60th Annual Meeting

September 16-20, 2025

CHARLOTTE

North Carolina, USA

FINAL PROGRAM

SRS

Scoliosis Research Society

CORPORATE SUPPORTERS

We are pleased to acknowledge and thank those companies that provided financial support to SRS in 2025. 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.

SRS TRIPLE DIAMOND CORPORATE SUPPORTER

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ANNUAL MEETING VENUE

Charlotte Convention Center
501 S College Street
Charlotte, North Carolina 28202, USA

All information as of August 18, 2025

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*

MEMBER'S BUSINESS MEETING AND LUNCH

Friday, September 19 | 12:15-13:30
Room E219 | Level 3

A hot lunch will be provided.

All SRS members are invited to the 2025 Member Business Meeting. This meeting is an opportunity to hear a summary of the many activities of the Society over the last year.

The agenda will include:

- Reports from the various SRS committees presented by each Council
  - Communication
  - Education
  - Governance
  - Research
- Updates on SRS activities, programs, and financial state
- Reports from the 2025 Traveling Fellows
- Voting on Bylaws changes, the Slate of Officers and the 2025-2026 Nominating Committee (e-vote)

Attendance at the Member's Business Meeting is an opportunity to not only hear updates, but actively participate in shaping the future of our Society. We encourage ALL MEMBERS to attend.

Scoliosis Research Society

Meeting Information

The Scoliosis Research Society gratefully acknowledges ATEC Spine for their grant support of the Pre-Meeting Course.

PRESIDENT'S MESSAGE

On behalf of the Scoliosis Research Society, it is my great pleasure to welcome you to the 60th SRS Annual Meeting in Charlotte, NC.

The Annual Meeting is the realization of the Society's vision- to provide global leadership in research and education that will result in enhanced quality of life for all patients with spinal deformities - and this year's program was chosen from the best abstracts and proposals which supports that vison. Co-chairs Jennifer Bauer, MD and Martin Repko, MD, along with the Annual Meeting Scientific Program Committee and Education Committee have done an outstanding job putting our program together and I think it will be truly impactful for everyone who attends.

As always, the SRS Annual Meeting kicks off with the prestigious Hibbs Society meeting on Tuesday afternoon, chaired by last year's SRS Travelling Fellows and featuring both cutting edge innovations in scoliosis care and updates on sagittal plane alignment. The meeting officially opens with the Pre-Meeting Course on Wednesday morning followed by three lunchtime symposia. Noelle Larson, MD and the Education Committee have put together an outstanding Pre-Meeting Course on New Technology in Complex Spine Care, and you'll have trouble choosing between three great Lunchtime Symposia (which fortunately will be recorded for later viewing) that follow!

We jump right in with the first abstract session Wednesday afternoon, following tradition with work focused on AIS, then the Opening Ceremonies will start at 17:20 on Wednesday evening. We'll be announcing several important grant and service awards, acknowledging our industry partners, and awarding the Walter P. Blount Humanitarian Award to this year's deserving recipient, Gregory M. Mundis Jr., MD.

The Opening Ceremonies also include the Steel Lecture, and I'm very excited to hear our invited speaker Michèle Flournoy's talk, Navigating the Changing Geopolitical Landscape. She is a co-founder and the current managing partner of WestExec Advisors and served as the Under Secretary of Defense for Policy under President Barack Obama. This presentation will be a question-and-answer discussion that I know our members will enjoy. I encourage everyone to attend and join the reception that follows, which is always the perfect atmosphere to reconnect with members and friends.

Thursday morning kicks off with sessions from the scientific program, followed by the Harrington Lecture featuring Peter Newton, MD, past President of the Scoliosis Research Society. Peter is a visionary thinker and his talk is entitled, "Where are we going, what are we doing. Just keep asking!" We will also present the Lifetime Achievement Award to John B. Emans, MD, who has exemplified distinguished service to SRS and to spinal deformity care and research.

Thursday also includes our great Industry Workshops, highlighting topics and technologies selected by the supporting companies. There are also afternoon networking sessions hosted by our industry supporters which provides another great environment for connecting. I encourage everyone to take advantage of both of these opportunities on Thursday.

Friday will be a full day of scientific sessions beginning with the Hibbs Award-Nominated Papers as well as the Presidential Address. The lunchtime Member's Business meeting covers all the updates from our committees, budget, progress reports and outlook for the coming year, including the always inspiring Traveling Fellow's report. I highly encourage you to attend to understand the Society's many achievements this year. Non-members can attend a concurrent Non-Member Information Session to learn more about joining our society.

Friday concludes with the Farewell Reception which will be held at the adjacent NASCAR Hall of Fame. You can try your hand as a pit crew team or experience driving a NASCAR simulator while enjoying refreshments with your friends.

We close the meeting with a half-day of scientific sessions on Saturday, including the Transfer of the Presidency to Suken Shah, MD. The afternoon is yours to explore the area, relax with friends or travel home.

It has been the honor of my career to serve as the President of the Scoliosis Research Society over the past year. The Presidential line and Board members are collaborative and creative leaders that use member input and a strong management team led by Ashtin Neuschaefer to set the direction for this society. When I accepted this role, it was my personal pledge to build on the positive momentum created by this talented and deeply committed group. I am so grateful for the opportunity to learn from the Society's committee members and leaders as we work towards our mission. The SRS is unique for its global participation and perspective, dedication to the highest quality research and education, and inclusivity of all those dedicated to our mission. I'm excited to be a part of the SRS as we continue to foster top quality research and education, and improve care for all patients with scoliosis and complex spinal conditions.

Laurel C. Blakemore, MD, SRS President

ANNUAL MEETING COMMITTEES

SRS PRESIDENT

Laurel C. Blakemore, MD

SRS EDUCATION COUNCIL CHAIR

Munish C. Gupta, MD, MBA

SRS EDUCATION COUNCIL CHAIR ELECT

Ronald A. Lehman Jr., MD

ANNUAL MEETING SCIENTIFIC PROGRAM COMMITTEE

Jennifer M. Bauer, MD, MS, Co-Chair
Martin Repko, MD, PhD, Co-Chair
Kariman Abelin-Genevois, MD, PhD
Nitin Agarwal, MD
Ivan Cheng, MD
Michael J. Faloon, MD, MS
Arvindera Ravi Ghag, MD, FRCSC
Jeffrey Gum, MD
Michael J. Heffernan, MD
Ilkka J. Helenius, MD, PhD
Steven W. Hwang, MD
W.G. Stuart Mackenzie, MD
Juan Esteban Muñoz Montoya, MD
Brian J. Neuman, MD
Ibrahim Obeid, MD
Mitsuru Yagi, MD, PhD

ANNUAL MEETING EDUCATION COMMITTEE

A. Noelle Larson, MD, Chair
Ali A. Baaj, MD
Carlos Eduardo Barsotti, MD
Patrick J. Cahill, MD
Panagiotis Diaremes, MD, PhD
Fernando A.M. Facanha-Filho, MD
Nicholas D. Fletcher, MD
Brian Hsu, MD
Eric O. Klineberg, MD
Luiz Müller Avila, MD
Venu M. Nemani, MD, PhD
Ali K. Ozturk, MD
William A. Phillips, MD
Javier Pizones, MD, PhD
Cristina Sacramento Dominguez, MD, PhD
Byron F. Stephens, MD
John S. Vorhies, MD
Michelle C. Welborn, MD

PROGRAM ABSTRACT REVIEWERS

Ahmed M. Abdelgawaad, MD, MHBA
Md Yousuf Ali
Mehmet B. Balioglu, MD
Aiyush Bansal, MD
Saumyajit Basu. MD
David B. Bumpass, MD
Michael S. Chang, MD
Jason Pui Yin Cheung, MBBS, MMedSc, MS, MD
Robert H. Cho, MD
Samuel K. Cho, MD
Alexandre Fogaça Cristante, MD, PhD
Alejandro Dabaghi Richerand, MD
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Romain Dayer, MD
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John T. Killian, MD
William F. Lavelle, MD
Jean-Christophe Leveque, MD
John P. Lubicky, MD, FAAOS, FAAP, FAOA
Hossein Mehdian, MD, FRCS(Ed)
Robert Meves, MD, PhD
Luiz Müller Avila, MD
Luis E. Munhoz da Rocha, MD
Scott J.B. Nimmons, MD
Betty P. Norheim, MD
Denis Sakai, MD
Samer Samy, MD, PhD
Masood Shafafy, FRCS(Orth)
Paulo Jose Silva Ramos, MD
Fernando Techy, MD
Khoi D. Than, MD
Per D. Trobisch, MD
Jay D. Turner, MD, PhD
Hanneke M. van West, MD
John S. Vorhies, MD
Guodong Wang, MD, PhD
Karen A. Weissmann, MD, PhD

GENERAL INFORMATION

MEETING DESCRIPTION

The Scoliosis Research Society (SRS) Annual Meeting is a forum for the realization of the Society's mission and goals: the improvement of patient care for those with spinal deformities. Five faculty-led instructional course lectures, 179 abstract papers, and 91 E-Point Presentations will be presented on an array of topics, including adolescent idiopathic scoliosis, neuromuscular scoliosis, growing spine, kyphosis, adult deformity, minimally invasive surgery, and machine learning.

LEARNING OBJECTIVES

Upon completion of the Annual Meeting, participants should be able to:

1. Discuss surgical indications, planning targets, and approaches available for obtaining appropriate spinal correction for patients with congenital or acquired spinal deformity.
2. Improve knowledge of operative techniques for fusion to the pelvis, role for sacroiliac joint fusion, and use of a multirod construct.
3. Analyze operative and non-operative standard of care for pediatric and adult spinal deformity surgery.
4. Recognize 3D concepts and summarize the new 3D classification of adolescent idiopathic scoliosis, including new modifiers emphasizing transverse plane deformities, which offers more comprehensive understanding of scoliosis beyond traditional sagittal and coronal measurements.
5. Assess preoperative and postoperative techniques to reduce the risk of complications and infection in spine surgery patients.
6. Increase level of knowledge about machine learning, artificial intelligence, and how to deploy these technologies in academic and clinical practice in the care of spinal deformity patients..

TARGET AUDIENCE

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

ABSTRACT VOLUME

All abstracts accepted for presentation at the 60th Annual Meeting are published in the Final Program. Abstracts are also available online on the Program page of the SRS Annual Meeting website (https://www.srs.org/Meetings-Conferences/Annual-Meeting/AM25#program) and in the Annual Meeting app.

ATTIRE

Business (suits) or business casual attire (polo or dress shirt, sport coat) are appropriate for all Annual Meeting sessions; ties are not required. Cocktail attire is appropriate for the Farewell Reception.

CELL PHONE PROTOCOL

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

CME INFORMATION

Accreditation Statement

The Scoliosis Research Society (SRS) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

Credit Designation

The Scoliosis Research Society designates this Live activity, 60th Annual Meeting, for a maximum of 27 *AMA PRA Category 1 Credits*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Maintenance of Certification (MOC) Credit

Successful completion of this CME activity, which includes participation in the evaluation component, enables the learner to earn credit toward the CME of the American Board of Orthopaedic Surgery's Maintenance of Certification program. It is the CME activity provider's responsibility to submit learner completion information to ACCME for the purpose of granting ABOS credit.

DISCLOSURE OF FINANCIAL RELATIONSHIPS

It is the policy of SRS to ensure balance, independence, objectivity, and scientific rigor in all educational activities. In accordance with this policy, SRS identifies all financial relationships held with an ineligible company* by individuals in a position to influence or control the content of a CME activity. Relevant financial relationships are mitigated by SRS to ensure that all scientific research referred to, reported, or used in a CME activity conforms to the generally accepted standards of experimental design, data collection, and analysis. Complete faculty disclosures can be found starting on page 234.

**An ineligible company is one whose primary business is producing, marketing, selling, re-selling, or distributing healthcare products used by or on patients.*

EMERGENCY & FIRST AID

The Charlotte Convention Center is fully prepared to handle emergency requests and first aid. Contact an SRS staff person for support. Remember to note all emergency exits within the venue.

GENERAL INFORMATION

E-POINT PRESENTATIONS

There are 91 E-Point Presentations available to view at the E-Point Presentation Kiosks located near Registration.

EVALUATIONS

Please take time to complete the Annual Meeting evaluation. The meeting evaluation is available online on the AM25 Meeting App. Your input and comments are essential in planning future Annual Meetings.

FDA STATEMENT (UNITED STATES)

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

INSURANCE/LIABILITIES AND DISCLAIMER

SRS will not be held liable for personal injuries or for loss or damage to property incurred by participants or guests at the Annual Meeting including those participating in tours, social events or virtually. Participants and guests are encouraged to take out insurance to cover losses incurred in the event of cancellation, medical expenses, or damage to or loss of personal effects when traveling outside of their own countries.

SRS cannot be held liable for any hindrance or disruption of the Annual Meeting proceedings arising from natural, political, social, or economic events, or other unforeseen incidents beyond its control. Registration of a participant or guest implies acceptance of this condition.

The materials presented at this Continuing Medical Education activity are made available for educational purposes only. The material is not intended to represent the only, nor necessarily best, methods or procedures appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement, or opinion of the faculty that may be helpful to others who face similar situations.

SRS disclaims all liability for injury or other damages resulting to any individual attending a scientific meeting and for all claims that may arise out of the use of techniques demonstrated therein by such individuals, whether these claims shall be asserted by a physician or any other person.

LANGUAGE

Presentations and meeting materials will be provided in English.

LOST & FOUND

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

NAME BADGES

Official name badges are required for admission to all Annual Meeting sessions, breaks, and lunches. Meeting attendees will receive a name badge with their registration materials. Name badges are required to be worn while inside the meeting venue, 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 badges draw unwanted attention to your status as visitors to the city.

NO SMOKING POLICY

Smoking is not permitted during any Annual Meeting activity or event.

PHOTOGRAPHY POLICY

SRS will be taking photographs throughout the Annual Meeting. SRS will use these photos in publications and to produce related literature and products for public release. Individuals photographed will not receive compensation for the use and release of these photos and will be deemed to have consented to the use and release of photos in which they appear. If you are opposed to being photographed, please immediately notify the photographer or an SRS staff member if your picture is taken. Thank you for your cooperation.

REGISTRATION DESK HOURS

Location: Level 3 | Ballroom Pre-function 1

Tuesday, September 16	10:30-17:00
Wednesday, September 17	07:00-19:00
Thursday, September 18	07:00-16:00
Friday, September 19	07:00-17:30
Saturday, September 20	07:30-11:30

SESSION RECORDING ACCESS

All SRS members and registered meeting delegates will be receive a private link to the full recordings of all sessions withing 3-4 weeks after the meeting.

GENERAL INFORMATION

SPEAKER READY ROOM

Location: Level 3 | Room E217

Presenters may upload their presentations onsite in the Speaker Ready Room. Presentations should be uploaded no later than 24 hours before the session is scheduled to begin.

Tuesday, September 16	12:00-17:00
Wednesday, September 17	07:00-18:30
Thursday, September 18	07:00-16:00
Friday, September 19	07:00-18:00
Saturday, September 20	07:30-11:30

SPECIAL NEEDS

If you have any health issues for which you may require special accommodation or assistance, please notify an SRS staff member. SRS will make every effort to accommodate any special needs.

SRS HISTORICAL DISPLAY

Location: Level 3 | Ballroom Pre-function 1

Explore the unique spine history of North Carolina at the SRS Historical Display. The SRS Historical Committee, in conjunction with Sam Chewning, MD, William Richardson, MD, and SRS Archivist Katie Dold, MLS, have created a display about notable contributions to spine and spine deformity surgery by those in the Carolina Region.

Selections from interviews of important contributors to the study of spinal deformity will be featured on a video monitor and can be viewed near the Historical Display.

JOIN THE CONVERSATION

Join the conversation surrounding the SRS Annual Meeting by using **#SRSAM25** in your social media posts.

@srs_org

@ScoliosisResearchSociety

@ScoliosisResearchSociety

@srs_org

@srs_org

SCIENTIFIC SESSIONS FOR REGISTERED ATTENDEES ONLY

As an international medical professional organization, SRS is required to adhere to the guidelines set forth by MedTech Europe in its Code of Ethical Business Practice. This ensures compliance with the regulations of non-U.S. institutions and maintains alignment with SRS's industry partners. Within this code it states that "*It is not appropriate for a Guest of a Healthcare Professional to attend either Company Events (including satellite symposia) or Third Party Organised Educational Events (unless the individual qualifies as participant in their own right), nor is it appropriate, in the interest of maintaining scientific exchange, for a Guest to participate in related hospitality during such Events (for example, lunches, industry booths and coffee breaks) even when the Healthcare professional pays for the Guest's expense.*"

Limited exceptions may be made for guest attendance during non-scientific content (ex. Opening Ceremonies, award presentations), or to view a presentation by the meeting attendee. **All exceptions** must be approved by the SRS Presidential Line and/or Executive Director. Requests may be sent to meetings@srs.org.

Under the MedTech Europe Code of Ethical Business Practice a guest is defined as "*spouses, partners, family or guests of the Healthcare Professionals, or other person who does not have a bona fide professional interest in the information being shared at an Event.*"

SRS MEMBERSHIP TABLE

Location: Level 3 | Ballroom Pre-function 1

Stop by the SRS Membership Table for more information about becoming an SRS member, application status, upcoming meetings, and more.

VIDEO RECORDING PROHIBITED

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

WIRELESS INTERNET

Wireless Internet access is available throughout the meeting space.

Network: SRS Annual Meeting
Password: 2025AM60

SESSION AND EVENT INFORMATION

HIBBS SOCIETY MEETING - $50

Tuesday, September 16 | 13:00-17:00
Available to meeting delegates for an additional fee of $50

Over the years, the Russell A. Hibbs Society, formed in 1947 as an international travel club for continuing medical education and furthering orthopaedic knowledge, has held an educational meeting at the SRS Annual Meeting. These meetings address difficult and complex issues that do not lend themselves to the usual kind of scientific presentations. The meeting encourages interaction among international participants and highlights new ideas, new concepts, and reports on personal experience. The Hibbs Society Meeting is planned by the SRS Traveling Fellows and will feature updates on deformity treatments.

OPENING CEREMONIES AND WELCOME RECEPTION

Wednesday, September 17
Opening Ceremonies | 17:20-19:00
Welcome Reception | 19:00-21:00
Available at no charge to meeting delegates, $50 per registered guest

The Annual Meeting will officially begin with the Opening Ceremonies and this year's Howard Steel Lecturer, Michéle Flournoy. The Opening Ceremonies are the kickoff to the Annual Meeting, giving the Society the opportunity to highlight award and research winners, thank our donors and corporate partners, and includes the presentation of the Walter P. Blount Humanitarian Award.

A hosted reception featuring hors d'oeuvres, cocktails, and reunions with colleagues and friends will immediately follow the Opening Ceremonies. If you would like to purchase guest ticket(s), you may do so at the SRS Registration Desk.

INDUSTRY NETWORKING SESSIONS

Thursday, September 18 | 16:00-17:30

Delegates are encouraged to attend hosted Networking Sessions immediately following the last session of the day. Networking Sessions will be hosted by: ATEC Spine, Carlsmed, Highridge Medical, Medtronic, Proprio and VB Spine. Please see page 232 for more information

INDUSTRY WORKSHOPS

Thursday, September 18 | 12:30-14:00

Delegates are encouraged to attend the industry workshops. Each workshop is programmed by a single-supporting company and features presentations on topics and technologies selected by the company. Lunch will be available during the workshops. CME credits are not available for workshops.

Industry workshops will be hosted by: ATEC Spine, Globus Medical, Highridge Medical, Johnson & Johnson MedTech, Medtronic, Orthofix and SI-BONE. Please see page 230 for program information.

LIVE WEBCAST

Wednesday, September 17 | 12:15-13:15

On Wednesday, September, 17 from 12:15-13:15, LTS3: *How Much is Enough: Multirod Constructs and Pelvic Fixation in Adult Spinal Deformity*, will be webcast live. More information about the webcast is available on the AM25 website: www.srs.org/am25.

The webcast is supported, in part, by Orthofix.

MEMBER BUSINESS MEETING

Friday, September 19 | 12:15-13:30

All SRS members are invited to the Member Business Meeting. The agenda will include reports from the various SRS committees, updates on SRS activities and programs, and voting. Attendance at the Member's Business Meeting is an opportunity to not only hear updates but actively participate in shaping the future of our Society. We encourage ALL MEMBERS to attend. A hot lunch will be provided.

NON-MEMBER INFORMATION SESSION & LUNCH

Friday, September 19 | 12:15-12:45

While SRS members participate in the Business Meeting, all non-member delegates are encouraged to attend the Non-Member Information Session to connect with colleagues and learn more about SRS.

FAREWELL RECEPTION - $50

Friday, September 19 | 19:30-22:00
Location: NASCAR Hall of Fame
Available to registered delegates for an additional fee of $50, $150 per registered guest

Registration is required and tickets must be purchased in advance. A limited number of tickets may be available onsite, please stop at the registration desk for information and ticket availability. Tickets are $50 for registered attendees and $150 for registered guests.

Attire is business casual.

ANNUAL MEETING APP

The Meeting app delivering content, networking, engagement, and navigation all in one convenient location is available to all delegates during the meeting.

DOWNLOADING THE APP

1. Go to your device's app store and search for *SRS AM 2025*.
2. Select the meeting app and install.

PUSH NOTIFICATIONS

Apple and Android device users who have downloaded the meeting app can receive push notifications including reminders and schedule changes. Upon downloading the app, you must provide permission to receive these notifications on your device. You can update these permissions at any time within the Settings area of your device if necessary.

USING THE APP

1. Open the downloaded app and enter your email address to sign up or log in.
2. If you already have an account, you will be asked to enter your password. If you do not already have an account, you will be prompted to create a password and add profile information (optional).
3. The app can also be accessed by entering the URL, www.eventmobi.com/am25 on any current internet browser.
4. Once you are logged in, all event information will be readily available.

USER DASHBOARD

Click the icon in the top-right corner to access the User Dashboard. Here, you can find your personal schedule, notes you have taken, companies you have added to your favorites, documents you have added to your collection, and your chat inbox.

EVENT MENU

Access the event menu by clicking the Menu icon in the top-left corner. Here, you will find a list of sections that contain all of the event content, from speakers and sessions to meeting information and social media links. Select the section you are interested in and navigate through to find the information.

ASK A QUESTION IN THE APP

If you see a Q&A tab at the top of a session page, you can submit pertinent questions and comments to the moderator during that session. You can submit as many questions as you would like and view questions submitted by other attendees.

1. From the Agenda, click on the session you are in and click Q&A to see the question list.
2. From here, type your question in the text box provided and click Submit. Your question will appear within the question list.
3. To upvote someone else's question, click the upvote button to the right of the question in the list.

AWARD VOTING

Cast your vote for the Hibbs, Moe and Goldstein Award nominations. Look for the Award Voting option on the left-hand navigation in the Annual Meeting 2025 meeting app.

Voting for the Hibbs, Moe, and Goldstein Awards closes on Friday, September 19 at 13:00

GAMIFICATION

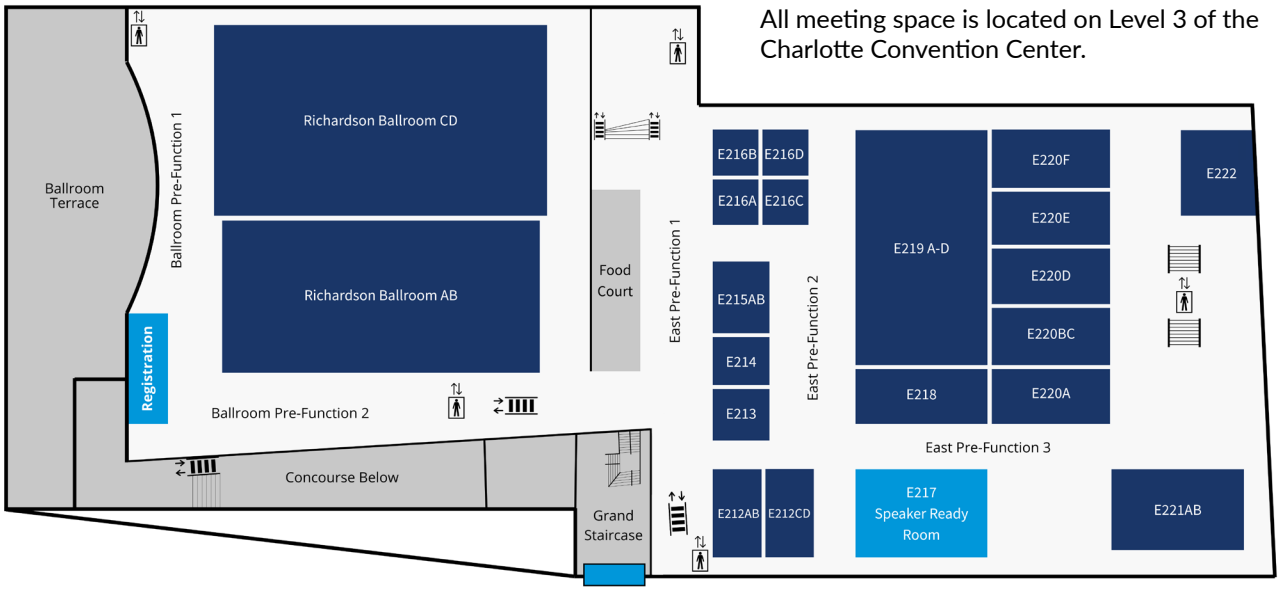
Gamification within the SRS Annual Meeting app is a unique way to interact with your peers and engage with the presenters by collecting codes to earn points.

