD) spine surgery

Design
Retrospective

Introduction
Preoperative rehabilitation programs have recently been implemented to prepare ASD patients for surgery and to promote patient health. The purpose of this study was to identify the effect of preoperative rehabilitation on surgical ASD patient outcomes.

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Methods
ASD patients with baseline (BL) and two-year (2Y) follow-up were included if they had preoperative rehabilitation data. Patients were divided into 2 groups: those who had preoperative rehabilitation [Prehab] and those who did not [no Prehab]. Prehab consisted of physical and mental components. Physical therapy for 3 months, 3 days a week for core, paraspinal and leg strengthening, with a review of post-op protocols to do at home, including gait and balance training. Patients were also referred for cognitive behavioral therapy for 2 weeks to prepare for the stress of surgery. Patients were excluded if they presented with any of the following at BL: severe neurological deficit (< 3/5), minimal ambulation, or current depression/anxiety. Means comparison tests and regression analysis controlling for age, CCI, ASA grade, and invasiveness assessed differences between patient groups.

Results
183 patients met inclusion criteria (52 Prehab, 131 no Prehab). The cohort was 50% female, mean age of 58.8 yrs and 6.9 levels fused and 159 (87.0%) undergoing an osteotomy. There was a significant difference in LOS for patients who had (3.9 days) and didn't have (6.2 days) Prehab, p<.05. Multivariate regression showed that Prehab was an independent predictor of a shorter LOS (OR .756 [CI .600-.954], p=.018). By 2Y, Prehab patients had lower rates of readmissions (7.7% vs 16.0%) than no Prehab patients, but not significantly different. Controlling for BL, Prehab patients were more likely to report better ODI scores than no Prehab patients at 2Y (OR .960 [CI .926-.996], p=.028).

Conclusion
Preoperative rehabilitation appears to be independently associated with a shorter length of stay compared following adult spinal deformity-corrective surgery. Patients who had preoperative rehabilitation also had better reported clinical outcomes by two-years postoperatively.

143. THE RISK OF PROXIMAL JUNCTIONAL KYPHOSIS INCREASES WITH GREATER PREOPERATIVE THORACIC KYPHOSIS IN THE ELDERLY PATIENT

Tina Raman, MD; *Themistocles S. Protopsaltis, MD*

Hypothesis
Radiographic risk factors for proximal junctional kyphosis may be identified preoperatively in elderly patients.

Design
Retrospective review of prospectively collected single center database.

Introduction
Despite improvements in spinal deformity techniques, proximal junctional kyphosis continues to pose a challenge. To date, there are few ASD studies evaluating radiographic risk factors for PJK in the elderly patient, who may have significant higher baseline thoracic kyphosis and lower capacity for thoracic compensation.

Methods
A total of 155 patients > 70 years of age who were followed for more than two years and underwent ASD surgery were included (Age: 75 ± 4 y; mFI: .84 ± .76; Levels fused: 9.3 ± 5.1). Patients were divided into PJK and non-PJK groups based on accepted radiographic criteria using whole spine standing radiographs.

Results
The cohort had sagittal malalignment as demonstrated by PT 32.2 ± 10.2°, PI–LL 27.4 ± 20.0°, TPA 38.4 ± 12.3°, and SVA 127.7 ± 69.6 mm. Mean PI for the cohort was 56.3 ± 13.5°, mean TK was 33.5 ± 17.8°, mean expected TK was 35.9 ± 14.4°, and mean thoracic compensation was 2.3 ± 21.9°. The PJK and non-PJK groups comprised 82 and 73 cases respectively. No differences were seen in the incidence of PJK with preoperative thoracic kyphosis < 20° (21%), 20-30° (34%), or 30-40° (48%), however a significantly higher rate was seen with a preoperative TK ≥40° (63%) (p<0.05). There was no significant difference in thoracic compensation between patients who developed PJK (1.6 ± 20.1°), and those who did not (3.1 ± 20.4°). The amount of change in TK before and just after surgery was significantly associated with PJK (PJK: 20.5 ± 21.9°, no PJK: 4.4 ± 30°, p<0.0001). and was a significant risk factor for PJK by regression analysis (OR 1.064, p <.0001).

Conclusion
Elderly patients (> 70 years) have a low level of thoracic compensation and those with preoperative kyphosis > 40° are at higher risk for development of PJK. Greater change in thoracic kyphosis before and just after surgery was a significant predictor of PJK.

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144. TREATMENT OF THE FRACTIONAL CURVE WITH INTERBODY FUSION L4-S1 VERSUS POSTERIOR FUSION ALONE: IMPACT ON SURGICAL OUTCOMES AND COMPLICATIONS

Tina Raman, MD; *Themistocles S. Protopsaltis, MD*

Hypothesis
Interbody fusion at L4-L5 and L5-S1 may lead to improved fractional curve correction, compared to posterior fusion alone.

Design
Retrospective review of prospectively collected single center database.

Introduction
There is a paucity of data evaluating the ideal strategy to correct the lumbosacral fractional curve. We sought to evaluate the impact of interbody fusion at L4-L5 and/or L5-S1 compared with posterior fusion alone on fractional curve correction, and rate of instrumentation related complications at the lumbosacral junction.

Methods
592 ASD patients (Age: 48 ± 23y; mFI: .4 ± .7; Levels: 10.3 ± 4.1), lumbosacral fractional curve > 10°, mean follow-up 39.5 months, were divided into 2 groups: PSF alone (PSF, n=382), and interbody fusion L4-S1(IBF, n=210; ALIF: 31, TLIF: 179). Outcomes evaluated were fractional curve and overall deformity correction .

Results
There was significantly greater EBL (2.3 vs. 1.3 L, p<0.0001), intraoperative pRBCs transfused (2.3 vs. 1.3 U, p<0.001), and longer operative time (7.1 vs. 6.3 hours, p<0.0001) in the IBF group compared with PSF. Both groups had similar magnitude of fractional curve correction (7.0 ± 7.1° IBF vs. 6.3 ± 6.9° PSF, p=0.26) and final coronal alignment (23.5 mm IBF vs. 19.8 mm IBF, p=0.08). Patients in the IBF group had a higher magnitude of SVA change (−30.6 mm vs. -19.5 mm, p<0.05) and increase in lumbar lordosis (11.5° vs 5.6°, p<0.001). There was no difference in the rate of revision surgery at minimum two year follow up for rod fracture, pseudarthrosis, or any instrumentation related complication. Sub-analysis demonstrated that there were no significant differences in magnitude of fractional curve correction, or improvement in lumbar lordosis, coronal, or sagittal alignment in the ALIF group compared to the TLIF group. There was no significant impact of number of levels at which a lumbar interbody fusion was performed on degree of fractional curve correction.

Conclusion
At minimum 2 year follow up, patients had comparable fractional curve and coronal alignment correction when treated with interbody fusion at L4-S1 versus posterior fusion alone. There was no different in rod fracture and pseudarthrosis rates at two year follow up. These data suggest that utilization of interbody technique at the lumbosacral junction is not clearly superior to posterior fusion alone for treatment of the fractional curve.

145. DIFFERENCES IN THE RATE OF DISTAL JUNCTIONAL PATHOLOGY BETWEEN L3 AND L4 PSO: MINIMUM ONE YEAR FOLLOW-UP FOR 117 PATIENTS

Vardhaan Ambati, MD; Saman Shabani, MD; Timothy Chryssikos, MD, PhD; Alma Rechev Ben Natan, BA; Jeremy Huang, BS; Alysha Jamieson, BS; *Mohamed Macki, MD*; Nitin Agarwal, MD; Michael Tawil, BS; Jeremy Guinn, BS; Hao-Hua Wu, MD; Minghao Wang, MD, PhD; Pingguo Duan, MD; Joshua Rivera, BS; Parishkrita Srivastava; Shane Burch, MD; Sigurd H. Berven, MD; Praveen V. Mummaneni, MBA; Dean Chou, MD; Lee A. Tan, MD

Hypothesis
We hypothesized that L4 PSO results in lower rates of distal junctional pathology compared to L3 PSO by achieving a physiological distribution of lumbar lordosis.

Design
Retrospective cohort study.

Introduction
Pedicle subtraction osteotomy (PSO) is a powerful technique for surgical correction of sagittal imbalance. Comparative radiographic outcomes and rates of distal junctional pathology between PSO at L3 versus L4 are under-reported.

Methods
A retrospective cohort study comparing patients that underwent either L3 or L4 PSO between 2005 and 2021 with at least 1-year radiographic follow-up was performed. Distal junctional pathology was defined as hardware failure or pseudarthrosis at or distal to the PSO level. Univariate and multivariate analyses were performed.

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Results
A total of 117 patients met inclusion criteria; 87 (73.2%) patients underwent L3 PSO, and 30 (26.8%) underwent L4 PSO. Mean imaging follow-up length was 4.1 years (1.0-10.9 years). There were no significant differences in age, sex, BMI, operation time, and estimated blood loss between cohorts. Preoperatively, there were no significant differences in sacral Hounsfield units or spinopelvic parameters, except L3 versus L4 PSO cohort had lower pelvic incidence (51.0±11.1 vs. 57.8±14.1, p=0.011). Postoperatively, there were no differences in primary rod diameter and metallic type, number of dual versus multi-rod constructs, graft materials, postoperative L5-S1 fusion, and PI-LL mismatch. The L4 cohort had larger postoperative L4-S1 segmental lordosis (37.2±13.3 vs. 21.4±11.3 vs., p<0.001) and fewer patients with low lordosis distribution index (LDI) (20.0% vs 58.6%, p<0.001) compared to the L3 cohort. The L4 versus L3 PSO cohort experienced lower rates of distal junctional pathology (16.7% vs. 49.4%, p=0.002), including hardware failure (42.5% vs. 16.7%, p=0.011) and pseudarthrosis (35.6% vs. 6.7%, p=0.002). Multivariate analysis confirmed that L4 PSO results in a 26% reduced risk of developing distal junctional pathology (OR 0.74, CI: 0.57 - 0.95).

Conclusion
L4 PSO had a lower rate of distal junctional pathology compared with L3 PSO. This could be related to more physiological distribution of lumbar lordosis by performing PSO at L4.

146. WHEN IS STAGING THE BETTER CHOICE?: IDENTIFYING SUBSETS OF ADULT SPINAL DEFORMITY PATIENT WHO BENEFIT FROM STAGED SURGERY

Peter Tretiakov, BS; Pooja Dave, BS; Kimberly McFarland, BS; Jamshaid Mir, MD; Tomi Lanre-Amos, MD; Bassel G. Diebo, MD; Shaleen Vira, MD; *Peter G. Passias, MD*

Hypothesis
Patients with greater degrees of comorbidities or frailty, as well as increased age and surgical invasiveness may demonstrate superior outcomes with decreased complications when undergoing staged procedures versus same-day procedures.

Design
Retrospective

Introduction
There remains a paucity in the literature assessing which patient and surgical variables are predictive of optimal outcome in staged versus same-day procedures, as well as indicators to determine when staging ASD surgery is appropriate.

Methods
ASD patients were stratified based on whether their surgeon chose to perform single-stage or multistage surgery. Means comparison assessed differences between 4 groups: Staged-Optimal/Suboptimal (Staged-O/S) and Same Day-Optimal (SameDay-O/S). Logistic regression and CIT identified thresholds correlating to optimal outcome, defined as >2 of the following: 1) no 90-day reoperation or revision 2) achievement of MCID in ODI 3) no mechanical complication, and 4) no major intraoperative complications by 6W.

Results
902 patients (63.0yrs, 64% F) were isolated. For SameDay-O patients, regression analysis revealed significant factors to be: age < 76.53 years, being classified as Not Frail by mASD-FI, BMI < 30.22 kg/m2, no history of drug/alcohol abuse, no history of renal disease, total levels fused < 9, and no planned VCR or corpectomy (model p <.006). In contrast, for Staged-O patients, significant factors were: age < 83.53 years, being classified as Not Frail or Frail by mASD-FI, BMI < 37.22 kg/m2, history of neurological deficits, history of arthritis, total levels fused < 11, and a UIV below C7 (model p=.002). For SameDay-S patients, factors associated with failure of meeting optimal outcomes were: age > 77.40 years, being classified as Frail or Severely Frail by mASD-FI, and blood loss of > 2010.72 mL. For Staged-S patients, however, only age > 85.60 years and operative time (total) > 540 min was associated with poor outcomes overall (all p<.05).

Conclusion
Though the majority of patients may be equally likely to see optimal results post-operatively regardless of staged/not-staged status, older patients with greater degrees of comorbidities and increased planned surgical invasiveness demonstrate superior outcomes with decreased risk of complications when undergoing staged procedures.

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148. NOVEL ATTACHABLE MAGNETIC NERVE STIMULATING PROBE IN INTRAOPERATIVE LUMBAR PEDICLE SCREW PLACEMENT: A PORCINE MODEL STUDY

Dong Suk Kim, MD; Minjun Choi, MD; Won Chul Shin, MD, PhD; *Jung Sub Lee, MD, PhD*; Tae Sik Goh, MD, PhD

Hypothesis
We aimed to investigate the efficacy of a novel probe for intraoperative neuromonitoring (ION) during lumbar pedicle screw placement in a porcine model.

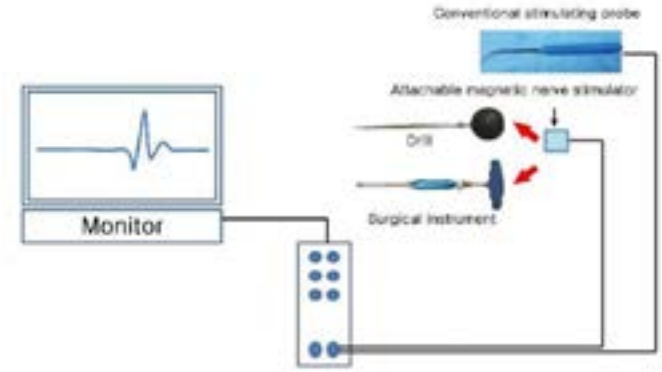
Design
Experimental Comparative Study

Introduction
Pedicle screw instrumentation is a fundamental technique in lumbar spine surgery. However, several complications could occur when placing a pedicle screw, the most serious being damage to the neural structures.

Methods
We developed an attachable nerve-stimulating probe for triggered electromyography (t-EMG) to avoid these. Forty pedicle screws were inserted bilaterally into the pedicles of the fourth and fifth lumbar vertebrae of five pigs; 20 were inserted typically into the pedicle without nerve damage (Group A), and the other 20 were inserted through the broken medial wall of the pedicle to permit contact with the neural structures (Group B). We measured the triggered threshold for pedicle screw placement through the conventional nerve probe and our newly developed magnetic probe.

Results
The triggered threshold obtained from the usually inserted pedicle screws (Group A) showed no statistical difference between the conventional probe and the magnetic stimulating probe ($p = 0.702$). Similarly, there was no significant difference between the two groups from the experiment on Group B assuming neural injury during lumbar pedicle screw placement ($p = 0.816$). Therefore, there was no difference in the triggered threshold between the two groups in the overall pedicle screw stimulation, including Groups A and B ($p = 0.828$). In addition, there were no differences between the two groups in the subgroup analysis based on the pedicle level and laterality. No complications or unexpected events were observed during the experiment using a magnetic stimulating probe, and the results were comparable to those obtained using a conventional stimulating probe.

Conclusion
Our newly developed magnetic stimulating probe can be attached to a screwdriver, thus preventing real-time screw malpositioning and making it practical and equally safe. This probe could become indispensable in revision spine surgeries with severe adhesions or endoscopic spine surgeries.



Schematic diagram comparing conventional probe and novel magnetic probe

149. BIOMECHANICAL ADVANTAGES OF DUET SCREWS PLUS BILATERAL SATELLITE RODS FIXATION FOR ADULT SPINAL DEFORMITY WITH LONG FUSION TO PELVIS USING S2-ALAR-ILIAC (S2AI) SCREWS

Zhong He, MD; Xiaodong Qin, PhD; Zhen Liu, PhD; Benlong Shi, MD, PhD; Yong Qiu, PhD; *Zezhang Zhu, PhD*

Hypothesis
The satellite could disperse the strain on each rod at PSO level and sacrum without sacrificing the motion of the spine.

Design
Randomized controlled trial.

Introduction
The current study aims to investigate the effect of satellite rods with duet screws usage on motion and primary rod strain in a cadaveric model underwent pedicle subtraction osteotomy (PSO) at L3 and long fusion to pelvis with S2-alar-iliac (S2AI) screws.

Methods
Six human cadaveric spine segments (T11-S2) underwent PSO at L3 with posterior fixation from

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L1-S2 using S2AI screws, and the satellite rods (L2-L4) are connected with primary rods using duet screws. Three constructs with two (group A), three (group B), and four (group C) rods were performed, and group B was divided into single rod side (group B-S) and double rods side (group B-D). In vitro motion tests were performed under pure moments in lateral bending (LB), flexion/extension (FE), and axial rotation (AR) to determine the range of motion. The primary rod strain was measured at L3 and S2. Comparison of spinal motion and rod strain among the 3 groups was compared using two-way ANOVA.

Results
All constructs significantly reduced LB, FE, and AR motion compared to the intact condition ($P<0.001$ for all). There was no significant difference of motion in the totality or at the upper lumbar segments (L1-L3) among the three groups, while a few differences of motion at the lower lumbar (L4 and L5) and the sacrum ($P<0.007$ for all). The rod strain significantly decreased with increasing satellite rod numbers ($P<0.004$ for all) and the rod strain in group B-D were significantly lower compared to group B-S ($P<0.042$ for all), indicating satellite rods with duet screws were highly effective in minimizing primary rod strains at L3. According to the same trend, the satellite rods could also decrease the primary rod strain at the sacrum.

Conclusion
This study supports the current clinical practice, providing strong biomechanical evidence to recommend the four-rod constructs using satellite rods with duet screws in patients who underwent PSO at L3 and long fusion to the pelvis with S2AI screws. The satellite could disperse the strain on each rod to reduce the incidence of pseudarthrosis and rod breakage at PSO level and sacrum, without sacrificing the motion of the spine.

150. DEVELOPMENT AND VALIDATION OF A SURGICAL DRILL WITH A HAPTIC INTERFACE IN SPINE SURGERY

Kento Yamanouchi, MD; Shunya Takano, MS; Yuichiro Mima, MD, PhD; Takuya Matsunaga, PhD; Kouhei Ohnishi, PhD; Morio Matsumoto, MD, PhD; Masaya Nakamura, MD, PhD; Tomoyuki Shimono, PhD; Mitsuru Yagi, MD, PhD; Go Ikeda,

Hypothesis
We hypothesized that a prototype high-speed drill with a haptic interface could detect the penetration of the porcine posterior lamina more accurately and more reproducibly than experienced spine surgeons could recognize.

Design
Experimental animal study

Introduction
Real haptics is a technology that reproduces the sense of force and touch by transmitting contact information with real objects by converting human movements and the feel of objects into data. In recent years, real haptics technology could be installed in several surgical devices. Spine surgery involves drilling the bone near the spinal nerves and vascular organs. This is an extremely demanding procedure because it involves manipulation of hard tissue in the vicinity of highly vulnerable soft tissue. As a result, intraoperative complications occur at a certain rate in spine surgery. In this study, the safety, efficacy, and reproducibility of the previously described prototype high-speed drill with a haptic interface were evaluated using a porcine spine, which is histologically similar to the human bone structure.

Methods
A custom-made surgical drill was used to drill into the posterior lamina to verify the time required for penetration detection and the distance the drill advanced after penetration. Three board certified spine surgeon operated the drill, and the same aspects were measured and verified. All experiments were performed on female miniature pigs at 9 months of age with a mean body weight of 23.6 kg (range 9-10 months and 22.5-25.8 kg, n = 12).

Results
There were more than 10 fold improvement in the average reaction time and the distance travelled after penetration when using haptic drill with the penetration detection function comparing to conventional handheld drill (0.17 +/- 0.04s & 2.98±1.24mm vs. 0.015 ± 0.001s & 0.12±0.096mm, $p<0.001$, respectively). The reaction time to detect penetration and the distance after penetration were both significantly improved when compared with those of the handheld surgical drill without the penetration detection function, with mean differences of 0.049 ± 0.019 s [95% CI: 0.012, 0.086 s] and 2.511 ± 0.537 mm [95% CI: 1.505, 3.516 mm].

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Conclusion
In this study, we successfully conducted a performance evaluation test of a custom-made haptic interface surgical drill. A prototype high-speed drill with a haptic interface successfully detected the penetration of the porcine posterior lamina more accurately.

152. NUMBER OF RODS (4-, 5-, AND 6-) ACROSS A LUMBAR PSO: IS MORE BETTER?

Niloufar Shekouhi, BS; Ardalan Seyed Vosoughi, PhD; Vijay K. K. Goel, PhD; *Alekos A. Theologis, MD*

Hypothesis
Range of motion (ROM) and rod stresses across a lumbar PSO are decreased with increasing number of rods.

Design
Finite element analysis.

Introduction
Multi-rod configurations to stabilize PSOs can be created using "satellite" rods (not connected to primary rod) and/or "accessory" rods (connected to primary rod). This study aimed to assess biomechanics of "super" multi-rod constructs consisting of satellite and accessory rods across a lumbar PSO.

Methods
A validated 3D spinopelvic finite element model (T10-pelvis) with a L3 PSO was used. The Control (2-Rods) was created with two bilateral rods connected all levels (T10-pelvis). Three multi-rod techniques were modeled and analyzed: (1) laterally-based satellite rods with no accessory rods (4-Rods), (2) laterally-based satellite rods with one medial accessory rod (5-Rods), and (3) laterally-based satellite rods with two accessory rods (6-Rod). Global and PSO ROM were recorded. Rods' von Mises stresses and PSO forces were recorded and the percent differences from Control were calculated.

Results
Increasing rods from four to six led to reduction in global ROM in all motions. Lower ROMs at the PSO were observed for 5- and 6-Rods compared to 4-Rods. Laterally-based satellite rods (4-Rods) showed higher PSO force than 2-Rods (347.1N vs. 336N). However, additional accessory rods reduced the PSO force to 327.8N (5-Rods) and 309.7N (6-Rods). All multi-rod models decreased von-Mises stresses on the primary rods at the PSO. 5- and 6-Rods led to lower von Mises stresses in these areas. In 4-Rods, two critical stress locations were observed: adjacent to the PSO and L5-S1. Adding the accessory rods (5- and 6-Rods) shifted the critical stress locations to connection points between primary rods and W-connectors.

Conclusion
In this finite element analysis, 4-Rods reduced stresses on primary rods across a lumbar PSO. Although increased rigidity afforded by 5- and 6-Rods decreased rod stresses, it resulted in less load transfer to the anterior vertebral column (particularly for 6-Rod), which may not be favorable for healing of the anterior column. A balance between the construct's rigidity and anterior load sharing is essential.

Posterior views of the four various instrumentation configurations used to stabilize the lumbar PSO

154. DESPITE A MULTIFACTORIAL ETIOLOGY, RATES OF DISTAL JUNCTIONAL KYPHOSIS AFTER ADULT CERVICAL DEFORMITY CORRECTIVE SURGERY CAN BE DRAMATICALLY DIMINISHED BY OPTIMIZING AGE SPECIFIC RADIOGRAPHIC IMPROVEMENT

Peter G. Passias, MD; Oscar Krol, BS; Jamshaid Mir, MD; Kimberly McFarland, BS; Peter Tretiakov, BS; Pooja Dave, BS; Tyler K. Williamson, MS, BS; Rachel Joujon-Roche, BS; Bailey Imbo, BA; Stephane Owusu-Sarpong, MD

Hypothesis
To investigate the impact of post-operative radiographic alignment on development of DJK in ACD patients.

Design
Retrospective cohort study of a multicenter prospective ACD database.

Introduction
Distal Junctional Kyphosis (DJK) is one of the most

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common complications in adult cervical deformity (ACD) correction. The utility of radiographic alignment alone in predicting and minimizing DJK occurrence warrants further study.

Methods
ACD patients (≥18 yrs) with complete baseline (BL) and two-year(2Y) radiographic data were included. DJF was defined as DJK greater than 15 (Passias et al.), or DJK with reop. Multivariable logistic regression (MVA) identified 3 month predictors of DJK. Conditional inference tree (CIT) machine learning analysis determined threshold cutoffs. Radiographic predictors were combined in a model to determine predictive value using area under the curve (AUC) methodology. "Match" refers to ideal age-adjusted alignment.

Results
140 cervical deformity patients met inclusion criteria (61.3yrs, 67%F, BMI: 29kg/m2, CCI: 0.96±1.3). Surgically, 51.3% had osteotomies, 47.1% had a posterior approach, 34.5% combined approach, 18.5% anterior approach, with an average 7.6± 3.8 levels fused and EBL of 824 mL. Overall, 33 patients (23.6%) developed DJK, and 11 patients (9%) developed DJF. MVA controlling for age, and baseline deformity, followed by CIT found 3M cSVA <3.7cm (OR: .2, 95% CI:.06-.6), and TK T4-T12 <50 (OR:.17, 95% CI:.05-.5, both p<.05) were significant predictors of a lower likelihood of DJK. Receiver operator curve AUC using age, T1S match, TS-CL match, LL-TK match, cSVA <3.7cm, and T4-T12 <50 predicted DJK with an AUC of .91 for DJK by 2Y, and .88 for DJF by 2Y.

Conclusion
These findings suggest post-operative radiographic alignment is strongly associated with distal junctional kyphosis. When utilizing age-adjusted realignment in addition to newly developed thresholds, a suggested post-operative cSVA target of 3.7cm and thoracic kyphosis less than 50, it is possible to substantially reduce the occurrence of distal junctional kyphosis and distal junctional failure.

155. WHAT FACTORS DETERMINE IF A PATIENT SHOULD UNDERGO A STAGED PROCEDURE FOR ADULT CERVICAL DEFORMITY CORRECTIVE SURGERY?

Peter G. Passias, MD; Bailey Imbo, BA; Oscar Krol, BS; Kimberly McFarland, BS; Pooja Dave, BS; Jamshaid Mir, MD; Peter Tretiakov, BS; Tyler K. Williamson, MS, BS; Rachel Joujon-Roche, BS; Lara Passfall, BS; Bassel G. Diebo, MD; Shaleen Vira, MD; Andrew J. Schoenfeld, MD; Renaud Lafage, MS; Virginie Lafage, PhD

Hypothesis
To determine the patients who benefit from a staged approach in CD-corrective surgery.

Design
Retrospective

Introduction
When determining surgical approach, a surgeon may elect to choose a "staged" method, in which a patient has recovery time between surgeries as opposed to a single-day operation. Understanding how this may be beneficial to patients on choosing one method over another is unknown.

Methods
CD patients with BL and 2Y follow up were included if they had available operative decision data. Patients were stratified into two groups based on operative technique; same day combined approach and staged. Means comparison tests and multivariate analysis assessed differences between patient groups.

Results
Of 104 patients that met inclusion criteria, 62 (51.9%) were same day procedures [Same] and 42 (48.1%) were Staged procedures [Staged]. When analyzing the cohort by those who were classified as frail and severely frail [F-SF], Staged patients reported significantly better neck pain at 2Y by NDI (31.8 vs. 43.3; p=0.012) and NRS Neck (4.0 vs. 5.8; p=0.004). Within this subset of patients, Staged saw significantly more improvement from BL to 2Y in NRS Neck (83.3% vs. 57.1%; p=0.010). Furthermore, only Staged patients were able to meet MCID in EQ5D if they were severely frail (37.5% vs. 0.0%; p=0.016). F-SF patients also fared better with neurological deficit improvements when staged. They were significantly more likely to no longer report hyperreflexia, paresthesia, and hand numbness (all p<0.05). When analyzing those in the cohort who had severe myelopathy (mJOA <14), staged patients were significantly more likely to no longer report any neurological deficit (25.0% vs. 4.0%; p=0.046) and more likely to improve radiographically in age-adjusted PT (20.0% vs. 0.0%; p=0.043) and one of Ames cervical criteria (16.0% vs. 0.0%; p=0.045). Additionally, severe myelopathy patients were less likely to

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experience dysphagia or pulmonary complications when undergoing a staged procedure (both p<0.05).

Conclusion
Staged procedures offer substantial benefit for frail patients undergoing operative correction of cervical deformity. Improvements are seen in clinical reported outcomes and neurological deficits. Also patients with severe myelopathy have greater radiographic improvement and less operative complications when undergoing a staged procedure.

156. MALPOSITION RATES OF SUBAXIAL CERVICAL PEDICLE SCREWS PLACED USING INTRAOPERATIVE CT (O-ARM) BASED 3D NAVIGATION

Jonathan N. Sembrano, MD; Jason J. Haselhuhn, DO; Kenneth J. Holton, MD; Michael J. Brush, BS; Christopher T. Martin, MD; Matthew A. Hunt, MD; Ann M. Parr, MD, PhD; *Kristen E. Jones, FAANS*; David W. Polly Jr., MD; Robert A. Morgan, MD

Hypothesis
We hypothesize that the majority of malpositions will be low grade, and that C7 will have the lowest malposition rate.