To get you started, enter "Charlotte" for free points. The app includes the details on points available and other ways to earn them. Delegates with the most points will win prizes.

The app also includes a leader board so you can see who is earning the highest points throughout the week. Stop by the SRS Registration Desk to learn more about gamification and the Annual Meeting app.

MEETING SPACE FLOORPLAN

CHARLOTTE CONVENTION CENTER



All meeting space is located on Level 3 of the Charlotte Convention Center.

GENERAL ROOM / LOCATION	FUNCTION
Ballroom Pre-function 1	Registration
Room E217	Speaker Ready Room

SESSION ROOMS

ROOM	FUNCTION
Richardson Ballroom AB	Concurrent Sessions
Richardson Ballroom CD	General Session, Concurrent Session
Room E219	Concurrent Session

INDUSTRY WORKSHOPS: Thursday, September 18

ROOM	COMPANY
Room E218	Highridge Medical
Room E220A	ATEC Spine
Room E220BC	Globus Medical
Room E220D	Johnson & Johnson MedTech
Room E220E	Orthofix
Room E220F	SI-BONE
Room E221AB	Medtronic

INDUSTRY HOSPITALITY SUITES

ROOM	COMPANY
Room E212AB	Medtronic
Room E212CD	Highridge Medical
Room E213	VB Spine
Room E214	Orthofix
Room E216A	ATEC Spine
Room E216B	Johnson & Johnson MedTech
Room E216C	Globus Medical

ROOM E222: *By Invitation Only*

FUNCTION	DAY
SRS Board of Directors Meeting	Monday
Committee Chair Breakfast	Tuesday
Traveling Fellows' Reception	Tuesday
Women in Spine Breakfast	Wednesday
L.E.A.D. Alumni Breakfast	Thursday
L.E.A.D. SRS Cohort Meeting	Thursday
Past Presidents' Breakfast	Friday
SRS Board of Directors Meeting	Saturday

MEETING OUTLINE

Monday, September 15, 2025		
08:00 - 16:00	SRS Board of Directors Meeting*	Room E222
Tuesday, September 16, 2025		
07:00 - 08:00	Committee Chair Breakfast* (by invitation only)	Room E222
08:00 - 16:30	Committee and Council Meetings*	Varied
10:30 - 17:00	Registration Open	Ballroom Pre-function 1
12:00 - 17:00	Speaker Ready Room Open	Room E217
13:00 - 17:00	Hibbs Society Meeting	Room E219
17:00 - 18:00	Traveling Fellows Reception* (by invitation only)	Room E222
18:30 - 21:30	SRS Leadership Dinner* (by invitation only)	Offsite
Wednesday, September 17, 2025		
07:00 - 19:00	Registration Open	Ballroom Pre-function 1
07:00 - 18:30	Speaker Ready Room Open	Room E217
07:00 – 08:00	Women in Spine Breakfast*	Room E222
08:00 – 08:45	PMC 1: Introduction to ML, AI, LLM, DL and Other Trending Acronyms*	Richardson Ballroom CD
09:15 – 09:50	PMC 2: AI in the Office and Academics	Richardson Ballroom CD
09:50 – 10:45	PMC 3: AI in the OR	Richardson Ballroom CD
11:00 – 12:00	PMC 4: Ethical Issues and Practice Considerations with the Advent of AI	Richardson Ballroom CD
12:00 - 12:15	Lunch Pick-Up	Ballroom Pre-function 1
12:15 - 13:15	LTS1: Lumbosacral Obliquity: A Case-Based Symposium LTS2: The Time Has Come to Transition from 2D to 3D in AIS Understanding and Treatment LTS3: How Much is Enough: Multirod Constructs and Pelvic Fixation in Adult Spinal Deformity	Richardson Ballroom AB Richardson Ballroom CD Room E219
13:30 - 15:00	Abstract Session 1 | Adolescent Idiopathic Scoliosis I	Richardson Ballroom CD
15:00 - 15:20	Refreshment Break*	Ballroom Pre-function 1
15:20 - 17:05	Abstract Session 2 | Adult Spinal Deformity I	Richardson Ballroom CD
17:20 - 19:00	Opening Ceremonies*	Richardson Ballroom AB
19:00 - 21:00	Welcome Reception*	Ballroom Pre-function 1
Thursday, September 18, 2025		
07:00 - 16:00	Registration Open	Ballroom Pre-function 1
07:00 - 16:00	Speaker Ready Room Open	Room E217
07:00 – 08:00	L.E.A.D. SRS Alumni Breakfast* (by invitation only)	Room E222
08:00 - 09:50	Abstract Session 3 | Neuromuscular/Syndromic Deformity	Richardson Ballroom CD
09:50 - 10:10	Refreshment Break*	Ballroom Pre-function 1
10:10 - 12:15	Abstract Session 4 | Cervical Deformity, ASLS II Update, Harrington Lecture & Lifetime Achievement Award	Richardson Ballroom CD
12:15 - 12:30	Lunch Pick-Up	East Pre-function 3
12:30 - 14:00	Industry Workshops* (7 Concurrent Sessions)	Varied: page 230
14:10 - 15:55	L.E.A.D. SRS Cohort Session* (by invitation only)	Room E222
14:10 - 15:55	Abstract Session 5A | Adult Spinal Deformity II Abstract Session 5B | Adolescent Idiopathic Scoliosis II Newer Technology: VBT + AI	Richardson Ballroom CD Richardson Ballroom AB
16:00 - 17:30	Industry Networking Sessions*	Varied: see page 232

**denotes non-CME Session/event*

MEETING OUTLINE

Friday, September 19, 2025		
06:30 - 07:30	Past Presidents' Breakfast* (by invitation only)	Room E222
07:00 - 17:30	Registration Open	Ballroom Pre-function 1
07:00 - 18:00	Speaker Ready Room Open	Room E217
07:00 - 08:00	*Spine Deformity Journal* Editorial Board Meeting* (by invitation) only	Room E219
08:00 - 09:50	Abstract Session 6 | Hibbs Award-Nominated Papers	Richardson Ballroom CD
09:50 - 10:10	Refreshment Break*	Ballroom Pre-function 1
10:10 - 11:50	Abstract Session 7 | Adult Spinal Deformity III and Presidential Address	Richardson Ballroom CD
12:15 - 13:30	Member Business Meeting (lunch pick-up at 11:50)	Room E219
12:15 - 12:45	Non-Member Information Session (lunch pick-up at 11:50)	Room 221AB
13:45 - 15:30	Abstract Session 8A | Early Onset Scoliosis Abstract Session 8B | Kyphosis, Spondylolysis + -listhesis, other Pathologies	Richardson Ballroom CD Richardson Ballroom AB
15:30 - 15:50	Refreshment Break*	Ballroom Pre-function 1
15:50 - 18:00	Abstract Session 9 | Adolescent Idiopathic Scoliosis III & Non-Operative Treatment Methods	Richardson Ballroom CD
18:30 - 19:30	President's Reception* (by invitation only)	Offsite
19:30 - 22:00	Farewell Reception* (ticket required)	Offsite
Saturday, September 20, 2025		
07:00 - 08:00	SRS Board of Directors Meeting*	Room E222
07:30 - 11:30	Registration Open	Ballroom Pre-function 1
07:30 - 11:30	Speaker Ready Room Open	Room E217
08:00 - 10:10	Abstract Session 10 | Adult Spinal Deformity IV, Hibbs Award Presentation & Transfer of Presidency	Richardson Ballroom CD
10:10 - 10:30	Refreshment Break*	Ballroom Pre-function 1
10:30 - 12:15	Abstract Session 11 | Quality/Safety/Value/Complications & Miscellaneous (Spondy, Trauma, Tumor, etc.)	Richardson Ballroom CD
12:15	SRS 60th Annual Meeting Concludes	

**denotes non-CME Session/event*

GUEST LECTURES

WEDNESDAY, SEPTEMBER 17

Howard Steel Lecture

Michéle Flournoy
Navigating the Changing Geopolitical Landscape

Michèle Flournoy is Co-Founder and Managing Partner of WestExec Advisors, and a Co-Founder, former Chief Executive Officer, and now Chair of the Center for a New American Security (CNAS).

Michèle served as the Under Secretary of Defense for Policy from February 2009 to February 2012. She was the principal advisor to the Secretary of Defense in the formulation of national security and defense policy, oversight of military plans and operations, and in National Security Council deliberations. She led the development of the Department of Defense's 2012 Strategic Guidance and represented the Department in dozens of foreign engagements, in the media and before Congress.

Prior to confirmation, Michèle co-led President Obama's transition team at the Defense Department. In January 2007, Michèle co-founded CNAS, a bipartisan think tank dedicated to developing strong, pragmatic and principled national security policies. She served as CNAS' President until 2009, and returned as CEO in 2014. In 2017, she co-founded WestExec Advisors, a strategic advisory firm.

Michèle serves on the boards of CNAS, Booz Allen Hamilton, the Council on Foreign Relations, Amida Technology Solutions, and CARE. She serves on a number of advisory boards, including for The Leadership Council for Women in National Security, PIMCO, and Girl Security. She is a member of the Aspen Strategy Group. She is a former member of the President's Intelligence Advisory Board and the CIA Director's External Advisory Board, and the Secretary of Defense's Defense Policy Board.

Michèle earned a bachelor's degree from Harvard University and a master's degree from Balliol College, Oxford University, where she was a Newton-Tatum scholar.

THURSDAY, SEPTEMBER 18

Harrington Lecture

Peter O. Newton, MD
Where are we going, what are we doing. Just keep asking!

Dr. Newton is a pediatric orthopedic surgeon at Rady Children's Hospital in San Diego, California where he has practiced for more than 30 years specializing in the care of children and adolescents with spinal deformities. He completed his undergraduate training in Bioengineering at UCSD before getting his medical degree from UT Southwestern Medical School in Dallas. He returned to UCSD for his orthopedic residency training and was back to Dallas at Texas Scottish Rite Hospital for his pediatric orthopedic and scoliosis fellowship. He joined the pediatric orthopedic group at Rady Children's Hospital San Diego in 1994. Currently, he is the chief of the Orthopedic division and Surgeon in Chief at Rady Children's. He is also a clinical professor in the department of Orthopedic Surgery at the University of California, San Diego. His professional society leadership has included posts as president of the Pediatric Orthopedic Society of North America and the Scoliosis Research Society. His clinical interests have been focused on novel treatments for scoliosis including: thoracoscopy in anterior thoracic spinal surgery, posterior methods designed to maximize the 3-dimensional correction of scoliosis as well as fusionless methods of spinal growth modulation. He is the past president of the Harms Study Group which he led for 2 decades in their efforts to produce influential multicenter scoliosis research and was president of the foundation, Setting Scoliosis Straight. In addition to clinical outcomes research, his laboratory has been involved in the basic science of spinal growth, biomechanical studies related to implants, 3-dimensional imaging methods/modeling and surgical quality improvement. Dr. Newton is committed to advancing the field through excellence in clinical care, education of future generations, innovative research and organizational leadership.

2025 SRS AWARDS

2025 WALTER P. BLOUNT HUMANITARIAN AWARD

Presented for outstanding service to those with spinal deformity and for generosity to the profession and Society. The 2025 Blount award will be presented on Wednesday, September 17.

Gregory M. Mundis, Jr., MD

Dr. Gregory M. Mundis, Jr., M.D, is currently Professor of Orthopedic surgery at the Scripps Clinic in San Diego, California, is the President of the San Diego Spine Foundation and director of the San Diego Spine Fellowship and board member of Global Spine Outreach.

Dr. Mundis was born in Springfield, MO to the family of missionaries and moved to Austria at the age of 2. He would live in Austria and graduate high school from the American International School of Vienna, Austria. Service has always been in his DNA watching his family serve the local church and eventually starting an international church. It was on a trip to Calcutta, India when Dr. Mundis felt the calling into medicine. This experience as a young man has fueled his passion not only for orthopedics but more importantly his passion to help those in need.

While in Medical School at Evangel University, Dr. Mundis had his first experiences with medical missions serving in eastern rural China as well as Nicaragua in an area that had been struck with natural disasters providing general medical care. While these trips were an important part of his journey, he quickly recognized the need for consistency and commitment when it comes the delivery of medical care.

Soon after completing his residency at the University of Oklahoma and Fellowship at the San Diego Spine Fellowship, Dr. Mundis was eager to put his faith into action. He partnered with numerous organizations to provide pediatric spinal deformity care in Nairobi, Kenya, Nicosia, Cyprus and Riyadh, Saudi Arabia. In 2016 Dr. Akbarnia connected Dr. Mundis with Tony Rinella (founder of Global Spine Outreach and BHA winner 2013) who was leading a mission in Cali, Colombia, and this relationship would prove to be critical to his love for outreach work. Together with Dr. Rinella, Dr. Mundis initiated the Chihuahua GSO site and within 4 years would host numerous deformity symposia in Mexico, start the Monterrey GSO site, and more recently adding Joinville, Brazil to the cities where GSO would be serving twice per year. Dr. Mundis would serve as the CEO of GSO from 2018 to 2023 leading the organization through many transitions including financial viability, new executive leadership, creating a sustainable model of growth, recruiting committed surgeons, and partnering with industry and on-site hospitals to make these humanitarian efforts possible.

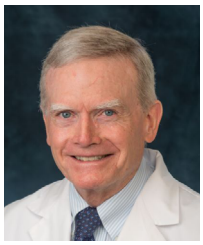
Dr. Mundis has made these efforts his life's passion sharing them with many residents, fellows, peers and most importantly his family who accompany him on many trips. He has found that the key to sustainability is to inspire others to see their own blessings and use them to impact the world around them. Ultimately, Dr. Mundis recognizes his role in outreach as insignificant without the dedicated support and competence of the team he is on. He would like to extend this award to his team including Melissa Hicks (executive director of GSO), his wife, Lesley Mundis, Tony Rinella, the GSO surgeon team, the local host surgeons, our hospital partners, our industry team members and most importantly to the kids and their families who have placed their trust and faith in this work.

2025 SRS AWARDS

2025 LIFETIME ACHIEVEMENT AWARD

Presented to a member who has exhibited long and distinguished service to SRS and to spinal deformity research and care. The 2025 Lifetime Achievement awards will be presented on Thursday, September 18.

John B. Emans, MD



John Emans is currently Professor of Orthopedic Surgery at Harvard Medical School and Director Emeritus of Spine Surgery at Boston Children's Hospital. Originally from upstate New York and Vermont, he attended Harvard College, Harvard Medical School, and completed general surgery residency at Peter Bent Brigham Hospital and orthopedic surgery residency at Massachusetts General Hospital. His first rotation in orthopedic residency was at Boston Children's, and first case in residency was an AIS fusion with Ray Morrissy as chief resident and John Hall as attending! After two years as Major in the Army Medical Corps, he returned in 1978 to Boston Children's as faculty with Chief of Orthopedics John Hall. His initial pediatric subspecialty assignments were in sports medicine with Lyle Micheli, then musculoskeletal tumors, then myelodysplasia. Like all pediatric orthopedists of the era, he did all aspects of pediatric orthopedics. Boston Children's was large enough to support full-time sub-specialization and for the last 4 decades he has concentrated on pediatric spine deformity.

He taught residents and fellows at Boston Children's and mentored several generations of pediatric orthopedic surgeons. He has long held a particular interest in congenital spine deformities, very early onset spine deformity and bracing for scoliosis. He was an early member of SRS, POSNA, SDSG, PSSG, and their leadership, committees, study groups and multi-center databases. Membership provided an opportunity to help advance the fields of early onset deformity, congenital deformity and non-operative treatment of AIS. A myriad of presentations, peer-reviewed publications, book chapters, and international visiting professorships were all possible thanks to SRS and other organizations. He recently received POSNA's Hall of Fame Award and ICEOS's Campbell Award for Innovation in Early Onset Scoliosis. He continues in practice at Boston Children's Hospital.

His spouse of 58 years, S. Jean Emans, MD, has had an illustrious parallel career at Boston Children's and Harvard as an international leader in adolescent medicine and pediatric and adolescent gynecology. Jean and John are fortunate to have 2 children, their spouses and 5 grandchildren living nearby.

Listen to upcoming episodes of Scoliosis Dialogues: An SRS Podcast for exclusive interviews with the Lifetime Achievement Award and Walter P. Blount Award winners. Scoliosis Dialogues can be found wherever you listen to podcasts or at www.srs.org/podcast.

SRS ANNUAL MEETING AWARDS

The ***2025*** Annual Meeting awards for the best basic/translational science and clinical research papers (Russell A. Hibbs Awards) and the best basic/translational science and clinical research E-Point Presentation (John H. Moe and Louis A. Goldstein Awards) will be presented on Saturday, September 20.

59TH ANNUAL MEETING RUSSELL A. HIBBS AWARDS

Presented to the best basic science and clinical research papers at the 59th Annual Meeting.

2024 Hibbs Award for Best Basic Science/Translational Research Paper

Examination of an Epigenetic Biomarker for Risk Stratification in Adult Spinal Deformity Surgeries

Michael P. Kelly, MD; Lawrence G. Lenke, MD; Justin S. Smith, MD, PhD; Shay Bess, MD; Justin K. Scheer, MD; Breton G. Line, BS; Virginie Lafage, PhD; Renaud Lafage, MS; Eric O. Klineberg, MD; Ferran Pellisé, MD, PhD; Mitsuru Yagi, MD, PhD; Khaled M. Kebaish, MD; Robert K. Eastlack, MD; Munish C. Gupta, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Douglas C. Burton, MD; Christopher P. Ames, MD; International Spine Study Group

2024 Hibbs Awards for Best Clinical Research Paper

Long-Term Outcomes of Operative Versus Nonoperative Treatment for Adult Symptomatic Lumbar Scoliosis (ASLS): Durability of Treatment Effects and Impact of Related Serious Adverse Events Through 8-Year Follow-Up

Justin S. Smith, MD, PhD; Michael P. Kelly, MD; Elizabeth L. Yanik, PhD; Christine Baldus, RN; Vy Pham, MD, MPH; David Ben-Israel, MD; Jon D. Lurie, MD, MS; Charles C. Edwards, MD; Steven D. Glassman, MD; Lawrence G. Lenke, MD; Oheneba Boachie-Adjei, MD; Jacob M. Buchowski, MD; Leah Y. Carreon, MD; Charles H. Crawford III, MD; Stephen J. Lewis, MD, FRCS(C); Tyler Koski, MD; Stefan Parent, MD, PhD; Virginie Lafage, PhD; Munish C. Gupta, MD; Han Jo Kim, MD; Christopher P. Ames, MD; Shay Bess, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Keith H. Bridwell, MD

59TH ANNUAL MEETING JOHN H. MOE AND LOUIS A. GOLDSTEIN AWARDS

Presented to the best basic science and clinical research E-Point Presentation at the 59th Annual Meeting.

2024 John H. Moe Award for Best Basic Science/Translational Research E-Point Presentation

Randomized Clinical Trial to Compare the Impact on Quality of Life Between Full-Time and Night-Time Braces in Adolescent Idiopathic Scoliosis: 12-Month Treatment Outcomes

Alejandro Peiro-Garcia, MD; Inmaculada Vilalta-Vidal, MD; Victor Martin-Gorgojo, MD; Carles Fabres-Martin, MD; Rocio Garcia-Garcia, MS

2024 Louis A. Goldstein Award for Best Clinical Research E-Point Presentation

Clinical and Radiological Outcomes of Posterior-Only Hemivertebra Resection and Short-Segment Fusion with Pedicle Screw Fixation in Children Under the Age of 5, Followed Until Skeletal Maturity

Bilge K. Yilmaz, MD; Ugur Yuzuguldu, MD; Hamisi M. Mraja, MD; Halil Gok, MD; Emre Kurt, MD; Baris Peker, MD; Tunay Sanli, BE, MA; Selhan Karadereler, MD; Meric Enercan, MD; Azmi Hamzaoglu, MD

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MEETING AGENDA

TUESDAY, SEPTEMBER 16, 2025

Program (topics, timing, and faculty) is subject to change.

13:00 - 17:00 | **Room E219**

Hibbs Society Meeting

Co-Chairs: Lindsay M. Andras, MD, Christina K. Hardesty, MD & Peter G. Passias, MD

13:00 - 14:11 | Hibbs Society 1: Getting Ahead of the Curve: Cutting Edge Approaches to Spinal Deformity Challenges

Moderators: Lindsay M. Andras, MD & Christina K. Hardesty, MD

13:00 - 13:05 **Introduction to the Hibbs Society**
David W. Polly Jr., MD

13:05 - 13:11 **Developing a Biomarker Bank**
Susana Núñez Pereira, MD, PhD

13:11 - 13:17 **MRI of Bone-Expanding Indications**
Tom PC Schlösser, MD, PhD

13:17 - 13:23 **Evaluating the Spine with Ultrasound Shear Wave Elastography**
Wafa Skalli, PhD

13:23 - 13:35 **Discussion**

13:35 - 13:41 **Continuous Dynamic Distraction System for Treatment of Early Onset Scoliosis**
René M. Castelein, MD, PhD

13:41 - 13:47 **Solving the Balance vs. Flexibility Dilemma: Instrument Long and Fuse Short**
Meric Enercan, MD

13:47 - 13:53 **Advances in Neuromonitoring**
Lindsay M. Andras, MD

13:53 - 13:59 **Advances in Management of Spinal Cord Injury**
Daniel M. Sciubba, MD, MBA

13:59 -14:11 **Discussion**

14:11 - 15:38 | Hibbs Society 2: Sagittal Alignment Through the Ages

Moderators: Christina K. Hardesty, MD & Peter G. Passias, MD

14:11 - 14:16 **Introduction to the Importance of Spinal Balance**
Virginie Lafage, PhD

14:16 - 14:21 **Sagittal Alignment Changes Through Childhood and Varies in Adults in Healthy Controls**
Marc Khalifé, MD, PhD, MS

14:21 - 14:26 **What are My Targets and What are the Consequences of Sagittal Alignment and Not Getting It Right in Early Onset and Adolescent Idiopathic Scoliosis?**
Kariman Abelin Genevois, MD, PhD

14:26 - 14:31 **How Do I Evaluate the Sagittal Plane in Early Onset Scoliosis and Adolescent Idiopathic Scoliosis, and What Are the Consequences?**
Javier Pizones, MD, PhD

14:31 - 14:36 **Technical Pearls of How I Approach Pediatric Deformity Sagittal Plane**
Brice Ilharreborde, MD, PhD

14:36 - 14:46 **My Alignment Strategy in a Nutshell: Case Examples**
Sleiman Haddad, MD, PhD, FRCS

14:46 - 14:51 **Advanced Postural Analysis**
Emmanuelle Ferrero, MD, PhD

14:51 - 14:56 **How Do I Achieve Appropriate Sagittal Alignment in My Adult Deformity Cases?**
Caglar Yilgor, MD

14:56 - 15:01 **Consequences of Not Achieving SA and Importance of Segmental Alignment**
Bassel G. Diebo, MD

**denotes a non-CME session/event*

MEETING AGENDA

TUESDAY, SEPTEMBER 16, 2025

Program (topics, timing, and faculty) is subject to change.

15:01 - 15:06 **The Emerging Importance of T4/L1PA and Case Debate**
Jeffrey M. Hills, MD

15:06 - 15:11 **3CO Technical Pearls and Case Debate**
Lawrence G. Lenke, MD

15:11 - 15:16 **Cervical Alignment Assessment Requires Perspective**
Peter G. Passias, MD

15:16 - 15:21 **Correction of Severe Cervical Deformity from Anterior Only**
Lee Tan, MD

15:21 - 15:26 **Posterior Cervical Osteotomy Technical Pearls and Case Debate**
Christopher P. Ames, MD

15:26 - 15:38 **Discussion**

15:38 - 15:58 **Refreshment Break* | East-Pre-function 2**

15:58 - 17:00 | Hibbs Society 3: Unique Solutions to Impossible Problems from Around the World
Moderators: Lindsay M. Andras, MD & Peter G. Passias, MD

15:58 - 16:04 **SI Joint Osteotomy for Correction**
Michael Ruf, MD

16:04 - 16:10 **3D Printing Options in All Stages of Deformity Surgery**
Cristina K. Hardesty, MD

16:10 - 16:16 **Osteocutaneous Vascularized Fibular Free Flap**
Ferran Pellisé, MD, PhD

16:16 - 16:28 **Discussion**

16:28 -16:34 **Lumbar Tether with a One Level Fusion at Apex**
Per D. Trobisch, MD

16:34 - 16:40 **Reconstruction of Laminectomy Defect with Femoral Strut Graft Following PVCR**
Azmi Hamzaoglu, MD

16:40 - 16:46 **Pelvic Considerations**
David W. Polly Jr., MD

16:46 - 16:58 **Discussion**

16:58 - 17:00 **Concluding Remarks**
Lindsay M. Andras, MD & Peter G. Passias, MD

17:00 - 18:00 **Traveling Fellows Reception* (by invitation only) | Room E222**

18:30 - 21:30 **SRS Leadership Dinner* (by invitation only)**

**denotes a non-CME session/event*

MEETING AGENDA

WEDNESDAY, SEPTEMBER 17, 2025

Program (topics, timing, and faculty) is subject to change.

08:00 - 12:00 | **Richardson Ballroom CD**

Pre-Meeting Course (PMC): The Future is Now: New Technology in our Practice

Chair: A. Noelle Larson, MD

08:00 - 08:45 | PMC 1: Introduction to ML, AI, LLM, DL and Other Trending Acronyms*

Moderators: Ali A. Baaj, MD & Serena S. Hu, MD

**Please note: CME credit is not available for this section of the Pre-Meeting Course.*

08:00 - 08:03 **Introduction**
A. Noelle Larson, MD

08:03 - 08:09 **Primer to AI: What is This Technology and How Could It Change Our World**
Brett Lullo, MD

08:09 - 08:15 **Primer to AI: What Tools Are Needed to Run AI and How to Achieve Iterative Learning Cycles**
Grant D. Hogue, MD

08:15 - 08:35 **Invited Lecture: How AI Can Transform Medical Care**
*Manoj Ramachandran, BSc(Hons), MBBS(Hons), MRCS(Eng), FRCS(Tr&Orth)***
**This speaker was supported, in part, by a grant from OrthoPediatrics*

08:35 - 08:45 **Discussion**

08:45 - 09:15 | **Refreshment Break* | Ballroom Pre-function 1**

09:15 - 09:50 | PMC 2: AI in the Office and Academics

Moderators: Ali A. Baaj, MD & Serena S. Hu, MD

09:15 - 09:21 **How I Do It: Use of Ambient Listening Technology in the Clinic**
Chinmay Paranjape, MD, MHSc

09:21 - 09:27 **How I Do It: Use of AI as a Personal Assistant: Email Management, Communications, Scheduling, Recruitment**
John S. Vorhies, MD

09:27 - 09:33 **How I Do It: Use of LLMS to Develop Research Direction, Document Drafting, Perform Literature Reviews, Basic Coding/Stats**
Javier Pizones, MD, PhD

09:33 - 09:39 **How I Do It: Use of AI to Schedule and Communicate with my Patients**
Amit Jain, MD, MBA

09:39 - 09:50 **Discussion**

09:50 - 10:45 | PMC 3: AI in the OR

Moderators: G. Ying Li, MD & Venu M. Nemani, MD, PhD

09:50 - 09:56 **Update in Knowledge: AI in Imaging**
Stefan Parent, MD, PhD

09:56 - 10:02 **Update in Knowledge: AI in Surgical Planning and Patient Selection**
Ferran Pellisé, MD, PhD

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

10:10 - 10:16 **Update in Knowledge: Ambient Listening/Video and Surgeon Performance in the OR**
Oliver Varban, MD

10:16 - 10:25 **VR and Simulation in the OR**
Mitsuru Yagi, MD, PhD

10:25 - 10:31 **Smart Tools and Robotics in the OR, the Adult Practice**
Brandon B. Carlson, MD, MPH

10:31 - 10:37 **Robotics in the Pediatric Practice, Opportunities and Limitations**
Craig Birch, MD

10:37 - 10:45 **Discussion**

**denotes a non-CME session/event*

10:45 - 11:00 Break

11:00 - 12:00 | PMC 4: Ethical Issues and Practice Considerations with the Advent of AI

Moderators: A. Noelle Larson, MD & Munish C. Gupta, MD

11:00 - 11:06 **Ethical Issues and Limitations of AI Strategies**
Jennifer M. Bauer, MD, MS

11:06 - 11:12 **Privacy Concerns and Data Ownership**
Patrick J. Cahill, MD

11:12 - 11:18 **Large Language Models and Computer Image Processing to Drive Registries and Dashboard Development**
Walter H. Truong, MD, FRCS(C), FAOA

11:18 - 11:26 **Discussion**

11:26 - 11:32 **Impact of AI on Patient Communications, Vulnerable Adults and Rare Diseases**
Michelle C. Welborn, MD

11:32 - 11:38 **Global Impact of AI: Will It Be an Equalizer, or Will It Increase Inequalities in Care?**
Cristina Sacramento Dominguez, MD, PhD

11:38 - 11:44 **How to Implement This into Your Practice: Finances, Funding & Feasibility**
Rajiv K. Sethi, MD

11:44 - 11:57 **Discussion**

11:57 - 12:00 **Conclusion**

12:00 - 12:15 Lunch Pick-up | Ballroom Pre-function 1

Lunchtime Symposia (LTS) *3 Concurrent Sessions*

12:15 - 13:15 Richardson Ballroom CD

LTS 1 | Lumbosacral Obliquity: A Case-Based Symposium

Moderators: Allen Kadado, MD & Eric O. Klineberg, MD

Welcome & Introduction

12:15 - 12:20 **Assessment of Lumbosacral Obliquity**
Allen Kadado, MD

12:20 - 12:25 **Surgical Execution: How to Get It Right**
Eric O. Klineberg, MD

Part 1: Congenital Lumbosacral Deformity
Daniel Sucato, MD, MS; Kai Li, MD; Terry Jianguo Zhang, MD; Michael Ruf, MD

12:25- 12:28 **Early Hemivertebra Resection and Fusion**
Kai Li, MD

12:28 - 12:31 **Observation + Late Resection and Fusion**
Daniel Sucato, MD

12:31 - 12:34 **Technical Tips for Resection**
Michael Ruf, MD

12:34 - 12:40 **Discussion and Q&A**

Part 2: Oblique Takeoff in "Idiopathic Scoliosis"
G. Ying Li, MD; Nicholas Fletcher, MD; Burt Yaszay, MD; Ryan Goodwin, MD

12:40 - 12:45 **Double Major Curve with Oblique L5 Spondylolisthesis**
Burt Yaszay, MD

12:45 - 12:50 **Vertebral Body Tethering**
Ryan Goodwin, MD

**denotes a non-CME session/event*

MEETING AGENDA

WEDNESDAY, SEPTEMBER 17, 2025

Program (topics, timing, and faculty) is subject to change.

12:50 - 12:55 **Discussion and Q&A**

Part 3: Lumbosacral Deformity in Adult Scoliosis
Pierce Nunley, MD; Yukihiro Matsuyama, MD, PhD; Munish C. Gupta, MD, MBA

12:55 - 13:00 **Lumbosacral Deformity in Degenerative Scoliosis**
Munish C. Gupta, MD, MBA

13:00 - 13:05 **Limb Length Discrepancy and THA**
Yukihiro Matsuyama, MD, PhD

13:05 - 13:15 **Discussion and Q&A**

12:15 - 13:15 Richardson Ballroom AB

LTS 2 | The Time Has Come to Transition from 2D to 3D in AIS Understanding and Treatment

Moderators: Carl-Eric Aubin, P. Eng, PhD, & Lawrence G. Lenke, MD

12:15 - 12:22 **Welcome and Introduction**
Lawrence G. Lenke, MD

12:22 - 12:34 **Concepts from 2D to 3D, and Presentation of the Transverse Plane Modifiers**
Carl-Eric Aubin, P.Eng, PhD

12:34 - 12:46 **Case Presentation: 3D Printed Models & Clinical Interpretation**
Brice Ilharreborde, MD, PhD & A. Noelle Larson, MD

12:46 - 12:58 **Freehand Survey to Test Understanding of Transverse Plane Modifiers and the New SRS - Lenke - Aubin 3D Classification**
Michelle C. Welborn, MD & Michael G. Vitale, MD, MPH

12:58 - 13:05 **Perspectives and Future Direction**
Peter O. Newton, MD

13:05 - 13:15 **Discussion**

12:15 - 13:15 Room E219

LTS 3 | How Much is Enough: Multirod Constructs and Pelvic Fixation in Adult Spinal Deformity

Moderators: Benjamin D. Elder, MD, PhD & Christopher P. Ames, MD

12:15 - 12:22 **Pelvic Fixation Strategies in Adult Spinal Deformity**
Christopher J. Kleck, MD

12:23 - 12:30 **Pelvic Fixation Strategies in Adult Spinal Deformity**
Scott Zuckerman, MD, MPH

12:31 - 12:38 **SI Joint Fusion Strategies-Biomechanical and Surgical Considerations**
David W. Polly Jr., MD

12:39 - 12:46 **SI Joint Fusion Strategies**
Robert K. Eastlack, MD

12:47 - 12:51 **Discussion**

12:52 - 13:10 **Case Discussion and Panel**
Alan H. Daniels, MD, Mostafa H. El Dafrawy, MD, Khaled M. Kebaish, MD, & Alekos A. Theologis, MD

12:53 - 12:58 **Sacral Osteotomy – Pelvic Screw and Rod Configuration Options**
Alan H. Daniels, MD

12:59 - 13:03 **Panel Discussion**

13:04 - 13:09 **Coronal Deformity in the Adult: A Guide to Kickstand Rod Technique**
Alekos A. Theologis, MD

13:10 - 13:15 **Panel Discussion**

13:30 - 15:00 | **Richardson Ballroom CD**

Abstract Session 1: Adolescent Idiopathic Scoliosis I

Moderators: Kariman Abelin Genevois, MD, PhD & Michael J. Heffernan, MD

13:30 - 13:35 **Introduction**

13:35 - 13:39 **Paper #1: Have We Become Better at Selective Thoracic Fusion for AIS in the Tethering Era?**
Anuj Gupta, MD; Sadettin Ciftci, MD; Peter G. Gabos, MD; Petya Yorgova, MS; Zhaoying Lu, PhD; Firoz Miyanji, MD; Amer F. Samdani, MD; Dan Hoernschemeyer, MD; Baron S. Lonner, MD; Peter O. Newton, MD; Harms Study Group; Suken A. Shah, MD

13:39 - 13:43 **Paper #2: Proportion of Lumbar End Vertebra Tilt to Overall Cobb Angle Predicts Spontaneous Lumbar Correction**
Omar Taha, BS; Matthew Weintraub, BS; Mehdi Elfilali, BA; Edwin Kulubya, MD; Michael G. Vitale, MD, MPH; Benjamin D. Roye, MD; Harms Study Group

13:43 - 13:47 **Paper #3: Selective Versus Nonselective Posterior Spinal Fusion for Lenke 1-4C Adolescent Idiopathic Scoliosis: a 10-Year Follow-up Study**
Nicholas D. Fletcher, MD; Tracey Bryan, MS; Suken A. Shah, MD; Stefan Parent, MD, PhD; Harms Study Group; Michael P. Kelly, MD

13:47 - 13:56 **Discussion**

13:56 - 14:00 **Paper #4: Dreaded Postoperative Coronal Malalignment in Lenke 5 Patients**
Elyette Lugo, BS; Jonathan Wang, BS; Paul D. Sponseller, MD, MBA; Khaled M. Kebaish, MD; Suken A. Shah, MD; Amer F. Samdani, MD; Firoz Miyanji, MD; Michael P. Kelly, MD; Baron S. Lonner, MD; Amit Jain, MD, MBA; Harms Study Group

14:00 - 14:04 **Paper #5: Clavicle Angle is a Viable Metric to Predict Normal Postoperative Shoulder Balance and Neck Balance, Defined by RSH, in Patients with Adolescent Idiopathic Scoliosis (AIS)**
Vishal Sarwahi, MD; Katherine Eigo, BS; Effat Rahman, BS; Swara Kalva, BS; Brian Li, BS; Sarah Trent, MD; Yungtai Lo, PhD; Terry D. Amaral, MD

14:04 - 14:08 **Paper #6: Pain Response is Unaffected by Fusion or Non-Fusion Surgical Approach in AIS**
Daniel Berman, MD; Olgerta Mucollari,BS; Tracey Bryan, MS; Nicholas D Fletcher, MD; Joshua S Murphy, MD; Amer F. Samdani, MD; Steven W. Hwang, MD; Baron S. Lonner, MD

14:08 - 14:17 **Discussion**

14:17 - 14:21 **Paper #7: Risk Factors for Unfused Lumbar Intervertebral Disc Degeneration over Ten Years After Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis**
Satoshi Suzuki, MD, PhD; Kazuki Takeda, MD, PhD; Takahito Iga, MD, PhD; Toshiki Okubo, MD, PhD; Masahiro Ozaki, MD, PhD; Narihito Nagoshi, MD, PhD; Morio Matsumoto, MD, PhD; Masaya Nakamura, MD, PhD; Kota Watanabe, MD, PhD

14:21 - 14:25 **Paper #8: Saving Fusion Levels in Lenke 1/2ARCurves: Can We Stop Short of the Last Substantially Touched Vertebra (LSTV)?**
Arun R. Hariharan, MD; Michael Brown, BS; Tracey Bryan, MS; David S. Feldman, MD; Craig R. Louer, MD; John S. Vorhies, MD; Joshua S. Murphy, MD; Keith Bachmann, MD; Robert H. Cho, MD; Amit Jain, MD, MBA; Peter G. Gabos, MD; Baron S. Lonner, MD; Firoz Miyanji, MD; Amer F. Samdani, MD; Suken A. Shah, MD; Michael P. Kelly, MD; Peter O. Newton, MD; Harms Study Group

14:25 - 14:29 **Paper #9: Effect of Sacral Slanting on Coronal Spinal Balance and Residual Curve After Correction of Structural Lumbar Curve in Patients with Adolescent Idiopathic Scoliosis: Result from a 5-Year Follow-Up Study**
Gumin Jeong, MD; Chang Ju Hwang, MD, PhD; Sehan Park, MD; Jae Hwan Cho, MD, PhD; Dong-Ho Lee, MD, PhD

14:29 - 14:38 **Discussion**

14:38 - 14:42 **Paper #10: Longer Operative Time is Associated with Higher Risk of Adverse Outcomes in Pediatric Idiopathic Scoliosis Surgery**
Vivien Chan, MD, MS, FRCS(C); Andy M. Liu, BS; Adeesya Gausper, BS; Suhas Etigunta, BS; Kenneth D. Illingworth, MD; Firoz Miyanji, MD; David L. Skaggs, MD, MMM

**denotes a non-CME session/event*

MEETING AGENDA

WEDNESDAY, SEPTEMBER 17, 2025

Program (topics, timing, and faculty) is subject to change.

14:42 - 14:46 **Paper #11: Navigation is Associated with Lower Revision Instrumentation Rates in Pediatric Scoliosis: A Retrospective Review of 15,917 Patients**
Andy M. Liu, BS; Vivien Chan, MD, MS; Adeesya Gausper, BS; Suhas Etigunta, BS; Christopher Mikhail, MD; Kenneth D. Illingworth, MD; Alexander Tuchman, MD; David L. Skaggs, MD, MMM

14:46 - 14:50 **Paper #12: Long Term Outcomes of AIS Patients After Anterior Spinal Fusion - Follow-Up with Minimum of 20 Years**
Anjaly Saseendran, BS; Kenny Y. Kwan, MD

14:50 - 15:00 **Discussion**

15:00 - 15:20 **Refreshment Break* | Ballroom Pre-function 1**

15:20 - 17:05 **Richardson Ballroom CD**

Abstract Session 2: Adult Spinal Deformity

Moderators: Ivan Cheng, MD & Emmanuelle Ferrero, MD, PhD

15:20 - 15:24 **Paper #13: A Novel Classification of Coronal Malalignment in Degenerative Lumbar Scoliosis for Predicting Postoperative Coronal Imbalance: A Multicenter Cohort Study**
Weipeng Qiu, MD; Zhuoran Sun, MD; Weishi Li, MD

15:24 - 15:28 **Paper #14: A Simple and Clinically Relevant Gait Score to Evaluate Functional Impairment in ASD**
Rami Rhayem, MD, MS; Rami Rachkidi, MD, MS; Abir Massaad, PhD; Renaud Lafage, MS; Virginie Lafage, PhD; Elio Mekhael, MD, MS; Nabil Nassim, MD, MS; Ali Rteil, MD, MS; Maria Saadé, MS; Elma Ayoub, MD, MS; Celine Chaaya, MD, MS; Marc Boutros, MS; Georges El Haddad; Ibrahim Hamati; Moustapha Rteil; Gilles Prince; Guy Awad; Joe Azar; Marc Mrad; Mohamad I. Karam, PhD; Ismat Ghanem, MD, MS; Ayman Assi, PhD

15:28 - 15:32 **Paper #15: Three Gait Parameters Are Sufficient to Evaluate Functional Impairment in ASD**
Elio Mekhael, MD, MS; Rami Rachkidi, MD, MS; Nabil Nassim, MD, MS; Maria Saadé, MS; Georges El Haddad; Marc Boutros, MS; Maria Karam; Emmanuelle Wakim; Maria Asmar; Mohamad I. Karam, PhD; Abir Massaad, PhD; Ismat Ghanem, MD, MS; Ayman Assi, PhD

15:32 - 15:41 **Discussion**

15:41 - 15:45 **Paper #16: Identifying High-Risk Patients in Adult Spinal Deformity Surgery: Leveraging Predictive Analytics to Assess Drivers of Increase Risk of Surgical Complications**
Peter Tretiakov, BS; M. Burhan Janjua, MD; Kyriakos Chatzis, BS; Max Fisher, MD; Tobi Onafowokan, MBBS; Clifford Crutcher, MD; Francesca Totis, MD; Drew Millar, MD; Ethan Cottrill, MD, PhD, MsEd; Deb Bhowmick, MD; Muhammad M. Abd-El-Barr, MD, PhD; Parastou Fatemi Quist, MD; David Huie, MD, MS; Khoi Duc Than, MD; Nima Alan, MD; Paul Park, MD; Jay D. Turner, MD; Renaud Lafage MS; Virginie Lafage, PhD; Christopher I. Shaffrey, MD; Peter G. Passias, MD

15:45 - 15:49 **Paper #17: Modified Global Alignment and Proportion Scoring with Body Mass Index and Bone Mineral Density and Paraspinal Muscle (GAPBM) for Improving Predictions of Mechanical Complications After Adult Spinal Deformity Surgery**
Sung Hyeon Noh, MD

15:49 - 15:53 **Paper #18: Incremental Benefit of Revision Surgery After Adult Spinal Deformity Corrective Surgery: At What Point Does the Value of Multiple Revisions Diminish**
Anthony Baumann, MD, DPT; Pooja Dave, MD; Kyriakos Chatzis, BS; Peter Tretiakov, BS; Max Fisher, MD; Tobi Onafowokan, MBBS; Shaleen Vira, MD; M. Burhan Janjua, MD; Francesca Totis, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Arman Kishan' MBBS; Pawel Jankowski, MD; Douglas G. Orhendorf, MD, Christopher Shaffrey, MD; Peter G. Passias, MD, Arman Kishan, MBBS

15:53 - 16:02 **Discussion**

16:02 - 16:06 **Paper #19: The Impact of Osteoporosis on Patient Presentation in the Adult Spinal Deformity Population**
Ethan Cottrill, MD, PhD; Yashar Javidan MD; Max Fisher, MD; Peter Tretiakov, BS, Kyriakos Chatzis, BS; Tobi Onafowokan, MBBS; Francesca Totis, MD, MSEd; Alyssa Bartlet, BS, MPH; Khoi Duc Tan, MD; Praveen Mummaneni, MD; Melissa Erickson, MD, MBA; Brett Rocos, MD; Douglas G. Orhendorf, MD; Olumide A. Danisa, MD, FAAOS; Kristen E. Jones, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Christopher I. Shaffrey, MD; William Richardson, MD; Peter G. Passias, MD; William Richardson, MD

16:06 - 16:10 **Paper #20: A Bone Optimization Rheumatology Clinic Increases Anabolic Bone Agent Use and Reduces Mechanical Complications in Adult Spinal Deformity Surgery**
Harsh Jain, MBBS; Omar Zakieh, MBBS; Austin Montgomery, BS; Walter Navid, BS; Philip Raj, BS; Hani Chanbour, MD; Soren Jonzzon, MD; Iyan Younus, MD; Ranbir Ahluwalia, MD; Tyler Zeoli, MD; Autumn D. Zuckerman, PharmD; S. Bobo tanner, MD; Julian Lugo-Pico, MD; Amir M. Abtahi, MD; Byron F. Stephens, MD; Scott Zuckerman, MD, MPH

16:10 - 16:14 **Paper #21: Loss of Patient-Reported Outcome Benefit over 8-Yr Follow-Up for Operatively Treated Adult Symptomatic Lumbar Scoliosis (ASLS) Patients Who Require Revision Surgery for Mechanical Complication**
Justin S. Smith, MD, PhD; Michael P. Kelly, MD; Elizabeth L. Yanik, PhD; Christine Baldus, RN; Vy Pham, MD, MPH; Hong Joo Moon, MD; Jon D. Lurie, MD, MS; Charles C. Edwards, MD; Steven D. Glassman, MD; Lawrence G. Lenke, MD; Jacob M. Buchowski, MD; Leah Y. Carreon, MD; Charles H. Crawford III, MD; Stephen J. Lewis, MD, FRCS(C); Tyler Koski, MD; Virginie Lafage, PhD; Han Jo Kim, MD; Christopher P. Ames, MD; Shay Bess, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Keith H. Bridwell, MD

16:14 - 16:23 **Discussion**

16:23 - 16:27 **Paper #22: Which Surgical Approach Provides Better Correction of the Lumbosacral Fractional Curve: ALIF, TLIF, LLIF, or No-LIF?**
Harsh Jain, MBBS; Omar Zakieh, MBBS; Anthony E. Bishay, BS; Jeremia Williams, BS; Soren Jonzzon, MD; Iyan Younus, MD; Tyler Zeoli, MD; Ranbir Ahluwalia, MD; Austin Montgomery, BS; Walter Navid, BS; Hani Chanbour, MD; Julian Lugo-Pico, MD; Amir M. Abtahi, MD; Byron F. Stephens, MD; Scott Zuckerman, MD, MPH

16:27 - 16:31 **Paper #23: A Cautionary Tale Regarding Singular Angular Measurements for Realignment: Examination of the Benefits and Limitations Conferred by T1-Pelvic Angle**
Ankita Das, MD; Brett Rocos, MD; Max Fisher, MD; Francesca Totis, MD; Tobi Onafowokan, MBBS; Peter Tretiakov, BS; Alan Daniels, MD; Arman Kishan, MBBS; Pawel Jankowski, MD; Bassel Diebo, MD; Kyriakos Chatzis, BS; Christopher Shaffrey, MD, Shaleen Vira, MD; M. Burhan Janjua, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Peter G. Passias, MD; Arman Kishan, MBBS

16:31 - 16:35 **Paper #24: Prediction of Postoperative Pelvic Tilt and T1 Pelvic Angle in Patients Undergoing Adult Spinal Deformity Surgery from Lower Thoracic Spine to the Pelvis**
Christopher J. Nielsen, MD; Fatemeh Alavi, PhD; Jeffrey M. Hills, MD; Michael P. Kelly, MD; Stephen J. Lewis, MD, FRCS(C)

16:35 - 16:44 **Discussion**

16:44 - 16:48 **Paper #25: Are There Distinct Patterns of Clinical Deficit in Adult Spinal Deformity? A Discriminant Analysis of Health-Related Quality of Life Measures**
Mikael Finoco, MD; Breton G. Line, BS; Shay Bess, MD; Christopher P. Ames, MD; Marc Khalifé, MD, PhD, MS; Alan H. Daniels, MD; Bassel G. Diebo, MD; Robert K. Eastlack, MD; Munish C. Gupta, MD; Richard Hostin, MD; Khaled M. Kebaish, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; David O. Okonkwo, MD, PhD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Renaud Lafage, MS; Virginie Lafage, PhD; International Spine Study Group

16:48 - 16:52 **Paper #26: Muscle Gene Expression and Cellular Morphology in Individuals with Adult Spinal Deformity Who Develop Proximal Junctional Failure**
Pearce B. Haldeman, BS; Camille Nosewicz, BS; Ethan Deller, BS; Robert K. Eastlack, MD; Gregory M. Mundis Jr., MD; Bahar Shahidi, PhD

16:52 - 16:56 **Paper #27: Two-Year Revision Rate for Mechanical Complications Following Adult Spinal Deformity Surgery in Patients Treated with Personalized Interbody Implants**
Justin S. Smith, MD, PhD; Christopher P. Ames, MD; Joseph A. Osorio, MD, PhD; Donald J. Blaskiewicz, MD; Robert Robinson, MD; Chun Po Yen, MD; Sigurd H. Berven, MD; J Rush Fisher, MD; Gregory M. Mundis Jr., MD; Mark Tantorski, MD; Joseph P. Gjolaj, MD, FACS, FAOA; Roland Kent, MD

16:56 - 17:05 **Discussion**

MEETING AGENDA

WEDNESDAY, SEPTEMBER 17, 2025

Program (topics, timing, and faculty) is subject to change.

17:20 - 19:00 | Richardson Ballroom AB

Opening Ceremonies & Steel Lecture

The 60th Annual Meeting will officially begin with the Opening Ceremonies and this year's Howard Steel Lecturer. The evening will include an introduction of the SRS officers, the presentation of the Walter P. Blount Humanitarian Award, and highlights from 2025.