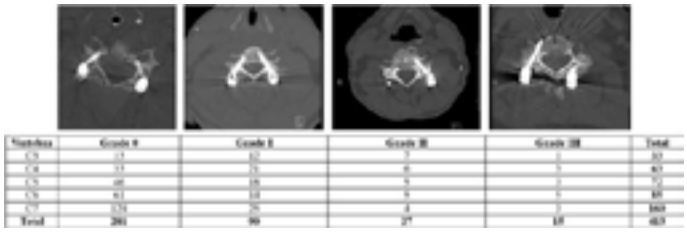
Design
Retrospective review

Introduction
Cervical pedicle screws (CPS) are biomechanically superior to other spinal fixation anchors; but placement is technically demanding, and malposition can have catastrophic consequences. Computer navigation (CN) has been shown to improve accuracy rates in thoracolumbar pedicle screw placement. However, there are limited studies on use of CN for placing CPS. We report accuracy rates of CN subaxial (C3-C7) CPS placement at a single institution.

Methods
We reviewed patients from 1/2014-3/2020 who underwent CN CPS placement with either postoperative computed tomography (CT) or intraoperative O-arm 3D scan for screw evaluation. CPS position was evaluated in axial, coronal and sagittal planes, and graded as shown in figure 1. Demographic data was collected and statistical analyses completed.

Results
413 CN CPS were placed in 100 patients (54M:46F), with a mean age of 56 years (range 10-81). Number of fusion levels ranged from 1-12. 44 patients had previous cervical spine fusion (29 anterior; 15 posterior). 12 patients underwent proximal extension of previous thoracolumbar fusion. Rates of serious screw malpositions were 3.6% (Gr III) and 10.2% (combined Gr II/III). A breakdown of screws can be seen in figure 1. Mean screw grade per level: C3=0.88, C4=0.67, C5=0.51, C6=0.46, C7=0.26. Using non-parametric ranksum tests with Bonferroni correction, significant differences were noted between the following: C3 vs C6 and C7 (p = 0.029 and <0.001, respectively) and C7 vs C3 and C4 (p = 0.029 and <0.001, respectively).

Conclusion
We found a 3.6% rate of dangerous (Gr III) and 10.2% non-ideal (Gr II/III) CPS placement using intraoperative 3D imaging and CN. Mean screw grade decreased caudally, indicating pedicle breach is more likely at the upper levels. This also confirms C7 is the safest level for CPS placement. Our results add to only few other studies that have reported on this technique. To our knowledge this is the biggest study on a uniform technique of CN subaxial CPS placement.



Grade 0: Fully within the pedicle. Grade I: Minor/ inconsequential breach (<25% screw width). Grade II: Non-ideal but acceptable breach (25-50% screw width). Grade III: Breach considered dangerous or compromises fixation strength (>50% screw width).

157. QUANTITATIVE ROMBERG ON A FORCE PLATE: OBJECTIVE ASSESSMENT AFTER SURGERY FOR PATIENTS WITH CERVICAL SPONDYLOTIC MYELOPATHY

Kyle Kesler, MD; Steven D. Glassman, MD; Jeffrey L. Gum, MD; Mladen Djurasovic, MD; Grant Schmidt, MD; Leah Y. Carreon, MD

Hypothesis
Measuring postural imbalance with a Romberg Test on a force plate provides an objective assessment of treatment effectiveness after surgery in patients with

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Cervical Spondylotic Myelopathy.

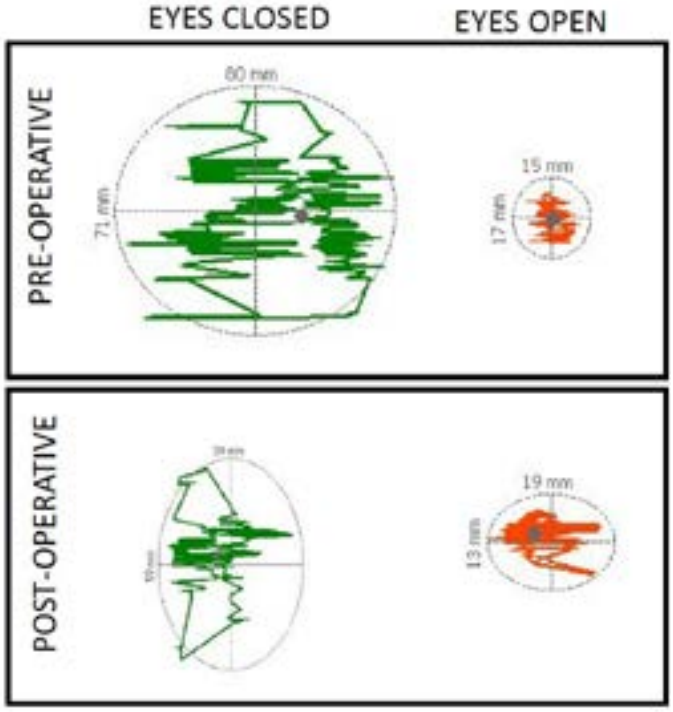
Design
Longitudinal Observational Cohort.

Introduction
Cervical Spondylotic Myelopathy (CSM) is characterized by balance deficiencies produced by impaired proprioception. Evaluation is subjective and binary physical exam findings that lack precision without the ability to assess postoperative outcome improvement. The purpose of this study was to evaluate the utility of quantitative Romberg measurements as a pre- and post-op outcome measure.

Methods
CSM patients were prospectively enrolled to undergo pre- and postoperative Romberg tests on a force plate to record center of pressure (COP) motion for 30 seconds with eyes open followed by eyes closed. Revision cases were excluded. Kinematics of COP movement parameters were compared between pre- and postop state for each patient.

Results
Nineteen CSM patients were enrolled and completed pre/post testing. Mean age was 59.8 years with 10 (53%) males, 5 (26%) smokers. Mean number of surgical levels was 2.53. The minimum mean follow up was six months. There was a statistically significant improvement in eyes closed postop compared to pre-op for total COP motion (590.74cm2 vs 447.05cm2, p=0.036), average sway speed (19.58cm/s vs 15.05cm/s, p=0.009) and total lateral COP motion (310.95cm2 vs 229.89cm2, p=0.044). There was statistically significant improvements in NDI (42.64 vs 29.78, p<0.001), neck pain (5.35 vs 2.88, p=0.001 and arm pain scores (4.50 vs 2.38, p=0.041).

Conclusion
CSM findings on Romberg quantitative testing significantly improves postoperatively in patients with CSM. These findings support this testing as representative of proprioceptive balance deficiencies seen in CSM. Quantitative Romberg testing may be used as an objective measure of clinical outcome and assist in stratification of surgical intervention timing and technique.



158. IMPACT OF EDUCATIONAL BACKGROUND ON PREOPERATIVE DISEASE SEVERITY AND POSTOPERATIVE OUTCOMES AMONG PATIENTS WITH CERVICAL SPONDYLOTIC MYELOPATHY: A QUALITY OUTCOMES DATABASE (QOD) STUDY

Nitin Agarwal, MD; Anthony M. DiGiorgio, DO; Mohamad Bydon, MD; Erica F. Bisson, MPH; Giorgos Michalopoulos, MD; Vijay Letchuman, MD; Andrew K. Chan, MD; Saman Shabani, MD; Raj S. Lavadi, MBBS; Daniel C. Lu, MD, PhD; Michael Y. Wang, MD; Regis W. Haid Jr., MD; John J. Knightly, MD; Brandon Sherrod, MD; Oren Gottfried, MD; Christopher I. Shaffrey, MD; Jacob L. Goldberg, MD; Michael S. Virk, MD, PhD; Ibrahim Hussain, MD; Steven D. Glassman, MD; Mark E. Shaffrey, MD; Paul Park, MD; Kevin T. Foley, MD; Brenton Pennicooke, MD, MS; Domagoj Coric, MD; Jonathan R. Slotkin, MD; Cheerag D. Upadhyaya, MSc; Eric A. Potts, MD; Luis M. Tumialán, MD; Kai-Ming G. Fu, MD, PhD; Anthony L. Asher, MD; Dean Chou, MD; Praveen V. Mummaneni, MBA

Hypothesis
If educational level is associated with increased disease severity, then patients with cervical spondylotic myelopathy, that have a lower educational level, are more likely to have poorer preoperative patient-reported outcomes.

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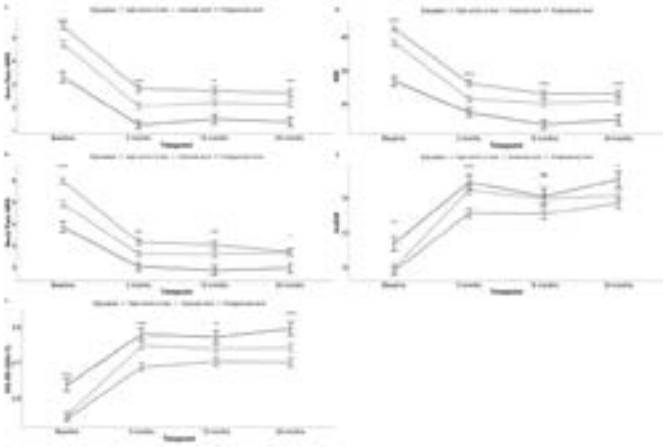
Design
Retrospective review of a prospectively maintained database.

Introduction
Patient education level has been suggested to correlate with health literacy and disease perception as well as socioeconomic status (SES) and access to health care. The association of educational level with disease severity has yet to be described in patients with cervical spondylotic myelopathy (CSM).

Methods
The CSM dataset of the Quality Outcomes Database (QOD) was utilized in this study to identify patients undergoing surgical management of CSM from January 2016 to December 2018. Education level was grouped as high school or below, graduate-level, and post-graduate level. The association of education level with baseline disease severity. Patient-reported measures (PROMs) included the North American Spine Society surgical satisfaction scale, Neck Disability Index (NDI), modified Japanese Orthopedic Association score (mJOA), arm and neck pain as numeric ranking scale (NRS), and quality-adjusted life-years (QALY).

Results
Among 1,141 patients with CSM included, 509 (44.6%) had an education level of high school or below. The three groups were significantly different in terms of SES index, proportion of smokers, symptom duration >3 months, and baseline PROMs. In multivariable analyses, lower education level was associated with symptom duration of >3 months, higher arm pain NRS, and higher neck pain NRS. All groups reported similar surgical satisfaction and minimal clinically important differences across all measures, except for neck pain.

Conclusion
Patients with CSM reporting a lower educational level tended to present with longer symptom duration, more disease-inflicted disability, higher pain scores, and lower QALY scores. These patients are a potentially vulnerable subpopulation, and their health literacy and access to care should be prioritized.



Line charts showing arm pain NRS (A), neck pain NRS (B), EQ-5D (C), NDI (D), and mJOA (E) at baseline and at follow-up time points among different educational levels.

159. PREDICTING ACHIEVEMENT OF A MINIMUM CLINICALLY IMPORTANT DIFFERENCE IN NECK PAIN AFTER SURGERY FOR CERVICAL SPONDYLOTIC MYELOPATHY: A COMPARISON OF SUPERVISED LEARNING ALGORITHMS

Andrew K. Chan, MD; Christine Park, BA; Christopher I. Shaffrey, MD; Oren Gottfried, MD; Erica F. Bisson, MPH; Mohamad Bydon, MD; Anthony L. Asher, MD; Domagoj Coric, MD; Eric A. Potts, MD; Kevin T. Foley, MD; Michael Y. Wang, MD; Kai-Ming G. Fu, MD, PhD; Michael S. Virk, MD, PhD; John J. Knightly, MD; Scott Meyer, MD; Paul Park, MD; Cheerag D. Upadhyaya, MSc; Mark E. Shaffrey, MD; Luis M. Tumialán, MD; Jay D. Turner, MD; Giorgos Michalopoulos, MD; Brandon Sherrod, MD; Nitin Agarwal, MD; Regis W. Haid Jr., MD; Dean Chou, MD; Praveen V. Mummaneni, MBA

Hypothesis
Different supervised machine learning algorithms will have varying abilities to predict achievement of MCID in neck pain after surgery for CSM patients.

Design
Retrospective analysis of prospectively-collected data

Introduction
In healthcare, multiple supervised machine learning algorithms are employed to aid in making classification decisions. It is unclear if a particular algorithm is superior in predicting patient-reported outcomes after surgical intervention.

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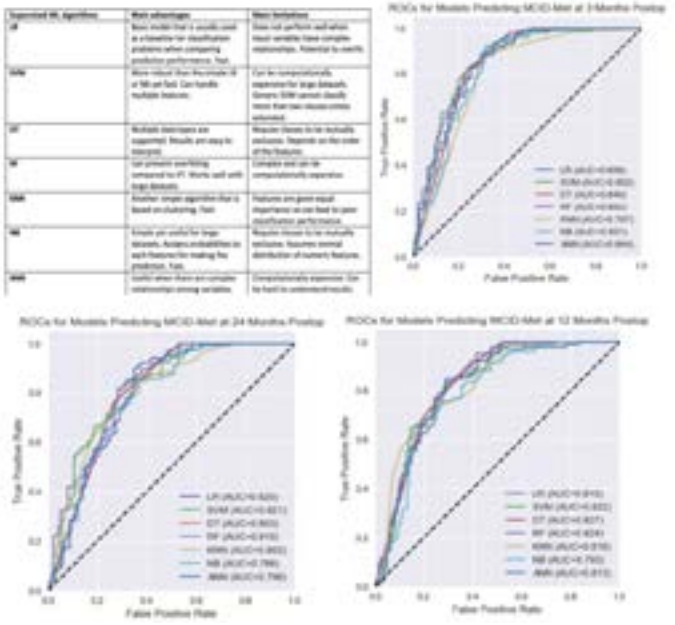
Methods
This was a bispective analysis of the Quality Outcomes Database (QOD) CSM module. The dataset was divided into 80% training and 20% test set. Various supervised learning algorithms (including logistic regression [LR], support vector machine [SVM], decision tree [DT], random forest [RF], K-nearest neighbor [KNN], Naïve Bayes [NB], and multilayer perceptron [MLP]) were evaluated on their performance in prediction of MCID in VAS-neck pain 3-, 12-, and 24-months postoperatively. Hyperparameter tuning was conducted for all the tested models to optimize their performance. Performance was assessed with accuracy, area under the receiver operating characteristic (AUC), sensitivity, and specificity.

Results
At all measured time points, the supervised learning algorithms all performed similarly well with AUC ranging from 0.797 to 0.858 for MCID-met at 3 months, 0.793 to 0.827 for 12 months, and 0.788 to 0.821 for 24 months. The best performing model at each measured time point was LR at 3 months (AUC 0.858, accuracy 0.782, sensitivity 0.769, specificity 0.792), DT at 12 months (AUC 0.827, accuracy 0.751, sensitivity 0.895, specificity 0.629), and SVM at 24 months (AUC 0.821, accuracy 0.755, sensitivity 0.857, specificity 0.669).

Conclusion
The algorithms performed similarly well at predicting achievement of MCID 3, 12, and 24 months after surgery for CSM given a set of baseline features. Our results show that appropriate selection of models for studies should be based on the strengths of each model and the aims of the studies.

Comparison of performance of models for achieving MCID at 3-, 12-, and 24 months postoperatively.



160. UTILIZING MACHINE LEARNING TO IDENTIFY EARLY ONSET SCOLIOSIS PATIENTS AT HIGH RISK FOR EXTENDED LENGTH OF STAY AFTER SPINAL FUSION

Michael Fields, MD; Jay Zaifman, BA; Christina C. Rymond, BA; Theodore Quan, BS; *Nathan J. Lee, MD*; Benjamin D. Roye, MPH; Michael G. Vitale, MPH

Hypothesis
Machine learning algorithms can create a risk stratification tool for identifying early onset scoliosis (EOS) patients at risk for extended length of stay (ELOS) after posterior spinal fusion (PSF), with ELOS used as a proxy for postoperative outcomes.

Design
This is a retrospective cohort study.

Introduction
EOS comprises complex etiologies with many potential postoperative complications. Identifying high-risk patients is crucial, though it can be difficult given the heterogenous nature of the patient population. Machine learning provides clinicians with an innovative and comprehensive mechanism to examine patient data and predict outcomes.

Methods
EOS patients under 10 years old who underwent PSF were selected from the American College of Surgeons NSQIP database. ELOS was defined as longer than 5

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days. Recursive feature elimination determined key patient characteristics for predicting ELOS. Data was analyzed with machine learning algorithms in Python using the Sci-Kit learn package. Prediction accuracy, area under the curve (AUC), and Brier score assessed algorithm accuracy and precision. The model with the highest AUC was optimized using sigmoid and isotonic calibration with 5-fold cross validation. This model was applied to create the risk calculator.

Results

1587 patients were studied (age 6.9 years±2.6; 59.2% female; BMI 17.0±8.7). ELOS was observed in 33.1% (n=526 patients). ASA class ranged from 1-4, with 3.3%, 27.1%, 62.4% and 7.2%, respectively. The average number of levels operated on was 1.6±0.8. The most common etiologies were idiopathic and neuromuscular (22.9% and 57.6%, respectively). 29.4% of patients required nutritional support and presence of pulmonary, cardiac, and neurologic comorbidities was 43.3%, 19.4% and 72.3%, respectively. Average operative time was 258 minutes±116. Operative time, age, BMI, ASA class, levels operated on, etiology, presence of nutritional support, and presence of pulmonary and neurologic comorbidities optimized algorithm predictive performance. Gradient boosting had the best performance with an accuracy of 0.723, AUC of 0.766, and Brier score of 0.183 (Table 1). Examples of the model applied as a risk-calculator are in Figure 1.

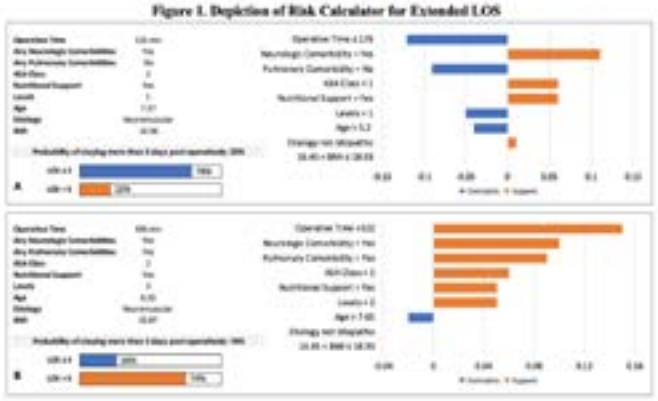
Conclusion

Machine learning algorithms accurately predicted ELOS and characterized key preoperative and intraoperative drivers of ELOS after PSF in EOS patients.

Table 1. Algorithm Performance on the Training and Testing Set

Algorithm	Train Accuracy	Test Accuracy	Precision	Recall	AUC	Brier Score
Gradient boosting	0.821	0.723	0.667	0.400	0.766	0.183
Random forest	1.000	0.720	0.641	0.375	0.756	0.186
Logistic regression	0.705	0.708	0.743	0.236	0.719	0.197
Bernoulli naive bayes	0.690	0.698	0.613	0.345	0.682	0.209
Support vector	0.685	0.657	0.545	0.055	0.657	0.223
Stochastic gradient descent	0.672	0.654	0.605	0.209	0.643	0.212
Gaussian process	1.000	0.629	0.459	0.409	0.600	0.247

Figure 1. Depiction of Risk Calculator for Extended LOS



F1 blue decreases ELOS risk & orange increases

161. LENGTHENING BEHAVIORS OF RIB-TO-PELVIS VS RIB-TO-SPINE MAGNETICALLY CONTROLLED GROWING RODS IN EARLY ONSET SCOLIOSIS

Jessica H. Heyer, MD; Jason B. Anari, MD; Keith Baldwin, MPH, MSPT; Stuart L. Mitchell, MD; John (Jack) M. Flynn, MD; Pediatric Spine Study Group; *Patrick J. Cahill, MD*

Hypothesis

Rib-to-spine and rib-to-pelvis MCGR will have diminished ability to lengthen over time.

Design

Retrospective cohort study

Introduction

Rib-based implants are an alternative to spine-based constructs in early onset scoliosis (EOS), and are believed to maintain their ability to lengthen over time. We examined a cohort of EOS patients with rib-to-spine and rib-to-pelvis MCGR to determine if they demonstrate diminishing lengthening over time, and if there are differences in lengthening behaviors between the construct types.

Methods

A prospectively-collected multicenter EOS registry was queried for patients with MCGR, with at least 2-year follow-up. Patients with rib-based proximal anchors and spine- or pelvis-based distal anchors were included. Patients were analyzed in two cohorts:

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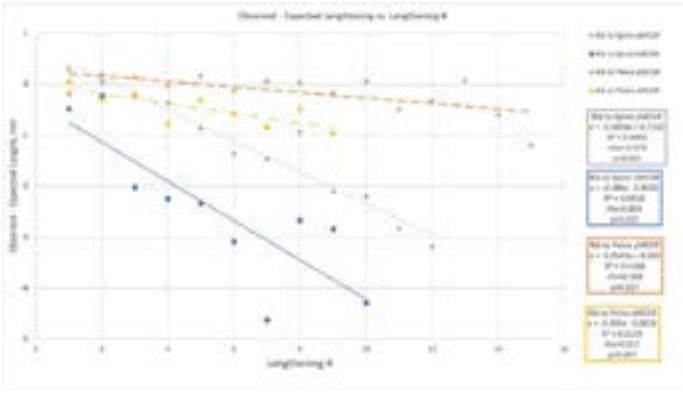
rib-to-spine and rib-to-pelvis MCGR. Primary-MCGR (pMCGR): patients with native MCGR implants; secondary-MCGR (sMCGR): patients converted from a pMCGR to a new MCGR. We defined failure of survival as either failure to lengthen (lengthening ≤2mm at 2 consecutive lengthenings or final lengthening of ≤2mm) or rod revision prior to 80% of maximal excursion.

Results

43 rib-to-spine and 31 rib-to-pelvis MCGR patients were analyzed. There was no difference in pre-implantation, post-implantation and pre-definitive T1-T12 or T1-S1 height, or Cobb angles between the groups (p>0.05). There is a decrease in rod length achieved at subsequent lengthenings for all groups: rib-to-spine pMCGR (rho=0.979,p<0.001), rib-to-spine sMCGR (rho=0.855,p=0.002), rib-to-pelvis pMCGR (rho=0.568,p=0.027), and rib-to-pelvis sMCGR (rho=0.817,p=0.007)(Figure). Rib-to-pelvis pMCGR lengthened more than rib-to-spine pMCGR (p=0.015). Both rib-to-spine and rib-to-pelvis sMCGR had poorer ability to lengthen compared to their pMCGR cohorts (p=0.0003, p=0.008, respectively). By etiology, rib-to-spine pMCGR had diminished lengthening ability over time for idiopathic, neuromuscular and syndromic patients (p<0.05), but there were no differences between groups' behavior (p>0.05). Rib-to-pelvis pMCGR neuromuscular patients had diminished lengthening over time (p=0.01), while rib-to-pelvis pMCGR syndromic patients demonstrated preserved ability to lengthen (p=0.65).

Conclusion

Rib-to-spine and rib-to-pelvis pMCGR and sMCGR demonstrate diminished ability to lengthen over subsequent lengthenings; primary rib-to-pelvis lengthens better than rib-to-spine MCGR.



163. TWO YEAR OUTCOMES OF THE NEMOST GROWTH ROD FOR EARLY ONSET SCOLIOSIS

Kristopher M. Lundine, MD, MSc, FRCSC, FRACS; Mwaura Kimani, MMed MSc; Michael B. Johnson, MBBS, FRACS

Hypothesis

The Nemost growth rod achieves spinal deformity correction and allows for ongoing spinal growth in patients with early onset scoliosis.

Design

Case Series

Introduction

Early onset scoliosis is a challenging clinical scenario with many surgical options to consider. Complications are common regardless of implant choice. We began using a new growth rod at our institution in June, 2017. This is a 'ratchet-like' system called Nemost that allows ongoing spinal growth after implantation without the need for further surgery. This study is a description of our 2-year outcomes using this device.

Methods

All patients undergoing scoliosis correction with Nemost with minimum 2-year outcomes were identified in the surgical database of a single paediatric institution. Patient charts were reviewed for demographic data and clinical outcomes. Pre-operative, post-operative and 2-year radiographs were reviewed to assess curve measurements and spinal growth.

Results

31 patients had the Nemost growth rod with 2-year outcomes. The average age at surgery was 10 years (range 7-13). The most common primary diagnosis was CP (9 patients) and 18 (58%) of the patients were non-ambulant. Mean pre-op Cobb angle was 87o, 46 o post-op and 50 o at most recent follow-up for a mean correction of 43%. Mean thoracic height (T1-12) increased from 177 mm pre-operatively to 204 mm post-correction and to 214 mm at 2 years. Mean total spine height (T1-S1) increased from 275 mm pre-operatively to 327 mm post-correction and to 339 mm at 2 years. 23 patients had at least 1 cm of ongoing lengthening of their growing rod from implantation to most recent review. There were 18 major complications in 12 patients including 17 unplanned return to theatre cases of which 3 were deep infections requiring washout.

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Conclusion
The majority of spinal deformity correction occurred with initial implantation of the Nemost growth rod which was maintained out to 2 years. This growth rod demonstrated ongoing spinal growth in 74% of patients. In this series of 31 patients, 39% experienced at least one major complication. Many complications have resulted in modifications of the original technique to improve safety and prevent future similar complications. This is the largest clinical series of this implant outside of the original centre where it was designed.

164. TGR VS MCGR: DOES IT MAKE A DIFFERENCE ON YOUR HRQOL AT GROWING ROD GRADUATION?

Ali Asma, MD; Petya Yorgova; Paul D. Sponseller, MBA; Scott J. Luhmann, MD; John (Jack) M. Flynn, MD; Viral V. Jain, MD; Peter F. Sturm, MD; Pediatric Spine Study Group; *Suken A. Shah, MD*

Hypothesis
MCGR fusion graduates would have higher EOSQ 24 scores than TGR fusion graduates

Design
Retrospective cohort

Introduction
Most of the literature on growing rod graduation discusses surgical and radiographical outcomes, as well as complications, but relatively little is known about HRQoL or whether there is a difference with TGR or MCGR revised to final fusion. The aim of this study was to examine HRQoL after graduation from these two different pathways.

Methods
Patients with early onset scoliosis and growing rods implanted for a minimum of two years and revised to definitive fusion (graduation) were reviewed from a multicenter database. Chi-square test was used for categorical variables comparison, Mann-Whitney U test was used for independent samples comparison and Wilcoxon test was used for related samples comparison for non-normally distributed variables

Results
115 (55 TGR, 60 MCGR) patients were included. Subgroups of EOS etiology in the two treatment groups are summarized in Table 1. The groups were then combined into congenital + idiopathic (CI) and neuromuscular + syndromic (NS) groups and the TGR group had a higher NS population (71%) compared to MCGR group (54%) (p=0.052). The TGR and MCGR groups were similar for pre-index (p=0.66), pre-definitive (p=0.87) and post-definitive (p=0.98) major curve magnitude both in the CI and NS populations. Post-index/Pre-definitive EOSQ-24 domains were similar for TGR and MCGR both in CI and NS except for the financial impact domain which was lower TGR (more burden) in NS (p=0.047). Post-definitive EOSQ-24 domains were similar except for general health domain which was lower for TGR in NS (p= 0.042). The delta change between pre-definitive and post-definitive EOSQ domains were similar for TGR and MCGR groups in CI and NS. No difference was seen between pre-definitive vs post-definitive fusion EOSQ domains both for TGR and MCGR patients in CI and NS populations. The unplanned return to operative room rates(UPROR) were similar for TGR and MCGR groups in both CI and NS

Conclusion
Post definitive fusion HRQoL outcomes were similar for MCGR and TGR. The financial impact burden was more appreciated by caregivers in the TGR group before definitive fusion; however, this leveled out after graduation

Table 1- EOS etiology subdivisions for TGR and MCGR groups

	TGR	MCGR
EOS Etiology	Count	Count
Congenital	6	8
Neuromuscular	18	22
Syndromic	21	10
Idiopathic	10	20
Congenital-Idiopathic	16	28
Neuromuscular-Syndromic	39	32
Total	55	60

165. HOW MUCH RADIATION FROM IMAGING STUDIES IS CONTROLLED BY ORTHOPAEDICS IN PATIENTS WITH NEUROMUSCULAR EOS?

Adrian Lin, BS; Michael J. Heffernan, MD; Vivian Chen; Cynthis Wong; Benita Tamrazi, MD; David L. Skaggs, MMM; Kenneth D. Illingworth, MD; *Lindsay M. Andras, MD*

†Luis A. Goldstein Best Clinical Research Poster *John H. Moe Best Basic Research Poster

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Hypothesis
Children with neuromuscular EOS obtain many imaging studies with radiation outside of their orthopaedic care

Design
Retrospective case series

Introduction
Children with neuromuscular EOS receive numerous radiographic studies from orthopaedics and other specialties. Ionizing radiation doses delivered by computed tomography (CT) are 100-500 times higher than conventional radiography. Efforts have been made to reduce radiation both through technique and technology (low dose biplanar scanning and limited CT). The purpose of this study was to evaluate the radiation neuromuscular EOS patients during their course of treatment.

Methods
Retrospective review at a tertiary children's hospital from 01/2010 to 06/2021. All patients with neuromuscular EOS followed by an orthopaedic specialist for a minimum of three years were included. Patients were excluded if the majority of their non-orthopaedic care was provided by outside institutions. Medical records were reviewed for data.

Results
18 patients met the inclusion criteria with mean follow up of 6.4 ± 2.3 years. A total of 1,312 plain radiographs and 35 CT scans were performed. Of these 1,312 plain radiographs, 34.7% (455/1,312) were ordered by orthopaedics and 65.3% (857/1312) were ordered by other providers. Of the CT scans, 4 were ordered by orthopaedics, while 88.5% (21/35) were ordered by other providers. Of the total 459 radiographs ordered by orthopaedic specialists, 322 were spine, 58 were pelvis, 75 were others. Of the total 35 CT scans, 19 were the brain, 5 chest, 4 abdomen, 2 spine, 2 pelvis, 2 densitometry studies, and 1 maxillofacial. Following availability in 2016, 92/213 spine radiographs were performed using biplanar scanning. An average of 74.7 (range 29-124) radiographs and 1.9 (range 0-9) CT scans ordered over the course of each patient's treatment for an average of 13.0 ± 6.0 radiographs and 0.3 CT scans per year. Considering radiation dosage delivered from CT scans is roughly 100 times greater than plain radiographs, the average 0.3 CT scans a year can account for as much radiation as 33 plain radiographs.

Conclusion
With an average of 75 radiographs and 1.9 CT scans ordered for each patient, consideration for steps to limit exposure to ionizing radiation in the neuromuscular EOS population should be made. This requires interdisciplinary coordination as 65% of radiographs and over 80% of CT scans were ordered by non-orthopaedic providers.

166. ULTRASONOGRAPHIC ASSESSMENT OF MAGNETIC GROWING RODS OVERESTIMATES THE GROWTH OF THE SPINE COMPARED TO X-RAY

Sergio De Salvatore, MD; *Leonardo Oggiano, MD*; Sergio Sessa, MD; Cloe Curri, MD; Pier Francesco Costici, MD

Hypothesis
This study aims to demonstrate the difference between US and radiographic growth assessment in patients with EOS treated with MGRs.

Design
Singe centre retrospective study, level of evidence III

Introduction
Magnetic growing rods (MGRs) are one of the most common procedures to treat early-onset scoliosis (EOS). Radiographic examinations or ultrasonographic (US) assessments are used to evaluate the lengthening of the rods. However, the former exposes the patient to repeated radiation, while the latter has not been officially validated and may be affected by the ability of the radiologist to assess elongation. This study aims to demonstrate the difference between US and radiographic growth assessment in patients with EOS treated with MGRs.

Methods
A single-centre retrospective study. Patients were consecutively enrolled at the Children's Hospital bambino gesù in Rome from July 2011 to July 2022. Noninvasive lengthening was performed every 4 months. Radiographic follow-up was performed post-op, 1 month after surgery and every 8 months. An experienced radiologist assessed mean US rod elongation per session. The mean elongation/session of T2-T12 and T2-S1 was calculated. A comparison of the results obtained was performed by an independent t-test.

Results
65 patients were included in the study. The mean

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value of years of follow-up was 4 ± 2. The mean age at the time of operation was 8.8 ± 2 years. The mean rod elongation per session assessed by the US was 3.04±0.55 mm. The average rod elongation evaluated by x-ray was: 1.38±1.01 (T2-T12) and 2.26±1.60 (T2-S1). The difference between the value measured by the US and by RX was statistically significant. X-ray - T2-T12: $p < 0.00001$; X-ray - T2-S1: $p < 0.00001$.

Conclusion
The US overestimates the extent of elongation compared with x-ray. To our knowledge, this is the single-centre study with the highest number of patients worldwide. A limitation of this study is the absence of inter- and intraobserver evaluation. Therefore, further clinical studies are needed to confirm these results. Although the US may help assess MRGs elongation, it may overestimate the data compared with X-ray. This data may be affected by the individual operator's assessment, so there is a need to standardize the US assessment of rod elongation.

167. A COMPARATIVE ANALYSIS OF REVISION SURGERY BEFORE OR AFTER 2 YEARS FOLLOWING GRADUATION FROM GROWTH-FRIENDLY SURGERY FOR EARLY ONSET SCOLIOSIS

Anjali Prior, BA; Christina K. Hardesty, MD; William R. Barfield, PhD; John B. Emans, MD; George H. Thompson, MD; Paul D. Sponseller, MBA; John T. Smith, MD; David L. Skaggs, MMM; *Sara Van Nortwick, MD*; Pediatric Spine Study Group; Robert F. Murphy, MD

Hypothesis
The demographics, rates of and reasons for revision surgery in EOS growth-friendly graduates are similar when comparing patients who undergo an Acute Revision (≤2yrs from graduation) versus a Delayed Revision (>2yrs).

Design
Retrospective comparative analysis

Introduction
Following discontinuation of growth-friendly (GF) surgery for early onset scoliosis (EOS), patients are termed "graduates": they undergo a spinal fusion, are observed with their implants retained, or observed with their implants removed. The purpose of this study was to compare the rates of and reasons for revision surgery in two cohorts of GF graduates: before or after two years following graduation.

Methods
A multicenter EOS registry was queried for all patients who underwent GF spine surgery and had a minimum of 2 years follow up after graduation, by clinical and/or radiographic evidence. Scoliosis etiology, graduation strategy, and incidence, number of and reasons for revision surgery were queried.

Results
933 patients with a minimum of 2 year follow up after graduation were eligible for analysis. There were 272 (29.2%) congenital, 300 (32.2%) neuromuscular, 198 (21.2%) syndromic, and 163 (17.5%) idiopathic. 897 (96.1%) had TGR/VEPTR as their GF construct and 36 (3.9%) had MCGR. 653 (70%) underwent spinal fusion as their graduation, 241 (25.8%) had implants retained, and 39 (4.2%) had implants removed. Of the 933, 124 (13.3%) underwent revision surgery, with 82 (66.1%) occurring as Acute Revisions (AR) between 0 and 2 years (average 0.6), and 42/933 (4.5%) patients (13 males) as Delayed Revision (DR) greater than 2 years (average 3.8). There was a significantly higher percentage in the AR group who underwent fusion as their graduation strategy (96% AR vs 83% DR, p=0.012). A higher percentage of AR patients underwent revision for infection (35%) than DR (12%, p=0.006). AR patients, on average, underwent more revision surgeries (avg 2, range 1-7) than DR (avg 1, range 1-2) (p=0.001). There was a higher percentage of congenital scoliosis patients in the DR group (38%) versus AR (21%, p=0.038)

Conclusion
The rate of revision in this cohort of 933 GF graduates was 13.3%, and the rate of DR was 4.5%. Patients who undergo fusion as their graduation strategy have a higher likelihood of AR, with infection as the most common cause. DR patients more frequently have congenital scoliosis.

169. ANALYSIS OF THE COSMETIC INDICES AFTER SURGICAL MANAGEMENT OF CONGENITAL SCOLIOSIS: A COMPARISON WITH ADOLESCENT IDIOPATHIC SCOLIOSIS

Changwei Liu, MD; Yanjie Xu, MD; Jie Li, MD; Zongshan Hu, PhD; Ling Chen, MD; Hui Xu, MD; *Zezhang Zhu, PhD*; Yong Qiu, PhD; Zhen Liu, PhD

Hypothesis
Radiographic parameters cannot fully reflect cosmetic appearances of scoliosis patients with congenital scoliosis.

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Design
Retrospective study

Introduction
For the scoliosis patient, the cosmetic deformity is often their major concern. Whether radiographic parameters can fully reflect cosmetic appearances of scoliosis patients with congenital scoliosis is unkown. So this study's objective is to compare the correlations between cosmetic and radiographic parameters in patients with congenital scoliosis and adolescent idiopathic scoliosis after surgical management.

Methods
A total of 23 patients with congenital scoliosis and 21 patients with adolescent idiopathic scoliosis were retrospectively reviewed.Seven cosmetic indices were measured on the photographs: Shoulder area index 1(SAI1), shoulder area index 2(SAI2), lumbar area index (LAI), shoulder angle(α1), axilla angle(α2), right and left waist angle difference (RLWAD) and hump index. Additionally, eight radiographic parameters were measured on the radiographs: Cobb's angle, T1 tilt, Clavicle-rib cage intersection (CRCI), Trapezius length (TL),Clavicle chest cage angle difference(CCAD), Coronal balance(CB), Thoracic containment (TC), Apical vertebral translation(AVT). The correlation between the changes in cosmetic parameters and radiographic parameters was analyzed by the Pearson correlation coefficient.

Results
Both AIS and CS patients showed significant improvement in radiographic parameters after surgical management, while CS patients showed lower satisfaction with cosmetic appearance than AIS patients. In patients with AIS, SAI1 and SAI2 were significantly correlated with preoperative T1 tilt, CB, TC, and AVT, and the changes in SAI2 were positively correlated with the correction rate of T1 tilt. In CS patients, SAI1 and SAI2 showed moderate correlation with RSHD, T1 tilt, and FRA . After surgery, T1 tilt and AVT improved significantly in CS patients, but the changes showed no significant correlation with the improvement in any cosmetic indices.

Conclusion
The correction of radiographic parameters can partially reflect the improvement of cosmetic appearances of patients with AIS after surgical management, but not in patients with congenital scoliosis.

170. HV RESECTION: A LONG-TERM FU BEYOND PUBERTAL GROWTH SPURT

Xiaojiang Pu, PhD; Yong Qiu, MD; *Zezhang Zhu, PhD*; Bangping Qian, MD; Bin Wang, MD; Xu Sun, MD

Hypothesis
Hemivertebra (HV) resection has become the mainstream surgical modality because it can directly remove the deformity and block the natural history of HV. And we suppose a significantly higher incidence of coronal decompensation after patients reaching the peak of puberty.

Design
Patients who underwent thoracolumbar HV resection and short segment fixation and fusion (≤ 4 levels) when younger than 8 years in our center between January 2003 and January 2012 were recruited. All patients reached the pubertal growth spurt at the last follow-up. Patients' demographic and radiographic data were analyzed.

Introduction
Coronal decompensation after hemivertebra resection has attracted more and more attention of spinal surgeons; however, analyses of coronal decompensation after long-term follow-up in young patients were limited. Therefore, there is an urgent need for long-term follow-up results of HV resection.

Methods
Patients were assigned into two groups according to the coronal compensation: Group 1(curve decompensated beyond 20°) and Group 2 (curve well compensated). Patients' demographic and radiographic data were compared between these groups. Characteristics of coronal decompensation and spinal imbalance were recorded. Logistic regression analysis was performed to identify the independent risk factors associated with coronal decompensation.

Results
A total of 40 patients (18 boys and 22 girls) with a mean age of 48.4±26.7 months at the time of surgery were finally recruited. The mean postoperative follow-up period was 124.3±15.7 months.14 (35%) developed curve decompensation . Of each patient, the curve direction was the same as the primary curve before surgery. At the last follow-up, only two (6%) patients had spinal imbalance. Postoperative LIV tilt

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was significantly greater in Group 1 than in Group 2 (p=0.005). And the postoperative LIV disc angle was larger in Group 1 than in Group 2 (p=0.016). Logistic regression analysis revealed that postoperative LIV tilt greater than 6.2° and postoperative LIV disc angle greater than 5.5° were independent factors predicting coronal decompensation after surgery.

Conclusion
In conclusion, posterior HV resection is a reliable and safe technique considering the long-term outcomes. The incidence of coronal decompensation is 35%. Posterior LIV tilt greater than 6.2° and postoperative LIV disc angle greater than 5.5° were independent factors predicting coronal decompensation after surgery.

171. MIDTERM RESULTS OF SERIAL DEROTATION CASTING AND BRACING AS A STRATEGY TO DELAY SURGERY

Nicholas Lopreiato, MD; Nichole S. Leitsinger, BS; Lindsay R. Schultz, CCRP; *Peter F. Sturm, MD*

Design
Single site, retrospective

Introduction
Congenital Scoliosis is a rare form of scoliosis that can manifest itself as a large progressive curve in a young child. Surgery is often performed in these patients to prevent progression, as casting and bracing are felt to be ineffective at managing congenital curves. However, the risks of posterior spinal fusion in young patients and the known complications of growing rod constructs complicate the decision to proceed with operative management. Recent studies have shown that serial derotational casting may delay time to surgery, and thus help alleviate some of the problems seen in early surgical management. The purpose of this study is to report on our institution's experience with serial derotation casting for children with congenital scoliosis as a strategy in delaying surgical care.

Methods
After IRB approval we retrospectively reviewed the charts of 15 patients with congenital scoliosis who underwent serial derotational casting at our institution. We recorded the age at the start of casting as well as the initial cobb angle of the curve involving the vertebral anomaly and the cobb angle of any compensatory curve. We then recorded these same values at either the time of surgery if the patient underwent surgery or at the patient's last follow up if they did not. All patients were treated with a a derotation cast that was changed every 1-3 months until age 4, at which time they were switch to full time brace wear until skeletal maturity.

Results
Patients started casting at a mean age of 25.4 +/- 10.5 months and underwent an average of 7.9 +/- 7.4 casts during their treatment course. The initial cobb angles were 57.8°+/-13.6° for the involved curve and 39.2°+/-14.4° for the compensatory curve. At an average follow up of 57.5 +/- 35.8 months, the final cobb angles measured 54.6° +/- 15.1° for the involved curve and 32.6°+/- 18.6° for the compensatory curve. Out of the 15 patients in the study, 5 (33.3%) underwent surgery for their curve and 10 (66.7%) did not. None of the patients sustained a casting related complication.

Conclusion
For patients with congenital scoliosis we found that patients did not have progression of their curve with serial derotational casting, and the majority of patients were able to delay surgery.

172. 18F-NAF SUVMAX VALUE IN PREDICTION OF TNF-A BLOCKER RESPONSE IN ANKYLOSING SPONDYLITIS

Dong Suk Kim, MD; Jung Sub Lee, MD, PhD; Minjun Choi, MD; Won Chul Shin, MD, PhD; *Tae Sik Goh, MD, PhD*

Hypothesis
We aimed to evaluate the pharmacokinetics and maximum standardized uptake value (SUVmax) of 18F-NaF PET/CT for assessment of disease activity and prediction of response in patients with ankylosing spondylitis (AS).

Design
Prospective Cohort Study (Cross-sectional)

Introduction
A few cross-sectional studies evaluating the feasibility of 18F-NaF PET/CT for assessing AS have been published; however, there is no study on the longitudinal outcome related to 18F-NaF PET/CT. Additionally, dynamic PET/CT enables the acquisition of pharmacokinetic information after the application of compartment modeling, which could provide insights into the molecular mechanism of 18F-NaF.

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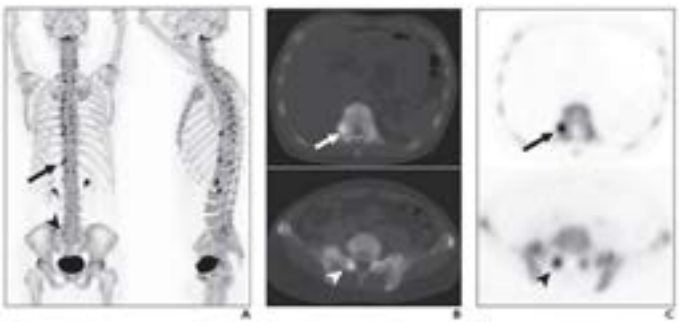
Methods
Twenty-seven patients (age, interquartile range, 30.25–49.75 years) with AS who were receiving a tumor necrosis factor–α (TNF-α) blocker were included. All patients underwent dynamic PET of the pelvis followed by whole-body PET/CT. Quantitative analysis of kinetic data of the sacroiliac joints (SIJs) was performed, and the SUVmax of the SIJs and SUVmax of the spine were calculated. Clinical indexes related to AS disease activity (serum C-reactive protein level, Bath ankylosing spondylitis disease activity index [BASDAI], and Bath ankylosing spondylitis functional index) were evaluated. Clinical response was defined as an improvement from the initial BASDAI score of 50% or more (BASDAI 50) within 2 years after baseline 18F-NaF PET/CT.

Results
The BASDAI score at 18F-NaF PET/CT was significantly different between the responders and nonresponders: 18F-NaF uptake at the spine was significantly higher in the responders than in the nonresponders. Only SUVmax of the spine had a significant positive correlation with BASDAI score at PET/CT (r = 0.38, p = 0.048). The BASDAI score at PET/CT (odds ratio [OR], 35.32; 95% CI, 2.09−57.84; p = 0.014) and SUVmax of the spine (OR, 14.69; 95% CI, 0.79−27.27; p = 0.027) were significantly associated with BASDAI 50 response prediction.

Conclusion
The results of our study suggest that the SUVmax of the spine on wholebody 18F-NaF PET/CT is a reliable and noninvasive biomarker for predicting therapeutic response to TNF-α blocker and shows better performance for predicting response than quantitative pharmacokinetic parameters. Fluorine-18-labeled NaF PET/CT showed axial bone lesions with bone formation and can be used as a monitoring tool in patients with AS receiving anti–TNF-αdrugs.



Representative images of our study

173. COMPARISON OF BONE MINERAL DENSITY IN CHILDREN AND ADOLESCENTS ON CT VERSUS DEXA SCAN

Akaila Cabell, MD; Steven D. Glassman, MD; John R. Dimar, II, MD; Christy L. Daniels, MS; Morgan Brown, MS; Grant Schmidt, MD; Leah Y. Carreon, MD

Hypothesis
Differences in bone mineral density (BMD) reported on DEXA scan are associated with changes in Hounsfield units (HU) on CT scan in children and adolescents.

Design
Retrospective chart review.

Introduction
Hounsfield Units (HU) within a Region of interest (ROI) on CT scans as a proxy for bone mineral density is widely used in adult patients. However, the utility of CT, and its correlation with DEXA measurements, has not been evaluated in children and adolescents.

Methods
Patients less than 18 years old with both a lumbar spine CT scan and a DEXA scan within 6 months were identified. Indications for imaging included malignances, congenital syndromes, menstrual issues, trauma, auto-immune disease and eating disorders. An ROI was used to measure the HU for each lumbar vertebral body using the bone window on axial cuts. Patient charts were reviewed for DEXA reports, medical comorbidities, and demographics. Patients were then stratified by Z score [≥ -1.0, between -1.0 and -2.0, and ≤-2.0] and matched by age and BMI to a cohort of healthy children.

Results
A total of 79 patients between the age of 4 and 17 years were included. A moderate correlation between mean DEXA Z-score and mean HU on CT was found (r2=0.42, p<0.001). When stratified by Z score [≥ -1.0, between -1.0 and -2.0, and ≤-2.0], patients with a Z score of ≤ -2.0 had a lower mean HU on CT compared to age matched controls, which was statistically significant (Table 1).

Conclusion
A lower HU was identified on lumbar CT in children and adolescents with DEXA Z-scores less than -2.0, when compared to healthy age and BMI matched controls. This is the first study to compare BMD on DEXA and CT in pediatric patients. This study suggests that HU on opportunistic CT scans of the spine may be

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used as a good proxy for bone mineral density in the pediatric population.

	N	HU Mean (SD)	BMI Mean (SD)	Age Mean (SD)
Age-matched Normal cohort	21	231.69 (36.20)	22.3 (4.40)	13.83 (4.04)
Cases (CT Scan and DEXA)				
Z-score >= (-1.0)	21	244.59 (57.41)	21.61 (4.22)	13.83 (4.02)
Z-score Between -1.0 and 2.0	21	218.5 (51.65)	20.61 (4.07)	14.00 (4.15)
Z-score <= (-2.0)	21	176.54 (95.36)	20.57 (4.04)	12.32 (3.34)
p-value		0.007	0.498	0.443

Table 1

174. DEVELOPMENT OF SOFTWARE FOR AUTOMATIC SIZING AND PLACEMENT OF PEDICLE SCREWS USING ARTIFICIAL INTELLIGENCE IN POSTERIOR CORRECTIVE AND FUSION SURGERY FOR SCOLIOSIS

Kota Watanabe, MD, PhD; Takeo Nagura, MD, PhD; Shuzo Kato, MD; Satoshi Suzuki, MD, PhD; Mitsuru Yagi, MD, PhD; Morio Matsumoto, MD, PhD; Masaya Nakamura, MD, PhD

Hypothesis
The surgical planning software which evaluates pedicle screw (PS) sizes and position utilizing artificial intelligence (AI) algorism can accurately simulate the diameter and length of PSs sizes and position of PSs. Study design: Analytical study

Design
Analytical study

Introduction
In the preoperative surgical planning for posterior correction and fixation surgery using pedicle screws will not only place a burden on the surgeons, but inaccurate preoperative planning may lead to insufficient PS size and increased distribution costs due to excessive preparation. Therefore, we developed software that automatically performs PS sizing and placement from preoperative CT using AI algorism.

Methods
We used 54 adolescent idiopathic scoliosis cases (918 vertebrae) who underwent posterior correction and fusion for the training and validation of the software. 54 axial images were created on CT images parallel to the cephalad endplate of each vertebra from T1 to L5 and through the maximum diameter of the pedicles. Then the optimal PS placement position, PS diameter, and PS length were set on the axial images by a physician specializing in spinal deformation surgery for training sets. Then, another 5 cases (85 vertebrae) were used for validation of the completed software.

Results
The average error of each output was 0.35±0.16 mm for the vertebral coordinate system, 0.43±0.19 mm and 0.37±0.13 mm for the left and right PS insertion point, 0.59±0.22 mm and 0.58±0.19 mm for the PS tip, 0.35±0.38 mm and 0.33±0.39 mm for PS diameter, respectively.

Conclusion
The error in PS location ranged from 0.35 to 0.58 mm and the diameter from 0.32 to 0.35mm, indicating that the PS position and sizes were predicted with high accuracy. In the future, validation in a clinical setting using actual surgical results is considered necessary. It was suggested that the software could contribute to the reduction of physicians' workload and medical distribution costs.

175. SPINE SURGEON VERSUS AI ALGORITHM - FULL LENGTH RADIOGRAPHIC MEASUREMENTS VALIDATION STUDY

Jason J. Haselhuhn, DO; Paul Soriano, MD; Priyanka Grover, MS; Janine Huertgen, MS; Marcel Dreischarf, PhD; Nathan R. Hendrickson, MD; Kristen E. Jones, FAANS; Christopher T. Martin, MD; Jonathan N. Sembrano, MD; *David W. Polly Jr., MD*

Hypothesis
We hypothesize that a novel AI algorithm can predict spinal measurements with excellent reliability (Intra-class correlation coefficient >0.75) in comparison to fellowship-trained spine surgeons.

Design
Retrospective review

Introduction
Spinal measurements are an integral component of planning for a variety of spinal procedures. EOS imaging generates high-quality true full-body radiographs for this purpose. However, these images take radiologists longer to read than conventional radiographs, and the radiologist measurements are less precise than those made by fellowship-trained spine surgeons. Image analysis software able to conduct these measurements quickly and reliably would be advantageous to surgeons, radiologists, and healthcare systems at large. The purpose of this study is therefore to compare measurements made by an AI

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algorithm to those made by fellowship-trained spine surgeons.

Methods

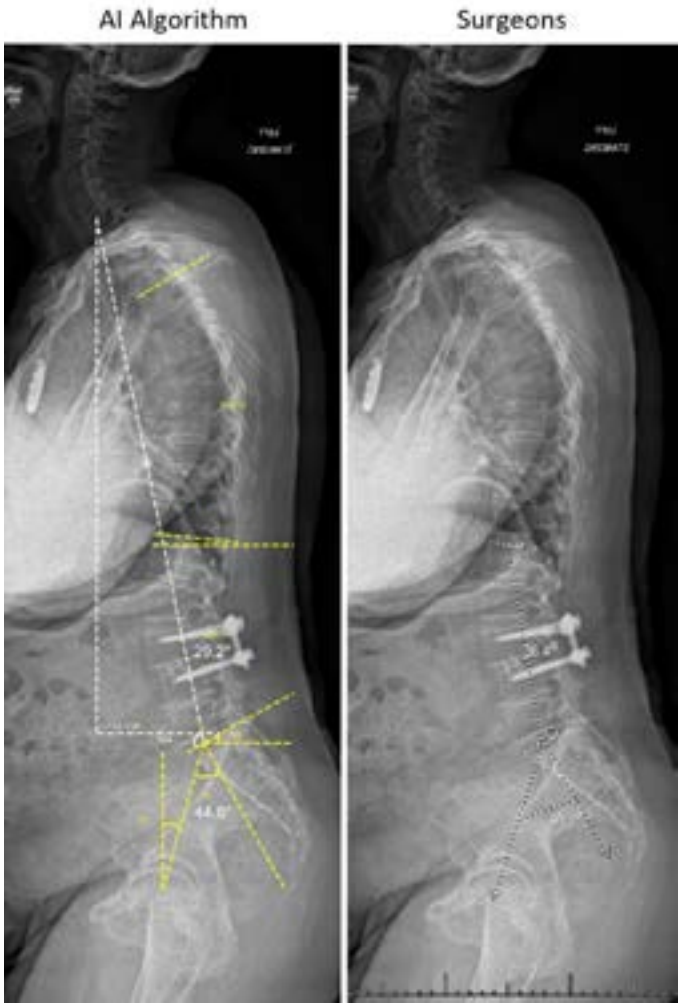
Full-length standing anterior-posterior and lateral radiographs of 125 patients were first obtained and measured by two fellowship-trained spine surgeons at our institution. Measurements included lumbar lordosis (LL), greatest coronal cobb angle (GCC), and pelvic incidence (PI). Intra-class correlation coefficient (ICC, absolute agreement) values were then calculated using an overlapping sample of 10 patients measured by both surgeons as well as for the dataset comparing the AI algorithm to the surgeons. ICC values >0.75 were considered excellent agreement (Cicchetti, Psychol Assess. 1994).

Results

ICC values for inter-rater reliability between surgeons were excellent and calculated to 0.97 for LL (95% CI: 0.88-0.99), 0.78 (0.33-0.94) for GCC and 0.86 (0.55-0.96) for PI. The algorithm computed the three selected parameters with ICC values between 0.80–0.90, indicating excellent reliability. Exemplary for the comparison of AI and surgeons, LL could be determined with the greatest ICC value of 0.90 (95% CI: 0.85-0.93). GCC and PI could be determined with ICC values of 0.82 (0.65-0.90) and 0.80 (0.72-0.86), respectively.

Conclusion

The novel AI algorithm presented here demonstrates excellent reliability, with ICC values corresponding to measurements conducted by experienced surgeons. In the future, it may facilitate the analysis of large data sets and aid physicians in diagnostics, pre-operative planning, and post-operative quality control.



Lateral radiographs with LL and PI measurements made by the AI algorithm and surgeons

176. CALIBRATION OF COMPREHENSIVE PREDICTIVE MODEL FOR THE DEVELOPMENT OF PROXIMAL JUNCTIONAL KYPHOSIS AND FAILURE IN ADULT SPINAL DEFORMITY PATIENTS WITH CONSIDERATION OF CONTEMPORARY GOALS AND TECHNIQUES

Peter Tretiakov, BS; *Peter G. Passias, MD*; Renaud Lafage, MS; Justin S. Smith, MD, PhD; Breton G. Line, BS; Oscar Krol, BS; Tyler K. Williamson, MS, BS; Bailey Imbo, BA; Bassel G. Diebo, MD; Alan H. Daniels, MD; Jeffrey L. Gum, MD; Themistocles S. Protopsaltis, MD; D. Kojo Hamilton, FAANS; Alex Soroceanu, MPH; Justin K. Scheer, MD; Robert K. Eastlack, MD; Gregory M. Mundis Jr., MD; Michael P. Kelly, MD; Pierce D. Nunley, MD; Eric O. Klineberg, MD; Khaled M. Kebaish, MD; Richard Hostin, MD; Munish C. Gupta, MD; Christopher P. Ames, MD; Douglas C. Burton, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Shay Bess, MD; Han

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Jo Kim, MD; Virginie Lafage, PhD; International Spine Study Group

Hypothesis
Incorporation of novel clinical, radiographic, and prophylactic measures will more accurately assess risk of PJK and PJF compared to previous models.