17:20 - 17:25 **Welcome to Charlotte**
A. Noelle Larson, MD

17:25 - 17:30 **Presidential Message**
Laurel C. Blakemore, MD

17:30 - 17:35 **Acknowledgement of SRS Donors**
Michael P. Kelly, MD

17:35 - 17:40 **Service Award - John Lonstein, MD - Spine Deformity Journal Editor-In-Chief 2011-2025**
Laurel C. Blakemore, MD

17:40 - 17:43 **Best Adult Deformity Paper Announcement**
Douglas C. Burton, MD

17:43 - 17:47 **SRS - Cotrel Foundation Basic Science Research Grant Award**
Brice Ilharreborde, MD

17:47 - 17:51 **Biedermann Innovation Award Winner**
Markku Biedermann, MD

17:51 - 17:55 **SRS Research Grant Award Winners**
Walter H. Truong, MD

17:55 - 17:58 **Directed Research Grant Award Winner**
Todd J. Albert, MD

17:58 - 18:02 **Presentation of Blount Humanitarian Award**
Dong-Gune Chang, MD, PhD

18:02 - 18:04 **Importance of Our Corporate Partners**
Han Jo Kim, MD

18:04 - 18:20 **Acknowledgement of Corporate Supporters**
Han Jo Kim, MD

18:20 - 18:25 **Introduction of Howard Steel Lecturer**
Laurel C. Blakemore, MD

18:25 - 18:55 **Howard Steel Lecture: Navigating the Changing Geopolitical Landscape**
Michèle Flournoy

18:55 - 19:00 **Closing Remarks**
Laurel C. Blakemore, MD

19:00 - 21:00 | Welcome Reception* | Ballroom Pre-function 1

A hosted reception featuring hors d'oeuvres, cocktails, and reunions with colleagues and friends will immediately follow the Opening Ceremonies.

Available at no charge to meeting delegates, Guest(s) of registered attendee: $50, per guest. If you would like to purcharse guest ticket(s), please stop at the Registration Desk.

The Welcome Reception is hosted, in part, by ATEC Spine.

**denotes a non-CME session/event*

08:00 - 09:50 | **Richardson Ballroom CD**

Abstract Session 3: Neuromuscular/Syndromic Deformity

Moderators: W.G. Stuart Mackenzie, MD & Brice Ilharreborde, MD, PhD

08:00 - 08:05 **Welcome**

08:05 - 08:09 **Paper #28: Developing the First Pediatric Spine Frailty Index: Machine Learning Models Predict Key Complications**
Matthew Weintraub, BS; Mehdi Elfilali, BA; Omar Taha, BS; Taemin Oh, MD; Benjamin D. Roye, MD; Michael G. Vitale, MD, MPH; Pediatric Spine Study Group

08:09 - 08:13 **Paper #29: Pediatric Spine Frailty Index Predicts Morbidity and Mortality in Spinal Deformity Surgery**
Vivien Chan, MD, MS, FRCS(C); Adeesya Gausper, BS; Andy M. Liu, BS; Lindsay M. Andras, MD; Kenneth D. Illingworth, MD; David L. Skaggs, MD, MMM

08:13 - 08:17 **Paper #30: The Natural History of Duchenne Muscular Dystrophy Scoliosis in Corticosteroid Era: A Mean 15-Year Follow-Up Study**
Sam Yeol Chang, MD; Sung Taeck Kim, MD; Ihnseok Chae, MD; Jeuk Lee, MD; Hyoungmin Kim, MD, PhD

08:17 - 08:26 **Discussion**

08:26 - 08:30 **Paper #31: Spinal Fusion Surgery in Cerebral Palsy: Complications, Reoperations, Clinical, and Radiographic Analyses with Minimum 5-Year Follow Up**
Arun R. Hariharan, MD; Michael Brown, BS; Tracey Bryan, MS; Craig R. Louer, MD; John S. Vorhies, MD; David S. Feldman, MD; Robert H. Cho, MD; Paul D. Sponseller, MD, MBA; Stefan Parent, MD, PhD; Patrick J. Cahill, MD; Joshua M. Pahys, MD; Vidyadhar V. Upasani, MD; Baron S. Lonner, MD; Suken A. Shah, MD; Amer F. Samdani, MD; Firoz Miyanji, MD; Harms Study Group

08:30 - 08:34 **Paper #32: The Impact of Prognostic Nutritional Index (PNI) in Neuromuscular Scoliosis Deformity Correction**
Subaraman Ramchandran, MD; Jesson James; Thomas Errico, MD; Stephen G. George, MD

08:34 - 08:38 **Paper #33: Impact of Age at Time of Corrective Surgery on Outcomes in Neuromuscular Scoliosis: a Retrospective Cohort Study**
Gregory I. Sacks, BS; Ryan S. Lebens, BS; James Barsi, MD

08:38 - 08:47 **Discussion**

08:47 - 08:51 **Paper #34: Outcomes of Posterior Spinal Fusion for Paralytic Scoliosis in Patients with Spinal Cord Injury**
Joshua M. Pahys, MD; Zachary Weingrad, BS; William Purtill, BA; Steven W. Hwang, MD; Terrence G. Ishmael, MBBS; Amer F. Samdani, MD

08:51 - 08:55 **Paper #35: Outcomes After Surgical Correction of Severe Scoliosis in Patients with Osteogenesis Imperfecta: A Prospective, Two-Year Minimum Follow-Up Study with Radiographic and Patient-Reported Outcomes**
Satoshi Takada, MD; Suken A. Shah, MD; Hiroshi Taneichi, MD, PhD; Yusuke Hori, MD, PhD; Petya Yorgova, MS; Andrea Elsby, BS; Jeanne M. Franzone, MD

08:55 - 08:59 **Paper #36: Correction Surgery for NF-1 Related Scoliosis Combined with Intraspinal Tumors: Is Tumor Resection Necessary?**
Jun Qiao, PhD; Sai-hu Mao, PhD; Benlong Shi, PhD; Zhen Liu, PhD; Zezhang Zhu, PhD; Yong Qiu, PhD

08:59 - 09:08 **Discussion**

09:08 - 09:12 **Paper #37: Proximal Junctional Kyphosis that Matters: Proximal Junctional Failure in Patients with Cerebral Palsy**
Kyung Park, BA; Zaid Elsabbagh, BS; Henry Stewart, BS; Amer F. Samdani, MD; Patrick J. Cahill, MD; Suken A. Shah, MD; Paul D. Sponseller, MD, MBA

09:12 -09:16 **Paper #38: How Sagittal Alignment Changes Can Affect Independent Horizontal Gaze After Neuromuscular Scoliosis Correction**
Sung Taeck Kim, MD; Sam Yeol Chang, MD; Hyoungmin Kim, MD, PhD; Bong-Soon Chang, MD, PhD; Jeuk Lee, MD; Ihnseok Chae, MD, Dong-Gune Chang MD, PhD

MEETING AGENDA

THURSDAY, SEPTEMBER 18, 2025

Program (topics, timing, and faculty) is subject to change.

09:16 - 09:20 **Paper #39: Intraoperative Traction Does Not Improve Curve or Pelvic Obliquity Correction in a Matched Cohort of Patients with Neuromuscular Scoliosis**
Alastair Sterns, BS; Jacquelyn Valenzuela-Moss, BS; Tyler Tetreault, MD; Tiffany N. Phan, BA; Efrain Amaro, BS; Gerard Williams, MD; Lindsay M. Andras, MD; Michael J. Heffernan, MD

09:20 - 09:29 **Discussion**

09:29 - 09:33 **Paper #40: Intrathecal Baclofen Pumps Do Not Increase Complications Following Spinal Fusion in Non-Ambulatory Patients with Cerebral Palsy**
Lexi Larson, BS; Daniel J. Miller, MD; Luis Torres-Gonzalez, BS; Tenner Guillaume, MD; Walter H. Truong, MD, FRCS(C), FAOA; Joseph H. Perra, MD; Linda Krach, MD; Maykala Williams, MPH; Sara Morgan, PhD

09:33 - 09:37 **Paper #41: Socioeconomic Status Affects Severity of Neuromuscular Scoliosis at Time of Surgery**
Margaret Crownover, BS; Suken A. Shah, MD; Petya Yorgova, MS; M. Wade Shrader, MD

09:37 - 09:41 **Paper #42: Neurofibroma Subtypes and Spinal Dural Ectasia: Key Factors Driving Rapid Scoliosis Progression in Neurofibromatosis Type 1 on Whole-Body Magnetic Resonance Imaging**
Ji Uk Choi, MD; Chang Ju Hwang, MD, PhD

09:41 - 09:50 **Discussion**

10:10 - 12:15 **Refreshment Break* | Ballroom Pre-function 1**

10:10 - 12:15 **Richardson Ballroom CD**

Abstract Session 4: Cervical Deformity, ASLS II Update, Harrington Lecture & Lifetime Achievement Award

Moderators: Todd J. Albert, MD & Ibrahim Obeid, MD

10:10 - 10:14 **Paper #43: Impact of Cervical Alignment Parameters on Surgical Outcomes Following Posterior Cervical Fusion: A Multi-Center Comparative Analysis of T1–CL and TIA Correlations**
Devender Singh, PhD; Eeric Truumees, MD; Morgan Laviolette, DPT; Qais Zai, MD; Vik Kohli, MD; Matthew Geck, MD; Rory R. Mayer, MD; John Stokes, MD; Sara L. Paul PA-C

10:14 - 10:18 **Paper #44: Delineation of Alignment Goals for Adult Cervical Deformity Correction for Optimal Clinical and Functional Outcomes**
Max Fisher, MD; Melissa Erickson, MD; Tobi Onafowokan, MBBS; Kyriakos Chatzis, BS; Peter Tretiakov, BS; Francesca Totis, MD; Ethan Cottrill, MD, PhD, MSEd; Caroline Wu, MD; Anthony Baumann, MD, DPT; Olumide A. Danisa, MD, FAAOS; Renaud Lafage, MS; Christopher Shaffrey, MD; Virginie Lafage, PhD; C. Rory Goodwin, MD; Peter G. Passias, MD

10:18 - 10:22 **Paper #45: Innovative Coronal Plane Parameters for Cervical Spine Deformity: Significance of Coronal Plane Horizontal Gaze**
Ahmed Sulieman, MD; Yesha Parekh, MD; Virginie Lafage, PhD; Renaud Lafage, MS; Breton G. Line, BS; Christopher P. Ames, MD; Shay Bess, MD; Thomas J. Buell, MD; Robert K. Eastlack, MD; Jeffrey L. Gum, MD; Munish C. Gupta, MD; Richard Hostin, MD; Han Jo Kim, MD; Darryl Lau, MD; Gregory M. Mundis Jr., MD; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Khaled M. Kebaish, MD; Sang Hun Lee, MD; International Spine Study Group

10:22 - 10:31 **Discussion**

10:31 - 10:35 **Paper #46: Optimizing Modifiable Health Conditions Prior to Adult Cervical Deformity Surgery Associated with Fewer Complications**
Thomas Buell, MD; Olumide A. Danisa MD, FAAOS; Max Fisher, MD; Tobi Onafowokan, BMBS; Peter Tretiakov, BS; Kyriakos Chatzis, BS; Francesca Totis, MD; Ethan Cottrill, MD, PhD, MSEd; Matthew Galetta, MD; Nathan Lorentz, MD; Jordan Lebovic, MD, MBA; Pawel Jankowski, MD; Robert Eastlack, MD; Arman Kishan, MBBS; Khoi Than, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Shaleen Vira, MD, MBA; Christopher Shaffrey, MD; Peter G. Passias, MD; Arman Kishan, MBBS

10:35 - 10:39 **Paper #47: Predictors of Achieving Neck Disability Index Minimum Clinically Important Difference Following Cervical Deformity Surgery**
Anthony L. Mikula, MD; Justin K. Scheer, MD; Rahul Kumar, MD, PhD; Jay D. Turner, MD; Jeffrey Mullin, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Khaled M. Kebaish, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; Alan H. Daniels, MD; Robert K. Eastlack, MD; Stephen J. Lewis, MD, FRCS(C); Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Munish C. Gupta, MD; Han Jo Kim, MD; Michael P. Kelly, MD; Lawrence G. Lenke, MD; Christopher I. Shaffrey, MD; Shay Bess, MD; Justin S. Smith, MD, PhD; Christopher P. Ames, MD; International Spine Study Group

10:39 - 10:43 **Paper #48: Reduced Preoperative Cervical Spine Flexion-Extension Range of Motion is Associated with the Development of Upper Thoracic Proximal Junction Kyphosis in Adult Spinal Deformity Patients**
Justin K. Scheer, MD; Fthimnir Hassan, MPH; Chun Wai Hung, MD; Ted Shi, BS; Nathan J. Lee, MD; Steven G. Roth, MD; Erik Lewerenz, BS; Joseph M. Lombardi, MD; Zeeshan M. Sardar, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

10:43 - 10:52 **Discussion**

10:52 - 10:56 **Paper#49: Impact of T1 Slope-Cervical Lordosis Discrepancy on Sagittal Vertical Axis and Patient-Reported Outcomes Following Posterior Cervical Fusion: a Multi-Center Retrospective Analysis**
Matthew Geck, MD; Eeric Truumees, MD; Devender Singh, PhD; Morgan Laviolette DPT; Vik Kohli, MD; John Stokes, MD; Rory Richard Mayer, MD; Sara L Paul, PA-C

10:56 - 11:00 **Paper #50: The Preliminary Observation of Curative Effect of Posterior Atlantoaxial Lateral Mass Joint Cage Graft Fusion and Internal Fixation in the Treatment of Irreducible Atlantoaxial Dislocation**
Yuekun Fang, MS; Haotian Li, MD; Zhilin Yang, MS; Hangchuan Bi, MD; Yi Li, MS; Yongquan Wang, MS; Lingqiang Chen, MD

11:00 - 11:04 **Paper #51: Extension of Fusion to Cervical Spine Vs. Upper Thoracic Spine for the Management of Proximal Junctional Kyphosis**
Ahmed Sulieman, MD; Yesha Parekh, MD; Virginie Lafage, PhD; Renaud Lafage, MS; Breton G. Line, BS; Christopher P. Ames, MD; Shay Bess, MD; Thomas J. Buell, MD; Robert K. Eastlack, MD; Jeffrey L. Gum, MD; Munish C. Gupta, MD; Richard Hostin, MD; Han Jo Kim, MD; Darryl Lau, MD; Gregory M. Mundis Jr., MD; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Khaled M. Kebaish, MD; Sang Hun Lee, MD; International Spine Study Group

11:04 - 11:13 **Discussion**

11:13 - 11:28 **ASLS II Final Update**
Justin S. Smith, MD, PhD

11:28 - 11:35 **Discussion**

11:35 - 11:40 **Harrington Lecture Introduction**
Laurel C. Blakemore, MD

11:40 - 12:00 **Harrington Lecture: Where are we going, what are we doing. Just keep asking!**
Peter O. Newton, MD

12:00 - 12:15 **Presentation of the Lifetime Achievement Award**
Suken A. Shah, MD

12:15 - 12:30 **Lunch Pick-up | East Pre-function 3**

12:30 - 14:00

Industry Workshops

7 Concurrent Sessions

Each workshop is programmed by a single-supporting company and will feature presentations on topics selected by the company. *Please note: CME credits are not available for Industry Workshops*

Please see page page 230 to view the detailed schedule.

MEETING AGENDA

THURSDAY, SEPTEMBER 18, 2025

Program (topics, timing, and faculty) is subject to change.

Abstract Sessions 5A & 5B *2 Concurrent Sessions*

14:10 - 15:55 **Richardson Ballroom CD**

Abstract Session 5A: Adult Spinal Deformity II

Moderators: Jeffrey L. Gum, MD & Javier Pizones, MD, PhD

14:10 - 14:14 **Paper #52: Comparative Performance of the ESSG-ADSCI and ISSG-SII in a Single-Center Adult Spinal Deformity Database**
Tobi Onafowokan, MBBS; Robert Eastlack, MD; Max Fisher, MD; Peter Tretiakov, BS; Kyriakos Chatzis, BS; Francesca Totis, MD; Ethan Cottrill MD, PhD, MSEd; Pawel Jankowski, MD; Dean Chou, MD; Anthony Mikula, MD; Christopher Shaffrey, MD; Christopher Ames, MD; Ferran Pellisé, MD, PhD; Calgar Yilgor, MD; Javier Pizones, MD, PhD; Sigurd H. Berven, MD; Meric Enercan, MD; Sleiman Haddad, MD, PhD; Renaud Lafage, MS; Virginie Lafage, PhD; Peter G. Passias, MD; Alan Daniels, MD

14:14 - 14:18 **Paper #53: Incidental Durotomies Do Not Impact Long Term Neurologic Function After Adult Spinal Deformity Surgery**
Ahmed Sulieman, MD; Indeevar Beeram, MD; Virginie Lafage, PhD; Renaud Lafage, MS; Breton G. Line, BS; Kojo D. Hamilton, MD, FAANS; Justin S. Smith, MD, PhD; Richard Hostin, MD; Peter G. Passias, MD; Bassel G. Diebo, MD; Eric O. Klineberg, MD; Jeffrey L. Gum, MD; Jeffrey Mullin, MD; Michael P. Kelly, MD; Thomas J. Buell, MD; Alex Soroceanu, MD, FRCS(C), MPH; Han Jo Kim, MD; Robert K. Eastlack, MD; Alan H. Daniels, MD; Gregory M. Mundis Jr., MD; Themistocles S. Protopsaltis, MD; Munish C. Gupta, MD; Neel Anand, MD; David O. Okonkwo, MD, PhD; Jay D. Turner, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Stephen J. Lewis, MD, FRCS(C); Praveen V. Mummaneni, MD, MBA; Christopher P. Ames, MD; Lawrence G. Lenke, MD; Shay Bess, MD; Sang Hun Lee, MD; Khaled M. Kebaish, MD; International Spine Study Group

14:18 - 14:22 **Paper #54: Thoracic Segmental Degeneration Severity in Adult Spinal Deformity (ASD) Patients: Impact on Baseline Alignment and Compensation**
Manjot Singh, BS; Michael Farias, BS; Joseph Nassar, BS; Richard Hostin, MD; Munish C. Gupta, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; Kojo D. Hamilton, MD, FAANS; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Han Jo Kim, MD; Khaled M. Kebaish, MD; Lawrence G. Lenke, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Frank J. Schwab, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Alan H. Daniels, MD; Bassel G. Diebo, MD; International Spine Study Group

14:22 - 14:31 **Discussion**

14:31 - 14:35 **Paper #55: Older Adult Idiopathic Scoliosis Patients Have Greater Improvement in Self-Image Compared to Younger Adult and Adolescent Idiopathic Scoliosis Patients Following Posterior Spinal Fusion**
Taylor J. Jackson, MD; Fthimnir Hassan, MPH; Matthew Weintraub, BS; Omar Taha, BS; Mehdi Elfilali, BA; Erik Lewerenz, BS; Edwin Kulubya, MD; Justin L. Reyes, MS; Riley Sevensky, BS; Josephine R. Coury, MD; Andrew S. Zhang, MD; Michael Strong, MD; Joseph M. Lombardi, MD; Zeeshan M. Sardar, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

14:35 - 14:39 **Paper #56: Predictors and Dynamics of Self-Image in Adult Spinal Deformity: A Cluster Analysis Approach**
Sleiman Haddad, MD, PhD, FRCS; Lluís Vila Castillo, MD; Chuck Lam, MD; Leo Mok, PhD; Morgan Jones, FRCS; Susana Núñez Pereira, MD; Anika Pupak, PhD, BS; Javier Pizones, MD, PhD; Yann Philippe Charles, MD, PhD; Ahmet Alanay, MD; Ibrahim Obeid, MD; Frank S. Kleinstueck, MD; Ferran Pellisé, MD, PhD; European Spine Study Group

14:39 - 14:43 **Paper #57: Predicting the Unpredictable: Modeling Post-Operative Spinal Alignment in Adult Deformity Surgery**
Jonathan C. Elysee, BS; Themistocles S. Protopsaltis, MD; Léonard Chatelain, MD; Breton G. Line, BS; Shay Bess, MD; Alan H. Daniels, MD; Bassel G. Diebo, MD; Robert K. Eastlack, MD; Munish C. Gupta, MD; Richard Hostin, MD; Khaled M. Kebaish, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; David O. Okonkwo, MD, PhD; Peter G. Passias, MD; Christopher P. Ames, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Virginie Lafage, PhD; Renaud Lafage, MS; International Spine Study Group

14:43 - 14:52 **Discussion**

14:52 - 14:56 **Paper #58: Where Does Most of the Coronal and Sagittal Correction of Main Thoracic and Thoracolumbar Curves Come from in Adult Idiopathic Scoliosis (ADIS) Surgery?**
Nathan J. Lee, MD; Fthimnir Hassan, MPH; Thomas M. Zervos, MD; Ted Shi, BS; Erik Lewerenz, BS; Chun Wai Hung, MD; Steven G. Roth, MD; Justin K. Scheer, MD; Lawrence G. Lenke, MD

14:56 - 15:00 **Paper #59: A Tale of Two Planes: the Impact of Coronal Deformity on Sagittal Alignment in Adult Spinal Deformity**
Pawel Jankowski, MD; Max Fisher, MD; Kyriakos Chatzis, BS; Peter Tretiakov, BS; Tobi Onafowokan, MBBS; Francesca Totis, MD; Arman Kishan, MBBS; Clifford Cruther, MD; Dean Chou, MD; Praveen Mummaneni, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Peter G. Passias, MD; Arman Kishan, MBBS

15:00 - 15:04 **Paper #60: Vertebral Pelvic Angles Accurately Predict Risk of Proximal Junctional Kyphosis in Long Segment Fusion for Adult Spinal Deformity Surgery**
Michael Fields, MD, BS

15:04 - 15:13 **Discussion**

15:13 - 15:17 **Paper #61: Are We Getting Better at Achieving Alignment in Minimally Invasive Adult Spinal Deformity Surgery?**
Ankita Das, MD; Khoi Duc Than, MD; Peter Tretiakov, BS; Kyriakos Chatzis, BS; Tobi Onafowokan, MBBS; Max Fisher, MD; Francesca Totis, MD; Ethan Cottrill, MD, PhD, MSEd; Juan S. Uribe, MD; Neel Anand, MD; Paul Park, MD; David O. Okonkwo, MD, PhD; Robert Eastlack, MD; Pierce Nunley, MD; Adam Kanter, MD; Richard Fessler, MD, PhD; Gregory M. Mundis, Jr., MD; Michael Wang, MD, PhD; Renaud Lafage, MS; Virginie Lafage, PhD; Pawel P. Jankowski, MD; Jay D. Turner, MD, PhD; Christopher Shaffrey, MD; Andrew K. Chan, MD; Dean Chou, MD; Praveen Mummaneni, MD; Peter G. Passias, MD

15:17 - 15:21 **Paper #62: How Changes in Segmental Lordosis Impact L1-Pelvic-Angle After Adult Spinal Deformity Surgery?**
Harsh Jain, MBBS; Omar Zakieh, MBBS; Jeremia Williams, BS; Anthony E. Bishay, BS; Walter Navid, BS; Austin Montgomery, BS; Keyan Peterson, MD, MS; Alan Tang, MD; Tyler Zeoli, MD; Ranbir Ahluwalia, MD; Soren Jonzzon, MD; Iyan Younus, MD; Hani Chanbour, MD; Adam M. Wegner, MD, PhD; Julian Lugo-Pico, MD; Amir M. Abtahi, MD; Byron F. Stephens, MD; Scott Zuckerman, MD, MPH

15:21 - 15:25 **Paper #63: What Degree of Malalignment Justifies Performance of Three Column Osteotomy in Revision Lumbar Spinal Fusion?**
Anthony Yung, MD, MS; Tobi Onafowokan, MBBS; Max Fisher; Renaud Lafage, MS; Virginie Lafage, PhD; Justin S. Smith, MD, PhD; Peter Tretiakov, BS; Breton G. Line, BS; Bassel G. Diebo, MD; Alan H. Daniels, MD; Jeffrey L. Gum, MD; Themistocles S. Protopsaltis, MD; Kojo D. Hamilton, MD, FAANS; Thomas J. Buell, MD; Alex Soroceanu, MD, FRCS(C), MPH; Justin K. Scheer, MD; Robert K. Eastlack, MD; Jeffrey Mullin, MD; Gregory M. Mundis Jr., MD; Naobumi Hosogane, MD, PhD; Mitsuru Yagi, MD, PhD; Michael P. Kelly, MD; Paul Park, MD; Pierce D. Nunley, MD; Dean Chou, MD; Praveen V. Mummaneni, MD, MBA; Eric O. Klineberg, MD; Khaled M. Kebaish, MD; Richard Hostin, MD; Munish C. Gupta, MD; Han Jo Kim, MD; Christopher P. Ames, MD; Lawrence G. Lenke, MD; Christopher I. Shaffrey, MD; Shay Bess, MD; Frank J. Schwab, MD; Peter G. Passias, MD

15:25 - 15:34 **Discussion**

15:34 - 15:38 **Paper #64: Lumbar Lordosis Distribution in Adult Spinal Deformity: Targets Based on Pelvic Morphology**
Kyriakos Chatzis, BS; Kristen Jones, MD; Peter Tretiakov, BS; Vickrambir Sahni, BA; Max Fisher, MD; Alan Daniels, MD; Bassel Diebo, MD; John C. Barr, MD; M. Burhan Janjua, MD; Arman Kishan, MBBS; Pawel Jankowski, MD; Tobi Onafowokan, MBBS; Renaud Lafage, MS; Virginie Lafage, PhD; Christopher Shaffrey, MD; Peter G. Passias, MD; Arman Kishan, MBBS

15:38 - 15:42 **Paper #65: Will my Sagittal Spinal Alignment Be Change After Total Hip Arthroplasty? An Analysis by Presence and Absence of Sagittal Spinal Deformity**
Aaron J. Buckland, MBBS, FRCSA; Fares Ani, MD; Eaman Balouch, MD, PhD; Jack R. Zhong, MD; Jonathan Vigdorchik, MD; Ran Schwarzkopf, MD; Themistocles S. Protopsaltis, MD

15:42 - 15:46 **Paper #66: Three Stages of Lower Extremity Compensation in Asd Patients with Sagittal Malalignment**
Sarthak Mohanty, BS; Zeeshan M. Sardar, MD; Fthimnir Hassan, MPH; Justin L. Reyes, MS; Erik Lewerenz, BS; Josephine R. Coury, MD; Joseph M. Lombardi, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

15:46 - 15:55 **Discussion**

MEETING AGENDA

THURSDAY, SEPTEMBER 18, 2025

Program (topics, timing, and faculty) is subject to change.