Design
Retrospective review of prospective ASD database

Introduction
Proximal junctional kyphosis (PJK) and failure (PJF) development remains a major concern after adult spinal deformity (ASD) corrective surgery. There remains a paucity of literature utilizing contemporary alignment metrics and novel prophylaxis measures to predict occurrence of PJK and PJF.

Methods
Operative ASD patients with baseline (BL) and 2-year (2Y) postoperative data were included. PJK was defined as ≥10° in sagittal Cobb angle between inferior UIV endplate and superior endplate of UIV+2. PJF was defined as meeting Lafage et al. criteria by 2Y. Backstep binary regression analysis assessed BL demographic, clinical and surgical information to predict the occurrence of PJK and PJF. Internal cross validation of the model was performed via 70:30 cohort split. Conditional inference tree (CIT) analysis determined thresholds at (α=.05).

Results
779 ASD patients (59.87±14.24 years, 78% female, 27.78±6.02kg/m2, mean CCI: 1.74±1.71) were included. 60.5% of patients (n=471) developed PJK, and 10.5% (n=82) developed PJF by their last recorded visit. The six most significant demographic, radiographic, surgical, and post-operative predictors of PJK/PJF were: BL age ≥ 74, BL SAAS T1PA modifier >1, BL SAAS PT modifier >0, levels fused > 16, nonuse of prophylactic hooks, and 6W SAAS PI-LL modifier > 1 (all p<.015) (Table 1). Overall, the model was deemed significant (p<.001), and internally validated ROC analysis returned an AUC of .923, indicating robust model fit.

Conclusion
Proximal junctional kyphosis and failure remain critical concerns in adult spinal deformity surgery, and efforts to reduce the occurrence of PJK and PJF have resulted in the development of novel prophylactic techniques and enhanced clinical and radiographic selection criteria. This study demonstrates a validated model incorporating such techniques that may allow for the prediction of clinically significant PJK and PJF, and thus assist in optimizing patient selection, enhance intraoperative decision making, and reduce post-operative complications in ASD surgery.

Table 1. Top six predictive factors for development of PJK and PJF.

Predictive Factor	Odds Ratio (<1 indicative of protective factor)	Confidence Interval	Significance
BL age ≥ 74	1.060	1.014 – 1.107	p<.005
BL SAAS T1PA modifier >1	0.352	0.189 – 0.733	p=.004
BL SAAS PT modifier > 0	0.547	0.344 – 0.870	p=.008
Levels fused > 16	1.139	1.022 – 1.269	p=.015
Use of prophylactic hooks	0.122	0.040 – 0.372	p<.001
6W SAAS PI-LL modifier > 1	3.604	1.840 – 7.061	P<.001

177. SIGNIFICANCE OF THORACOLUMBAR COBB ANGLE IN THE MANAGEMENT OF OSTEOPOROSIS IN POSTMENOPAUSAL WOMEN

Tae Sik Goh, MD, PhD; Minjun Choi, MD; Dong Suk Kim, MD; Won Chul Shin, MD, PhD; Jung Sub Lee, MD, PhD

Hypothesis
As Thoracolubmar Cobb angel (TLCobb) increases, the densitometric result will be worse, and the risk of fracture will also increase.

Design
Prospective Cohort Study

Introduction
Postmenopausal women are at risk of osteoporosis and are prone to severe adverse consequences such as vertebral compression fractures. The change of thoracolumbar kyphosis (TLK) is considered as a result of progressive osteoporotic compression fracture and becomes a cause of imbalance of the patient's posture, which leads to the patient being more susceptible to frailty related to fall changing the body's center of gravity. In addition, TLK is a cause of overestimated bone mineral density (BMD) from dual-energy X-ray absorptiometry (DXA), which results in the underdiagnosis of osteoporosis for the patients. Therefore, we aimed to examine the relationships between TLK and densitometric results and osteoporotic fracture risk in postmenopausal women.

Methods
We enrolled 470 postmenopausal women (median age: 62.78) who visited our hospital for a health check-

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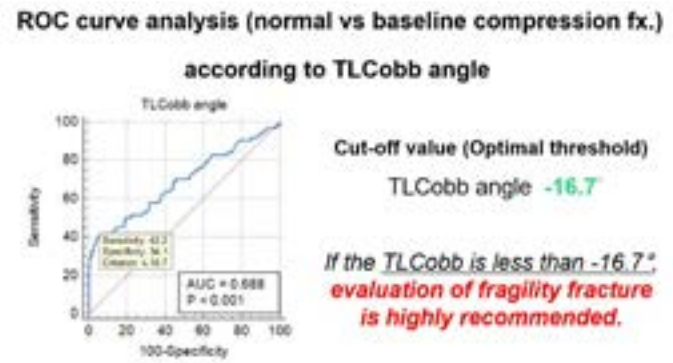
up between Sep 2013 and Sep 2017. Densitometric results of the lumbar spine (LS), including bone mineral density(BMD), T-score of L1-L4, and trabecular bone score (TBS) were calculated from dual-energy X-ray absorptiometry (DXA). Thoracolumbar kyphosis was examined by measuring the sagittal thoracolumbar Cobb angle (TLCobb). Both baseline and follow-up X-ray images were reviewed for the evaluation of thoracolumbar vertebral compression fracture, which were defined according to the Genant criteria.

Results

At baseline, 26.2% had normal BMD, 43.2 % had osteopenia, and 30.6% had osteoporosis. One hundred and thirteen baseline X-rays (24.0%) identified compression fractures and additional or progressive fractures in 21 participants (4.3 %) for the median 24 months of the follow-up period. The TLCobb did not show a difference according to the diagnosis of LS, whereas TLCobb was significantly higher in participants whose TBS deteriorated. TLCobb was considerably higher in patients with baseline fractures. During the follow-up, Cox regression analysis identified TLCobb as a significant risk factor for future vertebral fragility fracture.

Conclusion

Thoracolumbar kyphosis was found to be associated with TBS and baseline compression fracture and was suggested to have the potential to predict future vertebral fractures in patients.



ROC curve analysis according to TLCobb angle

179. IS IT WORTH THE WEIGHT? PRE-OP BMI OPTIMIZATION FOR THE MORBIDLY OBESE AND ITS EFFECTS ON POSTOP OUTCOMES

Brett Harris, BS; Fares Ani, MD; Camryn Myers, BA; Abel De Varona Cocero, BS; Constance Maglaras, PhD; Tina Raman, MD; *Themistocles S. Protopsaltis, MD*

Hypothesis

A change in BMI category is related to decreased intraop and postop complications as well as a decrease in 30 and 90day return to OR.

Design

Retrospective analysis of 1-4 lvl fusions from 2017-2020 at a single academic medical center with 1 year follow up.

Introduction

Benefits of weight reduction have shown to improve patient(Pt) health and satisfaction. In Pts destined for the OR, ASA grading is directly related to BMI as well as other comorbid conditions. What remains unclear is the effect of weight loss, specifically an improvement in BMI category on complications and outcomes after lumbar spinal fusion. This study evaluated the association of postop complications and return to OR after a 1-4 lvl fusion in Pts who lost weight (Wtloss), those with a normal BMI (Norm) and those who remained severe/morbidly obese(Obese).

Methods

Retrospective review of 1-4 lvl lumbar fusions 2017-2020 was performed for demographics, surgical characteristics, postop complications, BMI and nutrition consultations. Pts who have reduced their BMI reporting from Severe/Morbidly obese to Overweight/Norm were compared to Pts who maintained Norm BMI and those who maintained Obese BMIs via T-test,chi-square.

Results

Total of 703 Pts(n=136 Wtloss,n=204 Obese,n=362 Norm). Significance was found in Ptsage(60.64, 60.24, 57.39; p=.023), gender (Females=48.1%,59.4%,66.7%; p=<.001) and CCI(3.24,2.73,2.47; p=<.001). In the Wtloss cohort, Pts dropped on average 4.63(+/-3.58) BMI points in, on average, 1896 days. Surgeries in the Wtloss group had significantly lower op-time, blood loss and length of stay (p <.001 for all) compared to obese Pts superficial SSI were significantly lower in the Wtloss cohort (1.5% vs2.9%, p=.025), while Pts in the Wtloss category had increased rates of deep infections(2.25% vs0%, p=.20). It was found that the Wtloss group had less complications when compared to the Obese group, but in comparison to the Norm BMI group there are still increased risks.

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Conclusion
Patients who had statistically significant changes to their BMI prior to surgery demonstrated shorter op times, blood loss, and length of stay compared to obese Pts. Their metrics did not improve compared to the lvl of Norm. The data demonstrates that weight loss before lumbar fusion confers advantage compared to obese Pts in key surgical metrics, including SSI, but the Wt loss Pts continue to be compromised compared to those who always had Norm BMI.

Table 1 Comparison of Demographics, Procedural outcomes and complications between normal BMI, Severe/Morbidly Obese BMI, and the Weightloss cohort

	BMI	Normal BMI (n=362)	Severe/Morbidly Obese (n=[illegible])	Weightloss (n=[illegible])	p-value
Demographics	Age (years)	60.24 (+/- 13.95)	57.39 (+/-11.60)	60.64 (+/-12.63)	0.023
	Gender (% Female)	236 (68.7%)	117 (53.4%)	63 (46.1%)	< .001
	CCI	2.47 (+/-2.08)	2.73 (+/-1.90)	3.24 (+/-2.14)	< .001
	Smoking	Current: 25 (6.5%); Past: [illegible]	Current: 14 (6.5%); Past: 42 (20.6%)	Current: 16 (11.8%); Past: 31 (22.8%)	0.362
Procedural Outcomes	Pre-op radiculopathy	178 (49.2%)	104 (51.0%)	57 (42.2%)	0.26
	Open vs MIS	37 (10.2%)	24 (11.8%)	8 (5.9%)	0.181
	Levels Fused	1.76 (+/-.969)	1.83 (+/-.898)	1.90 (+/-1.04)	0.307
	Operative Time (min)	219.81 (+/- [illegible]	267.10 (+/- [illegible]	257.01 (+/- [illegible]	< .001
	EBL (mL)	239.70 (+/- 277.40)	374.16 (+/- 537.74)	327.65 (+/- 470.343)	<.001
	LOS (days)	3.01 (+/-2.07)	4.12 (+/-3.38)	3.83 (+/-3.19)	< .001
Complications	All Intraoperative Complications (%)	20 (5.5%)	12 (5.9%)	3 (2.2%)	0.248
	Neuromonitoring (%)	10 (2.8%)	6 (2.9%)	5 (3.7%)	0.867
	Durotomy (%)	18 (5%)	9 (4.4%)	3 (2.2%)	0.394
	All Postoperative Complications	65 (18%)	43 (24%)	23 (16.9%)	0.151
	Cardiac (%)	20 (5.5%)	12 (5.9%)	6 (4.4%)	0.342
	Neurological Deficit (%)	15 (4.2%)	10 (4.9%)	4 (3%)	0.786
	DVT/PE (%)	1 (.3%)	1 (.5%)	1 (.7%)	0.772
	Pulmonary (%)	6 (1.7%)	2 (1.0%)	0	0.291
	Urinary (%)	11 (3.0%)	7 (3.4%)	5 (3.7%)	0.897
	Deep Surgical Infection (%)	0	2 (1%)	3 (2.2%)	0.006
	Superficial Surgical Site Infection (%)	1 (.3%)	6 (2.9%)	2 (1.5%)	0.025
	Returns to OR				
	All returns in 30 days (%)	7 (1.9%)	7 (3.4%)	3 (2.2%)	0.529
	All returns in 90 days (%)	12 (3.3%)	6 (2.9%)	4 (2.9%)	0.96
	Instrumentation Revision (%)	1 (.3%)	3 (1.5%)	1 (.7%)	0.269
	Flatback (%)	0.00%	0.00%	1 (.07%)	0.124
	Adjacent segment Disease (%)	2 (.6%)	6 (2.9%)	5 (3.7%)	0.028
	Stenosis (%)	1 (3%)	6 (2.9%)	9 (6.6%)	0.134
	Herniated Nucleus Pulposus (%)	2 (.6%)	0	1 (.7%)	0.519
	Radiculopathy (%)	9 (2.5%)	2 (1%)	6 (4.4%)	0.13
	Fracture (%)	0	0	0.74%	0.125
	Pseudoarthrosis (%)	5 (1.4%)	4 (2%)	5 (3.7%)	0.264

180. POSTOPERATIVE RADICULITIS IN PATIENTS WITH PREOPERATIVE RADICULAR SYMPTOMS FOLLOWING SINGLE-LEVEL ANTERIOR LUMBAR INTERBODY FUSION

Kasra Araghi, BS; Mitchell Fourman, MPhil; Robert K. Merrill, MD; Omri Maayan, BS; Eric Zhao, BS; Anthony Pajak, BS; David Kim, MD; Tejas Subramanian, BS; Robert Kamil, BS; Olivia Tuma, BS; Max Korsun, BS; Pratyush Shahi, MBBS, MS; James E. Dowdell, MD; Sravisht Iyer, MD; Evan D. Sheha, MD; Sheeraz Qureshi, MD; John C. Clohisy, MD

Hypothesis
Certain clinical or demographic factors will increase the likelihood of postoperative radiculitis following L5-S1 ALIF with or without posterior instrumentation.

Design
Retrospective chart review.

Introduction
While the safety and efficacy of both stand-alone and traditional ALIF have been described, the rate of neurological deficits has been reported to be up to 6.8%. In the absence of iatrogenic injury, postoperative radiculitis, or weakness, appears to be the least predictable complication. Elucidating which factors may predict postop radiculitis is essential clinical information.

Methods
Adult patients (18-80 years) with preoperative radiculopathy who underwent L5-S1 (ALIF) with or without posterior fixation by 7 surgeons between 01/2016 and 12/2021 were included. Radiographic parameters were measured preop and at 2-wk, 6-wk, 3-mo, and 6-mo postop. PROMs included ODI, VAS Leg/Back, SF-12 PCS/MCS, and PROMIS at preop, 2-wk, 6-wk, 3-mo, 6-mo, & 1-yr. Multivariable logistic regression was performed with radiculitis as the dependent variable and different independent predictor variables. Statistical significance was taken at p-value < 0.05.

Results
From 140 patients, 48 developed postoperative radiculitis (34%). The average time to symptom onset and resolution was 30 and 158 days, respectively. Statistically significant independent predictors of postoperative radiculitis were preoperative Medrol dosepak use (p=0.02, OR=5.07), increased implant height (p=0.002, OR=1.41), and no posterior fixation (p=0.0015, OR=3.98). There were no differences in any pre & postop radiographic parameters between the 2 groups. No differences in preoperative PROMs. Postop between the 2 groups, there were statistically significant differences at 2-wk (leg & back VAS), and 6-wk (all PROMs except SF-12 PCS). There were no differences in any outcomes at 12-wk, 6-mo, or 1-yr.

Conclusion
Preoperative Medrol dosepak use, increased implant height, and no posterior fixation were statistically significant independent predictors of postoperative radiculitis. These findings offer important clinical

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insight into a poorly understood complication.

	No Postop N= 92	Postop Radiculitis N=48	P-Value
Male (%)	52 (56.5)	22 (45.8)	0.306
			0.493
No Diabetes	86 (93.5)	47 (97.9)	
Diabetes	5 (5.4)	1 (2.1)	
Insulin dependent diabetes	1 (1.1)	0 (0.0)	
Current Smoking (%)	10 (10.9)	5 (10.4)	1
Age (mean (SD))	52.92 (13.91)	53.00 (15.84)	0.975
BMI (mean (SD))	26.94 (4.74)	27.95 (5.69)	0.37
Age Adjusted CCI (mean (SD))	3.30 (1.74)	3.33 (1.91)	0.928
Length of symptoms in months (mean (SD))	35.49 (53.90)	41.37 (49.65)	0.596
Implant Height mm (mean (SD))	11.51 (2.15)	12.51 (2.00)	0.005
Implant Lordosis° (mean (SD))	12.33 (3.15)	12.58 (3.68)	0.902
Posterior Fixation (%)	52 (56.5)	14 (29.2)	0.004

Table 1. Comparison of preoperative demographic and implant characteristics between patients who did not develop radiculitis postoperatively and those who did.

181. COST-EFFECTIVENESS OF INSTRUMENTED VERSUS UNINSTRUMENTED FUSION FOR DEGENERATIVE SPONDYLOLISTHESIS

Andreas K. Andresen, MD, PhD; Mikkel î Andersen, MD; *Leah Y. Carreon, MD, MS*; Jan Sorensen, MS

Hypothesis
Instrumented posterolateral fusion is more cost-effective compared to uninstrumented fusion.

Design
Randomized controlled trial with 2 year follow up.

Introduction
Spinal fusion in the elderly population has increased over the last decades. With shifting demographics, an increased demand for good quality of life even in old age, and increased cost of healthcare, the application of cost-effective procedures is a major concern. The aim of this study is to investigate whether instrumented posterolateral fusion (IPLF) is cost-effective compared to un-instrumented posterolateral fusion (UPLF) in elderly patients who undergo fusion surgery for one-level degenerative spondylolisthesis with spinal stenosis.

Methods
This cost-effectiveness analysis is based on a single-center, open label, randomized controlled trial, where patients with symptomatic degenerative spondylolisthesis were randomly assigned 1:1 to either IPLF or UPLF. Quality-Adjusted Life Years (QALY) were obtained from EQ-5D. Use of health services were obtained from patient charts and accumulated until 2 years after index surgery.

Results
Of the 108 patients included in the study, 107 patients received the allocated intervention. There were no differences in preoperative demographics. Although the base price for IPLF was significantly higher than for UPLF, average cost of surgery was only €146 higher. The IPLF group had significantly less reoperations (2% vs 13%, p=0.03), outpatient visits (12 vs 38, p=0.015), MRIs performed (12.9% vs 35.0%, p=0.019) and hospital days (5.7 vs 7.3, p=0.02). The base case incremental cost-effectiveness ratio (ICER) was estimated at €1,536 per QALY gained. In sensitivity analysis including all reoperations or applying hospital reimbursement rates, the IPLF yielded better outcomes and lower costs than UPLF.

Conclusion
The results show significantly lower reoperation rates in the IPLF group than the UPLF group. The base case analysis suggested that the ICER for IPLF was well below usual levels of thresholds.

182. DOES TRANSFORAMINAL LUMBAR INTERBODY FUSION IMPROVE LORDOSIS? THE IMPORTANCE OF SURGEON INTENT

Charles H. Crawford III, MD; Benjamin Fitch, BS; Jeffrey L. Gum, MD; Kirk Owens, MD; Mladen Djurasovic, MD; Steven D. Glassman, MD; *Leah Y. Carreon, MD*

Hypothesis
Surgeon intent to restore normal alignment will affect change in lordosis.

Design
Retrospective comparative observational cohort.

Introduction
Current literature suggests that transforaminal lumbar interbody fusion (TLIF) is ineffective at improving lumbar lordosis. However, change in lordosis taken as a whole group average may be inappropriate, as surgeons may intend to generate greater lordosis in hypolordotic segments and no change in normal or hyperlordotic segments.

Methods
A consecutive series of patients undergoing a single-level TLIF at L4/L5 for degenerative spine conditions were identified from a multi-surgeon academic training center. Surgical level lordosis (SLL) were measured on preop, immediate postop, and one-year

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postop standing radiographs using PACS and stratified by preop SLL at L4/L5 into hypo- (<13°), normal (13°-21°), or hyperlordotic (>21°).

Results
159 patients were included, mean age of 56.8 years; 111 patients (69%) were female. For the entire cohort the mean pre-op SLL (L4/L5) was 20.1°, mean immediate post-op was 21.1° and mean one-year was 19.9°. While the group averages showed an insignificant change in lordosis, there was substantial variability (range = -15.9° to 15.3°). When stratified by pre-op alignment there was a statistically significant difference among groups. For hypolordotic cases (N=26) mean pre-op lordosis was 8.6°, immediate post-op was 13.2° and one-year was 12.1°. For patients with normal pre-op lordosis (N=58), mean pre-op lordosis was 17.6°, immediate post-op was 19.5° and one-year was 17.9°. For hyperlordotic cases (N=75), mean pre-op lordosis was 26.1°, immediate post-op was 25.0° and one-year was 24.2°. There was a statistically significant difference among the groups for immediate postop change in lordosis (hypo:4.6° vs N:1.9° vs hyper:-1.1°, p<0.001) and one-year change (hypo:3.5° vs N:0.4° vs hyper:-1.8°, p<0.001). Maximum lordosis gained was 15.3° in the hypolordotic, 11.1° in the normal, and 5.8° in the hyperlordotic group.

Conclusion
While group averages show an insignificant change in segmental lordosis following TLIF, hyperlordotic patients lost lordosis, normal lordosis patients maintained lordosis, and hypolordotic patients gained lordosis, supporting the hypothesis that surgeon intent to restore or maintain normal alignment parameters affects the change in lordosis seen after TLIF.

183. IS THE SPINOPELVIC ALIGNMENT ACHIEVED IN A SHORT SEGMENT LUMBAR FUSION AT 3 MONTHS AFTER SURGERY MAINTAINED AT 24 MONTHS?

Devon Lefever, MD; Caroline E. Drolet, PhD; Philip K. Louie, MD; Eric S. Varley, DO; Venu M. Nemani, MD, PhD; Rajiv K. Sethi, MD; Jean-Christophe A. Leveque, MD

Hypothesis
Despite compensatory changes at unfused levels after short segment lumbar fusions, spinopelvic alignment at 3 months will not differ significantly at 24 months.

Design
Retrospective cohort study from a multicenter, prospectively-collected database.

Introduction
Although the relationship between pelvic incidence (PI), lumbar lordosis (LL), and patient outcomes are well established in spinal deformity surgery, this relationship in short-segment lumbar fusions for degenerative pathology is still undetermined. We sought to examine the fate of postop spinopelvic parameters at early (3-month) and late (24-month) timepoints as well as clinical outcomes after 1-2 level lumbar fusions for degenerative pathology.

Methods
Spinopelvic parameters were measured on preop and postop (3- and 24- months postop) neutral standing lateral lumbar radiographs prospectively acquired from 76 patients who underwent 1-2 level lumbar fusion for degenerative pathology. Patients were categorized based on the PI-LL mismatch as aligned (AL)(PI-LL <10°) or malaligned (MAL)(PI-LL >10°) at all timepoints. Alignment was categorized postop as preserved (AL to AL), restored (MAL to AL), not corrected (MAL to MAL), or worsened (AL to MAL). Oswestry Disability Index (ODI) scores were collected at both time points.

Results
3 months postop, PI-LL matching was preserved in 61%, restored in 9%, not corrected in 28%, and worsened in 3% of patients. PI-LL matching at 24 months was preserved in 58%, restored in 8%, not corrected in 29%, and worsened in 5% of patients. Preop malalignment was predictive of postop malalignment. Preop ODI was not affected by preop alignment status (AL:40, MAL:43). All 4 categories of postop alignment had improved ODI at 3- and 24-months (p<0.0001). At 3-months, ODI did not statistically differ regarding alignment. However, at 24-months aligned patients had significantly lower ODI than malaligned patients (p=0.02, AL:17, MAL:27).

Conclusion
The spinopelvic alignment achieved at 3-months for 1-2 level lumbar fusions for degenerative pathology remains stable at 24-months. Patients report significant improvement in level of disability at 3 months after surgery regardless of alignment, however at 24 months, those who are appropriately

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aligned are significantly more improved than the malaligned group. Surgeons may consider longer follow-up in patients in which "proper" alignment was not initially achieved.

184. CLINICAL AND RADIOGRAPHIC OUTCOMES OF REPAIR OF SPONDYLITIC SPONDYLOLISTHESIS VIA DIRECT PARS REPAIR

John R. Dimar, II, MD; Nolan Smith, BS; Steven D. Glassman, MD; Charles H. Crawford III, MD; Mladen Djurasovic, MD; *Leah Y. Carreon, MD*

Hypothesis
Direct Pars Repair achieves healing and symptom relief in young patients with spondylitic spondylolisthesis.

Design
Retrospective chart review

Introduction
Lumbar Spondylitic Spondylolisthesis is a defect in the pars interarticularis, causing displacement of a vertebrae forward onto the one beneath it. While most cases can be managed non-operatively, a small percentage of patients require surgical intervention. Direct pars repair is often used in younger patients as it has a lower biomechanical profile and does not involve fusion of a spinal segment.

Methods
Medical records of patients who had undergone an open surgical pars repair were retrospectively reviewed. Standard demographic and surgical parameters were collected. All patients underwent a primary repair of the pars utilizing a standard wiring to pedicle screw surgical technique with autografting of the pars defect. CT scans were done preop/postop and were independently reviewed postoperatively for the success of healing; graded as none, partial and solid union. The patients completed standard patient outcome measures at standard time intervals.

Results
There were 68 patients identified (M=33, F=35) with an average age of 18.6 years and mean BMI of 23.5 kg/m2, with 6 smokers. Mean ASA score was 1.4, mean estimated blood loss was 139cc, and mean length of hospital stay was 3.7 days. CT evaluation revealed 12 (17.6%) non-unions, 21 (30.9%) partial unions, 35 (51.5%) solid unions. 34 (50%) had no postop pain, 24 (35.3%) had mild pain, 10 (14.7%) had persistent pain. Twelve patients (17.6%) required revisions with fusions. The majority of patients with non-unions on CT had mild (5) or persistent pain (4). While the majority of patients with partial or solid fusions had no pain (31, p=0.046). BMI (p=0.845). Age at time of surgery was not associated with achieving union (p=0.952). Patients with no or mild pain tended to be younger (17.5 yrs.) than those with persistent pain (24.6 yrs.).

Conclusion
The results of the study demonstrate an 83.4% partial (30.9%) or complete union (51.5%) rate on CT analysis. 50% of the patients had mild (35.3%) or persistent (14.7%) LBP. This raises the question about the success of pars repair in achieving a union and relief of symptoms with a 17.6% revision rate in a young population.

185. EXTERNAL VALIDATION OF AN ON-LINE MODEL (DIALOGUE SUPPORT) TO PREDICT PATIENT OUTCOMES AFTER LUMBAR FUSION SURGERY

Leah Y. Carreon, MD; Steven D. Glassman, MD; Andrew K. Chan, MD; Praveen V. Mummaneni, MBA; Anthony L. Asher, MD

Hypothesis
The on-line model, Dialogue Support, can accurately identify patients who will be satisfied, achieve success or have no leg pain after lumbar fusion surgery.

Design
Longitudinal Observational Cohort

Introduction
To help clinicians discuss risk vs benefit with patients considering lumbar fusion surgery, "Dialogue Support" (DS) has been made available on-line. As DS was created using a Swedish sample, there is a need to study how well DS performs in alternative populations.

Methods
Pre-op data from patients enrolled in the Quality Outcomes Database (QOD) were entered into DS. The probability for each patient to report satisfaction, achieve success (Leg Pain improvement ≥ 3) or have no leg pain 12 months after surgery were extracted. These probabilities were compared to the actual 12 month post-op data for each of the QOD cases. The ability of DS to identify patients in QOD who report satisfaction, achieve success or have no leg pain 12

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months after surgery was determined using ROC Curve Analysis, goodness-of-fit tests and calibration plots.

Results
Of 72,514 cases in QOD, 23,928 were included in the analysis. There was a significant improvement in all outcomes from baseline to 12 months post-op. Most (84%) reported satisfaction, 67% achieved success and 44% were pain free 12 months post-op. ROC analysis showed that DS had a low ability to predict satisfaction (AUC=0.606), success (AUC=0.546) and being pain free (AUC=0.578) at 12 months post-op. There was poor fit for satisfaction (<0.001) and being pain free (p=0.004), but acceptable fit for success (p=0.052). Calibration plots showed underestimation for satisfaction and success, but acceptable estimates for being pain free.

Conclusion
Dialogue Support is not directly transferable to predict satisfaction and success after lumbar surgery in a US population. This may be due to differences in patient characteristics, weights of the variables included or exclusion of unknown variables strongly associated with outcomes. Future studies to better understand and improve transferability of these models are needed.

187. THE 5-FACTOR MODIFIED FRAILTY INDEX (MFI-5) PREDICTS ADVERSE OUTCOMES AFTER ELECTIVE ANTERIOR LUMBAR INTERBODY FUSION (ALIF)

Neil Patel, MD; Daniel Coban, MD; Faisal Elali, BS; Stuart Changoor, MD; Neil V. Shah, MD, MS; Kumar Sinha, MD; Ki S. Hwang, MD; Michael J. Faloon, MD; Arash Emami, MD

Hypothesis
The mFI-5 will be an independent predictor of adverse events following elective ALIF.