14:10 - 15:55 | **Richardson Ballroom AB**

Abstract Session 5B: Adolescent Idiopathic Scoliosis II Newer Technology: VBT + AI

Moderators: Amer F. Samdani, MD & Per D. Trobisch,MD

14:10 - 14:14 **Paper #67: Outcomes of Vertebral Body Tethering in AIS: A Prospective, Multi-Center Study**
Hans K. Nugraha, MD; Lawrence L. Haber, MD; Dan Hoernschemeyer, MD; Patrick J. Cahill, MD; Amer F. Samdani, MD; Firoz Miyanji, MD; Peter O. Newton, MD; A. Noelle Larson, MD; Harms Study Group

14:14 - 14:18 **Paper #68: Surgical Outcomes and Complications for Patients Undergoing Vertebral Body Tethering with a 5-8 Year Follow-Up**
Rachelle Imbeault; Jesse Shen, MD, MSc; Abdulmajeed Alzakri, MD; Olivier Turcot, MD; Marie Beausejour, PhD; Marjolaine Roy-Beaudry, MSc; Isabelle Turgeon, BSc; Soraya Barchi, BSc; Stefan Parent, MD, PhD

14:18 - 14:22 **Paper #69: Are Complications Higher for Lumbar or Bilateral Vs. Thoracic VBT at 2-Year Follow Up? a Large, Single-Institution Retrospective Review**
Hans K. Nugraha, MD; Ria Paradkar, BS; Kellen Mulford, PhD; Todd A Milbrandt, MD, MS; A. Noelle Larson, MD

14:22 - 14:31 **Discussion**

14:31 - 14:35 **Paper #70: Six Modes of Failure for Vertebral Body Tethering (VBT)**
Lawrence L. Haber, MD; Katelyn Nicholson, BS; Amer F. Samdani, MD; Craig R. Louer, MD; Suken A. Shah, MD; Patrick J. Cahill, MD; A. Noelle Larson, MD; Dan Hoernschemeyer, MD; Firoz Miyanji, MD; Michelle Claire Marks, PT; Tracey Bryan, MS; Peter O. Newton, MD; Harms Study Group

14:35 - 14:39 **Paper #71: What Happens to Broken Thoracic and Lumbar Vertebral Body Tethers After Skeletal Maturity?**
Steven W. Hwang, MD; Amer F. Samdani, MD; Wasilat Dosunmu, BS; Samantha Murray, BS; Emily Nice, BS; William Purtill, BA; Terrence G. Ishmael, MBBS; Joshua M. Pahys, MD

14:39 - 14:43 **Paper #72: Understanding Overcorrection Risk Factors in Anterior Vertebral Body Tethering**
Alyssa Capasso, BS; Juan D. Rodriguez-Rivera, BS; Stefan Parent, MD, PhD; Tenner Guillaume, MD; Kenneth M. Cheung, MD, MBBS, FRCS; Kevin Smit, MD; Walter H. Truong, MD, FRCS(C), FAOA; Juan Carlos Rodriguez-Olaverri, MD; Pediatric Spine Study Group

14:43 - 14:52 **Discussion**

14:52 - 14:56 **Paper #73: Lumbar Tether Successfully Avoids Fusion in 85% of Patients at Two Year Follow Up - A Multicenter Study**
Omar Taha, BS; Matthew Weintraub, BS; Mehdi Elfilali, BA; Juan Carlos Rodriguez-Olaverri, MD; Laurel C. Blakemore, MD; Firoz Miyanji, MD; Taemin Oh, MD; Michael G. Vitale, MD, MPH; Pediatric Spine Study Group

14:56 - 15:00 **Paper #74: Surgical Treatment of Lenke Type 5 Curves Using Vertebral Body Tethering with Double Screw-Double Cord Fixation: Clinical and Radiological Outcomes over a Minimum 5-Year Follow-Up**
Sepehr Asadollahmonfared, MD; Inas M. Daadour, MD; Hamisi M. Mraja, MD; Selmin E. Arsoy, BS, PT ; Sinan Kahraman, MD; Selhan Karadereler, MD; Meric Enercan, MD; Azmi Hamzaoglu, MD

15:00 - 15:04 **Paper #75: Location of Tensioned Cord in Double Row Vertebral Body Tethering Constructs Significantly Affects Flexion Extension and Lateral Bending Range of Motion: A Cadaveric Biomechanics Study**
A. Noelle Larson, MD; Amy A. Claeson, PhD; Vijay N. Permeswaran, PhD

15:04 - 15:13 **Discussion**

15:13 - 15:17 **Paper #76: Sagittal Spinal Alignment 2 Years After Anterior Vertebral Body Tethering**
Jun Ouchida, MD; Peter O. Newton, MD; Vidyadhar V. Upasani, MD; Carrie E. Bartley, MA; Michael P. Kelly, MD

15:17 - 15:21 **Paper #77: Clinical and Radiological Outcomes of Hybrid Technique in the Management of AIS with Double Major Curves over a Minimum 5 Years Follow Up**
Inas M. Daadour, MD; Sepehr Asadollahmonfared, MD; Hamisi M. Mraja, MD; Halil Gok, MD; Sinan Kahraman, MD; Selhan Karadereler, MD; Meric Enercan, MD; Azmi Hamzaoglu, MD

15:21 - 15:25 **Paper #78: Does Vertebral Body Tethering Cause Coronal Hypermobility of Adjacent Non-Instrumented Levels?**
Hans K. Nugraha, MD; Todd A Milbrandt, MD, MS; A. Noelle Larson, MD

15:25 - 15:34 **Discussion**

15:34 - 15:38 **Paper #79: Revolutionizing Digital Transformation in Adolescent Idiopathic Scoliosis Screening: AI-Assisted Holistic Motion Analysis Via a Smartphone Camera for Scalable, Cost-Effective Screening**
Dong Chen, MS, BS; Huili Peng, MS; Kenneth M. Cheung, MD, MBBS, FRCS

15:38 - 15:42 **Paper #80: Generative Artificial Intelligence System for Radiation-Free Evaluation of Scoliosis: A Model Development and Validation Study**
Zhong He, MD; Xiaodong Qin, PhD; Neng Lu, MS; Yi Chen, MD; Zhen Liu, PhD; Yong Qiu, PhD; Wu-Jun Li, PhD; Zezhang Zhu, PhD

15:42 - 15:46 **Paper #81: Classification of Adolescent Idiopathic Scoliosis Curvature Using Unsupervised Machine Learning**
Chang Ju Hwang, MD, PhD; Sehan Park, MD; Jae Hwan Cho, MD, PhD; Dong-Ho Lee, MD, PhD

15:46 - 15:55 **Discussion**

16:00 - 17:30 Networking Sessions Hosted by Industry*

Each networking session is hosted by a single-supporting company. Please note: CME credits are not available for industry hosted cocktail events.

Please see page 232 to view the detailed schedule.

17:30 - 19:00 Major Donor Reception* (by invitation only)

**denotes a non-CME session/event*

MEETING AGENDA

FRIDAY, SEPTEMBER 19, 2025

Program (topics, timing, and faculty) is subject to change.

08:00 - 09:50 | **Richardson Ballroom CD**

Abstract Session 6: Hibbs Award-Nominated Papers

Moderators: Jennifer M. Bauer, MD, MS & Martin Repko, MD, PhD

08:00 - 08:05 **Welcome & Introduction to the Hibbs Award**

08:05 - 08:11 **Paper #82: Characteristics and 10-Year Postoperative Course of Back Pain in Patients with Thoracic Adolescent Idiopathic Scoliosis**§
Masayuki Ohashi, MD, PhD; Kei Watanabe, MD, PhD; Toru Hirano, MD, PhD; Kazuhiro Hasegawa, MD, PhD; Hideki Tashi, MD; Yohei Shibuya, MD; Masayuki Sato, MD; Mio Kubota, MD, PhD; Hiroyuki Kawashima, MD, PhD

08:11 - 08:17 **Paper #83: The More You Use the Brace, the Better the Results: The Dose-Response Curves Between 18 and 23 Hours/day Brace-Wearing in 687 Braist-Matched Children**§
Stefano Negrini, MD; Greta Jurenaite, MD; Fabio Zaina, MD

08:17 -08:23 **Paper #84: Disease Modifying Treatment (DMT) Does Not Mitigate Scoliosis in Spinal Muscular Atrophy (SMA)**§
Taylor M. Adams, BS; Lennert Plasschaert, MD; Patricia E. Miller, MS; Basil Darras, MD; Brian D. Snyder, MD, PhD

08:23 - 08:37 **Discussion**

08:37 - 08:43 **Paper #85: Wait to Operate: Surgery Demonstrated No Pulmonary Benefit Compared to Non-Operative Treatment in EOS Patients**§
Amy L. McIntosh, MD; Charles E. Johnston, MD; Tiffany Thompson, BS; JP Rathbun, BS; Chan-Hee Jo, PhD; Karina A. Zapata, PhD, PT, DPT

08:43 - 08:49 **Paper #86: Trunk Motion for Adolescent Idiopathic Scoliosis After Posterior Spinal Fusion Compared to Single Vs. Dual Cord Anterior Vertebral Body Tethering at Two Year Follow-Up**§
Joshua M. Pahys, MD; Amer F. Samdani, MD; Steven W. Hwang, MD; Terrence G. Ishmael, MBBS; Spencer Warshauer, MS; Robert Courter, PhD; John P Gaughan, PhD; Ross Chafetz, PhD

08:49 - 08:55 **Paper #87: Sagittal Malalignment in ASD Seems to Be Related to Frontal Instability During Gait**§
Georges El Haddad; Rami Rachkidi, MD, MS; Marc Boutros, MS; Maria Karam; Maria Asmar; Emmanuelle Wakim; Moustapha Rteil; Ibrahim Hamati; Gilles Prince; Jean-Pierre Saad; Yamen Beyh; Mohamad I. Karam, PhD; Ismat Ghanem, MD, MS; Abir Massaad, PhD; Ayman Assi, PhD

08:55 - 09:09 **Discussion**

09:09 - 09:15 **Paper #88: Accelerated Biological Aging in Patient with Adults Spinal Deformity: The Impact of Modifiable Lifestyle Factors on Phenotypic Age**†
Mitsuru Yagi, MD, PhD; Norihiro Isogai, MD, PhD; Ryosuke Maruiwa, MD; Ryo Mizukoshi, MD; Haruki Funao, MD, PhD; Retsu Fujita, PhD

09:15 - 09:21 **Paper #89: The Sodium-Glutamate Antagonist Riluzole Improves Outcome After Acute Spinal Cord Injury: Results from Riscis Randomized Controlled Trial Using a Global Statistical Analytic Technique**†
Michael G. Fehlings, MD, PhD, FRCS(C)

09:21 - 09:27 **Paper #90: Spinal Growth Regulation by Interfering Chondrocytes Function in Growth Plate is a Potential Treating Method for Scoliosis: Preliminary Study in Piglets**†
Zhaoquan Zhang, MD; Zhibo Song, MD; Yingsong Wang, MD; Zhi Zhao, MD; Ni Bi, MD; Jingming Xie, MD; Tao Li, MD; Li Zhang, MD; Ying Zhang, MD; Zhiyue Shi, MD

09:27 - 09:33 **Paper #91: The Unseen Waves: Ultrasonic Osteotomy Devices Can Affect Bone Healing and Central Nervous System Function**†
Zonglin He, MBBS, MPhil; Meiru An, MS, BS; Dong Chen, MS, BS; Kenneth M. Cheung, MD, MBBS, FRCS

09:33 - 09:49 **Discussion**

09:49 - 09:50 **Audience Vote**

09:50 - 10:10 | **Refreshment Break* | Ballroom Pre-function 1**

**denotes a non-CME session/event*

§ = Hibbs Award Nominee – Best Clinical Paper † = Hibbs Award Nominee – Best Basic Science/Translational Paper

10:10 - 11:50 | **Richardson Ballroom CD**

Abstract Session 7: Adult Spinal Deformity III and Presidential Address

Moderators: Serena S. Hu, MD & Michael P. Kelly, MD

10:10 - 10:14 **Paper #92: Do Mechanical Complications Decrease when Ideal L1PA Values Are Obtained in Adult Spinal Deformity Patients Undergoing Lumbopelvic Fixation? A Study with Mean 13 (5-26) Years Follow Up**
Sinan Kahraman, MD; Hamisi M. Mraja, MD; Sepehr Asadollahmonfared, MD; Ahmet H. Olcar, MD; Mustafa Bugra Ayaz, MD; Inas M. Daadour, MD; Serkan Devran; Selhan Karadereler, MD; Meric Enercan, MD; Azmi Hamzaoglu, MD

10:14 - 10:18 **Paper #93: Spinal Shape Assessed by Vertebral Pelvic Angles Can Correspond to Variable Thoracic and Lumbar Curvatures**
Renaud Lafage, MS; Daniel Bass, BS; Themistocles S. Protopsaltis, MD; Jonathan C. Elysee, BS; Breton G. Line, BS; Shay Bess, MD; Alan H. Daniels, MD; Bassel G. Diebo, MD; Robert K. Eastlack, MD; Munish C. Gupta, MD; Richard Hostin, MD; Khaled M. Kebaish, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; David O. Okonkwo, MD, PhD; Peter G. Passias, MD; Christopher P. Ames, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Virginie Lafage, PhD; International Spine Study Group

10:18 - 10:22 **Paper #94: Early Postoperative T4PA-L1PA Malalignment in Lower Thoracic to Pelvis Fusions is Associated with PJK**
Sarthak Mohanty, BS; Zeeshan M. Sardar, MD; Fthimnir Hassan, MPH; Justin L. Reyes, MS; Erik Lewerenz, BS; Joseph M. Lombardi, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

10:22 - 10:31 **Discussion**

10:31 - 10:35 **Paper #95: Rethinking Sagittal Alignment: The Value of Evaluating Spinal Shape in Conjunction with T4-L1PA Measurement to Prevent Proximal Junctional Failure**
Renaud Lafage, MS; Max Kohn, BS; Themistocles S. Protopsaltis, MD; Emil Haikal, MD; Breton G. Line, BS; Shay Bess, MD; Alan H. Daniels, MD; Bassel G. Diebo, MD; Robert K. Eastlack, MD; Munish C. Gupta, MD; Richard Hostin, MD; Khaled M. Kebaish, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; David O. Okonkwo, MD, PhD; Peter G. Passias, MD; Christopher P. Ames, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Virginie Lafage, PhD; International Spine Study Group

10:35 - 10:39 **Paper #96: Reciprocal Change, Redefined: Postoperative T4L1PA Mismatch in Lower Thoracic Fusions**
Atahan Durbas, MD; Han Jo Kim, MD; Andrea Pezzi, MD; Robert Uzzo, MBA; Gabrielle Dykhouse, BS; Tejas Subramanian, BS; Stephane Owusu-Sarpong, MD; Mihir Dekhne, MD; Jung Mok, MD; Kasra Araghi, BS; Quante Singleton, MD; Farah Musharbash, MD; Matthew E. Cunningham, MD, PhD; Francis C. Lovecchio, MD

10:39 - 10:43 **Paper #97: Evolution of Sagittal Plane Metrics: Moving Beyond Pi-LI Mismatch**
Jeffrey M. Hills, MD; Christopher P. Ames, MD; Jean-Charles Le Huec, MD, PhD; Zeeshan M. Sardar, MD; Camilo Molina, MD; Hee-Kit Wong, MD, PhD; Kazuhiro Hasegawa, MD, PhD; Lawrence G. Lenke, MD; Michael P. Kelly, MD

10:43 - 10:52 **Discussion**

10:52 - 10:56 **Paper #98: Optimizing Free Hand Sacro-Alar-Iliac (SAI) Screw Placement for Pelvic Retroversion: Utilizing the Safety Margin**
Se Jun Park, MD; Hyun Jun Jang, MD; Bong Ju Moon, MD, PhD; Jeong Yoon Park, MD, PhD; Sung Uk Kuh, MD, PhD; Dong Kyu Chin, MD, PhD; Keun Su Kim, MD, PhD; Kyung Hyun Kim, MD, PhD

10:56 - 11:00 **Paper #99: Pelvic Fixation for Adult Spine Deformity: Two Year Results from an International, Multicenter, Randomized Trial**
David W. Polly Jr., MD; Gregory M. Mundis Jr., MD; Jean-Christophe A. Leveque, MD; Robert K. Eastlack, MD; Avery L. Buchholz, MD; Isador H. Lieberman, MD; Han Jo Kim, MD; Ryan Snowden, MD; Jonathan N. Sembrano, MD; T. Matt Chapman, Jr., MD; Joshua P. Herzog, MD; Robert S. Lee, MBBS, FRCS; Benjamin D. Elder, MD, PhD

11:00 - 11:04 **Paper #100: Rethinking Spinal Reconstruction: The Impact of Patient-Specific Implants on Thoracolumbar Deformity Surgery**
Christopher Kleck, MD; Max Fisher, MD; Evalina Burger, MD; David Ou-Yang, MD; Vikas Patel, MD; Renzo Laynes, MD, Afshin Aminian, MD; Tobi Onafowokan, MBBS; Peter Tretiakov, BS; Kyriakos Chatzis, BS; Francesca Totis, MD; Peter G. Passias, MD; Afshin Aminian, MD

11:04 - 11:13 **Discussion**

MEETING AGENDA

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Program (topics, timing, and faculty) is subject to change.

11:13 - 11:16 **2026 IMAST Preview**
Amit Jain, MD, MBA & Caglar Yilgor, MD

11:16 - 11:19 **2026 Annual Meeting Preview**
Nicholas D. Fletcher, MD & Eric O. Klineberg, MD

11:19 - 11:22 **2026 Regional Courses Preview**
Martin Repko, MD, PhD

11:22 - 11:25 **Acknowledgment of 2025 Awards & Scholarship Winners**
Dong-Gune Chang, MD, PhD

11:25 - 11:30 **Introduction of the President**
Suken A. Shah, MD

11:30 - 11:50 **Presidential Address**
Laurel C. Blakemore, MD

12:15 - 13:30 Member Business Meeting* (lunch pick-up at 11:50) | Room E219

All SRS members are invited to the Member Business Meeting. The agenda will include reports from the various SRS committees, updates on SRS activities and programs, and voting. Attendance at the Member's Business Meeting is an opportunity to not only hear updates but actively participate in shaping the future of our Society. We encourage ALL MEMBERS to attend. A hot lunch will be provided.

12:15 - 13:15 Non-Member Information Session* (lunch pick-up at 11:50) Room E221AB

While SRS members participate in the Business Meeting, all non-member delegates are encouraged to attend the Non-Member Information Session to connect with colleagues and learn more about SRS.

13:45 - 15:30 Richardson Ballroom CD

Abstract Session 8A: Early Onset Scoliosis

Moderators: Robert H. Cho, MD & Ilkka J. Helenius, MD, PhD

13:45 - 13:49 **Paper #101: Golden Responders: Which Early Onset Scoliosis Patients Have Improved PFTS 2 Years After Surgical Intervention?**
Amy L. McIntosh, MD; Vivek Abraham, MD; Karina A. Zapata, PhD, PT, DPT; Burt Yaszay, MD; Mark A. Erickson, MD; Richard E. McCarthy, MD; Ron El-Hawary, MD; Pediatric Spine Study Group

13:49 - 13:53 **Paper #102: Point of Care Spirometry - A Prospective Comparison Vs. Laboratory Spirometry for Children with Early Onset Scoliosis‡**
Klane K. White, MD; Sungmin Kim, BS; Amy L. McIntosh, MD; Brian D. Snyder, MD, PhD; Kevin Smit, MD; Megan E. Johnson, MD; Patrick J. Cahill, MD; Viral V. Jain, MD; Gregory Redding, MD; Pediatric Spine Study Group

13:53 - 13:57 **Paper #103: No Improvement in Longitudinal Pulmonary Function After Surgery for Early Onset Scoliosis**
Scott Yang, MD; Michael Trask, BS; Natalie Maharaj, BS; Apeksha Gupta, MS, MPH; Anna Faino, MSc; Sean Pirkle, MD; Kelson Adcock, BS; Jennifer M. Bauer, MD, MS; Burt Yaszay, MD; Gregory Redding, MD

13:57 - 14:06 **Discussion**

14:06 - 14:10 **Paper #104: 10 Year Experience with MCGR: Are We Moving the Needle on Early Onset Scoliosis?**
Michelle C. Welborn, MD; Daniel Bouton, MD

14:10 - 14:14 **Paper #105: Traditional Vs Magnetically Controlled Growing Rods for Idiopathic Early-Onset Scoliosis: Outcomes at 5-Year Follow-Up**
Antti J. Saarinen, MD, PhD; John M. Flynn, MD; George H. Thompson, MD; John B. Emans, MD; Peter F. Sturm, MD; Paul D. Sponseller, MD, MBA; Pediatric Spine Study Group; Ilkka J. Helenius, MD, PhD

14:14 - 14:18 **Paper #106: Pelvic Fixation for Early Onset Scoliosis: Comparative Risks of Complications and Unplanned Return to the Operating Room (UPROR)**
Rayyan Abid, BA; Susan Wager, MD; Christina K. Hardesty, MD; Pediatric Spine Study Group

14:18 - 14:27 **Discussion**

‡ = SRS Funded Research Grant

14:27 - 14:31 **Paper #107: What Are the Incidence and Risk Factors for Complications in Growth-Friendly Constructs in Congenital Scoliosis?**
Sanjana Davuluri; Scott J. Luhmann, MD; Amer F. Samdani, MD; Lindsay M. Andras, MD; Megan E. Johnson, MD; Paul D. Sponseller, MD, MBA; Jaime A. Gomez, MD; John T. Smith, MD; Mark A. Erickson, MD; John B. Emans, MD; Pediatric Spine Study Group; Steven W. Hwang, MD

14:31 - 14:35 **Paper #108: Postpone and Posterior if Possible: Comparison of Surgical Approaches for Hemivertebrectomy**
Brandon Yoshida, MD; Jacquelyn Valenzuela-Moss, BS; Tyler Tetreault, MD; Tishya Wren, PhD; Purnendu Gupta, MD; Joshua M. Pahys, MD; Michael G. Vitale, MD, MPH; Amer F. Samdani, MD; Lindsay M. Andras, MD; Pediatric Spine Study Group; Michael J. Heffernan, MD

14:35 - 14:39 **Paper #109: Is There a Role for Bracing/Casting in the Treatment of Early Onset Congenital Scoliosis?**
Kenneth A. Shaw, DO; Jaime A. Gomez, MD; John T. Smith, MD; Sumeet Garg, MD; Mark A. Erickson, MD; Michael G. Vitale, MD, MPH; Lindsay M. Andras, MD; Megan E. Johnson, MD

14:39 - 14:48 **Discussion**

14:48 - 14:52 **Paper #110: Growth Preserving Anterior Release and Posterior Distraction-Based Growing Systems for Early Onset Scoliosis (EOS): A Propensity Matched Cohort Study**
Akshara Sharma, MBBS; Mathew D. Sewell, PhD, FRCS, MBA; Morgan Jones, FRCS; George McKay, FRCS; Irfan Sidiqqui, FRCS; Matthew P. Newton Ede, FRCS Tr & Orth; Jonathan Spilsbury, FRCS Tr & Orth; David S. Marks, MBBS, FRCS, FRCS(Orth); Adrian Gardner, FRCS (Tr & Orth); Jwalant S. Mehta, MD, FRCS (Orth), MCh (Orth), MS (Orth), D Orth

14:52 - 14:56 **Paper #111: Prevalence of Spinal Deformities in Myelomeningoceles Treated in Utero and Postnatally Using 3D EOS Panoramic X-Ray Technology**
Vinicius de Meldau Benites, MD; Vinicius Santos Baptista

14:56 - 15:00 **Paper #112: Connective Tissue Disease Patients Do Not Have Higher Rates of PJK Compared with Idiopathic EOS Following Growth Friendly Instrumentation**
Kenneth A. Shaw, DO; John T. Smith, MD; Paul D. Sponseller, MD, MBA; Joshua M. Pahys, MD; George H. Thompson, MD; Pediatric Spine Study Group; Brandon A. Ramo, MD

15:00 - 15:09 **Discussion**

15:09 - 15:13 **Paper #113: Cured Patients with Early Onset Idiopathic Scoliosis (EOIS) After Serial Casting Are at Risk of Recurrence at Intermediate Follow-Up**
Rayyan Abid, BA; Abigail Manning, BS; Craig M. Birch, MD; Peter F. Sturm, MD; Ying Li, MD; Michal Szczodry, MD; Michael P. Glotzbecker, MD; Pediatric Spine Study Group

15:13 - 15:17 **Paper #114: A Novel Peek Rib Plate for Growth Modulation for Spine Deformity Correction of the Immature Rib Cage in Early-Onset Scoliosis: A Porcine Model**‡
Hong Zhang, MD; Brad Niese, PhD; Daniel J. Sucato, MD, MS

15:17 - 15:21 **Paper #115: Tell Me Your Triradiate is Closed Without Telling Me It's Closed: Assessment of Surrogate Radiographic Factors for Prediction of Triradiate Closure**
Kevin M. Neal, MD; Ying Li, MD; Grant D. Hogue, MD; Maia Regan, BA; Megan E. Johnson, MD; Jason B. Anari, MD; Keith Baldwin, MD, MD, MPH, MSPT

15:21 - 15:30 **Discussion**

13:45 - 15:30 **Richardson Ballroom AB**

Abstract Session 8B: Kyphosis, Spondylolysis + -listhesis, other Pathologies

Moderators: Amit Jain, MD, MBA & Ferran Pellisé, MD, PhD

13:45 - 13:49 **Paper #116: A Novel and Safe Surgical Strategy to Correct Extremely Severe Potts Deformity from Pathological to Physiological Kyphosis**
Junlong Zhong, MD; Zhenhai Zhou, MD, PhD; Jiachao Xiong, MD, PhD; Kai Cao, MD, PhD

13:49 - 13:53 **Paper #117: Finite Vertebral Osteotomy for Angular Kyphotic Deformity in Upper-Middle Thoracic Spine: A Comparative Study with Posterior Vertebral Column Resection**
Jiahao Zhang, MD; Yan Zeng, MD

‡ = SRS Funded Research Grant

MEETING AGENDA

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Program (topics, timing, and faculty) is subject to change.