Design
Retrospective Database Study

Introduction
The mFI-5 is the most frequently cited frailty index and has shown to be a concise and effective tool for predicting adverse events following various spine procedures. However, no studies have assessed its utility as a risk stratification tool in patients undergoing ALIF. Therefore, the purpose of this study was to analyze the predictive capabilities of the mFI-5 for 30-day postoperative adverse events following elective ALIF.

Methods
The National Surgical Quality Improvement Program (NSQIP) database was queried from 2010 through 2019 to identify patients who underwent ALIF using Current Procedural Terminology (CPT) codes 22558 and 22585. Exclusion criteria removed patients under the age of 50, as well as those with sepsis, disseminated cancer, a prior operation in the last 30 days, ascites, wound infection, or an emergency surgery. The mFI-5 score was calculated using variables for hypertension, congestive heart failure, comorbid diabetes, chronic obstructive pulmonary disease, and partially or fully dependent functional status which were each assigned 1 point. Univariate analysis and multivariate logistic regression models were utilized to identify the associations between mFI-5 scores, and 30-day rates of overall complications, readmissions, reoperations, and mortality.

Results
11,711 patients were included (mFI-5=0: 4,026 patients, mFI-5=1: 5,392, mFI-5=2: 2,102, mFI-5=3+: 187). Multivariate logistic regressions revealed that mFI-5 scores of 1 (OR: 2.2, CI: 1.2 – 4.2, p=0.02), 2 (OR: 3.6, CI: 1.8 – 7.3, p<0.001), and 3+ (OR: 7.0, CI: 2.5 – 19.3, p<0.001) versus a score of 0 were significant predictors of pneumonia. An mFI-5 score of 2 (OR: 1.3; CI: 1.01 – 1.6, p=0.04), and 3+ (OR: 1.9; CI: 1.1 – 3.1; p=0.01) as compared to a score of 0, were both independent predictors of related readmissions. An mFI score of 3+ was an independent predictor of any major or minor complication (OR: 1.5, CI: 1.01 – 2.2, p=0.004), UTI (OR: 2.4, CI: 1.1 – 5.2, p=0.02), and unplanned intubation (OR: 4.5, CI: 1.3 – 16.1, p=0.02).

Conclusion
The mFI-5 was an independent predictor for 30-day postoperative major or minor complications, readmissions, UTI, pneumonia, and unplanned intubation following elective ALIF surgery in adults over the age of 50.

†Luis A. Goldstein Best Clinical Research Poster *John H. Moe Best Basic Research Poster

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188. HOW LOW CAN YOU GO?: A PROPENSITY SCORE MATCHED STUDY ON HIGH VERSUS LOW DOSE BONE MORPHOGENETIC PROTEIN-2 (BMP-2) USAGE IN MINIMALLY INVASIVE TRANSFORAMINAL LUMBAR INTERBODY FUSION (MIS-TLIF) FOR SPONDYLOLISTHESIS

Ramkumar Mohan, MBBS; Andrew G. Wu; *Reuben C. Soh, MBBS, FRCS*

Hypothesis
Use of low dose and high dose BMP-2 have similar rates of fusion with better adverse effect profile in low dose group in both matched and unmatched cohorts.

Design
Prospective study of 216 patients who underwent minimally invasive Transforaminal Lumbar Interbody Fusion (MIS-TLIF) procedure, comparing low dose vs high dose BMP-2 usage.

Introduction
The current optimal dose of Bone Morphogenetic Protein-2 (BMP-2) has not been established in minimally invasive posterior approach lumbar spine surgery. We present a study on a direct comparison between low dose and high dose BMP-2 usage in MIS-TLIF.

Methods
216 consecutive patients that underwent MIS-TLIF procedures for degenerative spondylolisthesis who received BMP-2 from January 2011 to September 2018 in our institution were included into the study. From the years 2011 to 2013, 4.2mg per level of BMP-2 was used in MIS-TLIF procedures in this institution, subsequently, from 2014, 2.1mg per level of BMP-2 was used.

Results
172 patients received BMP-2 dose of 4.2 mg per level while 44 patients received BMP-2 dose of 2.1mg per level. Patients were subsequently propensity score matched at a 1:1 ratio (n=43) and reevaluated. When cohorts of high and low dose BMP-2 were directly compared, there were no significant differences noted in terms of fusion. No statistical differences were noted in terms of adverse effects between the 2 cohorts, however trends toward lower adverse effect in low dose cohort was noted with a combined total of 8 out of 9 adverse effects occurring in the high dose cohort. After matching similarly, there were no significant findings in terms of post-operative outcomes or adverse effects noted. With matched populations, fusion rates at 6 months, 12 months and 24 months mark had no significant differences (table 1).

Conclusion
Our study shows that low dose BMP-2 usage has similar rates of fusion and recovery with reduced adverse effect profile. We surmise that based on observed trends, larger cohort data would point to an increased number of adverse outcome with regard to the use of high dose BMP-2.

	4.2mg per level (High dose)	2.1mg per level (Low dose)	p-value
Demographics			
Female, n (%)	21 (48.8)	24 (55.8)	0.666
Age, median [IQR]	59.00 [53.00, 65.50]	60.00 [52.00, 66.50]	0.928
BMI, median [IQR]	25.56 [23.28, 30.07]	25.63 [22.62, 29.90]	0.876
Smoking history, n (%)	1 (2.3)	2 (4.7)	1.000
Diabetes Mellitus, n (%)	4 (9.3)	6 (14.0)	0.737
Fusion			
6 months, n (%)	30 (69.8)	30 (69.8)	0.595
12 months, n (%)	36 (83.7)	41 (95.4)	0.462
24 months, n (%)	36 (83.7)	42 (97.7)	0.260
Adverse Effects			
Heterotopic Ossification, n (%)	1 (2.3)	0 (0.0)	1
Subsidence, n (%)	1 (2.3)	1 (2.3)	1

Table 1: Matched low vs high dose BMP-2 patient cohorts (n=43:43)

189. MINIMALLY INVASIVE VERSUS OPEN TRANSFORAMINAL LUMBAR INTERBODY FUSION FOR GRADE 1 LUMBAR SPONDYLOLISTHESIS: 60-MONTH FOLLOW-UP FROM THE QOD MULTI-CENTER PROSPECTIVE REGISTRY

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Hypothesis
Minimally invasive and open transforaminal lumber interbody fusion have similar clinical outcomes at 60 months.

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Design
Retrospective analysis of prospectively-collected data

Introduction
Though minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) has short-term benefits compared to open TLIF, the impact on long-term patient-reported outcomes (PROs) is less clear. We compare the outcomes of open and MIS TLIF for grade 1 degenerative lumbar spondylolisthesis 60-months postoperatively.

Methods
We utilized the prospective Quality Outcomes Database registry and queried patients with grade 1 degenerative lumbar spondylolisthesis who underwent single-segment MIS or open TLIF. Patient-reported outcomes (PROs) were compared 60 months postoperatively—ODI, NRS Back Pain (NRS-BP), NRS Leg Pain (NRS-LP), EQ-5D, NASS Satisfaction, and cumulative reoperation rate. Multivariable models were used, adjusting for variables reaching p<0.20 on univariate analyses.

Results
297 patients were included: 72 MIS TLIF (24.2%) and 225 open TLIF (75.8%). 60-month follow-up was similar (MIS TLIF: 86.1% vs. open TLIF: 75.6%, p=0.06). The cohorts were similar at baseline for all PROs (p>0.05). MIS TLIF was associated with less blood loss (108.8±85.6 vs. 299.6±242.2 ml, p<0.001), longer operations (228.2±111.5 vs. 189.6±66.5 min, p<0.001), and a trend toward decreased length of hospitalization (2.9±1.8 vs. 3.3±1.6 days, p=0.08). Discharge disposition to home was similar (94.4% vs. 91.1%, p=0.38). Both cohorts improved significantly from baseline for all 60-month outcomes (p<0.001). In adjusted analyses, MIS TLIF—compared to open TLIF—was associated with similar 60-month ODI, ODI change, ODI MCID achievement, NRS-BP, NRS-BP change, NRS-LP, NRS-LP change, EQ-5D, EQ-5D change, and NASS satisfaction (adjusted p>0.05). The 60-month reoperation rates did not differ significantly (MIS TLIF: 5.6% vs. open TLIF: 11.6%, p=0.14).

Conclusion
For single-level, grade 1 degenerative lumbar spondylolisthesis, MIS TLIF was associated with decreased blood loss but there was no difference in 60-month outcomes for disability, back pain, leg pain, quality of life, satisfaction, or reoperation. These results suggest that in appropriately selected patients, either procedure may be employed depending on patient and surgeon preferences.

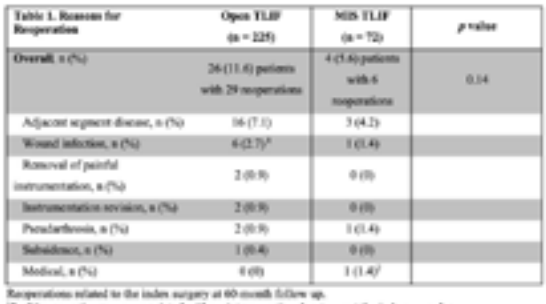

Table 1. Reasons for Reoperation	Open TLIF (n = 225)	MIS TLIF (n = 72)	p value
Overall, n (%)	26 (11.6) patients with 29 reoperations	4 (5.6) patients with 6 reoperations	0.14
Adjacent segment disease, n (%)	16 (7.1)	3 (4.2)	
Wound infection, n (%)	6 (2.7)*	1 (1.4)	
Removal of painful instrumentation, n (%)	2 (0.9)	0 (0)	
Instrumentation revision, n (%)	2 (0.9)	0 (0)	
Pseudarthrosis, n (%)	2 (0.9)	1 (1.4)	
Subsidence, n (%)	1 (0.4)	0 (0)	
Medical, n (%)	0 (0)	1 (1.4)†	

Reoperations related to the index surgery at 60 month follow up.
*2 of 6 reoperations were associated with an intraoperative durotomy at the index procedure.
†The index surgery—a planned MIS TLIF—was aborted after the decompression was completed due to an air embolism. The patient returned in one month for instrumentation.

Table 2. Multivariable analysis of 60-month outcomes following surgery for grade 1 lumbar spondylolisthesis (reference—open TLIF)	Adjusted* β† Coefficients (95% CI)	p value
Primary Outcomes		
ODI, 60 months	-2.4 (-7.0 to 2.2)	0.31
ODI, 60-month change	-1.9 (-6.5 to 2.7)	0.43
ODI MCID, 60 months	1.3 (0.7 to 2.7) (OR)	0.45
Secondary Outcomes		
NRS Back Pain, 60 months	-0.5 (-1.3 to 0.3)	0.23
NRS Back Pain, 60-month change	-0.4 (-1.1 to 0.4)	0.35
NRS Leg Pain, 60 months	-0.5 (-1.3 to 0.2)	0.17
NRS Leg Pain, 60-month change	-0.4 (-1.2 to 0.4)	0.36
EQ-5D, 60 months	-0.01 (-0.07 to 0.04)	0.61
EQ-5D, 60-month change	-0.01 (-0.07 to 0.04)	0.64
NASS Satisfaction‡, 60 months	1.0 (0.5 to 1.8) (OR)	0.99

ODI – Oswestry Disability Index; MCID – minimum clinically important difference; NRS – Numerical Rating Scale; EQ-5D - EuroQol-5D; NASS – North American Spine Society; OR – odds ratio.
β Coefficients are reported such that a negative value for ODI, NRS back pain, and NRS leg pain and a positive value for EQ-5D represents more favorable outcomes at 60 months for MIS TLIF, compared to open TLIF.
Odds ratios (OR) are reported such that an OR>1.0 for NASS satisfaction represents greater satisfaction at 60 months for MIS TLIF, compared to open TLIF.
*Multivariate models adjusted for factors with p<0.20 on univariate comparisons and respective baseline PRO values
†Unless otherwise stated
‡OR < 1.0 represents an increased odds of greater satisfaction following surgery for MIS TLIF

190. THE USE OF THORACIC SPINAL CORD STIMULATION IN PATIENTS WITHOUT OPTIONS FOR CORRECTIVE SURGERY; 1-YEAR FOLLOW-UP FROM DISTINCT, A PROSPECTIVE RCT

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Hypothesis
To evaluate the effectiveness of passive recharge burst SCS, compared to CMM, in improving chronic back pain (> 6 months) and function in patients who have not had lumbar spine surgery and for whom corrective surgery is not indicated.

†Luis A. Goldstein Best Clinical Research Poster *John H. Moe Best Basic Research Poster

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Design
A prospective, multi-center, randomized, controlled clinical study with an optional crossover component after 6 months. Subjects will be followed at 1,3, 6, 9, 12, 18 and 24 months. Endpoints are assessed at the 6-month follow-up visit.

Introduction
Low back pain (LBP) is a highly prevalent and costly condition. Patients with an identifiable anatomic pain generator may receive back surgery and achieve relief, but many are not candidates as they lack an identifiable surgically correctable pathology. Standard non-operative strategies include physiotherapy, oral analgesics, and image guided injections; these may not provide durable relief. SCS is sometimes used to treat these patients but level I evidence is sparse. We present 12-month follow-up from DISTINCT (NCT04479787), the largest RCT to date, comparing passive recharge burst SCS to CMM in patients suffering from chronic, refractory back pain who have not had lumbar spine surgery and for whom corrective surgery is not indicated.

Methods
An independent board-certified spine surgeon reviewed each case and confirmed a lack of suitable corrective surgical options. Outcomes collected measure pain relief, function, emotional distress and patient impression. Responder analysis used published clinical meaningful changes. Means, standard deviations and 95% confidence intervals were calculated as appropriate.

Results
107 subjects were randomized to CMM and 162 were randomized to SCS therapy. In a 6-month ITT analysis, significantly more subjects in the SCS arm reported 50% pain relief or greater compared to CMM (73.1% v's 6.2%; p<0.0001). Per Treatment Analysis (PTE) reported 85.3% (95% CI: 76.9-91.5) responding on SCS compared to 6.2% (95% CI:2.0-13.8) on CMM. At 12-months NRS was reduced to 2.5 ± 2.2. ODI decreased by 28.5 points ± 16.9 from baseline to 22.8 ± 12.7. 79.2% responded on PCS (12-month score = 7.8 ± 9.6). PROMIS-29 physical function and pain interference improved by 9.3 ± 6.8 and 12.9 ± 8.9 respectively. 77% responded on PGIC.

Conclusion
6-month and 12-month data both support meaningful improvements in the SCS group on NRS, ODI, PCS, PROMIS-29 and PGIC.

191. A SINGLE SITE REVIEW OF COVID-19'S IMPACT ON ELECTIVE SPINE SURGERY: TEMPORARY DECREASE IN VOLUME, BUT BUSINESS AS USUAL?

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Hypothesis
We hypothesized that patients selected for elective surgery would overall be younger, have less comorbidity, and lower American Society of Anesthesiologists (ASA) scores as compared to pre-COVID. Similarly, we hypothesized that patient outcomes would not be significantly worse during the pandemic.

Design
Retrospective case series

Introduction
The COVID-19 pandemic has had large impacts on patient care across all fields, including orthopaedic spine surgery. At many institutions, elective procedures were cancelled or postponed for a time to mitigate the risks of COVID exposure. The effects of reduced case volume and changing practice parameters has been incompletely explored.

Methods
We identified all patients undergoing elective spine surgery at our single tertiary institution from January 1st 2019, to December 31st 2020. All surgeries were performed by five board certified orthopaedic spine surgeons. They were divided into two cohorts, those receiving surgery before and after March 15th, 2020, which corresponds to the date the elective procedure deferment was implemented. Demographic and procedural information for each patient was collected, including age, comorbidities, ASA classification, and procedure type. Outcomes data up to 90 days was collected, including major and minor medical complications, reoperation and readmission rates, length of stay greater than 3 days, and discharge location.

Results
1545 elective spine surgeries were identified. Of those, 957 were before March 15th, 2020 (Pre-COVID),

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and 588 occurred after. 266 patients underwent lumbar fusions, 149 underwent cervical fusions, and 319 underwent lumbar decompression pre-COVID, compared to 166, 112, and 111 in the COVID cohort. Surgical volume returned to baseline within three months after elective surgery deferment began, faster than anticipated by the authors. There was a significant decrease in reoperation rates in the COVID cohort compared to pre-COVID (p=0.006) for all procedures. When divided by procedure type, fusion patients experienced a significant decrease in reoperation rates (p<0.001).

Conclusion

Our study suggests that, despite the COVID-19 pandemic, elective spine procedures did not carry significantly increased risk. Elective procedure volume returned to baseline within three months. These findings have a positive implication for future COVID variants or pandemics.

Operative outcomes of Patients Pre-COVID and during COVID

Cervical Fusion	Pre-COVID n = 149	COVID n = 112	Adjusted OR (95% CI)	p-value
Postoperative Complication within 3 Months	18	9	0.45 (0.146-1.37)	0.158
Reoperation	27	17	0.79 (0.38-1.68)	0.544
90-Day readmission	16	9	0.61 (0.22-1.74)	0.359
Length of stay >3 Days	46	26	1.06 (0.55-2.05)	0.867
Average LOS (d)	4.6	6.7		0.053
Lumbar Fusion	Pre-COVID n = 266	COVID n = 166	Adjusted OR (95% CI)	p-value
Postoperative Complication at 3 Months	25	10	1.077 (0.52-2.21)	0.840
Reoperation	**64**	**13**	**0.29 (0.14-0.54)**	**<0.001**
90-Day readmission	19	15	1.28 (0.56-2.94)	0.564
Length of stay >3 Days	149	93	0.973 (0.62-1.53)	0.907
Average LOS (d)	5.89	5.85		0.917
Lumbar Decompression	Pre-COVID n = 266	COVID n = 166	Adjusted OR (95% CI)	p-value
Postoperative Complication at 3 Months	13	8	1.21 (0.39-3.80)	0.736
Reoperation	39	11	0.49 (0.23-1.04)	0.065
90-Day readmission	11	6	0.940 (0.288-3.06)	0.919
Length of stay >3 Days	21	12	0.87 (0.34-2.27)	0.783
Average LOS (d)	1.50	1.71		0.642

Bolded variables indicate significance with P<0.05

Pre-COVID Versus COVID

193. TRENDS IN INDICATIONS AND CONTRAINDICATIONS FOR CERVICAL DISC ARTHROPLASTY FROM 2009 TO 2019

Jerry Du, MD; Collin W. Blackburn, MD; Han Jo Kim, MD; Sravisht Iyer, MD; Sheeraz Qureshi, MD; Randall E. Marcus, MD; *Todd J. Albert, MD*

Hypothesis

There will be changes in the trends of indications and contraindications for the use of CDA

Design

Cross sectional study

Introduction

As spine surgeons become more familiar with cervical disc arthroplasty (CDA), there may be changes in trends of indications and "contraindications" per the original United States Food and Drug Administration investigative device exemption (IDE) trial criteria.

Methods

The Medicare Provider Analysis and Review Limited Data Sets for 2009, 2014, and 2019 were utilized. Patients undergoing elective CDA were included. Diagnosis for index surgery was assessed. Incidence of "contraindications" were also assessed, including inflammatory arthropathy, insulin dependent diabetes, chronic steroid use, osteoporosis, morbid obesity, and isolated neck pain without neurogenic symptoms. Variables were identified by International Classification of Diseases (ICD)-9 or ICD-10 diagnosis and procedural codes.

Results

There was a total of 1067 elective CDA patients included. There were 230 patients in 2009, 300 patients in 2014, and 537 patients in 2019. Age of patients increased with the proportion of patients age <45 years decreasing from 20% to 10% and the proportion of patients age 65+ increasing from 35% to 51% (p<0.001). From 2009 to 2019, incidence of CDA for radiculopathy increased from 57% to 69% (p<0.001), myelopathy increased from 23% to 78% (p<0.001), and spondylosis without radiculopathy or myelopathy decreased from 19% to 3% (p<0.001). Incidence of "hybrid" surgery with concurrent anterior cervical discectomy and fusion decreased from 28% to 23% (p=0.007). Incidence of insulin dependent diabetes increased from 0% to 2.6% (p=0.001), long term steroid use increased from 0% to 2.4% (p=0.002), and morbid obesity increased from 2% to

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6% (p=0.019). Incidence of inflammatory arthropathy changed from 3.5% in 2009 to 0.7% in 2014 to 4.1% in 2019 (p=0.018) and osteoporosis changed from 0.9% in 2009 to 2% in 2014 and 0% in 2019.

Conclusion
From 2009 to 2019, there is an increased treatment of older patients with CDA. There has been an increase use of CDA for treatment of myelopathy and radiculopathy and decrease for treatment of cervical spondylosis. There are also general increases in use of CDA in patients with "contraindications" as per the original IDE studies. There should be further clinical studies on the outcomes following CDA for patients with contraindications.

194. PELVIC FIXATION IMPROVES CORONAL BALANCE, DECREASES PELVIC OBLIQUITY, BUT IS NOT ESSENTIAL IN NEUROMUSCULAR SCOLIOSIS (NMS)

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Hypothesis
Pelvic fixation is not required to maintain a leveled pelvis and decompensation in NMS patients undergoing PSF with all pedicle screw fixation

Design
Ambispective study

Introduction
Non-ambulatory NMS patients are typically fused to the pelvis to augment fixation, prevent loss of correction and improve seating balance. However, pelvic fixation extends the length of surgery, increases EBL, and may increase pain. This study evaluates the radiographic outcomes after PSF with all pedicle screws in NMS fixated (FP) and not fixated at the pelvis (NFP).

Methods
Radiographic measurements, OR parameters and demographics were recorded for surgeries between 2006-2016. Patients were divided into NFP and FP. Median values and Wilcoxon rank sum tests were used. Subanalysis was performed for patients with preop PO < and > 20°.

Results
There were 91 patients; 63 were non-ambulatory. Between NFP (n=54) and FP (n=37), preop Cobb (60 vs 55.1,p=0.215), PO (4.5 vs 8.8,p=0.158), and decompensation (52.8 vs 20.0, p=0.247) were similar. Both had similar final Cobb (20.0 vs 11.5,p=0.146) and PO (3.2 vs 2.2,p=0.162), but NFP had significant coronal imbalance (35.8 vs 14.6,p<0.004). PO worsened (% change) in the NFP group from postop to final, while it improved in the FP group (-66.7 vs. -76.5,p=0.023). With preop PO<20 (n=58), the NFP and FP had similar preop PO (3.8 vs 5.4, p=0.255) and decompensation (30.3 vs 14.5,p=0.120). At final, NFP had similar PO (2.0 vs 1.5, p=0.425), however decompensation was significant (17.4 vs 14.0,p=0.042) to FP. Change in PO (%) from post to final was significantly worse in NFP (-102.4 vs 16.3,p=0.026). With preop PO>20, patients had similar preop PO (22.3 vs 22.0,p=0.545) and decompensation (166.1 vs 129.3,p=0.075). NFP had higher final PO (15.3 vs 5.8,p=0.123) and significantly higher decompensation (135.4 vs 25.2,p=0.008). The change in PO (-76.5 vs -10.0,p=0.298) and decompensation (-35.8 vs -76.4,p=0.616) from postop to final was similar.

Conclusion
NFP with preop PO>20 had significant coronal imbalance and PO at final follow up. Change in PO and coronal balance over time was similar between the two groups in less severe PO. PF achieves better coronal and PO correction.

195. MORE THAN A FLESH WOUND: TRISOMY 21 PATIENTS UNDERGOING POSTERIOR SPINAL FUSION FOR SCOLIOSIS HAVE HIGH ODDS OF WOUND COMPLICATIONS

Grant D. Hogue, MD; M. Timothy Hresko, MD; Daniel J. Hedequist, MD; Craig M. Birch, MD

Hypothesis
T21 patients will have higher wound complications rates than otherwise healthy adolescent idiopathic scoliosis (AIS) patients undergoing posterior spinal fusion.

Design
Retrospective cohort study with 1:5 matched cohort.

Introduction
Patients with T21 often have soft tissue differences that lead to greater risk of postoperative wound complications. It is difficult to determine the magnitude of that risk based on small sample sizes of current published cohorts. Our aim is to use a

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matched cohort of AIS patients with >2year outcomes to determine odds of specific wound complications when comparing between T21 and AIS patients.

Methods
14 T21 and 544 AIS patients were available for matching. Propensity score matching was conducted using logistic regression models and yielded a 1:5 match of 14 T21 patients and 70 AIS patients. Bivariate analyses were conducted across T21 patients and non-trisomy 21 patients. The proportion of wound complications was estimated along with a 95% confidence interval. Multivariable logistic regression analysis was utilized to determine if there was a significant association between trisomy 21 patients and outcomes, controlling for propensity score, age at surgery, and BMI percentile. Odds ratios were estimated for significant factors along with 95% CI. P-values less than 0.05 were considered significant.

Results
Sixty-four percent of T21 patients experienced a wound complication (9/14; 95% CI=35.63-86.02) while only 3% of the AIS patients experienced a wound complication (2/70; 95% CI=0.50-10.86). Patients with T21 had a significantly higher proportion of wound complications compared to the sex and major curve magnitude matched AIS patients ($p<0.001$). Patients with T21 had 56.6 times the odds of having a wound complication compared to AIS patients (OR=56.57; 95% CI=8.12-394.35; $p<0.001$), controlling for age at surgery, BMI percentile, and propensity score. T21 patients had 10.4 times the odds of reoperation compared to AIS patients (OR=10.36; 95% CI=1.62-66.02; $p=0.01$), controlling for age at surgery, BMI percentile, and propensity score.

Conclusion
T21 patients have 10.4x the odds of reoperation and 56.6x the odds of overall wound complication when compared to AIS patients in a 1:5 matched cohort with appropriate controls. This is important for surgical planning, surgeon awareness, and communication with families preoperatively.

Table 3. Cohort outcomes (N=84).

	Full cohort (N=84)			Trisomy 21 (n=14)			AIS (n=70)		
Characteristic	Freq.	(%)	(95% CI)	Freq.	(%)	(95% CI)	Freq.	(%)	(95% CI)
Wound complication	11	(13%)	(7.03-22.64)	9	(64%)	(35.63-86.02)	2	(3%)	(0.50-10.86)
Return to the OR	6	(7%)	(2.94-15.47)	4	(29%)	(9.58-58.00)	2	(3%)	(0.50-10.86)

Cohort Outcomes

196. CONGENITAL SCOLIOSIS PATIENTS CAN ATTAIN SIMILAR CURVE CORRECTION AND PERIOPERATIVE OUTCOMES TO AIS PATIENTS WITHOUT THE NEED FOR HEMIVERTEBRA EXCISION

Vishal Sarwahi, MD; Sayyida Hasan, BS; Jesse M. Galina, BS; Jeffrey Goldstein, MD; Thomas J. Dowling III, MD; Jordan Fakhoury; Yungtai Lo, PhD; Terry D. Amaral, MD

Hypothesis
Our hypothesis is that this approach leads to similar perioperative correction and radiographic outcomes to AIS patients.

Design
A retrospective case-controlled matched study.

Introduction
Hemivertebra excision is a technically challenging procedure and complications include spinal cord injury, nerve root injury, and CSF leak. We have utilized a hemivertebra-sparing approach in these patients alongside multi-level Ponte osteotomies and all pedicle screw constructs.

Methods
24 patients with congenital scoliosis and associated hemivertebra were included. These 24 patients were compared with the most recent 54 AIS correction surgeries. Additional analysis was done to match hemivertebra patients from a database of 330 AIS patients. Patients were matched based on gender, age, BMI, and preoperative Cobb. Overall, 12 pairs(24 patients) were matched and analyzed to compare the surgeries after accounting for possible confounding variables. Wilcoxon signed-rank tests were used.

Results
When comparing hemivertebra to the most recent AIS patients, age($p = 0.81$), BMI($p = 0.24$) and preoperative Cobb($p = 0.06$) were similar. Postoperative Cobb($p = 0.048$) was significantly larger for AIS patients($p = 0.048$), however, overall Cobb correction was similar between the groups($p = 0.297$). Estimated blood loss was similar($p = 0.095$) while surgical time ($p < 0.001$) and length of stay($p < 0.001$) were significantly longer for hemivertebra patients. After matching patients in both groups postoperative Cobb($p = 1.0$) and overall correction($p = 0.966$) were similar. Patients had a similar number of levels fused($p = 0.227$) and a similar number of fixation points($p = 0.23$). Surgical time($p = 0.413$) and blood loss($p = 0.954$) were similar between groups. The only significant difference was

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that hemivertebra patients had longer hospital stay(p = 0.001).