13:53 - 13:57 **Paper #118: Does L5-S1 Interbody Fusion Provide Additional Biomechanical Benefit in Setting of Multipoint Pelvic Fixation with Quad Rods Across the Lumbosacral Junction?**
Robert Rudy, BS; Anna Sawa, PhD; Sarah McBryan, MS; Luke Mugge, MD; Katherine Thielen, BS; Temesgen G. Assefa, MD; David W. Polly Jr., MD; Juan S. Uribe, MD; Brian P. Kelly, PhD; Jay D. Turner, MD

13:57 - 14:06 **Discussion**

14:06 - 14:10 **Paper #119: Low Pelvic Incidence in Scheuermann's Kyphosis Should Be Considered in Surgical Thoracic Kyphosis Correction**
Riley Sevensky, BS; Zeeshan M. Sardar, MD; Justin L. Reyes, MS; Oluwademilade Tega, BA; Fthimnir Hassan, MPH; Josephine R. Coury, MD; Joseph M. Lombardi, MD; Lawrence G. Lenke, MD

14:10 - 14:14 **Paper #120: Radiographic Predictors of Functional and Pain Outcomes in Scheuermann's Kyphosis: A Roc-Based Minimal Clinically Important Difference (MCID) Analysis**
Matthew Geck, MD; Devender Singh, PhD; Vik Kohli, MD; Morgan Laviolette, DPT; Qais Zai, MD; Rory R. Mayer, MD; John Stokes, MD; Eeric Truumees, MD

14:14 - 14:18 **Paper #121: Selection of Upper Instrumented Vertebra Level (T9 Vs T10) on Radiologic and Clinical Outcomes in the Surgical Treatment of Adult Spinal Deformity Patients over a Minimum 5 Years Follow-Up**
Hamisi M. Mraja, MD; Ahmet H. Olcar, MD; Mustafa Bugra Ayaz, MD; Basri Pur, MD; Halil Gok, MD; Serkan Devran; Selhan Karadereler, MD; Sinan Kahraman, MD; Meric Enercan, MD; Azmi Hamzaoglu, MD

14:18 - 14:27 **Discussion**

14:27 - 14:31 **Paper #122: High-Grade Pediatric Spondylolisthesis: Pelvic Retroversion Corrects Spontaneously After In-Situ Posterior Spinal Fusion**
Karim Aboelmagd, MD; Anne Vesteeg, MD, PhD; Mark Camp, MD; Reinhard D. Zeller, MD, FRCS(C); David E. Lebel, MD, PhD

14:31 - 14:35 **Paper #123: Sagittal Balance and Hrqols in Young Patients with High Grade Dysplastic Spondylolisthesis Who Underwent Modified Harm's Technique Reduction- Long Term Follow Up, Single Centre Study**
Sakthivel Ramasamy, MS; Appaji Krishnan Krishnamurthy, MD; Sharan Achar T, MS; Kunal Chanji, MS; Sajan K Hegde MBBS, MS

14:35 - 14:39 **Paper #124: Conservative Treatment Protocol for the Management of Spondylolysis in Adolescent Athletes: Excellent Rates of Return to Sport and Clinical Resolution in 176 Patients**
Patrick Nian, BA; Amith Umesh, BA; Ithika Senthilnathan, BS; Isabella G. Marsh, BS; Austin Kaidi, MD; Shevaun Doyle, MD; John S. Blanco, MD; Roger F. Widmann, MD; Jessica H. Heyer, MD

14:39 - 14:48 **Discussion**

14:48 - 14:52 **Paper #125: Femoral BMD is the Superior Predictor of Screw Insertional Torque over Lumbar BMD and Hounsfield Unit in Lumbar Fusion Surgery**
Yoji Ogura, MD, PhD; Taisei Kato, MD; Yuichiro Nishiyama, MD, PhD; Arya G. Varthi, MD; Yoshihisa Suzuki, MD, PhD

14:52 - 14:56 **Paper #126: Selection of Proximal Fusion Level in Chronic Osteoporotic Vertebral Compression Fracture (OVCF) with Spinal Kyphosis: The Importance of Hounsfield Unit**
Junyu Li, MD; Yiqiao Zhang, MD; Ben Wang, MD; Baitao Liu, MD; Xueshi Tian, MD; Runan Pan; Zhuoran Sun, MD; Yongqiang Wang, MD; Miao Yu, MD; Yan Zeng, MD; Weishi Li, MD

14:56 - 15:00 **Paper #127: Biomechanical Evaluation of a Novel Endplate Penetrating Pedicle Screw Fixation Method Using Cadaver Spine: A Comparison with a Traditional Pedicle Screw Trajectory**
Takumi Takeuchi, MD, PhD; Yosuke Kawano, MD; Takehiko Moroi, MD; Kazumasa Konishi, MD; Masahito Takahashi, MD, PhD; Miki Nagase, MD, PhD; Naobumi Hosogane, MD, PhD

15:00 - 15:09 **Discussion**

15:09 - 15:13 **Paper #128: The Economic and Clinical Burden of Poor Bone Health in Adult Spinal Deformity Surgery**
Peter G. Passias, MD; Kojo Hamilton, MD; Max Fisher, MD; Tobi Onafowokan, MBBS; Peter Tretiakov, BS; Kyriakos Chatzis, BS; Francesca Totis, MD; Virginie Lafage, PhD; Renaud Lafage, MS; Breton Line, BS; Bassel Diebo, MD; Alan Daniels, MD; Jeffrey P. Mullin, MD, MBA; Jeffrey Gum, MD; Alekos Theologis, MD; Praveen Mummaneni, MD; Dean Chou, MD; Gregory M. Mundis, Jr., MD; Darryl Lau, MD; Joshua Bunch, MD; Brandon Carlson, MD; Stephen Lewis, MD; Tom Buell, MD; Justin Scheer, MD; Robert Eastlack, MD; Khaled Kabeish; MD; Munish Gupta, MD; Han Jo Kim, MD; Alex Soroceanu, MD; Anthony Mikula, MD; Neel Anand, MD; David O. Okonkwo, MD; PhD, Pierce Nunley, MD; Themistocles Protopsaltis, MD; Mitsuru Yagi, MD; Naobumi Hosogane, MD; Lawrence Lenke, MD; Richard Hostin, MD; Justin Smith, MD, PhD; Eric Klineberg, MD; Christopher Ames, MD; Frank Schwab, MD; Shay Bess, MD; Christopher Shaffrey, MD; International Spine Study Group

15:13 - 15:17 **Paper #129: Weight Loss Following Treatment with Glucagon-Like Peptide-1 (GLP-1) Receptor Agonists Significantly Decreases Bone Mineral Density in the Spine as Measured by CT-Based Hounsfield Units**
Michael Martini, MD, PhD; Abdelrahman Hamouda, BS; Zach Pennington, MD; Julian Rechberger, MD, PhD; Jennifer Perez, MD, PhD; Patrick Flanigan, MD; Anthony L. Mikula, MD; Nikita Lakomkin, MD; Brett A. Freedman, MD; Ahmad Nassr, MD; Jeremy L. Fogelson, MD; Kurt A. Kennel, MD; Benjamin D. Elder, MD, PhD

15:17 - 15:21 **Paper #130: Paid in Bone: The Hidden Cost of Electrocautery in Spinal Fusion**
Duby Okonkwo, BS; Rachel Mckee, BS; J. Court Reese, BS; Byron F. Stephens, MD; Craig R. Louer, MD; Stephanie N. Moore-Lotridge, PhD; Jonathan Schoenecker, MD, PhD

15:21 - 15:30 **Discussion**

15:30 - 15:50 **Refreshment Break* | Ballroom Pre-function 1**

15:50 - 18:00 **Richardson Ballroom CD**

Abstract Session 9: Adolescent Idiopathic Scoliosis III & Non-Operative Treatment Methods

Moderators: Arvindera Ghag, MD & Lindsay M Andras, MD

15:50 - 15:54 **Paper #131: In-Brace Correction in Scoliosis: Curve Type Matters More than Demographics**
Omar Taha, BS; Matthew Weintraub, BS; Mehdi Elfilali, BA; Chidebelum Nnake, BS; John Tunney, BOCPO; Ritt Givens, BS; Michael G. Vitale, MD, MPH; Benjamin D. Roye, MD

15:54 - 15:58 **Paper #132: In-Brace Radiographs and Not Coronal Deformity Angular Ratio Independently Predict Curve Progression in Nighttime Brace Treatment for Idiopathic Scoliosis**
Karina A. Zapata, PhD, PT, DPT; Daniel J. Sucato, MD, MS; Kara Davis, MS, CPO; Chan-Hee Jo, PhD; Megan E. Johnson, MD

15:58 - 16:02 **Paper #133: The Grit Factor: A Prospective Study to Predict Brace Compliance in AIS**
Katerina M. Kourpas, AB; Andrew G. Kim, BS; Sulagna Sarkar, MS; Julianna Lee, BA; Sara Kiani, MD; Patrick England, MD; John M. Flynn, MD

16:02 - 16:11 **Discussion**

16:11 - 16:15 **Paper #134: Early Brace Treatment: The New Standard for Adolescent Idiopathic Scoliosis?**
Karina A. Zapata, PhD, PT, DPT; Megan E. Johnson, MD; JP Rathbun, BS; Donald Virostek, BS, LPO/CPO; Chan-Hee Jo, PhD; Daniel J. Sucato, MD, MS

16:15 - 16:19 **Paper #135: Effectiveness of Daily Calcium and Vitamin D Supplementation on Preventing Curve Progression and Need for Bracing in Skeletally Immature Adolescent Idiopathic Scoliosis Females with Smaller Curves - A Randomised Double-Blinded Placebo-Controlled Trial**
Adam Yiu-chung Lau, MBBS, FRCS; Kenneth Guangpu Yang, PhD, MBBS; Wayne Yuk-wai Lee, PhD; Alec Lik-hang Hung, MBBS, MS, FRCS; Jack Chun-yiu Cheng, MD, FRCS; Tsz-Ping Lam, MBBS, FRCS

16:19 - 16:23 **Paper #136: Reversing Muscle Asymmetry in Adolescent Idiopathic Scoliosis: Emg-Validated Benefits of Scoliosis-Specific Exercise**
Jason Pui Yin Cheung, MD, MBBS, MS, FRCS; Kenneth M. Cheung, MD, MBBS, FRCS; Charlene Y. Fan, PT

16:23 - 16:32 **Discussion**

**denotes a non-CME session/event*

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Program (topics, timing, and faculty) is subject to change.

16:32 - 16:36 **Paper #137: Optimizing Prediction Models for Curve Progression - Is Sanders Superior to Risser Grading?**
Martin Heegaard, MD; Lærke C. Ragborg, MD; Amy L. McIntosh, MD; Anne-Marie Datcu, BS; Banahene Glover, BS; Martin Gehrchen, MD, PhD; Daniel J. Sucato, MD, MS; Benny T. Dahl, MD, PhD, DMSc; Soren Ohrt-Nissen, MD, PhD; Megan E. Johnson, MD

16:36 - 16:40 **Paper #138: Revisiting the Natural History of Moderate Adolescent Idiopathic Scoliosis in Mature Girls: What Factors Lead to Progression for Larger Curves?**
Kevin M. Neal, MD; Anna J. Rambo, MD; Ramin Espandar, MD; Kylie Krombholz, MS; Mona Matthew, PhD

16:40 - 16:44 **Paper #139: What Happens if I Wait? How Fast and Frequent Will AIS Patients Have Meaningful Progression if Surgery is Delayed?**
Austin Montgomery, BS; Firoz Miyanji, MD; Suken A. Shah, MD; Paul D. Sponseller, MD, MBA; Stefan Parent, MD, PhD; Peter O. Newton, MD; Burt Yaszay, MD; Craig R. Louer, MD

16:44 - 16:53 **Discussion**

16:53 - 16:57 **Paper #140: Preoperative Expectations in Patients with Adolescent Idiopathic Scoliosis**‡
Sara Kiani, MD; Alejandro Cazzulino, BA; Kian Niknam, BS; Ishaan Swarup, MD

16:57 - 17:01 **Paper #141: Waistline Asymmetry Patterns and Clinical Impact in Patients with Adolescent Idiopathic Scoliosis**
Tomohiro Banno, MD, PhD; Yu Yamato, MD, PhD; Tomohiko Hasegawa, MD, PhD; Go Yoshida, MD, PhD; Hideyuki Arima, MD, PhD; Shin Oe, MD; Koichiro Ide, MD; Tomohiro Yamada, MD; Kenta Kurosu, MD; Yusuke Murakami, MD, PhD; Yukihiro Matsuyama, MD, PhD

17:01 - 17:05 **Paper #142: Does Sagittal Correction Index Correlate with Patient Reported Srs-Self-Image in Severe Spine Deformity**
Arthur Sackeyfio, MD; Kwadwo Poku Yankey, MD; Alexander Upfill-Brown, MD, MS; Sarah K. Obiri, BS; Irene A. Wulff, MD; Derrick Owusu Nyantakyi, MPH; Oheneba Boachie-Adjei, MD

17:05 - 17:14 **Discussion**

17:14 - 17:18 **Paper #143: Use of a Novel Posterior Internal Distraction Device for Single-Stage Correction of Severe AIS**
Andrey Panteleyev, MD, PhD; Georgiy V. Tsopanov, MD; Maxim Sazhnev, MD, PhD; Karen A. Egiazaryan, MD, PhD

17:18 - 17:22 **Paper #144: Rib Resection in Spinal Fusion: Enhancing Radiographic Outcomes, Patient Satisfaction, and Clinical Benefits**
Vishal Sarwahi, MD; Katherine Eigo, BS; Effat Rahman, BS; Brian Li, BS; Sayyida Hasan, BS; Keshin Visahan, BS; Chris Athanasian, BS; Victor Koltenyuk, BS; Jon-Paul P. DiMauro, MD; Yungtai Lo, PhD; Terry D. Amaral, MD

17:22 - 17:26 **Paper #145: Using Normative Proximal Junctionnal Angles to Define Proximal Junctionnal Kyphosis: Does It Make Any Difference?**
Sebastien Pesenti, MD, PhD; Solène Prost, MD; Yann Philippe Charles, MD, PhD; Federico Solla, MD; Brice Ilharreborde, MD, PhD; Benjamin Blondel, MD, PhD

17:26 - 17:35 **Discussion**

17:35 - 17:39 **Paper #146: The Evolution of Sagittal Alignment in Children: A Study of 300 Typically Developing Children**
Anuj Gupta, MD; Satoshi Takada, MD; Petya Yorgova, MS; Suken A. Shah, MD

17:39 - 17:43 **Paper #147: Modern AIS Surgery Using Patient Specific Rods Results in Radiographic Outcomes that Closely Match Predicted and "Optimal" Sagittal Parameters**
Matthew Weintraub, BS; Omar Taha, BS; Mehdi Elfilali, BA; Ritt Givens, BS; Edwin Kulubya, MD; Benjamin D. Roye, MD; Michael G. Vitale, MD, MPH

17:43 - 17:47 **Paper #148: Which Factors Contribute to the Loss of Planned Kyphosis when Using Pre-Contoured Rods in Adolescent Idiopathic Scoliosis (AIS)?**
Kingsley Ogelle, BS; Abel De Varona-Cocero, BS; Alexandra Yiachos, BS; Akil Paturi, MD; Constance Maglaras, PhD; Themistocles S. Protopsaltis, MD; Juan Carlos Rodriguez-Olaverri, MD

17:47 - 17:51 **Paper #149: Achieving "Ideal" Sagittal Alignment Does Not Influence HRQO: Outcomes 5 Years Following PSF for Lenke 1 AIS**
Kenneth A. Shaw, DO; Michael P. Kelly, MD; Harms Study Group; Nicholas D. Fletcher, MD

17:51 - 18:00 **Discussion**

‡ = SRS Funded Research Grant

MEETING AGENDA

FRIDAY, SEPTEMBER 19, 2025

Program (topics, timing, and faculty) is subject to change.

18:30 - 19:30 **President's Reception* (by invitation only)**

19:30 - 22:00 **Farewell Reception* (ticket required)**

Open to all registered attendees and guests of registered attendees. Registration is required and tickets must be purchased in advance. Tickets are $50 for registered attendees and guest tickets may be purchased for $150 per guest.

**denotes a non-CME session/event*

MEETING AGENDA

SATURDAY, SEPTEMBER 20, 2025

Program (topics, timing, and faculty) is subject to change.

08:00 - 10:10 | **Richardson Ballroom CD**

Abstract Session 10: Adult Spinal Deformity IV (Hibbs Award/Transfer of Presidency)

Moderators: Kenny Y. Kwan, MD & Brian J. Neuman, MD

08:00 - 08:04 **Paper #150: Sarcopenic Obesity: An Underrated Phenomenon Impacting Adult Spinal Deformity Intervention Outcomes**
Peter G. Passias, MD; Ankita Das, MD; Max Fisher, MD; Tobi Onafowokan, MBBS; Kyriakos Chatzis, BS; Peter Tretiakov, BS; Peter Fecci, MD, PhD; Clifford Crutcher, MD; Christopher Brown, MD; Francesca Totis, MD; Ethan Cotrill, MD, PhD, MSEd; Olumide A. Danisa, MD, FAAOS; Christopher Shaffrey, MD; Paul Park, MD; Pawel Jankowski, MD; Arman Kishan, MBBS; Alan Daniels, MD; Bassel Diebo, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Arman Kishan, MBBS

08:04 - 08:08 **Paper #151: Cell Saver in Adult Spinal Deformity Surgery: Helping or Hurting?**
Harsh Jain, MBBS; Omar Zakieh, MBBS; Sakshi Krishna, BS; Alexander Lyons, BS; Sameer Sundrani, BS; Osama Tagalsir, BS; Austin Montgomery, BS; Walter Navid, BS; Tyler Zeoli, MD; Ranbir Ahluwalia, MD; Iyan Younus, MD; Soren Jonzzon, MD; Hani Chanbour, MD; Julian Lugo-Pico, MD; Amir M. Abtahi, MD; Byron F. Stephens, MD; Scott Zuckerman, MD, MPH

08:08 - 08:12 **Paper #152: Examining the Burden of Complications on Long-Term Satisfaction in Adult Spinal Deformity (ASD)**
Kojo D. Hamilton, MD, FAANS; Rohit P. Kumar, BA; Nitin Agarwal, MD; Lawrence G. Lenke, MD; Peter G. Passias, MD; Eric O. Klineberg, MD; Virginie Lafage, PhD; Shay Bess, MD; Justin S. Smith, MD, PhD; Jeffrey L. Gum, MD; Renaud Lafage, MS; Jeffrey Mullin, MD; Michael P. Kelly, MD; Bassel G. Diebo, MD; Breton G. Line, BS; Han Jo Kim, MD; Khaled M. Kebaish, MD; Robert K. Eastlack, MD; Alan H. Daniels, MD; Alex Soroceanu, MD, FRCS(C), MPH; Rida Mitha, MBBS; Gregory M. Mundis Jr., MD; Richard Hostin, MD; Themistocles S. Protopsaltis, MD; Munish C. Gupta, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; International Spine Study Group

08:12 - 08:21 **Discussion**

08:21 - 08:25 **Paper #153: Surgical Treatment for Adult Spine Deformity Improves Quality of Life and Promis Health Domains to Normal Population Values at Minimum 2-Year Postoperative**
Shay Bess, MD; Breton G. Line, BS; Virginie Lafage, PhD; Renaud Lafage, MS; Khaled M. Kebaish, MD; Lawrence G. Lenke, MD; Christopher I. Shaffrey, MD; Alan H. Daniels, MD; Bassel G. Diebo, MD; Christopher P. Ames, MD; Stephen J. Lewis, MD, FRCS(C); Eric O. Klineberg, MD; Robert K. Eastlack, MD; Gregory M. Mundis Jr., MD; Jeffrey L. Gum, MD; Kojo D. Hamilton, MD, FAANS; David O. Okonkwo, MD, PhD; Thomas J. Buell, MD; Richard Hostin, MD; Munish C. Gupta, MD; Michael P. Kelly, MD; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Han Jo Kim, MD; Frank J. Schwab, MD; Justin S. Smith, MD, PhD; International Spine Study Group

08:25 - 08:29 **Paper #154: The Variable Impact of Frailty on Adult Spine Deformity Patients Based on Contemporary Definitions: Are We Speaking the Same Language?**
Peter G. Passias, MD; Tobi Onafowokan, MBBS; Francesca Totis, MD; Kyriakos Chatzis, BS; Peter Tretiakov, BS; Max Fisher, MD; Bassel G. Dieb,o MD; Alan H. Daniels, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Pawel P. Jankowski; MD, Breton G Line, BS; Jeffrey Mullin, MD; Kojo D. Hamilton, MD; Jeffrey L. Gum, MD; Alekos A. Theologis, MD; Praveen V. Mummaneni, MD, MBA; Dean Chou, MD; Gregory M. Mundis. Jr., MD; Stephen J. Lewis, MD; Thomas J. Buell, MD; Justin K. Scheer, MD; Brandon B. Carlson, MD, MPH; Robert K. Eastlack, MD; Khaled M. Kebaish, MD; Munish C. Gupta, MD; Han Jo Kim, MD; Alex Soroceanu, MD, MPH; Themistocles S. Protopsaltis, MD; Mitsuru Yagi, MD, PhD; Naobumi Hosogane, MD, PhD; Lawrence G. Lenke, MD; Richard Hostin, MD; Eric O. Klineberg, MD; Justin S. Smith, MD, PhD; Christopher P. Ames, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Shay Bess, MD; International Spine Study Group

08:29 - 08:33 **Paper #155: Preoperative Cervical Degeneration Predisposes Adult Spinal Deformity Patients to Poor Postoperative Cervical Sagittal Alignment After Thoracolumbar Deformity Correction**
Josephine R. Coury, MD; Fthimnir Hassan, MPH; Justin L. Reyes, MS; Erik Lewerenz, BS; Riley Sevensky, BS; Joseph M. Lombardi, MD; Taylor J. Jackson, MD; Andrew S. Zhang, MD; Michael Strong, MD; Ronald A. Lehman, MD; K. Daniel Riew, MD; Zeeshan M. Sardar, MD; Lawrence G. Lenke, MD

08:33 - 08:42 **Discussion**

SATURDAY, SEPTEMBER 20, 2025

Program (topics, timing, and faculty) is subject to change.

08:42 - 08:46 **Paper #156: Predicting Proximal Junctional Kyphosis in Patients Undergoing Adult Spinal Deformity Surgery: A Multifactorial Artificial Intelligence Based Approach**
Ted Shi, BS; Varun Arvind, MD, PhD; Justin L. Reyes, MS; Cole Morrissette, MS; Yong Shen, BA; Mark Herbert, BS; Gabriella Greisberg, BS; Roy Miller, MS; Matan Malka, BA; Fthimnir Hassan, MPH; Zeeshan M. Sardar, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD; Joseph M. Lombardi, MD

08:46 - 08:50 **Paper #157: The Relationship of CT Hounsfield Units at UIV+1 and UIV+2 Relative to UIV Predicts Proximal Junctional Kyphosis in Patients with Long Spinal Constructs**
Josephine R. Coury, MD; Justin L. Reyes, MS; Fthimnir Hassan, MPH; Luke Whitmer, BS; Oluwademilade Tega, BA; Joseph M. Lombardi, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD; Zeeshan M. Sardar, MD

08:50 - 08:54 **Paper #158: Thoracic Spine Degeneration Impacts Reciprocal Changes and Proximal Junctional Kyphosis (PJK) Following Correction of Adult Spinal Deformity (ASD)**
Manjot Singh, BS; Joseph Nassar, BS; Richard Hostin, MD; Munish C. Gupta, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; David O. Okonkwo, MD, PhD; Kojo D. Hamilton, MD, FAANS; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Han Jo Kim, MD; Jeffrey L. Gum, MD; Justin S. Smith, MD, PhD; Khaled M. Kebaish, MD; Lawrence G. Lenke, MD; Shay Bess, MD; Frank J. Schwab, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Alan H. Daniels, MD; Bassel G. Diebo, MD; International Spine Study Group

08:54 - 09:03 **Discussion**

09:03 - 09:07 **Paper #159: Underreporting Bias of Proximal Junctional Kyphosis and Failure in Adult Spine Deformity Surgery: A Multicenter Radiological Review Using Multiple Diagnostic Criteria**
So Kato, MD, PhD; Eric O. Klineberg, MD; Caglar Yilgor, MD; Michael P. Kelly, MD; Lawrence G. Lenke, MD; Christopher I. Shaffrey, MD; Kenneth M. Cheung, MD, MBBS, FRCS; Sigurd H. Berven, MD; Yong Qiu, PhD; Yukihiro Matsuyama, MD, PhD; Ferran Pellisé, MD, PhD; Jonathan N. Sembrano, MD; Benny T. Dahl, MD, PhD, DMSc; Ahmet Alanay, MD; Stephen J. Lewis, MD, FRCS(C)

09:07 - 09:11 **Paper #160: Transition Rods with or Without Junctional Tethering in the Prevention of Proximal Junctional Kyphosis in Adult Spinal Deformities Surgery**
Francesco Lolli, MD; Andrea Baioni, MD; Carmela Altruda, MD; Ilaria Barni, MD; Marco Cancedda, MD; Riccardo Draghi, MD; Andrea Messina, MD; Niccolò Regge Gianas, MD; Ignazio Borghesi, MD

09:11 - 09:15 **Paper #161: A Novel Surgical Technique to Prevent Proximal Junctional Kyphosis in Adult Spinal Deformity: The Combined Use of Sublaminar Tethering and Shorter UIV Screws**
Satoshi Suzuki, MD, PhD; Kazuki Takeda, MD, PhD; Takahito Iga, MD, PhD; Mitsuru Yagi, MD, PhD; Toshiki Okubo, MD, PhD; Masahiro Ozaki, MD, PhD; Narihito Nagoshi, MD, PhD; Morio Matsumoto, MD, PhD; Masaya Nakamura, MD, PhD; Kota Watanabe, MD, PhD

09:15 - 09:24 **Discussion**

09:24 - 09:28 **Paper #162: Machine Learning-Derived Alignment Targets for ASD: Multi-Center Validation of Age-Adjusted PI-LL Goals**
Sarthak Mohanty, BS; Fthimnir Hassan, MPH; Lawrence G. Lenke, MD; Virginie Lafage, PhD; Justin S. Smith, MD, PhD; Michael P. Kelly, MD; Peter G. Passias, MD; Eric O. Klineberg, MD; Kojo D. Hamilton, MD, FAANS; Jeffrey L. Gum, MD; Renaud Lafage, MS; Jeffrey Mullin, MD; Bassel G. Diebo, MD; Thomas J. Buell, MD; Justin K. Scheer, MD; Han Jo Kim, 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; Munish C. Gupta, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; Shay Bess, MD; International Spine Study Group

09:28 - 09:32 **Paper #163: The Association Between Lumbosacral Transitional Vertebrae and Distal Adjacent Segment Degeneration Following L4/5 Instrumented Fusion**
Sungjae An, MD; Junseok W. Hur, MD, PhD

09:32 - 09:36 **Paper #164: Comparing Motion of Discs Adjacent to One- and Two-Level Soft-Landing Techniques Proximal to Lumbar Deformity Constructs: A Cadaveric Biomechanical Study**
Amber R. Witt, BS; Donald D. Davis, MD; Izabella T. Lachcik, MS, BS; Nathaniel Myers, BS; Joshua P. McGuckin, MS; Jonathan M. Mahoney, BS; Rod J. Oskouian, MD; Jens Chapman, MD; Brandon Bucklen, PhD

09:36 - 09:45 **Discussion**

09:45 - 09:55 **Presentation of the Hibbs, Moe & Goldstein Awards**
Jennifer M. Bauer, MD, MS & Martin Repko, MD, PhD

09:55 - 10:10 **Transfer of the Presidency**
Laurel C. Blakemore, MD & Suken A. Shah, MD

MEETING AGENDA

SATURDAY, SEPTEMBER 20, 2025

Program (topics, timing, and faculty) is subject to change.

10:10 - 10:30 Refreshment Break* | Ballroom Pre-function 1

10:30 - 12:15 Richardson Ballroom CD

Abstract Session 11: Quality/Safety/Value/Complications & Miscellaneous (Spondy, Trauma, Tumor, etc.)

Moderators: Laurel C. Blakemore, MD & Carl-Eric Aubin, P. Eng, PhD

10:30 - 10:34 **Paper #165: Utility of Initial Clinic Imaging Following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis**
Soham Ghoshal, BA; Shanika De Silva, PhD; Margaret L. Sullivan, BS; David Liu, MD; K. Mikayla Flowers Zachos, MA; Craig M. Birch, MD; Daniel Hedequist, MD; M. Timothy Hresko, MD; Grant D. Hogue, MD

10:34 - 10:38 **Paper #166: Novel Ultrasound Algorithm Reduces Unnecessary Radiography in School Scoliosis Screening by 56% - A Prospective and Validation Study in 508 Adolescent Girls**
Cheuk-kin Kwan, MBChB; Kenneth Guangpu Yang, PhD, MBBS; Alec Lik-hang Hung, MBBS, MS, FRCS; Tsz-Ping Lam, MBBS, FRCS; Jack Chun-yiu Cheng, MD, FRCS; Kelly Ka-Lee LAI, MS; Yong Ping Zheng, PhD; Adam Yiu-chung Lau, MBBS, FRCS

10:38 - 10:42 **Paper #167: Magnetic Resonance Imaging Generated Synthetic Computed Tomography in Pediatric Spine Patients**
George Michael, BS; Suhas Etigunta, BS; Andy M. Liu, BS; David L. Skaggs, MD, MMM; Meliza Perales, RN; Cristabelle Alexander, MS; Christopher Watterson, MD; Daniel Hoghougi, BS; Norman Gellada, BS; Kenneth D. Illingworth, MD

10:42 - 10:51 **Discussion**

10:51 - 10:55 **Paper #168: Incidence and Risk Factors of Postoperative Motor Deficits After Spine Deformity Surgery: Results of the Sdim Study**
Juan Sardi, MD; Justin S. Smith, MD, PhD; Lawrence G. Lenke, MD; Yong Qiu, PhD; Ferran Pellisé, MD, PhD; Ahmet Alanay, MD; Saumyajit Basu, MS(Orth), DNB(Orth), FRCSEd; Go Yoshida, MD, PhD; Brett Rocos, MD, FRCS; Stephen J. Lewis, MD, FRCS(C)

10:55 - 10:59 **Paper #169: False Negative Intraoperative Neuromonitoring Alerts During Pediatric Spinal Deformity Surgery: The Dreaded Outcome**
Christopher K. Bozorgmehr, BS; Hilton C. Braithwaite IV, BS; Leah Rakers, MBS, CNIM; Scott J. Luhmann, MD

10:59 - 11:03 **Paper #170: Can the Recovery of Root-Level Intraoperative Neuromonitoring Data Result in a Lower Risk for Postoperative Lower Extremity Weakness in Spine Deformity Surgery?**
Nathan J. Lee, MD; Fthimnir Hassan, MPH; Alexandra Dionne, BS; Chidebelum Nnake, BS; Mitchell Yeary, BS; Michael Fields, MD, BS; Matthew Simhon, MD; Ted Shi, BS; Varun Arvind, MD, PhD; Anastasia Ferraro, BS; Matthew Cooney, BS; Erik Lewerenz, BS; Justin L. Reyes, MS; Steven G. Roth, MD; Chun Wai Hung, MD; Justin K. Scheer, MD; Thomas M. Zervos, MD; Earl D. Thuet, BS; Joseph M. Lombardi, MD; Zeeshan M. Sardar, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD

11:03 - 11:12 **Discussion**

11:12 - 11:16 **Paper #171: Liposomal Bupivacaine Results in a Six-Fold Reduction of Inpatient Opioid Use Following Posterior Spinal Fusion (PSF) in Adolescent Idiopathic Scoliosis (AIS) Surgery**
Kenneth A. Shaw, DO; John T. Anderson, MD; Richard Schwend, MD; Michael Benvenuti, MD; Michon Huston, PA-C; Nicolette Saddler, FNP-C; Anne Stuedemann, CPNP

11:16 - 11:20 **Paper#172: Low Utility of Pre-Operative Cardiology Referrals Using a Cutoff of Cobb >70 Degrees for Patients with Adolescent Idiopathic Scoliosis**
Alyssa Barre, MD; Andrew Kirk, MD; Ryan D Muchow, MD; Vishwas R. Talwalkar, MD; Aamir Kadri, MD; Vincent Prusick, MD

11:20 - 11:24 **Paper #173: Impact of Postoperative Dexamethasone on Inflammation and Opioid Consumption Following PSF for AIS: A Prospective Study**
Nicholas D. Fletcher, MD; Hilary Harris, BS; Tracy Ruska, NP

11:24 - 11:33 **Discussion**

11:33 - 11:37 **Paper #174: Economic Benefits of Rapid Recovery Pathway Protocol Utilizing Intrathecal Morphine**
Vishal Sarwahi, MD; Katherine Eigo, BS; Effat Rahman, BS; Cole Dutton, BS; Nora Donahue, BS; Sayyida Hasan, BS; Keshin Visahan, BS; Benita Liao, MD; Yungtai Lo, PhD; Jon-Paul P. DiMauro, MD; Terry D Amaral, MD

11:37 - 11:41 **Paper #175: The Importance of Postoperative Thoracic Kyphosis as a Predictor of Pain Improvement in Adolescent Idiopathic Scoliosis: A Multicenter Study**
Alejandro Gomez-Rice, MD, PhD; Susana Núñez Pereira, MD; Sleiman Haddad, MD, PhD, FRCS; Riccardo Raganato, MD; Francisco Javier S. Perez-Grueso, MD; Frank S. Kleinstueck, MD; Ibrahim Obeid, MD; Ahmet Alanay, MD; Ferran Pellisé, MD, PhD; Javier Pizones, MD, PhD; European Spine Study Group

11:41 - 11:45 **Paper #176: Adolescent Idiopathic Scoliosis Patients Undergoing Minimally Invasive Surgery Have Superior Pain Control to Traditional Posterior Spinal Fusion**
Vishal Sarwahi, MD; Katherine Eigo, BS; Effat Rahman, BS; Brian Li, BS; Victor Koltenyuk, BS; Yungtai Lo, PhD; Terry D. Amaral, MD

11:45 - 11:54 **Discussion**

11:54 - 11:58 **Paper #177: Is Medullar Canal Invasion as a Predictor for Posterior Ligamentous Complex Injury in Thoracolumbar Burst Fractures?**
Murat Korkmaz, MD; Taha furkan Yağcı, MD; Yekta Furkan ALTIN, MD; Turgut Akgul, MD

11:58 - 12:02 **Paper #178: Dynamic Spinal Cord Mapping: A Study of Accuracy, Sensitivity, and Specificity in Localizing Spinal Cord Injury Using an Animal Model**
Adam Mansour, MD; Mutaleeb Shobode, MBBS; Kirsten Tulchin-Francis, PhD; Daryn Strub, BA; Anirejuoritse Bafor, MBBS; Darek Stanfield, D.C., CNIM; Reid C. Chambers, DO; Allen Kadado, MD

12:02 - 12:06 **Paper #179: "Transient Spinal Neuropraxia in Pediatric Patients" (T-SNIPP): Analysis of an Institutional Experience Four Decades After the Introduction of Sciwora**
Diwas Gautam, BS; Douglas L. Brockmeyer, MD; Rajiv Iyer, MD; Vijay Ravindra, MD; Kyril Cole, BS; Katie Russell, MD

12:06 - 12:15 **Discussion**

12:15 **SRS 60th Annual Meeting Concludes**

Abstracts

Podium Presentation Abstracts 50
E-Point Presentation Abstracts..... 169

The Scoliosis Research Society gratefully acknowledges Kuros Biosciences for their Educational Grant support of the Annual Meeting.

PODIUM PRESENTATION ABSTRACTS

1. Have We Become Better at Selective Thoracic Fusion for AIS in the Tethering Era?

Anuj Gupta, MD; Sadettin Ciftci, MD; Peter G. Gabos, MD; Petya Yorgova, MS; Zhaoying Lu, PhD; Firoz Miyanji, MD; Amer F. Samdani, MD; Dan Hoernschemeyer, MD; Baron S. Lonner, MD; Peter O. Newton, MD; Harms Study Group; *Suken A. Shah, MD*

Hypothesis
Selective thoracic fusion (STF) outcomes have improved compared to the pre-VBT era

Design
Retrospective cohort study

Introduction
STF was introduced in the 1980s, continues to evolve & could be considered the standard of care for Lenke type 1 & 2 curves. Newer techniques like VBT, appealing to retain motion and allow early recovery, are employed for thoracic curves. Comparative studies showing tether breakage, reoperation and conversion to fusion have swung the pendulum back to PSF. What drove this change? What did we learn? Are we better at STF now than 10 years ago and are we more willing to "break the rules?"

Methods
A prospective AIS database was queried for those managed with STF from 2012 to 2023 with minimum 2 years FU. A cut point was identified based on uptick in VBT cases enrolled in database: Group 1 (2012- 2018) & group 2 (2019-2023). Patients were compared for demographic, clinical, intra-operative, radiographic & functional outcomes.

Results
919 patients were included and placed in group 1 (n=688) and group 2 (n=231). Mean age was 14.6 years in both groups (F:M= 566:121 in group 1, 192:38 in group 2, p=0.33). Mean thoracic curve pre-operatively in groups 1 & 2 was 55° and 56° respectively (p=0.29). Group 2 had higher C lumbar modifiers (24.7% vs 19, p=0.017). SRS-22 scores in all domains were similar. EBL was lower in group 2 (426.8 ml vs. 560.7ml; p<0.0001) but surgical times were similar (255 min vs 246 min, p=0.13). Length of stay was shorter in Group 2 (3.34 vs 4.24 days, p<0.0001). The mean follow-up duration was 3.6 & 2.2 years respectively. Postoperatively, residual thoracic and lumbar curves, kyphosis restoration, & AVT were similar in both groups. SRS-22 scores in all domains were similar except in general function that was higher in group 2 (4.53 vs 4.4, p=0.001). Group 1 had 20 cases (3%) revised due to implant failure, adding on of the lumbar curve, prominent implants, pseudarthrosis or deep infection. Group 2 had 6 cases (2.6%) revised due to implant failure and pseudarthrosis, none for adding on.

Conclusion
STF has consistent, reproducible radiographic and functional outcomes. Temporal trends reflected here displayed better surgical outcomes in terms of reduced blood loss, length of stay and decreased complications in the later group. Moreover, the surgeons have been expanding the scope of STF lately by taking on more cases involving type C lumbar curves.

2. Proportion of Lumbar End Vertebra Tilt to Overall Cobb Angle Predicts Spontaneous Lumbar Correction

Omar Taha, BS; Matthew Weintraub, BS; Mehdi Elfilali, BA; Edwin Kulubya, MD; Michael G. Vitale, MD, MPH; *Benjamin D. Roye, MD*; Harms Study Group

Hypothesis
Patients with selective thoracic fusion will experience more lumbar correction as the contribution of the lumbar curve's lower end vertebra (LEV) tilt to the lumbar Cobb decreases.

Design
Multicenter retrospective cohort from an international registry

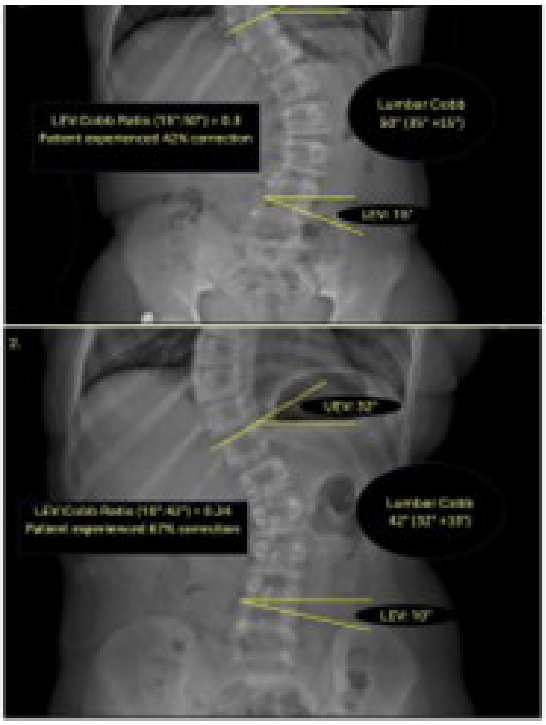
Introduction
Understanding factors influencing spontaneous lumbar correction in adolescent idiopathic scoliosis (AIS) patients undergoing selective thoracic fusion is essential for optimizing surgical outcomes. The role of the end vertebral tilt and its proportional contribution to the overall Cobb angle remains unexplored.

Methods
92 AIS patients, Lenke 1-4 with lumbar modifier type B or C, who underwent selective thoracic fusion were identified. Lumbar UEV, LEV tilt, and lumbar apical translation at preoperative, postoperative, and 2-year follow-up timepoints were collected. Patients with incomplete measurements were excluded. The ratio of UEV to Lumbar Cobb and LEV to Lumbar Cobb were calculated to represent the proportion of the lumbar curve attributed to either the UEV or LEV tilt respectively (Figure). Univariate linear regression evaluated correlations with lumbar correction at 2 years. Multivariate regression identified significant predictors of lumbar correction.

Results
Our cohort was 86% female with a mean age at surgery of 15.4 ± 2.1. LEV:Cobb ratio (R=−0.236, p=0.024), lumbar apical translation (R=-0.22, p=0.035) and lumbar flexibility (R=0.255, p=0.017) correlated with percent lumbar correction at 2 years post-operatively. Multivariate regression identified lower LEV:Cobb ratio and higher lumbar flexibility as key predictors of lumbar correction at 2-year follow-up (R=0.358, p=0.003). In general, UEV:Cobb was greater than LEV:Cobb, but as LEV tilt proportionally increased lumbar correction decreased. In other words, the most spontaneous correction was seen in patients with less tilt in the lumbar LEV.

Conclusion
This study highlights, intuitively, the predictive value of end vertebral tilt ratios in predicting spontaneous lumbar correction, previously un-described in the literature. More spontaneous lumbar correction is seen when the LEV of the lumbar curve is less tilted. Incorporating these findings into

predictive models may improve preoperative planning (e.g. fusion levels) and outcomes in AIS.



Example UEV and LEV tilt to lumbar Cobb ratio. Patient 1 (higher LEV:Cobb) experienced less lumbar correction than patient 2 (lower LEV:Cobb).

3. Selective Versus Nonselective Posterior Spinal Fusion for Lenke 1-4C Adolescent Idiopathic Scoliosis: A 10-Year Followup Study

Nicholas D. Fletcher, MD; Tracey Bryan, MS; Suken A. Shah, MD; Stefan Parent, MD, PhD; Harms Study Group; Michael P. Kelly, MD

Hypothesis
Selective thoracic fusion would have equivalent radiographic results but superior clinical outcomes when compared to nonselective fusion at minimum 10 year follow up .

Design
Retrospective review of prospectively collected multicenter database.

Introduction
Selective thoracic fusion (STF) is assumed preferable to non-selective fusions (NSF) for patient with adolescent idiopathic scoliosis (AIS) because of preserved motion segments.

Methods
A review of a prospectively collected multicenter database was performed for patients with Lenke 1-4 scoliosis treated with either STF (L1 and proximal) vs NSF (L2 and distal) who had a minimum of 10-year follow up. Baseline demographics, spinal deformity characteristics, complications, lumbar mobility, and SRS-22 scores were compared at first post operative, 2-year, and 10-year follow up.

Results
35 NSF and 39 STF patients were followed for 10 years after surgery. Main thoracic (MT, 63 deg NSF vs 56 deg STF, p=0.001) and thoracolumbar (TL, 54 deg NSF vs 44 deg STF, p<0.001) curves were larger in the NSF group. 2 year MT and proximal thoracic (PT) curves were no different between groups while residual lumbar curve magnitude was lower in NSF (17deg vs 23deg, p<0.001). At 10-year follow up, MT and PT curves were not different. While lumbar curves remained larger in STF patients, this diminished at final follow up (19 deg NSF vs 23 deg STF, p=0.04) and C7-CSVL decreased over time for both groups. T10-L2 kyphosis remained unchanged. Final pelvic parameters were not different. Lateral bending was greater in STF patients (p<0.001), and spinal forward flexion did not differ between groups. There was no difference in SRS pain or function scores at 10 year follow up and there was no difference in complications or reoperation between groups.

Conclusion
STF was associated with a larger residual lumbar curve at 10 year follow up however this did decrease over time as did coronal imbalance. STF was associated with more lateral flexibility but this did not translate to better pain scores. 10-year follow up of patients treated with NSF shows this to be a durable operation with stable and reliable radiographic and clinical outcomes. Further study will need to follow the long term effects of a longer fusion on spinal health.

4. Dreaded Postoperative Coronal Malalignment in Lenke 5 Patients

Elyette Lugo, BS; Jonathan Wang, BS; Paul D. Sponseller, MD, MBA; Khaled M. Kebaish, MD; Suken A. Shah, MD; Amer F. Samdani, MD; Firoz Miyanji, MD; Michael P. Kelly, MD; Baron S. Lonner, MD; *Amit Jain, MD*, MBA; Harms Study Group

Hypothesis
We hypothesize that Lenke 5 adolescent idiopathic scoliosis (AIS) patients with immediate postoperative coronal malalignment will realign over time

Design
Retrospective multicenter

Introduction
Lenke 5 patients who undergo selective thoracolumbar fusion often present with coronal malalignment preoperatively. In a subset of patients, coronal malalignment may develop postoperatively. This “radiographic complication” is often concerning to surgeons and families alike. The aim of the study is to report the incidence of this phenomenon, and to analyze the fate of these patients over the 2-year follow-up.

Methods
We queried a multicenter retrospective registry of Lenke 5 AIS patients who underwent posterior spinal fusion and had pre-operative, immediately postop, and 2-year follow-up

PODIUM PRESENTATION ABSTRACTS

radiographs. We classified patients having coronal malalignment if they had a distance >3cm between C7 coronal plumb line and the central sacral vertical line (CSVL) on radiographs. We measured changes in coronal alignment and Scoliosis Research Society (SRS)-22 scores at each follow up, using paired t-tests for significance.

Results
Among 170 Lenke 5 AIS patients, preoperatively, 117 (69%) were coronally aligned (≤3 cm), while 53 (31%) were coronally malaligned (>3 cm). At the first erect (FE) evaluation, 35 patients (20%) were coronally malaligned (>3 cm), including 19 with iatrogenic malalignment and 16 with persistent coronal malalignment (PCM). Meanwhile, 98 (58%) remained aligned, and an additional 37 (22%) corrected to normal alignment postoperatively. By the 2-year follow-up, of the 35 patients with coronal malalignment at FE, 32 (91%) corrected to normal alignment (≤3 cm). Compensation to regain normal alignment occurred through changes in end instrumented vertebrae (EIV) angulation and the wedging of the disc below the fusion construct. There was no significant improvement in the SRS-22 scores between patients in PCM group that rebalanced at the 2-year follow-up versus patients that remained misaligned. (p= 0.3089).

Conclusion
Immediate postoperative coronal malalignment is a common finding in Lenke 5 patients, found in 20% of the cohort. Over 2-year follow-up, only 1% of the patients remain coronally malaligned, demonstrating most patients improve over time.

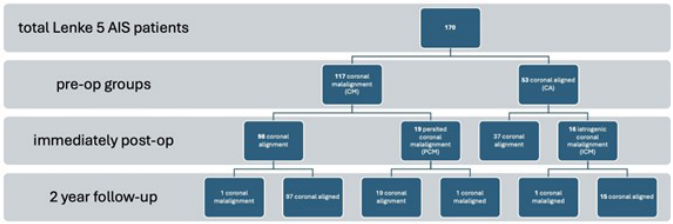


Figure I: Stratification of entire cohort

5. Clavicle Angle is a Viable Metric to Predict Normal Postoperative Shoulder Balance and Neck Balance, Defined by RSH, in Patients with Adolescent Idiopathic Scoliosis (AIS)

Vishal Sarwahi, MD; Katherine Eigo, BS; Effat Rahman, BS; Swara Kalva, BS; Brian Li, BS; *Sarah Trent, MD*; Yungtai Lo, PhD; Terry D. Amaral, MD

Hypothesis
We hypothesize that restoring CA to near 'normal' levels can aid in yielding normal RSH postoperatively.

Design
Retrospective Cohort Study

Introduction
Shoulder imbalance following Posterior Spinal Fusion (PSF) is a significant concern. This study aimed to identify radiographic predictors of shoulder balance by analyzing X-rays of control patients with no spinal deformity and X-rays of patients with Adolescent Idiopathic Scoliosis (AIS) who underwent PSF.