Conclusion
Patients with hemivertebra can benefit from hemivertebra sparing approach. The radiographic and perioperative outcomes were similar to AIS patients. This approach is safer compared to hemivertebra excision and has similar or better curve correction than previously reported. Choosing fusion levels on similar principles akin to AIS leads to avoidance of hemivertebra excision in most case including lumbosacral hemivertebra cases. The correction likely results at disc levels above and below the hemivertebra.

197. POSTERIOR-ONLY SKIPPING HEMIVERTEBRECTOMIES AND SEPARATED SHORT FUSIONS IN INFANTILE AND JUVENILE CONGENITAL SCOLIOSIS WITH MULTIPLE HEMIVERTEBRAE

Song Li, MD, PhD; Sai-hu Mao, PhD; *Zezhang Zhu, PhD*; Benlong Shi, MD, PhD; Zhen Liu, PhD; Yitong Zhu, MD; Yong Qiu, PhD

Hypothesis
Posterior-only skipping hemivertebrectomies and separated short fusions is a safe, effective, and less invasive procedure for CS with multiple HVs.

Design
Retrospective study.

Introduction
Posterior-only skipping HV resection and short fusion as well as the mid-term outcomes were scarcely reported. The aim of this study is to comprehensively analyze the effectiveness of such procedures in CS with multiple HVs.

Methods
16 consecutive patients with multiple HVs treated surgically at a mean age of 5.6±3.4 years were retrospectively reviewed. The surgical outcomes and the related complications were analyzed.

Results
The resected HVs locating contra-laterally and ipsilaterally of the spine were found in 10 and 6 patients, respectively. Caudal HV was resected firstly to achieve caudal horizontalization, follow by the cephalic HV. After surgery, the upper and lower curves were significantly corrected from 37.6±12.9° and 34.8±8.2° to 10.0±6.9° and 5.6±3.9°, respectively. Similarly, segmental kyphosis was improved from 30.9±12.9° to 5.8±9.0°. During the average follow-up period of 5.0±2.7 years, the spinal length was significantly improved from 293.9±51.9mm postoperatively to 346.3±43mm. Coronal decompensation with the emerging curve (≥20°) was detected in 9 patients (56.3%) 1.2 years postoperatively, with a mean age of 8.5 years.

Conclusion
Posterior-only hemivertebrectomies and separated short fusions is a safe, effective, and less invasive procedure yielding near-satisfactory mid-term outcomes for CS with multiple HVs. Contralateral HVs being afar or the ipsilateral ones should be resected aggressively. Distal HV resection, especially at lumbosacral region, took priority for horizontalizing basement of spine. Recurrence of scoliosis were not rare during follow-up, which would assist in counselling scoliosis parents in regards to their concerns with surgical outcome.

198. 3D CT MODELING DEMONSTRATES THE ANATOMIC FEASIBILITY OF S1AI SCREW TRAJECTORY FOR SPINOPELVIC FIXATION IN NEUROMUSCULAR SCOLIOSIS

Xochitl Bryson, BA; Nicole A. Segovia, MPH; Lawrence A. Rinsky, MD; John S. Vorhies, MD; *Serena S. Hu, MD*

Hypothesis
We hypothesize that an S1 alar iliac screw (S1AI) trajectory will allow for the placement of a screw of similar size the the S2 alar iliac(S2AI) screw with less dissection and less screw prominence.

Design
Retrospective cohort study

Introduction
The S2 alar iliac(S2AI) screw trajectory is effective however distorted pelvic anatomy in pediatric neuromuscular scoliosis can complicate its placement. Additionally, screw prominence can lead to pressure related injuries with devastating consequences. Here we use 3D CT modeling to demonstrate the anatomic feasibility of an S1 alar iliac screw (S1AI) in a population of patients with neuromuscular scoliosis and compare it to S2AI screws.

Methods
This retrospective study used CT scans of 14 patients with spinal deformity. We used CT-based

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3D reconstructions of the lumbar spine and pelvis to model the trajectories of bilateral S2AI and S1AI screws. S1AI screws were modeled with the start point superolateral to the first dorsal foramen angled inferiorly and laterally above the sciatic notch(Figure1). We compared feasibility of insertion, max length & diameter of the screw, as well as the potential for implant prominence.

Results

We modeled 28 S1AI and 28 S2AI screws. Patients with neuromuscular scoliosis had a mean age of 14.42(range: 8-21), a mean major coronal cobb angle of 85°(range: 54-141) and a mean pelvic obliquity of 28°(range:4-51). Maximum screw length and diameter of S1AI and S2AI trajectories was similar. S2AI screws were on average 6.3±5 mm more prominent than S1AI screws relative to the iliac crests. S2AI screws were feasible in all patients however in 2 patients the S1AI trajectory was not feasible because bony anatomy would block screw introduction.

Conclusion

S1AI trajectory offers comparable screw size with less dissection vs S2AI as its start point is more cranial. The S1A1 screw head was, on average, less prominent vs S2AI. In some patients the S1AI screw may not be feasible to place because the entry trajectory may interfere with the posterior elements of the level above

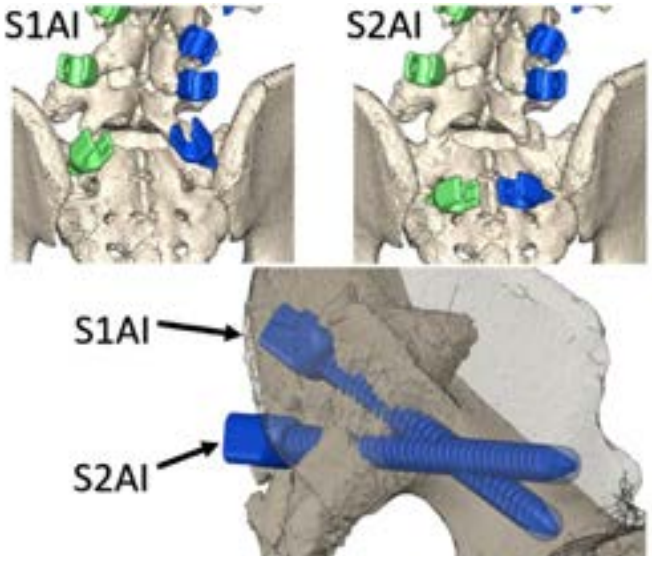

Figure 1: 3D CT models of the S2AI and S1AI screw trajectories demonstrating entry point and trajectory as well as implant prominence

199. PROPHYLACTIC PROXIMAL JUNCTIONAL MEASURES IMPROVES COST EFFICACY OF ADULT SPINAL DEFORMITY SURGERY, WITH OPTIMAL COST UTILITY SEEN IN THOSE WITH CONCURRENT OPTIMAL REALIGNMENT

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Hypothesis

PJK prophylaxis improves cost utility of ASD surgery both with and without ideal age-adjusted realignment.

Design

Retrospective

Introduction

Prophylaxis usage has been established in literature as an important component of minimizing the risk of PJK and PJF development. However, there remains a paucity in literature on the effects of prophylaxis in patients who have achieved adequate post-operative alignment and those who maintained poor alignment post-operatively.

Methods

Operative ASD patients with an UIV at L1 or below and available baseline(BL) and 2-year (2Y) radiographic and HRQL data were included. “Matched” and “unmatched” alignment refers to the age-adjusted alignment criteria. PJK prophylaxis(ppx) was defined by usage of cement, hooks, or tethers. PJF was defined as PJK with reoperation. Costs were calculated using the PearlDiver database, accounting for additional costs of ppx when applicable, through estimates from Medicare pay-scales for services within a 30 day window, including estimates regarding costs of postoperative complications, outpatient healthcare encounters, revisions and medical related

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readmissions. QALY was calculated using SF6D.

Results
738 patients met inclusion criteria, 40% of patients had ppx. Controlling for age, CCI, osteoporosis, levels fused, 3CO, UIV, BL SVA and BL PI-LL, with ppx patients matched in PT, SVA, or PI-LL had lower PJF rates (OR:.5, p=.01), and patients unmatched in SVA, PILL, and PT post-op also had lower PJK and PJF. (p<0.05). Adjusted ANCOVA shows patients with ideal age-adjusted alignment and ppx resulted in a lower 2Y cost per QALY ($399,948 vs $514,228, p<.001). Similarly, in unmatched patients, ppx resulted in lower 2Y cost per QALY ($466,409 vs 672, 024, p<.001), primarily due to decreased costs of reoperation and greater improvements in QALY among ppx cohorts.

Conclusion
Despite additional surgical cost, optimization of radiographic realignment in conjunction with utilization of proximal junctional failure prophylactic techniques achieves ideal cost utility, predominately due to the minimization of mechanical failure related reoperations. Similarly, without optimal realignment, junctional prophylactic measures improved cost utility, emphasizing its critical role of minimization of junctional failures to achieve cost efficiency in adult spinal deformity surgery.

201. OPIOID SPARING ANESTHESIA DECREASES IN-HOSPITAL AND ONE YEAR POST-OPERATIVE OPIOID CONSUMPTION COMPARED TO TRADITIONAL ANESTHESIA: A PROPENSITY-MATCHED COHORT STUDY

Amer Ahmad, MD; *Leah Y. Carreon, MD*; Steven D. Glassman, MD; Jennifer Harpe-Bates, DNAP; Benjamin M. Sampedro; Morgan Brown, MS; Christy L. Daniels, MS; Grant Schmidt, MD; Bren Hines, RN; Jeffrey L. Gum, MD

Hypothesis
In-hospital opioid consumption and one-year opioid prescriptions is lower in patients receiving Opioid Sparing Anesthesia (OSA) versus traditional Non-Opioid Sparing Anesthesia (Non-OSA) for lumbar spinal fusion.

Design
Propensity-matched longitudinal comparative observational study

Introduction
The recent opioid crisis in the US highlights opioid related side-effects and the dire need to reduce opioid exposure with alternative approaches. Currently, opioids are a primary component of anesthesia during spinal surgery. We developed an opioid sparing anesthesia (OSA) protocol for lumbar spinal fusion surgery to mitigate opioid exposure.

Methods
Patients undergoing lumbar fusion for degenerative conditions over 1 to 4 levels were identified. Patients taking opioids preoperatively were excluded. Patients receiving OSA were propensity-matched to non-OSA patients based on sex, smoking status, BMI, ASA grade, and revision vs primary procedure

Results
Of 296 OSA patients meeting inclusion criteria, 172 OSA patients were successfully propensity-matched to 172 Non-OSA patients. Demographics were similar between cohorts OSA (77 males, mean age=57.69 years) and Non-OSA (67 males, mean age=58.94 years). Patients undergoing OSA had lower EBL (326mL vs 399mL, p=0.014) surgical time (201min vs 233min, p<0.001) emergence to extubation time (9.1min vs 14.2min, p=<0.001) and time spent in the recovery room (119min vs 140min, p=0.0.012) compared to Non-OSA patients. There was a lower proportion of patients requiring non-home discharge in the OSA group (18 vs 41, p=0.001) compared to the Non-OSA group, but no difference in LOS (90.3hrs vs 98.5hrs, p=0.204). Daily opioid consumption was lower in the OSA vs the Non-OSA cohort starting from Post-op Day 1 (223MME vs 185MME, p=0.017) and maintained each day with lower total consumption (293MME vs 225MME, p=0.003) throughout Post-op Day 4. The proportion of patients with active opioid prescriptions at 1 (71% vs 94%), 3 (46% vs 81%), 6 (36% vs 74%) and 12 (27% vs 70%) months after surgery was consistently statistically less (p<0.001) in the OSA compared to the Non-OSA patients.

Conclusion
Opioid-sparing anesthesia for lumbar spinal fusion surgery decreases in-hospital and one-year post-operative opioid consumption.

203. YOUNGER SURGEONS HAVE HIGHER COMPLICATION RATES IN SPINAL DEFORMITY. HOW CAN THEY OPTIMIZE THE OUTCOMES?

Fares Ani, MD; Camryn Myers, BA; Brett Harris, BS;

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Abel De Varona Cocero, BS; Constance Maglaras, PhD; Tina Raman, MD; *Themistocles S. Protopsaltis, MD*

Hypothesis
Spine surgeons with significant independent practice experience will have improved outcomes in the setting of long fusions compared to those in the beginning of their career.

Design
Retrospective review of a prospectively collected single center database.

Introduction
Adult spinal deformity surgery is a field that requires significant experience to be able to master. Even after fellowship, surgeons without independent experience may have difficulty with long fusions that require meticulous planning and execution. This study explores differences in cases between those with significant independent practice experience versus those new to it.

Methods
There were a total of 611 patients underwent thoracolumbar fusion with 5+ levels fused. Patients were reviewed for primary surgeon, demographics, operative characteristics, and post-operative course. Experience after fellowship was quantified by the difference between year of surgery and year the surgeon graduated fellowship. Surgeons within the bottom 25th percentile for overall experience were grouped (less than 9-years) and compared to surgeons with more experience(9+ years). Independent-samples T-test and Chi-square analysis were performed for the cohort, significance set to p<0.05).

Results
Average surgeon experience was 16±9years. Surgeons with 9+ years experience (n=460) were more likely to operate on older patients (60.8± 16.3 years vs 57.1± 18.1years,p=0.02) compared to younger surgeons (n=151). Operatively, younger surgeons were more likely to have higher estimated blood loss (EBL, 2082± 1669ml vs 1628± 1458ml,p=0.002), overall interoperative complications (25.8% vs 12.8%, p=0.001), and delayed extubation (11.9% vs 6.1%,p=0.02) compared to older surgeons. Patients with younger surgeons were also more likely to suffer a post-operative complication (45.7% vs 34.6%,p=0.014), post-operative ileus (6.6% vs 3.0,p=0.05), and have a longer length of stay (LOS,8.5± 6.5 vs 7.6± 4.2 days,p=0.04) compared to older surgeons

Conclusion
Primary surgeons with 9+ years post-fellowship experience demonstrate improved rates of blood loss and complications after spine deformity surgery. The topic of independent practice experience in spinal deformity should be looked at in detail as to close this experience gap.

	Primary surgeon years exp	less than 9years	9+ years	
	No 611	n=151	n=460	
Demographics	Gender (%female)	63.60%	66.50%	0.51
	Age	**57.1 ± 18.1**	**60.8 ± 16.3**	**0.02**
	BMI	27.8 ± 6.5	28.8 ± 6.5	0.74
Operative characteristics	levels fused	10.5 ± 3.2	10.8 ± 3.4	0.29
	Operative time	459.2 ± 150.9	446.1 ± 152.5	0.7
	EBL	**2082 ± 1669**	**1628 ± 1458**	**0.002**
	overall intraoperative complication	**25.80%**	**12.80%**	**0.001**
	Neuromonitoring changes	4.00%	3.00%	0.58
	Incidental Durotomy	11%	7.40%	0.14
	Delayed extubation	**11.90%**	**6.10%**	**0.02**
Post-operative course	LOS	8.5 ± 6.5	7.6 ± 4.2	**0.038**
	overall post-operative complications	**45.70%**	**34.60%**	**0.014**
	Cardiac complication	12.60%	12.60%	0.99
	post-operative ileus	**6.60%**	**3.00%**	**0.049**
	Neurologic complication	6.60%	7.20%	0.82
	DVT/PE	4.00%	1.50%	0.07
	Urinary complication	7.30%	7.40%	0.97
	Pulmonary complication	8.60%	5.90%	0.24
	RTO 90 days	4.60%	5.70%	0.63

Figure 1. Comparison of peri-operative characteristics of surgeries between those that had surgeons with 9+ years of experience versus less than 9 years.

204. THE MACHINE-VISION IMAGE GUIDED SURGERY SYSTEM REDUCES FLUOROSCOPY TIME, IONIZING RADIATION AND INTRAOPERATIVE BLOOD LOSS IN POSTERIOR SPINAL FUSIONS FOR SCOLIOSIS

Kevin B. Lim, FRCS(Orth), MBA; Inez Yeo, BS; Woei Jack Pan, FRCSEd(Orth); Stacy Ng, FRCSEd(Orth); Nicole Lee, PhD

Hypothesis
The Machine-Vision Guided Surgery System reduces fluoroscopy time, ionizing radiation and intraoperative blood loss in posterior spinal fusion for scoliosis, compared with conventional 2D fluoroscopy,

Design
Retrospective case control (Level 3).

Introduction
2D fluoroscopy has been commonly used as an adjunct in pedicle screw implantation in posterior spinal fusion (PSF). However, radiation exposure from fluoroscopy remains a significant concern. The

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advent of surgical navigation systems that do not utilize ionising radiation could significantly improve safety of the surgical patient and all personnel in the operating room. The aim of this study is to determine if the novel 3D Machine-Vision Image Guided Surgery (MvIGS) system can reduce radiation exposure while improving surgical outcomes when compared to 2D fluoroscopic navigation.

Methods
The clinical and radiographic records of patients with severe scoliosis who underwent PSF between 2017 and 2021, utilising either MvIGS or 2D fluoroscopy, were retrospectively reviewed and analysed.

Results
In this series there were 128 patients who underwent PSF with pedicle screws using 2D fluoroscopy or the MvIGS system. Age, gender, BMI, and scoliosis etiology were equivalent between the two groups. Compared to 2D fluoroscopy, MvIGS reduced fluoroscopy time (37.86±15.95s vs. 19.16±7.19s; p<0.001), radiation exposure (127.27±115.35 cGycm2vs. 52.91±38.17 cGycm2; p<0.001), change in the largest Cobb angle (33.72±12.99° vs. 40.00±11.63°; p=0.005), and estimated blood loss (870.25±616.57 mL vs. 553.75±434.32 mL; p<0.001). Overall, the average navigation time for the MvIGS system was 114.07±51.88 minutes, and 5.79±3.15 minutes per screw implanted. The number of levels fused, number of pedicle screws implanted, pre- and post-operative Cobb angles, operative time and length of hospital stay were not significantly different between the two groups.

Conclusion
The use of the MvIGS as an adjunct for pedicle screw placement in PSF, has contributed to a significant reduction in fluoroscopy time, intraoperative radiation exposure, and estimated blood loss. Exposure to radiation was significantly associated with intraoperative blood loss.

205. DOES PREOPERATIVE REHABILITATION FOR ADULT SPINAL DEFORMITY SURGERY IMPROVE PATIENT RECOVERY KINETICS AND COST EFFECTIVENESS?

Peter G. Passias, MD; Bailey Imbo, BA; Kimberly McFarland, BS; Pooja Dave, BS; Jamshaid Mir, MD; Peter Tretiakov, BS; Oscar Krol, BS; Tyler K. Williamson, MS, BS; Rachel Joujon-Roche, BS; Lara Passfall, BS; Bassel G. Diebo, MD; Shaleen Vira, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Alan H. Daniels, MD; Andrew J. Schoenfeld, MD; Stephane Owusu-Sarpong, MD; Jordan Lebovic, MBA

Hypothesis
Identify if preoperative rehabilitation influence patients ability to recover and cost effectiveness

Design
Retrospective

Introduction
While advances in spinal realignment have shown promising short-term clinical results, the durability of ASD-corrective surgery remains a clinical challenge. Little is known about the effect of preoperative rehabilitation on patient outcomes and costs of the procedure.

Methods
ASD patients with BL and 2Y follow-up and available preoperative rehabilitation data were included. Patients were divided on whether or not they completed a preoperative rehabilitation assignment (Prehab) or not (no Prehab). Normalized HRQL scores at BL and follow-up intervals (6W, 1Y, 2Y) were generated. Normalized HRQLs were plotted and area under the curve was calculated, generating one number describing overall recovery (Integrated Health State [IHS]). Cost was calculated using the PearlDiver database. This data is representative of national average Medicare cost differentiated by complication/comorbidity outcome, surgical approach, and revision status. Cost per Quality-Adjusted Life Year (QALY) at 2Y were calculated. Binary regression analysis assessed patient reported outcomes and cost adjusting for baseline and surgical characteristics.

Results
100 pts were included (36 Prehab, 64 no Prehab). Normalized HRQLs determined Prehab pts to exhibit better ODI than no Prehab pts at 2Y follow-up, P<.05. Multivariate analysis confirmed Prehab pts more likely to improve in ODI (OR .055 [CI .006-.476], p=.008) at 2Y. However, Prehab and no Prehab pts exhibited similar ODI IHS recovery rates from BL to 2Y, P<.05. Total cost for Prehab pts was $59,272 compared to $72,878 for not Prehab, P<.05. Utility Gained at 2Y was 0.168 for Prehab and 0.121 for not Prehab, P<.05. This translated to QALY gained at 2Y of 5.09 for Prehab

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and 4.21 for not Prehab, P>.05. Cost effectiveness was determined via cost per QALY: Prehab = $14,463 and not Prehab = $45,515, P<.05.

Conclusion
Patients who had a preoperative rehabilitation prior to corrective surgery were in a better state of postoperative back disability at two year follow-up. While both patient cohorts had improvement following surgery, patients with preoperative rehabilitation had greater utility gained at two year follow-up. Costs by procedure and cost effectiveness were better for patients who had preoperative rehabilitation.

206. CORRELATION BETWEEN SINGLE-PULSE AND PULSE-TRAIN STIMULATION DURING NEUROMONITORING OF THORACIC PEDICLE SCREWS IN SCOLIOSIS SURGERY

Luis Eduardo Carelli Teixeira Da Silva, MD, MS; *Luiz Eduardo Almeida, MD*; Juan Cabrera, MD

Hypothesis
Is Single pulse triggered electromyography equivalent to pulse-train triggered electromyography?

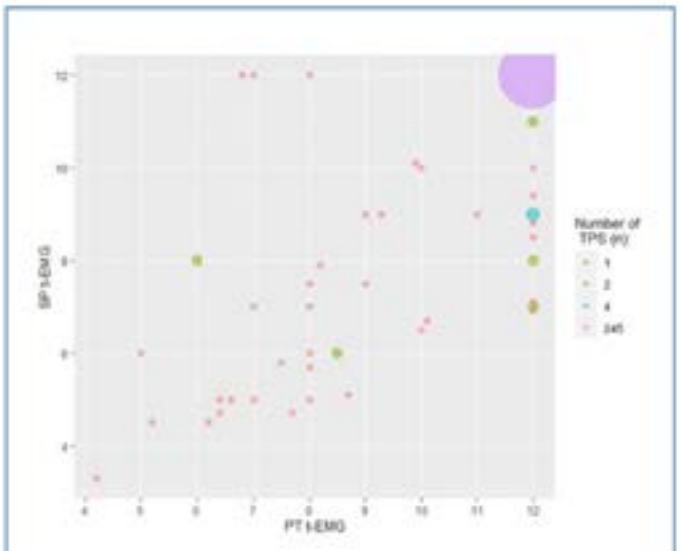
Design
Retrospective cohort study

Introduction
Thoracic pedicle screws (TPS) during scoliosis surgery entails an inherent risk of new neurological deficit. Triggered electromyography (t-EMG) is an accurate neuromonitoring test for the detection of TPS malpositioning. However, single-pulse t-EMG stimulation (SP t-EMG) has shown variable capability for detecting medial pedicle breaches while pulse-train t-EMG (PT t-EMG) could be more accurate. The aim is to analyze the correlation between SP t-EMG and PT t-EMG.

Methods
Retrospective study including 20 patients of scoliosis correction with 294 TPS placed. A total of 588 tests with both SP t-EMG and PT t-EMG were performed, analyzed, and compared. The results of both t-EMG techniques were stratified into three different groups according to threshold obtained: Group 1 (≤ 6 mA), Group 2 (6.1 – 11.9 mA) and Group 3 (≥12 mA). Generalized Linear Model was performed for analyze the correlation between the methods.

Results
SP t-EMG elicited response in 5 screws (1.7%) at ≤ 6 mA; in 28 screws (9.5%) at 6.1 – 11.9 mA; and in 261 screws (88.8%) at ≥12 mA. PT t-EMG elicited response in 16 screws (5.4%) at ≤ 6 mA; in 30 screws (10.2%) at 6.1 – 11.9 mA; and in 248 screws (84.4%) at ≥12 mA. There is a strong positive and significant association between SP t-EMG and PT t-EMG with a decrease ratio of 2% (95% CI: 1% to 3%).

Conclusion
SP t-EMG and PT t-EMG stimulation techniques had similar results when the stimuli were applied the TPS, but PT t-EMG could have greater accuracy in low-threshold group.



bubble plot of Single pulse and pulse train triggered electromyography of 294. Size and colors correspond to the number of thoracic pedicle screws with the same measure.

207. IMPACT OF CONTROLLED VS. UNCONTROLLED MFI-5 FRAILTY ON PERIOPERATIVE COMPLICATIONS FOLLOWING ADULT SPINAL DEFORMITY SURGERY

Jarod Olson, BS; Kevin C. Mo, MHA; Jessica Schmerler, BS; Wesley M. Durand, MD; Khaled M. Kebaish, MD; Richard L. Skolasky, PhD; *Brian J. Neuman, MD*

Hypothesis
Patients with uncontrolled frailty have a higher risk for perioperative complications following adult spinal deformity (ASD) surgery.

Design
Retrospective Review

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Introduction
Preoperative risk assessment is crucial before adult spinal deformity, due to its relatively high surgical invasiveness and likelihood of complications. Frailty has been found across multiple surgical subspecialties to be associated with risk of complications. However, the current frailty measures do not account for whether certain points refer to a controlled or uncontrolled condition. The goal of this study was to sub-stratify the mFI-5 frailty index into controlled or uncontrolled and assess the relationship to perioperative complications.

Methods
ASD patients with fusion of ≥5 vertebral levels were identified. Frailty was calculated using mFI-5. Uncontrolled frailty was defined as having any of the following mFI-5 components: 1) blood pressure >140/90 2) HbA1C > 7% or 3) COPD exacerbation, while on mediction. Patients were then divided into three cohorts: non-frail, controlled frail, and uncontrolled frail. Bivariate analysis was first performed. Multivariable analysis assessed the relationship between frailty state and perioperative complication.

Results
A total of 178 ASD patients were identified. There were 97 non-frail, 54 controlled frail, and 27 uncontrolled frail patients. Patients with uncontrolled frailty were more likely to be >60 years old (84% vs. 24%), have hyperlipidemia (42% vs. 20%), and ODI >42 (84% vs. 52%) ($p<0.05$ for all). Controlled frailty was associated with >60 years old (41% vs. 24%), hyperlipidemia (52% vs. 20%) ($p<0.05$ for all). On multivariable regression analysis controlling for hyperlipidemia, functional independence, motor weakness, ODI>42, and Age >65, uncontrolled frailty was associated with 4.24x greater odds of any major complication and 9.47x odds of any wound complication. Controlled frailty was not associated with increased risk of perioperative complications ($p>0.05$ for all).

Conclusion
The results of this study suggest that patients with uncontrolled frailty have higher risk of perioperative complications compared to those with controlled frailty. Furthermore, components of uncontrolled frailty, that did not exist in the current mFI-5 frailty index, represent new modifiable risk factors that can be targeted for preoperative optimization in ASD patients.

	Non-frail	%	Controlled Frail	%	p-values	Uncontrolled Frail	%	p-values
Total	97		54			19		
Any Major Complications	**13**	**13%**	**10**	**19%**	**0.36**	**7**	**37%**	**0.011**
Reoperation	27	28%	9	17%	0.29	9	47%	0.095
Length of Stay > 5 days	62	64%	37	69%	0.57	14	74%	0.413
Non-home Discharge	58	60%	39	72%	0.13	15	79%	0.114
Any Wound Complication	**4**	**4%**	**4**	**7%**	**0.39**	**4**	**21%**	**0.008**
Thromboembolic Complication	4	4%	3	6%	0.66	0	0%	0.373
Intubation	2	2%	2	4%	0.53	2	11%	0.06

Complication rates of controlled or uncontrolled frail versus non-frail patients.

208. INCIDENTAL DUROTOMIES: DOES SURGEON PREFERENCE EFFECT PATIENT OUTCOMES?

Fares Ani, MD; Camryn Myers, BA; Arnaav Walia; Julianna Bono, BS; Gregory Perrier, BS; Constance Maglaras, PhD; *Themistocles S. Protopsaltis, MD*; *Tina Raman, MD*

Hypothesis
Current trends and techniques in incidental durotomy treatment will have equivalent effect on the patient's postop course.

Design
Single-center retrospective review.

Introduction
There are various surgical approaches to resolving incidental durotomies. Given the rarity of this intraoperative complication, evidence is limited evaluating the effect of surgeon treatment preference on postop outcomes.

Methods
Patients with incidental durotomies (ID) from 2015-2020 with minimum 1 year follow up. T-test and chi square analyses were used to compare outcomes: location of ID, surgery type, portion of the procedure, procedure invasiveness, repair type (primary, patch, glue or combination), number of drains, total drain output, sequelae of ID, neurological complications, days of bed flat status, return to operating room (RTO), readmission, and emergency room visit.

Results
20 patients (mean age: 64.0±9.0, BMI:28.2±4.0kg/m2, gender: 49.6% female, days of bed flat status: 1.5±0.9,

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and total inpatient drainage: 548.1±848ml). ID was most prevalent at lateral edge of dural tube (53.0%). L3/L4 (24.2%) and L4/L5 (25%) were most frequent ID locations. Laminectomy and fusion were most likely to incur durotomy (46.6%). Surgeons were more likely to primarily repair the dura if procedure was open versus minimally invasive (26.7% v 11%, p=0.04). IDs occurred more during decompression (78.5%), exposure (7.5%), thecal sac manipulation (4.7%), and cage trialing and placement(3.7%). 82 (73%) of ID were primary repairs, 98.3% utilized glue, and 58 (48.3%) used a patch. During the hospital course, 20 patients (16.7%) experienced headache, 1 (0.8%) experienced a CSF Leak through the skin, 7 (5.8%) had a postop neurologic deficit, and 4 (3.3%) RTO during their index stay. After discharge, there were 10 (8.3%) wound complications. At first postop visit, 6 (5.0%) had headaches, 23 (19.2%) neuro deficits (2 noted due to intraoperative injury), 1 (0.8%) had episode of arachnoiditis, 2 (1.7%) CSF leaks through skin, and 4 (3.3%) psuedomeningoceles. 8.5% of patients were readmitted within a year, most commonly for wound drainage (n=8, 6.7%).

Conclusion

In comparing IDs repaired primarily versus secondary (glue or patch), no differences in overall wound complications, readmission, neurological complications, headaches, CSF leak, or infection, were observed. Patched deficits were more likely to develop psuedomeningocele (6.9% vs 0%, p=0.035) compared to those without patch.

Table 1: Demographics, Surgical Characteristics, Post-Op Stay, and Characteristics after Discharge

Gender (% Female)	39 (47.6%)	16 (53.3%)	0.6
Revision Surgery	24 (29.3%)	7 (23.3%)	0.53
Age	64.6 ± 12.6	60.9 ± 12.1	0.17
BMI	29.5 ± 5.6	30.0 ± 5.6	0.7
Surgical characteristics			
Minimally invasive	9 (11.0%)	8 (26.7%)	0.04
Levels fused	2.4 ± 3.1	3.0 ± 3.1	0.43
Glue	80 (97.6%)	30 (100%)	0.54
Patched	51 (62.2%)	4 (13.3%)	0.001
Muscular Overlay	2 (2.4%)	4 (13.3%)	0.023
EBL	578 ± 819	299 ± 358	0.014
Optime	260 ± 143	244 ± 124	0.62
Osteotomy done	6 (7.3%)	2 (6.7%)	0.91
Number of Drains	1.2 ± 1.1	0.7 ± 1.1	0.04
Post-operative stay			
Days of Flat Bed Status	1.5 ± 1.0	1.4 ± 0.9	0.65
Headache	8 (20%%)	12 (14.6%)	0.43
Neurodeficit	4 (4.9%)	1 (3.3%)	0.73
MRI/CT Index	4 (4.9%)	0 (0%)	0.22
CSF leak through skin	1 (1.2%)	0 (0%)	0.54
Surgical site infection	5 (6.1%)	0 (0%)	0.17
Length of Stay	3.0 ± 3.4	4.8 ± 3.2	0.23
Total drain output during stay	468 ± 682	460 ± 834	0.96
After Discharge			
Wound Complications	7 (8.5%)	1 (3.3%)	0.34
Antibiotics	5 (6.1%)	0 (0%)	0.17
Headache	7 (7.4%)	1 (3.3%)	0.4
Meningocele	3 (3.7%)	0 (0%)	0.29
Neurodeficit	14 (17.1%)	8 (20.0%)	0.72
Neurodeficit resolved by 6MO	1 (16.7%)	4 (23.5%)	0.79
MRI/CT	10 (12.2%)	5 (16.7%)	0.54
Arachnoiditis	2 (0%)	1 (3.3%)	0.03
RTO 1yr	5 (6.1%)	1 (3.3%)	0.57
CSF Leak	2	1	
Cauda Equina Syndrome	2	0	
Dehiscence	1	0	
ER visit - 1yr	5 (6.1%)	1 (3.3%)	0.57
Readmission - 1yr	7 (8.5%)	2 (6.7%)	0.75
CSF leak through skin	0 (0%)	1 (3.3%)	0.03
Persistent neurodeficit	10 (12.2%)	5 (16.7%)	0.54

209. BUNDLED PAYMENTS IN SPINE SURGERY

Andrew Pugely, MD; *Catherine Olinger, MD*

Hypothesis

Participation vs non-participation in BPCI-A was associated with lower re-admission rates, ED utilization and total costs

Design

Retrospective study

Introduction

Centers for Medicare and Medicaid (CMS) Bundle Payment Care initiative Advanced (BPCI-A) is a single, retrospective bundled payment model covering 90-day clinical episodes developed to improve patient outcomes and costs. Our center instituted care delivery improvements prior to BPCI-A participation including weekly multi-disciplinary stakeholder meetings, full-time nurse care coordinator for BPCI-A patients and alignment of orthopedic/neurosurgery service lines. The purpose was to compare BPCI-A performance during year one of participation against Medicare claims data before BPCI-A participation.

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Methods
Medicare claims/medical record data from spine surgeries with diagnosis related group (DRG) of cervical spine surgery (C_PSF, 471, 472, 473), lumbar spinal fusion (L_PSF, 459-460) or lumbar decompression/discectomy (Decomp, 518, 519, 520) were collected. Patient/surgery characteristics, 90-day ED or readmission rates and total costs were compared between patients with surgeries prior to BPCI-A participation (Pre-BPCI: 1/1/13-11/30/17) and those from year one of BPCI-A participation (BCPI: 10/1/18-9/30/19).

Results
Analysis included 358 pre-BPCI and 82 BPCI patients. There were no significant differences in 90-day ED utilization (Pre-BPCI: 26.5%, BPCI 30.2%, p=0.551) between pre-BPCI vs BPCI patients but a slight reduction in 90-day readmissions (Pre-BPCI 26.8% vs BPCI: 15.9%) that did not reach statistical significance (p=0.065). The number of post-discharge readmissions per patient significantly decreased after BPCI (p=0.039). Analyses adjusted for service line, patient admission type and comorbidities (CCI score) yielded similar results for 90-day ED utilization, but greater odds of readmission in the pre-BPCI group vs BPCI patients (OR=2.53, 95%CI=1.14-5.58, p=0.022). There was a significant increased in total episode costs in BPCI vs pre-BPCI patients (mean=$10,549, 95%CI=$4,814-%16,284, p<0.0001) with significantly higher anchor visit costs ($6,803, 4,160-9,446, p<0.000) but no differences in post anchor visit costs ($3,709, 0-8,933, p=0.122).

Conclusion
Spine bundled payments (BPCI-A) at a large academic medical center presented lower readmission rates, but no cost savings. Alignment of stakeholder interests via a bundled payment framework may mobilize additional health system resources to improve outcomes.

210. STAGED CIRCUMFERENTIAL LUMBAR FUSIONS HAVE LESS INTRAOPERATIVE COMPLICATIONS AND SHORTER OPERATIVE TIME WITH NO DIFFERENCE IN 30-, 90-, AND 1-YEAR COMPLICATIONS: A PROPENSITY-MATCHED COHORT ANALYSIS OF 190 PATIENTS

Jeremy Thompson, MD; Mladen Djurasovic, MD; Steven D. Glassman, MD; Morgan Brown, MS; Christy L. Daniels, MS; Grant Schmidt, MD; Leah Y. Carreon, MD

Hypothesis
There is no difference in complications between single-anesthetic and staged cLF.

Design
Retrospective cohort

Introduction
Circumferential Lumbar Fusions (cLFs) are becoming more common with increasing and more minimally invasive anterior access techniques. Staging allows reassessment of indirect decompression and alignment prior to the posterior approach, and optimization of OR time management. Safety of staging has been well documented in deformity surgery but has yet to delineated in less extensive, degenerative cLFs.

Methods
From 123 patients undergoing single-anesthetic and 154 patients undergoing staged cLF, 95 patients in each group were propensity-matched based on age, sex, BMI, ASA score, smoking, revision, and number of levels. We compared perioperative, 30-day, 90-day, and 1-year complications between the two cohorts.

Results
Mean days between stages was 1.58. Single-anesthetic cLF had longer total surgery time (304 vs 240 min, p<0.001) but shorter total PACU total time (133 vs 196 min, p<0.001). However, there was no difference in total anesthesia time (368 vs 374min, p=0.661) and total EBL (357 vs 320cc, p=0.313). Intra-operative complications were 9 incidental durotomies in the single-anesthetic and 1 iliac vein injury in the staged group (9% vs 1%, p=0.018). There was no difference of in-hospital (38 vs 31, p=0.291), 30-day (16 vs 23, p=0.281), 90-day (10 vs 15, p=0.391), 1-year complications (9 vs 12, p=0.644), and overall cumulative 1-year complications (54 vs 56, p=0.883) between the two cohorts.

Conclusion
There is a decrease in total surgical time and intraoperative complications during staged compared to single-anesthetic cLF with no difference in in-hospital, 30-day, 90-day, and 1-year complications between approaches.

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	AP-Same-Day	AP-Staged	
Total	95	95	
Male	35-(37%)	47-(49%)	0.079
Age-at-Surgery	57.2-(11.51)	55.99-(11.43)	0.468
BMI	31.38-(6.04)	31.98-(4.25)	0.423
ASA	(0%)	(0%)	0.546
1	1-(1%)	1-(1%)	
2	26-(27%)	20-(21%)	
3	67-(71%)	74-(78%)	
4	1-(1%)	0-(0%)	
Public-Insurance	67-(71%)	55-(58%)	0.069
Smoking-Status	(0%)	(0%)	0.312
Non-Smoker	38-(40%)	28-(29%)	
Former-Smoker	51-(55%)	56-(58%)	
Current-Smoker	26-(27%)	51-(53%)	
Revision	43-(45%)	53-(56%)	0.147
Number-of-Levels			1.000
1	41-(43%)	41-(43%)	
2	44-(46%)	44-(46%)	
3	8-(8%)	8-(8%)	
4	8-(8%)	2-(2%)	
LOS-(hrs)	101.86-(49.15)	115.53-(52.15)	0.065
Total-Surgery-Time	304.4-(78.16)	239.63-(85.51)	<.001
Total-Anesthesia-Time	367.97-(80.25)	373.64-(96.17)	0.661
Total-PACU-Time	132.82-(68.93)	196.16-(75.35)	<.001
Total-EBL	357.37-(235.84)	319.57-(275.55)	0.313
Days-between-stages	NA	1.58-(1.02,-1-7)	NA
LOS-(hrs)	101.86-(49.15)	115.53-(52.15)	0.065
Total-Surgery-Time	304.4-(78.16)	239.63-(85.51)	<.001
Total-Anesthesia-Time	367.97-(80.25)	373.64-(96.17)	0.661
Non-Home-Discharge	15-(16%)	9-(9%)	0.190
Prevalence-(No.-of-cases)-of-complications			
Intra-op	9-(9%)	1-(1%)	0.018
Post-Op	38-(40%)	31-(33%)	0.291
30-day-Post-Op	16-(17%)	23-(24%)	0.281
Cumulative-90-day-Post-Op	44-(46%)	46-(48%)	0.885
90-day-Post-Op	10-(11%)	15-(16%)	0.391
Cumulative-90-day-Post-Op	48-(51%)	51-(54%)	0.663
365-day-Post-Op	9-(9%)	12-(13%)	0.644
Cumulative-365-day-Post-Op	54-(57%)	56-(59%)	0.883

Summary of Results

211. RAPID RECOVERY PATHWAY (RRP) UTILIZING INTRATHECAL MORPHINE DECREASES OVERALL HOSPITAL COSTS AND IMPROVES QUALITY OF CARE IN ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS)

Vishal Sarwahi, MD; Sayyida Hasan, BS; Michelle Kars, MD; Yungtai Lo, PhD; Terry D. Amaral, MD; Benita Liao, MD

Hypothesis
We hypothesize that utilization of a standardized RRP using multimodal analgesia without PCA improves patient quality of care, decreases opioid use, and costs less than traditional PCA methods.

Design
Retrospective review

Introduction
Posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS) is a complex procedure for which charges can exceed $150,000, among which inpatient and intensive unit care contribute 22%. This study aims to determine the effects of a multi-modal RRP, utilizing intrathecal morphine (ITM) in combination with oral pain medication, on hospital costs and patient management.

Methods
AIS patients undergoing PSF from 2013 – 2019 were retrospectively reviewed. Patients after February 2018 were placed in the RRP group. These patients received ITM as part of their multimodal analgesia. Fusion level-matched control patients, treated before February 2018, received hydromorphone PCA as the mainstay of their postoperative pain management. At discharge PCA patients received 14-day prescriptions for oxycodone compared to 7-day prescriptions in the ITM group. Perioperative data, requests for opioid refill, and overall costs were compared using McNemar's and Wilcoxon Signed-Rank tests.

Results
363 patients were included (PCA: 255, RRP/ITM: 108). BMI ($p = 0.786$) and median preoperative Cobb angle ($p = 0.343$) were similar between both groups. RRP patients had a significantly shorter length of stay (3 days vs. 5 days, $p < 0.001$). 65.2% of RRP patients ambulated by post-operative day (POD) 1 compared to 43.4% of PCA patients ($p < 0.001$). The fraction of patients who requested opioid refills was similar between both groups ($p = 0.082$). The cost of intraoperative anesthesia was significantly higher for RRP patients ($2,286.87 v $1,958.70, $p<0.001$). Perioperative hospital stay ($39,990.00 vs $55,680.00, $p<0.001$) was significantly lower for the RRP patients. Due to different prescription durations, the cost of home opioid medications was $98.94 for PCA patients versus $56.28 for RRP, based on standard Medicaid costs.

Conclusion
With increasing concerns about opioid dependence and increasing hospital costs, our RRP pathway, which incorporates micro dose ITM injections at the time of surgery, allow for optimum perioperative management, improved costs, with overall better outcomes than the traditional PCA approach.

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212. DEFINING A HIGH RISK ADULT SPINAL DEFORMITY PATIENT

Peter G. Passias, MD; Oscar Krol, BS; Jamshaid Mir, MD; Pooja Dave, BS; Peter Tretiakov, BS; Kimberly McFarland, BS; Bailey Imbo, BA; Tyler K. Williamson, MS, BS; Rachel Joujon-Roche, BS

Hypothesis
Baseline and surgical factors can identify which ASD patient presents as a high risk patient.

Design
Retrospective cohort study

Introduction
High risk committees have recently been instituted at many hospitals, in an effort to minimize operative risk and recruit a multi-disciplinary discussion. Both surgical and medical risk factors can lead to the occurrence of adverse events and prolonged recovery course. Little consensus has been reached as to which components of patient profiles and surgical factors predispose pre-operative discussion.

Methods
Operative ASD patients with available baseline (BL) and 2-year (2Y) radiographic and HRQL data were included. High medical risk was defined as a major medical complication before 90 days with negative clinical impact (failing to meet MCID for ODI). High surgical risk defined as major surgical complication or PJK revision surgery within two years also with a negative clinical impact. Conditional inference tree developed threshold cutoffs for continuous variables.

Results
381 ASD patients met inclusion criteria. For High Medical Risk, age >70, prior revision, BL ODI >56, BL Frailty Index >5, CCI >3, heart, liver, or lung disease, BL SVA >15cm, BL C7PL >7cm, and BL PI-LL >25 predicted a poor outcome with an AUC of 94% and accuracy of 90%. Patients with at least 1 of these factors had a greater degree of major (21% vs 5%), mechanical (19% vs 10%), and overall complications (64% vs 46%, all p<.05). For High Surgical Risk, age >70, BL ODI >56, BMI >34, Frailty >5, BL SVA >15cm, BL C7PL >7cm, BL PI-LL >25, previous surgical fusion, >16 levels fused, 3CO, and >3 interbody fusions predicted poor outcome with an AUC of 91% and accuracy of 90%. Patients with at least 2 of these factors had higher rates of major (20% vs 9%), mechanical (20% vs 10%), and overall complications (65% vs 48%, all p<.05).

Conclusion
Recognition of patient-specific and surgical factors that contribute to a high risk of major medical and surgical complications with poor clinical outcomes will allow surgeons to better profile which patients may require multi-disciplinary collaboration for appropriate perioperative optimization.

213. SURVIVAL ANALYSIS USING FUSION STATUS AFTER ADULT SPINAL DEFORMITY (ASD) SURGERY WITH MINIMUM 4-YEAR FOLLOW-UP

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Hypothesis
Comorbidities (e.g., osteoporosis) significantly impact long-term fusion status after ASD surgery.

Design
Prospective multicenter observational series

Introduction
Prior reports assessed fusion status after ASD surgery; however, few focus on fusion status at long-term fu (≥4y).

Methods
Surgically treated ASD pts prospectively enrolled into a multicenter study (2008-2020) were assessed for bilateral fusion (A), unilateral fusion (B), partial fusion (C), or no fusion (D). Inclusion required postop fusion grading at minimum 4y fu. Demographics, frailty, comorbidities, alignment (baseline and initial correction), index ops (num levels fused, iliac fixation, interbody fusion [IBF], use of bone morphogenetic protein [BMP] and/or demineralized bone matrix [DBM], 3-column osteotomy) were assessed to identify potential predictors of nonunion (grade C or D), which were then analyzed using Kaplan-Meier survival curves and log-rank comparisons.

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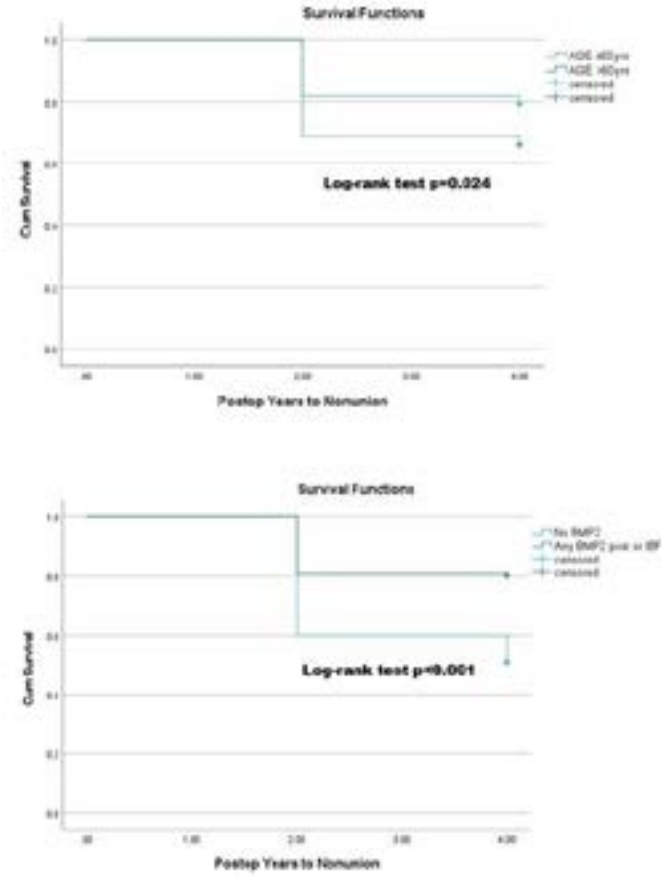
Results
Two-hundred and twenty-seven pts achieved minimum 4y fu and were included (age 58±14y, 82% women, BMI 27±5kg/m2, 40% prior spine surgery, ASD-FI 0.31 [frail], 15% osteoporosis). Index ops had 12±4 post levels, 70% iliac fixation, 62% IBF, 76% had BMP, 33% had DBM (of which 52% also had BMP), and 15% had 3CO. At final fu, 61 pts (27%) demonstrated nonunion (grade C or D). Older age (61±14 vs. 57±14, p=0.015), no BMP usage (p<0.001), and use of DBM (p=0.005) were associated with nonunion. No other significant differences btw fusion vs. nonunion pts were demonstrated among assessed variables. On multivariate analysis, older age (1.038 [1.011 – 1.064], p=0.005) was associated with nonunion, and use of BMP demonstrated protective effect (0.298 [0.140 – 0.632], p=0.002). Kaplan-Meier analyses (figure) revealed that older pts (age >60yrs) had significantly higher probability of nonunion (log-rank test p=0.024), and BMP had protective effect (log-rank test p<0.001). Sub-analysis of the 75 DBM pts demonstrated protective effect of concurrent BMP use: final fusion rate of DBM-only (n=36) vs. DBM+BMP (n=39) was 44% vs. 77%, respectively (p=0.004). Final HRQL was not significantly different between fused vs. nonunion pts (p>0.05).

Conclusion
This study demonstrated that older age (>60y) was associated with significantly higher rates of nonunion at long-term fu (≥4y) after ASD surgery, and that use of BMP had significant protective effect against this complication.



214. AMPAC MOBILITY SCORE <13 PREDICTS DEVELOPMENT OF ILEUS FOLLOWING ADULT SPINAL DEFORMITY SURGERY

Kevin C. Mo, MHA; Jarod Olson, BS; Jessica Schmerler, BS; Andrew B. Harris, MD; Khaled M. Kebaish, MD; Richard L. Skolasky, PhD; *Brian J. Neuman, MD*

Hypothesis
AMPAC scores below a certain threshold will accurately predict the development of ileus.

Design
Retrospective review

Introduction
Limited study exists on quantifying the mobility associated with development of ileus. The aim of this study is to determine whether Activity Measure for Post-Acute Care (AMPAC) "Six Clicks" scores (see figure) would accurately predict the development of ileus.

Methods
85 consecutive ASD surgeries with ≥5 levels fused were identified in a single-institution database.

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Daily AMPAC scores were collected after surgery by a physical therapist/physiatrist. Both bivariate and multivariable analysis was conducted to assess the association of AMPAC with ileus. Multivariable linear regression was first assessed to determine the marginal effect of ileus on AMPAC scores. Then, threshold linear regression with Bayesian Information Criteria was utilized to identify a threshold for AMPAC scores associated with ileus.

Results
Out of 85 ASD patients included, 12% (10) developed ileus. Mean postoperative day of developing ileus was day 3.3 ± 2.35. Mean first postoperative AMPAC score was 16, last AMPAC score was 18. On bivariate analysis, patients who developed ileus had a lower mean first AMPAC score (13 vs. 16; $p<0.05$).Ileus was associated with a first AMPAC score of 3 points lower (Coef. -2.96; $p<0.01$). A cut-off of <13 first AMPAC score was identified, and patients with a first AMPAC score <13 were associated with 6.4x greater odds of developing ileus ($p=0.023$). Neither last AMPAC score immediately prior to discharge nor the change in AMPAC score per day were associated with ileus.

Conclusion
In our institutional cohort, early postoperative mobility can be assessed to predict the development of postoperative ileus. This analysis idenfied a cut-off of first AMPAC score <13, which corresponds to an inability to walk or stand for more than 1 minute. Early identification of patients who cannot walk or stand after surgery can aid in identifying patients who can benefit from prophylactic management of postoperative ileus.

AMPAC Score	Expectation
24	Walk 75 Meters or More
22-23	Walk 7.5 Meters or More
18-21	Walk 10 Steps or More
16-17	Standing (1 or More Minutes)
10-15	Move to Chair/Commode
8-9	Sit at Edge of Bed
6-7	Bed Activities/Dependent Transfer
4-5	Lying in Bed

AMPAC <13 is associated with postoperative ileus.

215. BRACING FOR AIS SHOWS REDUCTION IN CURVE SIZE AT 2 YEARS EVEN WITH DECREASING ADHERENCE AND DIFFERENCES IN SOCIOECONOMIC FACTORS

Nicole Agaronnik, BS; Craig M. Birch, MD; M. Timothy Hresko, MD; Daniel J. Hedequist, MD; *Grant D. Hogue, MD*

Hypothesis
Socioeconomic factors (SEF) effect brace wear adherence and overall curve correction/maintenance.

Design
Retrospective cohort

Introduction
Management of AIS with bracing can reduce progression of curvature. Temperature sensors facilitate objective measures of adherence. The purpose of this study was to investigate curve magnitude over the course of brace wear and differences in adherence based on SEF.

Methods
AIS patients meeting SRS bracing criteria from 2014-2019 at a single-center were reviewed. Demographic, curve, and SEF information were abstracted. Data was downloaded from sensors. Linear mixed modeling was utilized to determine change in adherence and curve magnitude.

Results
77 patients had sufficient data. Mean age at initiation was 12.5 years, 82% were female. Median pre-brace curve magnitude was 30°. Adherence Median adherence after the weaning period was 63% which

†Luis A. Goldstein Best Clinical Research Poster *John H. Moe Best Basic Research Poster

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increased to 85% at 6-months. Adherence decreased to 82%, 74%, and 68% at 12, 18, and 24-months. 26 patients had a 24-month follow-up. Adherence increased by 18% at 6-months compared to the weaning period adherence (17.6; 95% CI=12.5-22.8; p<0.001), and increased by 14% at 12-months compared to the weaning period (14.1; 95% CI=8.9-19.4; p<0.001). Males had a 20% decrease in adherence compared to females (-20.5; 95%-CI=-35.0--6.0; p=0.006). Patients who identified as Hispanic had a 31% decrease in adherence compared to patients who identified as non-Hispanic (-31.0; 95% CI= -60.2--1.8; p=0.04). Curve magnitude Mixed modeling analysis found that curve magnitude decreased by 15° after the weaning period compared to the pre-brace curvature (-15.0; 95% CI=-16.8- -13.1; p<0.001). Curve magnitude decrease by 3° at the 12 month follow-up visit compared to pre-brace (-2.7; 95% CI=-4.6- -0.8; p=0.005). Additionally, the 18 month follow-up showed a 6° decrease from pre-brace measurement (-5.9; 95% CI=-9.0- -2.8; p<0.001). For every $10,000 increase in income, curve magnitude decreased by 1°(-0.5; 95% CI= -0.9- -0.1; p=0.01). Additionally, for each additional year in age at the pre-brace visit, the curve magnitude increased by 2° (1.8; 95% CI=0.6-3.0; p=0.003).

Conclusion

SEF and gender may predict brace adherence. Higher income may also predict decreased curve magnitude, but the clinical significance is uncertain. Regardless of these issues, the cohort as a whole had reduction of curvature during the study period.

Figure 1A. Bracing adherence after weaning period (1 month), 6 months, 12 months, and 24 months.

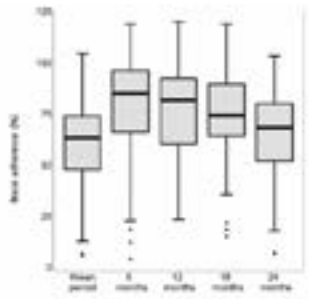
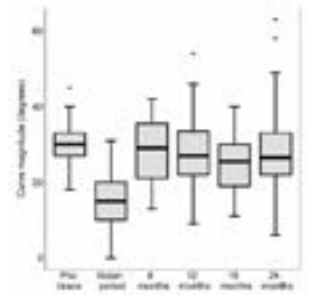


Figure 1B. Curve magnitude from pre-brace x-ray, initial in-brace x-ray [i.e. curve correction] after weaning period (1 month), and out-of-brace x-rays at 6 months, 12 months, and 24 months.



216. NON-OPERATIVE TREATMENT FOR SEVERE SCOLIOTIC CURVES EXCEEDING 40 DEGREES AT PEAK OF GROWTH BY BRACE AND SCHROTH - PHYSIOTHERAPEUTIC SCOLIOSIS SPECIFIC EXERCISES (PSSE)

Nikos Karavidas, PhysiOtherapist

Hypothesis

Brace and Schroth - PSSE can be effective treatment for scoliosis curves more than 40 degrees around peak of growth.

Design

Prospective study

Introduction

Current Scoliosis Research Society (SRS) indication about brace treatment for Adolescent Idiopathic Scoliosis is for curves 25 to 40 degrees, during growth and operative treatment is usually recommended for curves above 40o. Our purpose was to investigate the efficacy of a combined therapy with brace and PSSE in severe scoliosis.

Methods

48 patients (47 females and 1 male) received treatment by Cheneau brace and Schroth - PSSE. Our inclusion criteria were at least one structural curve with Cobb angle >40o, Risser stage 0-2, age > 10 years,

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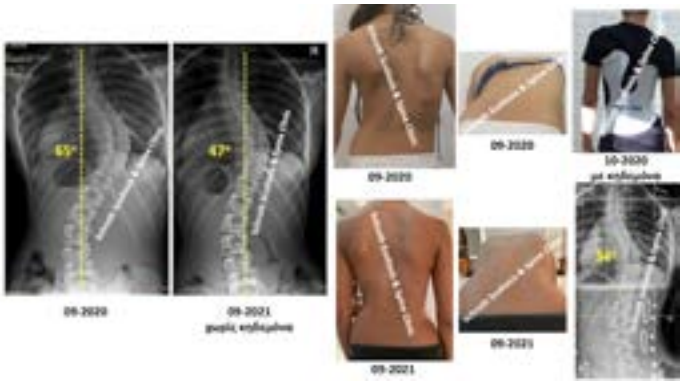
< 1 year post-menarche, without prior treatment. Average Cobb angle was 55.3o for thoracic (41o – 85o) and 52.6o (40o – 78o) for lumbar curves, Risser 0.6 and age 12.4 years. 10 curves were single and 38 double. Outcome parameters were Cobb angle post-treatment, Angle Trunk Rotation (ATR), TRACE scale and SRS-22 questionnaire score. Mean follow-up was 36.3 months. Statistical analysis performed by paired t-test.

Results

Totally, 24 (50%) subjects remained stable, 13 (27.1%) improved > 5o and 11 (22.9%) progressed > 5o. Cobb angle post-treatment significantly improved (52.8o, p=0.05 for thoracic and 47.4o, p= 0.02 for lumbar curves). A statistically significant reduction was reported for ATR, thoracic reduced from 12.8o to 10.3o (p=0.01) and lumbar from 11.6o to 9.7o (p=0.02). TRACE scale decreased from 8.4 to 6.2 (p=0.008) and SRS-22 total score improved from 73.4 to 79.6 (p=0.004). Mean in-brace correction (IBC) was 32.3% for thoracic and 27.4% for lumbar curves. In progressed cases was 13.5% for thoracic and 23.6% for lumbar, while in improved cases 49.3% and 32.7% respectively. IBC in single curves was 49.9% for thoracic and 50.9% for lumbar, while 27.2% (p=0.0002) and 25.5% respectively (p=0.0004) for double curves. In double curves progression rate was 28.9% and in single curves 0% (p=0.0003).

Conclusion

Conservative treatment achieved a success rate of 77.1% in scoliotic curves above 40o in a group with a high risk of progression at the peak of growth. A significant improvement was detected for trunk rotation (ATR), body symmetry and quality of life. Single curves have better prognosis than double.



Significant correction of severe scoliosis

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EXHIBITS AND HANDS-ON WORKSHOPS

IMAST EXHIBITORS

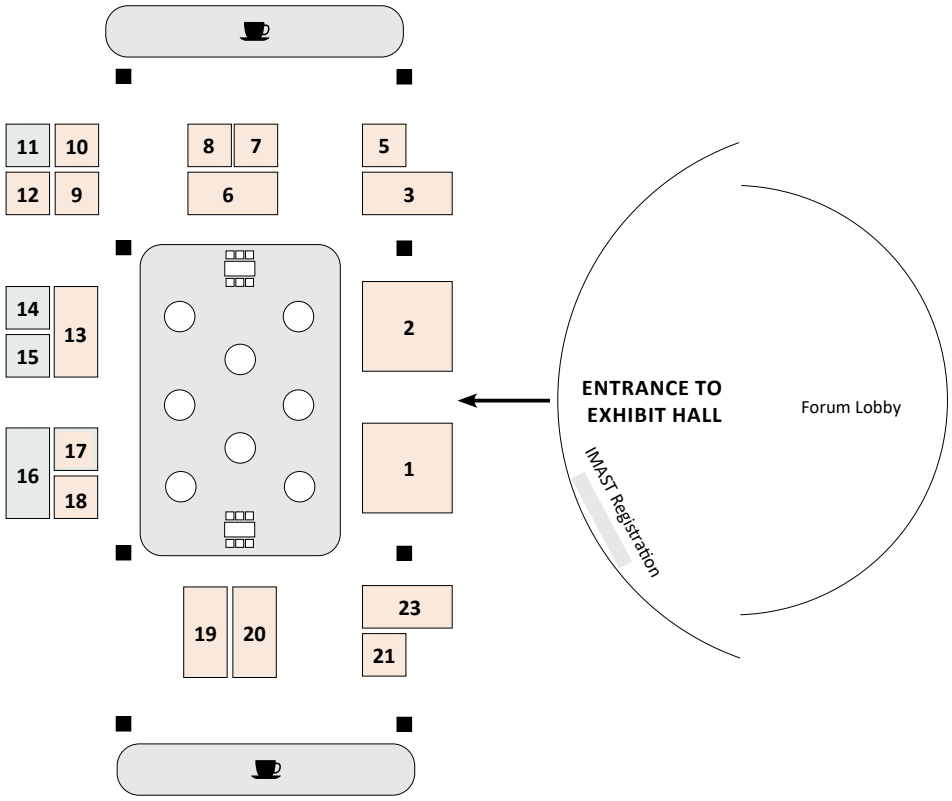
Many new spinal systems and products are on display in the Exhibit Hall. We encourage you to visit the exhibits throughout the meeting to learn more about the technological advances.

The IMAST Exhibitors are located in the Forum, Ground Level.

HOURS:

Wednesday, March 22 18:00 - 20:00 (Welcome Reception – 18:00 - 20:00)
Thursday, March 23 09:00 - 17:00
Friday, March 24 08:30 - 16:00

Booth #	Company
1	Medtronic
2	Globus Medical
3	Orthofix
5	SpineGuard
6	NuVasive
7	Pacira BioSciences, Inc.
8	Cerapedics
9	B. Braun
10	Isto Biologics
11	Printing Station
11	E-Point Presentations
12	Silony Medical
13	Stryker Spine
14	SRS Membership
15	SRS Communications Hub
16	IMAST 2023 Photo Booth
17	ZimVie
18	SI-BONE
19	DePuy Synthes
20	Medacta International SA
21	Biedermann Motech
23	ATEC Spine
Color Key	
	SRS Booths
	Exhibitors



EXHIBITOR DESCRIPTIONS

ATEC SPINE

ATEC is more than a medical technology company. We are an **Organic Innovation Machine**™ Revolutionizing the Approach to Spine Surgery. We are committed to creating clinical distinction by developing new approaches that integrate seamlessly with the Alpha InformatiX™ System to achieve the goals of spine surgery. Our ultimate vision is to be The Standard Bearer in Spine.

B.BRAUN

As a product brand in the B. Braun portfolio, Aesculap is a partner for surgical and interventional treatment concepts in inpatient and ambulatory care. As one of the world's leading medical technology companies, B. Braun protects and improves the health of people around the world. For over 180 years, the family-owned company has been accelerating progress in health care with pioneering spirit and groundbreaking contributions. This innovative strength continues to be the foundation of B. Braun's success today—always with the goal of improving clinical outcomes, cost of care and patient benefits.

More than 66,000 employees live Sharing Expertise worldwide, they make B. Braun a true partner that develops smart solutions and sets new standards. By linking products, services and consulting, the company improves treatment processes and supports medical staff. In doing so, B. Braun always acts with future generations in mind, which is why responsibility for sustainable growth is embedded into all business processes. In 2021, the B. Braun Group generated sales of € 7.9 billion.

BIEDERMANN MOTECH

Since 1916 Biedermann has been working in synergy with world-class surgeons to solve clinical challenges through the development of next-generation technology. Specializing in the spine since the 1980s has allowed us to become a leader in spinal innovation, bringing life-changing technology to the world through specialist surgeons.

Biedermann is a mid-sized, international, family-owned, and operated group of companies with headquarters in the Black Forest, Germany (Villingen-Schwenningen) and the USA (Miami). Our focus is on the development, production, and distribution of innovative implants and instruments for spinal and extremity surgery. We research, develop, manufacture, and distribute high-quality implant systems in collaboration with healthcare professionals, technology partners, scientific institutions, and specialist companies with the goal of achieving improved clinical outcomes.

CERAPEDICS

Cerapedics is an advanced orthobiologics company with the only biologic bone graft in spinal applications that incorporates a small peptide (P-15) as an attachment factor. i-FACTOR® Peptide Enhanced Bone Graft (P-15/ABM) is only the second FDA PMA approved bone graft on the market, and it it's novel mechanism of action (Attract, Attach, Activate) has shown to be statistically superior to local autograft through an IDE trial on single-level ACDFs in overall clinical success at one year and maintained at two years.

DEPUY SYNTHES

DePuy Synthes, the Orthopaedics Company of Johnson & Johnson, provides one of the most comprehensive orthopaedics portfolios in the world that helps heal and restore movement for the millions of patients we serve. DePuy Synthes solutions, in specialties including joint reconstruction, trauma, craniomaxillofacial, spinal surgery and sports medicine, in addition to the VELYS™ Digital Surgery portfolio, are designed to advance patient care while delivering clinical and economic value to health care systems worldwide.

Building on our proud product innovation and legacy of industry firsts, we are reimagining the orthopaedic landscape with new advancements in medical technologies and digital surgery across the entire continuum of care to Keep People Moving today and tomorrow.

GLOBUS MEDICAL

Globus Medical, a leading musculoskeletal solutions company, is driving significant technological advancements across a complete suite of products ranging from spinal, trauma, and joint reconstruction therapies to imaging, navigation, and robotics. Founded in 2003, Globus' single-minded focus on advancing spinal surgery has made it the fastest growing company in the history of orthopedics. Globus is driven to utilize high-level engineering and technology to achieve pain-free, active lives for all patients with musculoskeletal disorders.

EXHIBITOR DESCRIPTIONS

ISTO BIOLOGICS

Isto Biologics is a 100% biologics-focused company dedicated to helping patients heal faster. With a portfolio comprised of the market leading autologous concentration device as well as best-in-class bone grafting solutions, Isto is equipped to offer a range of customizable options to surgeons of varying specialties. We take pride in our customer partnerships and are committed to bringing procedural expertise and cost-effective solutions to better treat patient needs.

We invite you to visit us at Booth #10 to learn more about our game-changing products including Magellan, Influx, Influx SPARC, Influx Fibrant, InQu, and more! For more information, please visit our website at www.istobiologics.com.

MEDACTA

Medacta is an international company specializing in the design, production, and distribution of **innovative orthopaedic products**, as well as in the development of accompanying **surgical techniques**. Established in 1999 in Switzerland, Medacta is active in **joint replacement, spine surgery, and sports medicine**. Medacta is committed to improving the care and well-being of patients, maintaining a strong focus on **healthcare sustainability**. Medacta's innovation, forged by close **collaboration with expert surgeons globally**, began with **minimally invasive surgical techniques** and has evolved into **personalized solutions for every patient**. Medacta's spine procedures, designed for **cervical**, **degenerative** and **deformity** cases, offer benefits to both the surgeon and the patient, with a substantial reduction of radiation exposure and promotion of cost-effective solutions. Through the M.O.R.E. Institute, Medacta supports surgeons with a comprehensive and tailored program dedicated to the advancement of **medical education**. Medacta is headquartered in Castel San Pietro, Switzerland, and operates in over 40 countries.

MEDTRONIC

We lead global healthcare technology. Our Mission — to alleviate pain, restore health, and extend life — unites a global team of 90,000+ people. Transforming the lives of two people every second, every hour, every day. Medtronic. **Engineering the extraordinary.**

NUVASIVE

NuVasive (NASDAQ: NUVA) is the leader in spine technology innovation, with a mission to transform surgery, advance care and change lives. The Company's less invasive, procedurally integrated surgical solutions are designed to deliver reproducible and clinically proven outcomes. NuVasive has ~2,800 employees and operates in more than 50 countries.

ORTHOFIX

Our newly merged Orthofix-SeaSpine organization is a leading global spine and orthopedics company with a comprehensive portfolio of biologics, innovative spinal hardware, bone growth therapies, specialized orthopedic solutions, and a leading surgical navigation system. Our products are distributed in 68 countries worldwide.

Our company is headquartered in Lewisville, Texas, and has primary offices in Carlsbad, CA, with a focus on spinal product innovation and surgeon education, and Verona, Italy, with an emphasis on product innovation, production, and medical education for orthopedics. Our combined company's global R&D, commercial and manufacturing footprint also includes facilities and offices in Irvine, CA, Toronto, Canada, Sunnyvale, CA, Wayne, PA, Olive Branch, MS, Maidenhead, UK, Munich, Germany, Paris, France, and São Paulo, Brazil. For more information, visit Orthofix.com.

PACIRA

Pacira BioSciences, Inc. (Nasdaq: PCRX) is committed to providing a non-opioid option to as many patients as possible to redefine the role of opioids as rescue therapy only. The company is also developing innovative interventions to address debilitating conditions involving the sympathetic nervous system, such as cardiac electrical storm, chronic pain, and spasticity. Pacira has three commercial-stage non-opioid treatments: EXPAREL® (bupivacaine liposome injectable suspension), a long-acting, local analgesia currently approved for postsurgical pain management; ZILRETTA® (triamcinolone acetonide extended-release injectable suspension), an extended-release, intra-articular, injection indicated for the management of osteoarthritis knee pain; and iovera°®, a novel, handheld device for delivering immediate, long-acting, drug-free pain control using precise, controlled doses of cold temperature to a targeted nerve. To learn more about Pacira, including the corporate mission to reduce overreliance on opioids, visit www.pacira.com.

EXHIBITOR DESCRIPTIONS

SI-BONE

Advancing the diagnostic understanding of the sacroiliac joint and minimally invasive surgery for certain causes of SI joint disorders.

SI-BONE was founded in 2008 and has developed an innovative, patented implant for some causes of SI joint pain. To date, more than 75,000 minimally invasive surgical SI joint fusions have been performed with the iFuse Implant System® by more than 3,000 surgeons worldwide.

SI-BONE is focused on helping patients in one of the most under-served, underdiagnosed, and under-treated areas in orthopedics, the sacroiliac (SI) joint. The iFuse Implant System® is intended for sacroiliac fusion for conditions including sacroiliac joint dysfunction that is a direct result of sacroiliac joint disruption and degenerative sacroiliitis. The iFuse Implant System® is also intended for sacroiliac fusion to augment immobilization and stabilisation of the sacroiliac joint in skeletally mature patients undergoing sacropelvic fixation as a part of a lumbar or thoracolumbar fusion.

SILONY MEDICAL

Silony Medical develops spinal implant and instrument systems which specifically consider the needs of patients, doctors and hospital staff.

We believe spinal implants and instruments should adapt to the user – rather than the other way around. As such, we refine our products jointly with clinicians to ensure they are both practical and state-of-the-art. To achieve this, we wish our customers to consider us as partners, not merely as a supplier. We cooperate closely with many of Europe's most renowned surgeon specialists. To learn from their best practice, and to take their valuable suggestions on board, which help us realise and improve our spinal systems as well as our offered services. We believe that service is only worthy of the name if it remains flexible, transparent, of high quality and time conscious. We join forces to obtain intelligent solutions to existing challenges, guard against future obstacles and optimise proven solutions to the highest standard.

Everyone at Silony Medical is highly motivated and committed to differentiate themselves in the spinal industry. We all subscribe to a set of core values: commitment, integrity, teamwork and uncompromising quality.

SPINEGUARD

Founded in 2009 in France and the USA by Pierre Jérôme and Stéphane Bette, SpineGuard is an innovative company deploying its proprietary radiation-free real time sensing technology DSG® (Dynamic Surgical Guidance) to secure and streamline the placement of implants in the skeleton. SpineGuard designs, develops and markets medical devices that have been used in over 90,000 surgical procedures worldwide. Twenty-one studies published in peer-reviewed scientific journals have demonstrated the multiple benefits DSG® offers to patients, surgeons, surgical staff and hospitals. Building on these strong fundamentals and several strategic partnerships, SpineGuard has expanded the scope of its DSG® technology in innovative applications such as the « smart » pedicle screw, the DSG Connect visualization and registration interface, dental implantology and surgical robotics. DSG® was co-invented by Maurice Bourlion, Ph.D., Ciaran Bolger, M.D., Ph.D., and Alain Vanquaethem, Biomedical Engineer. SpineGuard has engaged in multiple ESG initiatives.

STRYKER

Stryker is one of the world's leading medical technology companies and, together with its customers, is driven to make healthcare better. The company offers innovative products and services in Medical and Surgical, Neurotechnology, Orthopaedics and Spine that help improve patient and healthcare outcomes. Alongside its customers around the world, Stryker impacts more than 100 million patients annually. More information is available at www.stryker.com.

ZIMVIE

ZimVie Spine is dedicated to restoring daily life for patients through comprehensive spinal solutions with a focus on education, training, and clinical support for surgeons. Along with cervical disc replacement, vertebral body tethering, comprehensive spinal fixation, and fusion implants, ZimVie Spine offers minimally invasive procedural solutions and a complete suite of biologic solutions.

HANDS-ON WORKSHOPS

IMAST delegates are encouraged to attend the Hands-On Workshops (HOWs). Each workshop is programmed by a single-supporting company and will feature presentations on topics and technologies selected by the company. Catering will be served at each Workshop.

*Please note: CME credits are not available for Hands-On Workshops.

HOWs are located on Level 1 and Level 2.

SCHEDULE

	THURSDAY, MARCH 23	FRIDAY, MARCH 24
MORNING	**08:00 - 09:00**	**07:30 - 08:30**
Liffey Hall 1, Level 1	DePuy Synthes	
Liffey Hall 2, Level 1	Globus Medical	
LUNCH	**12:15 - 13:15**	**11:30 - 12:30**
Liffey Hall 1, Level 1	NuVasive	DePuy Synthes
Liffey Hall 2, Level 1	Globus Medical	Globus Medical
Wicklow Hall 2A, Level 2	ZimVie	Pacira BioSciences, Inc.
Wicklow Hall 2B, Level 2	Medtronic	Stryker
AFTERNOON		**14:30 - 15:30**
Liffey Hall 1, Level 1		ATEC Spine
Wicklow Hall 2B, Level 2		Stryker

HANDS-ON WORKSHOPS

THURSDAY, MARCH 23 | 08:00 - 09:00

DEPUY SYNTHES

Liffey Hall 1, Level 1

Innovations in Adult Spinal Deformity

Please join our distinguished faculty for this session featuring masters' techniques and case based discussion.

Faculty: Tobias Schulte, MD; Daniel Sciubba, MD; Justin S. Smith, MD, PhD; Alekos Theologis, MD

GLOBUS MEDICAL

Liffey Hall 2, Level 1

How Robotic Navigation is Transforming Pediatric and Adult Deformity Surgery

The discussion will focus on surgical techniques when addressing complex deformity cases for pediatric and adult patients with ExcelsiusGPS® robotic navigation. The speakers will discuss their clinical applications of ExcelsiusGPS® and how this platform can impact deformity procedures. The discussion will include pediatric and adult deformity case review and a live Q&A.

Speakers: David Skaggs, MD & Corey T. Walker, MD

THURSDAY, MARCH 23 | 12:15 - 13:15

GLOBUS MEDICAL

Liffey Hall 2, Level 1

Non-Fusion Correction in the Treatment of AIS: Techniques, Benefits and Cases

The discussion will focus on surgical techniques, benefits of non-fusion correction in comparison to fusion, and challenging cases for adolescent idiopathic scoliosis.

Speakers: Prof. Ahmet Alanay & Dr. Randall Betz

MEDTRONIC

Wicklow Hall 2A, Level 2

Accelerating the Patient-Specific Care Continuum

As the demand for customized care increases, Medtronic is driving the patient-specific care continuum through a host of complementary technologies: artificial intelligence-driven surgical planning, patient-specific spinal implants for complex constructs, and navigation and robotic-assisted surgical delivery. Together, these technologies and systems may be leveraged in a synergistic manner to drive patient-specific approaches to care. This wokshop will provide a unique opportunity to discover how spine surgeons are leveraging these integrated solutions into their practice and how Medtronic is accelerating the transition to a new era of patient-specific medicine.

Faculty: Larry Lenke, MD & Chris Ames, MD

NUVASIVE

Liffey Hall 1, Level 1

Intelligent Surgery for Complex Spine Using Big Data, Enabling Technologies, and Novel Techniques to Get it Right the First Time

Ongoing advances in technology offer ever-increasing opportunities to improve patient outcomes. Join Dr. David Okonkwo and Dr. Justin Smith as they review technology driven strategies and tools to maximize outcomes for your challenging spine cases. In this session, the faculty will provide case examples and discuss how to "get it right the first time."

Faculty: David O. Okonkwo, MD, PhD & Justin S. Smith, MD, PhD

ZIMVIE

Wicklow Hall 2B, Level 2

What We Know that has Optimized VBT Outcomes

An expert panel of surgeons will share their best practices and techniques when using The Tether™. The discussion will highlight patient selection criteria and surgical techniques that support optimal outcomes. Attending surgeons will better understand VBT applications that coincide with a patient's pathology. Topics for discussion will include level selection, tensioning, and complication avoidances for thoracic and lumbar curves.

Faculty: Dr. Amer Samdani, Dr. Baron Lonner, & Dr. Firoz Miyanji

HANDS-ON WORKSHOPS

FRIDAY, MARCH 24 | 11:30 - 12:30

DEPUY SYNTHES

Liffey Hall 1, Level 1

Innovations in Pediatric Spinal Deformity

Please join our distinguished faculty for this session featuring masters' techniques and case based discussion.

Faculty: Stefan Parent, MD, PhD; Amer F. Samdani, MD; Michelle Welborn, MD

PACIRA BIOSCIENCES, INC.

Wicklow Hall 2A, Level 2

Innovative Pain Management Techniques For Treating Adult and Pediatric Spine Patients

An introduction of novel techniques in treating post-surgical pain after adult and pediatric spine surgery. Regional blocks performed under ultrasound guidance, fluoroscopy, or direct visualization will be reviewed as a foundation for an ERAS® protocol to successfully minimize opioid use while enhancing the patient experience after surgery.

Faculty: Daniel M. Sciubba, MD; Peter O. Newton, MD; Jeffrey C. Gadsden, MD, FRCPC

GLOBUS MEDICAL

Liffey Hall 2, Level 1

Cases Discussions with ExcelsiusGPS® with Robotic Navigation

The speaker will discuss his clinical experience with ExcelsiusGPS® as well as facilitate case discussion focusing on Deformity and Complex Cases. The speaker will review tips and tricks, such as addressing challenging trajectories, and achieving the desired implant placement with robotic navigation.

Speaker: Dr. Themi Protopsaltis

STRYKER

Wicklow Hall 2B, Level 2

Enhanced Clarity, Simplifies Planning

A great plan starts with a great image. With full spine view in one scan, and sharp image quality, paired with the latest planning software in the US market that can automatically segment and label the thoracolumbar spine, you are equipped with more knowledge. When you see more, you can do more. Please join Griffin Baum, MD and Benny Dahl, MD, PhD as they discuss the Q Guidance System with Spine Guidance Software and the Airo TruCT mobile CT scanner offer tools that may help simplify surgical planning and navigation.

Faculty: Griffin Baum, MD & Benny Dahl, MD, PhD

FRIDAY, MARCH 24 | 14:30 - 15:30

ATEC SPINE

Liffey Hall 1, Level 1

Solutions for Spinal Deformity Featuring PTP and Invictus SI.CORE: The Foundation for Every Deformity Construct

Proctor: Puya Alikhani, MD

Speaker: Daniel Cavanaugh, MD

STRYKER

Wicklow Hall 2B, Level 2

Fixated on Science: Why Material Matters

Inspired by biology and enabled by design, Tritanium In-Growth Technology is designed to mimic cancellous bone and provide an environment favorable to bone regeneration and fusion. Our proprietary Tritanium matrix has been shown to drive osteogenic differentiation and other bone growth cell responses – without the use of bone growth supplements – in both in vitro cell culture and in vivo animal studies. Please join Eric Klineberg, MD; Peter Loughenbury, MD and Joseph Robinson, PhD as they discuss the science behind this exciting technology, which is printed in the world's largest additive manufacturing facility for orthopaedic implants – the AMagine Institute – Cork, Ireland.

Moderator: Eric Klineberg, MD

Faculty: Peter Loughenbury, MD & Joseph Robinson, PhD, Principal Engineer at Stryker

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ABOUT SRS

Scoliosis Research Society

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 1,400 health care professionals.

MISSION STATEMENT

The purpose of the Scoliosis Research Society is to foster the optimal care of all patients with spinal deformities.

MEMBERSHIP

SRS is open to orthopaedic surgeons, neurosurgeons, researchers, and allied health professionals who have a practice that focuses on spinal deformity. Visit www.srs.org/professionals/membership for more information on membership types, requirement details, and to apply online.

PROGRAMS AND ACTIVITIES

SRS is focused primarily on education and research that include the Annual Meeting, the International Meeting on Advanced Spine Techniques (IMAST), Worldwide Courses, 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.

SCOLIOSIS RESEARCH SOCIETY

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SOCIAL MEDIA

Join the conversation surrounding IMAST by including #SRSIMAST23 in your social media posts.

@srs_org

@ScoliosisResearchSociety

@srs_org

@Scoliosis Research Society

DEI STATEMENT

The SRS recognizes the benefit of bringing the knowledge, perspectives, experiences and insights of a diverse membership to our society. We are committed to including outstanding members from the broad spectrum of human ethnicities, genders, sexual orientations, national origins, geographic backgrounds, abilities, disabilities, religious beliefs, and ages. We will create a culture that is equitable and inclusive, where everyone has a voice and differences are celebrated. By building a membership and leadership who better reflect the diverse communities we study and care for, we foster better and more equitable care for patients with spinal disorders.

58TH ANNUAL MEETING

September 6-9, 2023

Seattle, Washington USA

Scoliosis Research Society

Registration Opens: **May 2, 2023**
Advanced Registration Closes: **August 10, 2023**

www.srs.org/am23

31st IMAST

San Diego

CALIFORNIA, USA APRIL 10-13, 2024

International Meeting on Advanced Spine Techniques

SRS
Scoliosis Research Society

MEETING OVERVIEW

All IMAST sessions take place at the Convention Centre Dublin (CCD).

WEDNESDAY, MARCH 22, 2023		
15:00 - 18:00	Registration Open	The Forum Lobby
16:00 - 18:00	Cases & Cocktails Sessions	Wicklow Hall 1 Wicklow Hall 2A Wicklow Hall 2B
18:00 - 20:00	Welcome Reception & Exhibitor Viewing*	The Forum
THURSDAY, MARCH 23, 2023		
07:00 - 18:00	Registration Open	The Forum Lobby
09:00 - 17:00	Exhibit Hall Open	The Forum
08:00 - 09:00	Hands-On Workshops with Breakfast*	Liffey Hall 1 Liffey Hall 2
09:00 - 09:30	Refreshment Break	The Forum
09:30 - 12:00	Session 1: Whitecloud Nominees & Keynote Address	The Liffey B
12:00 - 12:15	Lunch Pick-Up	The Forum
12:15 - 13:15	Hands-On Workshops* Lunch pick-up available inside HOW rooms	Liffey Hall 1 Liffey Hall 2 Wicklow Hall 2A Wicklow Hall 2B
13:45 - 15:15	Session 2A: Culture of Innovation in Spine Surgery: Ideas, Execution & Adoption Session 2B: Patient-Specific Approaches and Implants in Spine Surgery: 2023 vs 2033	2A: The Liffey A 2B: The Liffey B
15:15 - 15:45	Refreshment Break	The Forum
15:45 - 16:55	Session 3A: Miscellaneous (Tumor, Infection, Non-Op, Other) Session 3B: Cervical Spine, Kyphosis and Lumbar Degenerative	3A: The Liffey A 3B: The Liffey B
17:15 - 18:45	Session 4: 30 Years of Innovation	The Liffey B
FRIDAY, MARCH 24, 2023		
08:00 - 17:00	Registration Open	The Forum Lobby
08:30 - 16:00	Exhibit Hall Open	The Forum
08:30 - 09:00	Refreshment Break	The Forum
09:00 - 11:00	Session 5A: AIS, Motion Preservation, Innovative Methods and Neuromuscular Session 5B: Adult Spinal Deformity & Quality / Safety / Value / Complications	5A: The Liffey A 5B: The Liffey B
11:15 - 11:30	Lunch Pick-Up	The Forum
11:30 - 12:30	Hands-On Workshops* Lunch pick-up available inside HOW rooms	Liffey Hall 1 Liffey Hall 2 Wicklow Hall 2A Wicklow Hall 2B
12:45 - 14:15	Session 6A: Non-Fusion Surgical Treatment for AIS: Expanding the Portfolio Session 6B: Patient-Focused MIS	6A: The Liffey A 6B: The Liffey B
14:30 - 15:30	Hands-On Workshops with Snacks & Coffee*	Liffey Hall 1 Wicklow Hall 2B
15:30 - 16:00	Refreshment Break	The Forum
16:00 - 17:30	Session 7: Expert Techniques	The Liffey B
18:30 - 19:30	Faculty Reception (invitation only)	
19:00 - 21:00	Innovation Celebration (pre-registration required)	EPIC, The Irish Emigration Museum
SATURDAY, MARCH 25, 2023		
	Innovation Day*	

**Denotes Non-CME Session*