Methods
An analysis of 243 control and 546 AIS patients. The study used Radiographic Shoulder Height (RSH) as a proxy for shoulder height, with RSH less than 20 mm considered normal. T1 tilt and clavicle angle (CA) in the same orientation as RSH were defined as concordant. The study was divided into three parts: Part I: X-rays of control patients were evaluated, with T1, CA, and RSH recorded to determine "normal" values. Kruskal-Wallis tests were performed. Part II: Preoperative, postoperative, and final follow-up X-rays of AIS patients who underwent PSF were measured. Spearman's correlation was used to assess the correlation between radiographic parameters and RSH. Fisher's exact test was used to evaluate the distribution of abnormal postoperative RSH. Part III: External Validation-X-rays from multiple surgeons were evaluated to predict RSH, and Fisher's exact test was used to evaluate the distribution of abnormal postoperative RSH.

Results
Part I: 243 control patients were evaluated. 224 had normal RSH and 19 were abnormal. T1 tilt (2.4 vs 5.0) and CA (1.5 vs 5.0) were significantly different between the two groups ($p<0.05$). Part II: In 419 patients, preoperative and postoperative CA correlated very strongly with RSH ($r = 0.83$). Concordant T1 tilt correlated weakly with RSH ($r = 0.25$). CA below 3 degrees yielded normal RSH postop ($p<0.001$). Restoring Concordant T1 tilt below 3 degrees yielded normal RSH in nearly all cases ($p=0.01$). Part III: In 127 patients across 4 surgeons, restoring CA below 3 degrees yielded normal RSH at postop in all cases. Restoring concordant T1 tilt below 3 degrees yielded normal RSH at postop in nearly all cases.

Conclusion
We found that restoring CA < 3° yields normal RSH postoperatively. In addition, when T1 is concordant, restoring it to < 4 degrees can yield normal RSH. Additionally, proximal thoracic fusion did not correlate with post op RSH.

6. Pain Response is Unaffected by Fusion or Non-Fusion Surgical Approach in AIS

Daniel Berman, MD; Olgerta Mucollari, BS; Tracey Bryan, MS; Nicholas D Fletcher, MD; oshua S Murphy, MD; Amer F. Samdani, MD; Steven W. Hwang, MD; *Baron S. Lonner, MD*

Hypothesis
Correction of AIS leads to a clinically meaningful improvement in pain regardless of fusion or non-fusion approach.

Design
Retrospective review of a multi-center prospectively enrolled AIS registry.

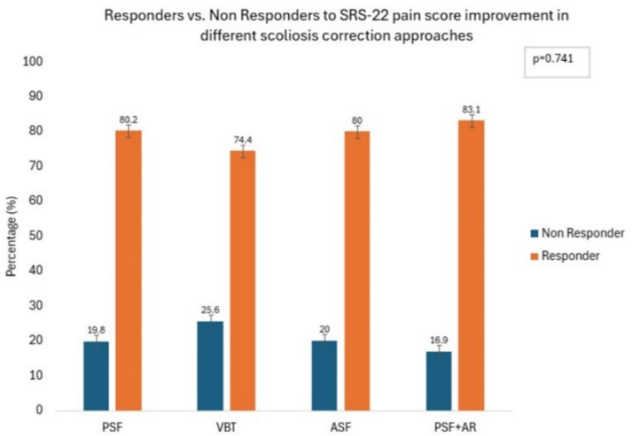
Introduction
Adolescent idiopathic scoliosis (AIS) can be associated with back pain and its improvement is a surgical goal. Operative

approaches include posterior spinal fusion (PSF), posterior fusion with anterior release (PSF + AR), anterior fusion (ASF), and vertebral body tethering (VBT). Patient counseling requires an understanding of factors associated with persistent pain or its resolution including procedure type, especially with the introduction of non-fusion surgery. The aim of this study was to identify factors that predict which operatively treated AIS patients would be pain responders (PR) vs non-responders (NR).

Methods
Consecutive operated AIS patients with minimum 2 year FU (2 yr), preoperative (<4.0) and 2 yr SRS-22 pain scores (SRSP) were included. After univariate analysis, a binary logistic regression was performed to identify independent predictors of pain response with collinearity eliminated. Factors assessed included operative approach, demographic, radiographic and operative data, Lenke type, major curve location, and complications. Pain responders were defined by previously established minimal detectable measurement difference (MDMD) of 0.3 on the pain domain of the SRSP at 2 yr.

Results
1409 patients met inclusion criteria, 1253 PSF, 39 VBT, 40 ASF, and 77 PSF + AR. Of these patients, the percentage of PR were similar for all groups; 80.2% PSF, 74.4% VBT, 80.0% ASF, and 83.1% PSF + AR (p=0.741). On univariate analysis, re-operation, major complication, worse pre-operative pain and self image SRS-22 score, larger 2 year post-operative TL/L curve, two year major curve size, larger 2 year coronal C7-CSVL, and lower major curve % correction were significantly associated with non responders. After binary logistic regression, only post-operative major complication was a predictor of NR.

Conclusion
Operative AIS patients with preoperative pain can be counseled that there is a high rate of pain response at two year follow-up regardless of surgical approach. There are no identifiable demographic or curve characteristics that can predict pain response. Post-operative complication is associated with pain NR.



7. Risk Factors for Unfused Lumbar Intervertebral Disc Degeneration over Ten Years After Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

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Hypothesis
Long fusion constructs for thoracic adolescent idiopathic scoliosis (AIS) may accelerate degeneration of unfused intervertebral lumbar disc (IVDD) over time.

Design
Prospectively collected, retrospective analyzed cohort study

Introduction
While several studies have investigated IVDD following posterior spinal fusion for AIS, specific risk factors associated with main thoracic curvature remain unclear. This study aims to identify factors contributing to IVDD progression over a ten-year postoperative period.

Methods
119 AIS patients (10 male, 109 female, mean age of 27.2 years) who underwent posterior collection surgery and were followed for more than 10 years were included. Lumbar MRI and standing X-ray were evaluated preoperatively and at the 10-year follow-up. IVDD progression was assessed using a modified Matsumoto classification. Patients were categorized into two groups based on IVDD progression: the degenerated group (Group D), which consisted of patients with deteriorated IVDD, and the non-degenerated group (Group ND), which consisted of those without significant deterioration. Demographic data, surgical factors, radiographic parameters, and SRS-22 scores were compared between the two groups using univariate and multivariate analysis. Statistical significance was set at P<0.05.

Results
A total of 460 lumbar discs were evaluated. IVDD deterioration was observed in 63 discs (13.7%) among 47 patients in Group D. Significant differences between groups were observed in BMI (19.7 vs 18.5, p=0.02), preoperative lumbar flexibility (63.3% vs 76.1%, p<0.01), distal adding on (23.4% vs 2.8%, p<0.01), and L4 translation (6.1mm vs 2.8mm, p<0.01). Logistic regression analysis identified preoperative lumbar flexibility (Odds ratio 0.97, 95%CI 0.945-0.997), distal adding on (OR 18.6, 95%CI 3.12-111), and L4 translation (OR 1.18, 95%CI 1.05-1.33) as significant risk factors for IVDD progression. Patients in Group D reported significantly lower satisfaction scores in postoperative SRS-22 than those in Group ND (3.7 vs. 4.1, p=0.03).

Conclusion
Reduced preoperative lumbar flexibility, distal adding on, and increased L4 translation were significant risk factors for the progression of unfused lumbar IVDD ten years after posterior spinal fusion for AIS. These findings highlight the

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long-term impact of surgical planning on postoperative disc health and patient satisfaction.

8. Saving Fusion Levels in Lenke 1/2AR Curves: Can We Stop Short of the Last Substantially Touched Vertebra (LSTV)?

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Hypothesis
Greater Risser and curve flexibility protect against adding-on in Lenke 1/2AR curves with LIV short of LSTV.

Design
Retrospective review of prospectively collected multicenter data

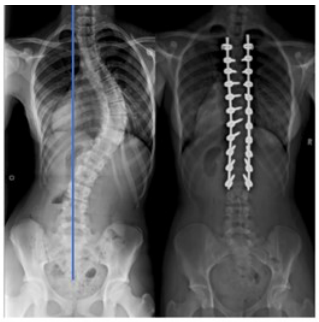
Introduction
In Lenke 1/2AR curves, LIV selection is often dictated by the LSTV to prevent adding-on, leading to longer fusions involving the lumbar spine. This study identifies patient factors that allow a more proximal LIV without increasing the risk of distal adding-on.

Methods
We analyzed Lenke 1/2AR patients who underwent PSF with a minimum of 2y f/u with the LIV at least one level cranial to LSTV. Distal adding-on was identified by established parameters: increase in Cobb of 5deg and distalization of the end vertebra or change in disc angulation of 5deg below the LIV from the first erect to the 2y. Statistics: univariate regression, and binary logistic regression using the Forced Entry Model of clinically relevant factors.

Results
A total of 144 patients met inclusion criteria, with a mean age of 15.6 years; 76% (106/140) were Risser 3-5, and the mean preoperative major Cobb was 55.2° ± 8.7°. Adding-on occurred in 21.5% (n=31). Univariate analysis identified significant protective factors, including older age (p=0.019), greater thoracic (p<0.001) and lumbar correction (p=0.002), thoracic apex distance to CSVL (p=0.043), and higher Risser grade (p=0.009). Multivariate regression, controlling for collinearity, demonstrated that Risser (OR=1.97, 95% CI: 1.26-3.06, p=0.003) and thoracic correction (OR=1.13, 95% CI: 1.06-1.2, p<0.001) were independently protective against adding-on. Patients with Risser 0-2 had an adding-on rate of 44.1% (15/34), compared to 14.2% (15/106) for Risser 3-5 (p<0.001). CART analysis and 95% CI identified a threshold of >60% thoracic correction. A combination variable analysis showed that adding-on was least frequent in Risser 3-5 patients with >60% correction (4.2%).

Conclusion
In skeletally mature patients (Risser 3-5) with >60% thoracic correction, the risk of adding-on is significantly reduced even with an LIV proximal to the LSTV. This suggests that in select patients, shorter fusions may be feasible, preserving lumbar motion and long-term spinal health.

Combination of Variables	% Adding-On
Risser 0-2, <60% correction	85.7% (12/14)
Risser 0-2, >=60% correction	15% (3/20)
Risser 3-5, <60% correction	34.3% (12/35)
Risser 3-5. >60% correction	4.2% (3/71)



Risser 3
Last Touched Vertebra (LTV): L2
Last Substantially Touched Vertebrae (LSTV): L3
Last Instrumented Vertebra: L2

Table demonstrating rates of adding on based on Risser and Curve Correction and example of a 1AR case where LIV is cranial to LSTV without adding on.

9. Effect of Sacral Slanting on Coronal Spinal Balance and Residual Curve After Correction of Structural Lumbar Curve in Patients with Adolescent Idiopathic Scoliosis: Result from a 5-Year Follow-Up Study

Gumin Jeong, MD; *Chang Ju Hwang, MD, PhD*; Sehan Park, MD; Jae Hwan Cho, MD, PhD; Dong-Ho Lee, MD, PhD

Hypothesis
We hypothesized that elevated sacral slanting may lead to adding on when the fusion extends to L3. Conversely, opting for fusion up to L4 may elevate the risk of coronal decompensation over time.

Design
Retrospective cohort study.

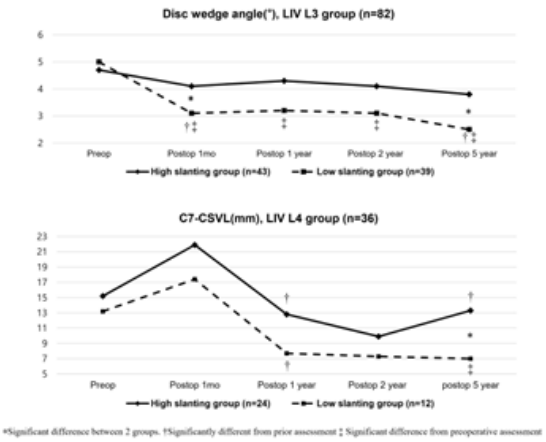
Introduction
Sacral slanting is defined as the angle between the horizontal line and the upper endplate of the sacrum. The study aimed to elucidate the outcomes of distal remaining segments and coronal balance in patients with adolescent idiopathic scoliosis (AIS) exhibiting sacral slanting, after a 5-year follow-up following surgery.

Methods
Patient with AIS who have a structural lumbar curve and underwent posterior correction and fusion extending to L3 or L4 were included. The follow-up period was at least 5 years. Clinical and radiologic outcomes, including sacral slanting, C7-CSVL, and disc wedge angle (DWA, the angle between the lowest instrumented vertebra [LIV] and LIV +1) were evaluated preoperatively and at various postoperative intervals (immediate, 1, 2, 5 years). A comparative analysis were conducted within the LIV L3 and LIV L4 groups, comparing patients in the high slanting (pre-sacral slanting ≥ 5°) and the low slanting group (< 5°).

Results
A total of 118 consecutive patients (LIV L3=82 , LIV L4=36) were included. In the LIV L3 analysis(High slanting group=43 , Low slanting group=39), the DWA of the high slanting group was significantly greater (3.8±2.4° vs 2.5± 2.0° p < 0.05), and the low slanting group showed a gradual decrease in DWA over time for 5 year follow-up. However, the high slanting group did not show significant changes in DWA over time. In the LIV L4 analysis (High slanting group =24, Low slanting group = 12), The high slanting group exhibited a gradual increase in C7-CSVL over time, with values at the 5-year follow-up significantly greater in the high slanting group (7.0 ± 4.8 mm vs. 13.3 ± 8.4 mm). (Figure 1.)

Conclusion
In AIS with structural lumbar curve, a higher preoperative sacral slanting is associated with an increase in DWA when choosing LIV L3; however, it did not change over time. In contrast, selecting LIV L4 in patients with high sacral slanting leads to coronal decompensation, which tends to increase over time.

Figure 1.



*Significant difference between 2 groups. †Significantly different from prior assessment ‡ Significant difference from preoperative assessment

Analyses of LIV L3 and LIV L4 group comparing patients in the high slanting (≥ 5°) and the low slanting group (< 5°)

10. Longer Operative Time is Associated with Higher Risk of Adverse Outcomes in Pediatric Idiopathic Scoliosis Surgery

Vivien Chan, MD, MS, FRCS(C); Andy M. Liu, BS; Adeesya Gausper, BS; Suhas Etigunta, BS; Kenneth D. Illingworth, MD; Firoz Miyanji, MD; David L. Skaggs, MD, MMM

Hypothesis
We hypothesized longer operative time is associated with increased risk of adverse outcomes in pediatric idiopathic scoliosis surgery.

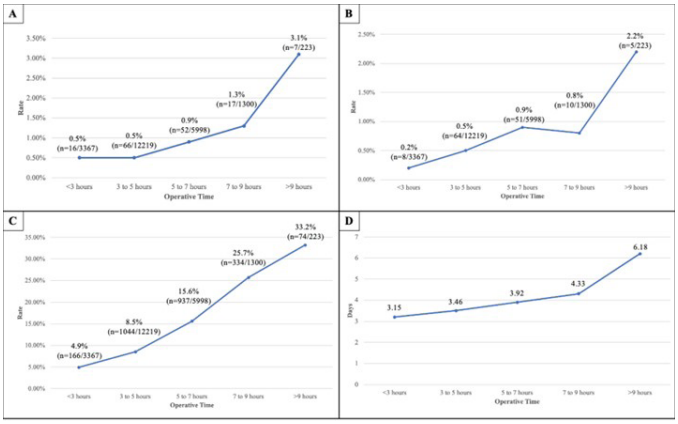
Design
Retrospective cohort study.

Introduction
Longer operative time has been associated with increased postoperative complications in various surgical specialities. This has not been studied in pediatric idiopathic scoliosis surgery.

Methods
The NSQIP pediatric database years 2016-2022 was used for this study. Patients were included in this study if they were under 18 years of age and received spinal fusion for idiopathic scoliosis. The primary outcome was rate of adverse event. Secondary outcomes were surgical site infection, allogeneic transfusion, and length of stay. Logistic regression analyses were performed to determine the association between operative time and adverse event, surgical site infection, and allogeneic transfusion. Linear regression analysis was performed to determine the association between operative time and length of stay. Adverse event rate, surgical site infection rate, transfusion rate, and mean length of stay were stratified by operative time (<2hrs, 2-4hrs, 4-6hrs, 6-8hrs, 8-10hrs).

Results
There were 21,689 patients included in this study. Mean operative time was 4.6 hours. The rate of adverse event increased with operative time (<2hrs: 0.0%, 2-4hrs: 0.5%, 4-6hrs: 0.6%; 6-8hrs: 1.0%; 8-10hrs: 2.2%). The rate of surgical site infection increased with operative time (<2hrs: 0.0%, 2-4hrs: 0.4%, 4-6hrs: 0.7%; 6-8hrs: 0.9%; 8-10hrs: 1.6%). The rate of allogeneic transfusion increased with operative time (<2hrs: 3.4%, 2-4hrs: 7.2%, 4-6hrs: 11.2%; 6-8hrs: 21.4%; 8-10hrs: 31.5%). The mean length of stay increased with operative time (<2hrs: 2.9, 2-4hrs: 3.2, 4-6hrs: 3.6; 6-8hrs: 4.2; 8-10hrs: 4.8). In adjusted regression analyses, each operative hour was associated with higher odds of adverse event (OR 1.16, p=0.005), higher odds of surgical site infection (OR 1.16, p=0.009), higher odds of allogeneic transfusion (OR=1.40, p<0.001), and longer length of stay (B=0.225, p<0.001).

Conclusion
Increasing operative time is associated with higher risk of adverse event, surgical site infection, transfusion, and longer length of stay. Surgical strategies that reduce operative time should be utilized to optimize outcomes.



Rates of A) adverse event, B) surgical site infection, C) transfusion, and D) length of stay stratified by operative time.

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11. Navigation is Associated with Lower Revision Instrumentation Rates in Pediatric Scoliosis: A Retrospective Review of 15,917 Patients

Andy M. Liu, BS; Vivien Chan, MD, MS, FRCS(C); Adeesya Gausper, BS; Suhas Etigunta, BS; Christopher Mikhail, MD; Kenneth D. Illingworth, MD; Alexander Tuchman, MD; David L. Skaggs, MD, MMM

Hypothesis
We hypothesize that navigation assistance will be correlated with a significantly lower instrumentation revision rate.

Design
Retrospective cohort study

Introduction
Navigation assisted spine surgery has become widely used in adult patients with studies demonstrating improved outcomes. This remains poorly studied in pediatric patients. This study will examine the impact of navigation on complication rates following correction of idiopathic scoliosis in pediatric patients.

Methods
A national insurance database identified pediatric patients (<21 years old) with idiopathic scoliosis who underwent posterior spine fusion with ≥2 years of follow-up. Patients were divided into navigated and non-navigated cohorts. A multivariable logistic regression identified risk factors for instrumentation revision, and cohorts were matched 1:2 based on significant variables. The primary outcome was instrumentation revision at 6 months, 2 years, and 10 years postoperatively. Secondary outcomes were postoperative neurological deficit and surgical site infection.

Results
A total of 15,917 patients were identified: 1,599 navigated and 14,318 non-navigated cases. For both navigated and non-navigated patients, decreased age and male sex were associated with increased risk of instrumentation revision. Following cohort matching, a total of 4,747 patients were included: 1,585 navigated and 3,162 non-navigated cases. At all-time points analyzed, navigated cases had significantly lower rates for instrumentation revision. Navigated cases had revision rates of 1.1%, 2.7%, and 3.8% at 6 months, 2 years, and 10 years, respectively, while non-navigated cases had revision rates of 2.1%, 4.4%, and 6.3% at the same time points. Navigated cases had a significantly lower rate of surgical site infection at 2 years (6.4% vs. 4.2%) and 10 years (8.3% vs 4.7%). There was no significant difference in the rate of postoperative neurological deficit.

Conclusion
In the largest study to date on use of navigation in pediatric idiopathic scoliosis surgery, we found that navigated procedures had significantly lower rates of instrumentation revision and surgical site infection compared to non-navigated cases.

Revision	Matched Navigation (n = 1,585)	Matched No Navigation (n = 3,162)	p value
1 Month	< 10	25 (0.8%)	-
6 Months	18 (1.1%)	65 (2.1%)	**0.004**
1 Year	34 (2.1%)	101 (3.2%)	**0.01**
2 Years	43 (2.7%)	139 (4.4%)	**0.002**
5 Years	60 (3.8%)	191 (6.0%)	**0.001**
10 Years	61 (3.8%)	200 (6.3%)	**<0.001**

Rates of post operative instrumentation revision for navigated and non-navigated cohort. Cohorts were matched for age, gender, and levels fused.

12. Long Term Outcomes of AIS Patients After Anterior Spinal Fusion - Follow-Up with Minimum of 20 Years

Anjaly Saseendran, BS; *Kenny Y. Kwan, MD*

Hypothesis
We hypothesized that patients undergoing ASF for AIS had excellent long term outcomes.

Design
Case series

Introduction
ASF modifies curve flexibility by discectomies at each level and results in a perfect fusion block. Nonetheless, wedging between LIV and LIV+1, and the overall sagittal profile after ASF may affect long term outcomes.

Methods
20 patients who underwent ASF for AIS with a minimum of 20 year follow-up with pre-operative and immediate post-operative radiographs available were invited to have assessments of the quality of of life, radiographic measures, and MRI of the lumbar spine.

Results
All 20 patients had thoracolumbar curves ranging from 35 to 68deg (mean of 50.4deg) underwent ASF from end to end vertebrae. Mean Cobb of the fusion block immediate post-operative was 12.9deg (range 1-28deg). At a minimum of 20 years follow up (range 20 to 26), the fusion block had been maintained, mean thoracic kyphosis was 18.6deg (range, 0.6-40.2), lumbar lordosis was 37.4deg (range, 3.2-65.8), and the SVA was +31.1mm (range, -35.5 to +70.6). Accelerated disc degeneration was seen on the MRI when wedging is observed between LIV and LIV+1. Overall, patients experienced minimal disability on ODI (14.29, SD=15.28) but worse ODIs were reported with higher levels of DDD on MRI, and sagittal malalignment despite good coronal correction. Average SRS-22 was 3.67 (SD=0.33) and Eq5D5L: 0.6945 on average (SD = 0.18).

Conclusion
Although ASF can achieve a balance fusion block coronally, factors that lead to unsatisfactory long-term outcomes

include acceleterated disc degeneration below the LIV including wedging between LIV and LIV+1, and inability to correct the sagittal alignment.

13. A Novel Classification of Coronal Malalignment in Degenerative Lumbar Scoliosis for Predicting Postoperative Coronal Imbalance: A Multicenter Cohort Study

Weipeng Qiu, MD; *Zhuoran Sun, MD*; Weishi Li, MD

Hypothesis
We hypothesize that, compared to global coronal balance, regional coronal measurements are more sensitive predictors of postoperative coronal imbalance (CIB) in patients with degenerative lumbar scoliosis (DLS).

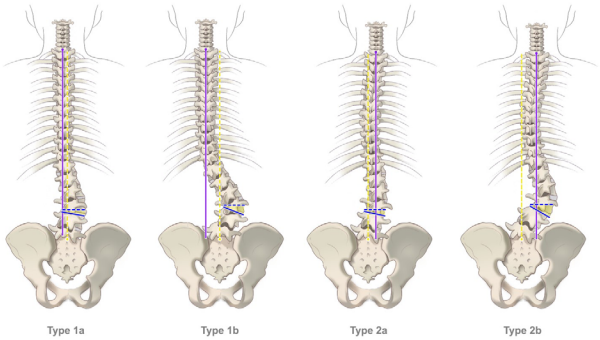
Design
A multi-institution, retrospective cohort study.

Introduction
Postoperative CIB has been linked to a decline in health-related quality of life in DLS patients, and iatrogenic CIB remains a concern and warrants careful attention.

Methods
A total of 269 patients with DLS who underwent posterior long-segment fusion surgery were included. Patients were divided into two groups: postoperative CIB and postoperative coronal balance. Clinical and radiographic data were compared between the two groups. Coronal measurements included the orientation of C7 plumb line (C7PL), coronal balance distance (CBD), major curve, lumbosacral fractional curve, L4 coronal tilt, L5 coronal tilt and apical vertebral translation. A novel classification was developed based on the factors identified in the multivariate logistic regression analysis.

Results
104 patients (38.4%) developed postoperative CIB (CBD>2cm). The C7PL orientation and L4 coronal tilt were identified as the most significant predictors of postoperative CIB. Accordingly, patients were classified into four types: Type 1a(concave-side C7PL, L4 coronal tilt<17.5°, n=84), Type 1b(concave-side C7PL, L4 coronal tilt>17.5°, n=44), Type 2a(convex-side C7PL, L4 coronal tilt<17.5°, n=70), and Type 2b(convex-side C7PL, L4 coronal tilt>17.5°, n=71). Type 2b exhibited the highest incidence of postoperative CIB (73.2%), while Type 1a exhibited the lowest risk (8.3%). Distinct distribution of CIB patterns was observed in Type 1 and Type 2. The ROC curve analysis indicated that the new classification had strong predictive performance for postoperative CIB (AUC=0.788, 95% CI: 0.733-0.843).

Conclusion
We propose a novel coronal classification, which enhances preoperative risk stratification of postoperative CIB and supports surgical decision-making regarding coronal realignment in DLS surgery. The achievable correction of L4 coronal tilt should be considered in the surgical plan. If the horizontal L4 coronal tilt cannot be restored, a matching correction between the major curve and the lumbosacral fractional curve should be considered.



Schema of the PUTH-CM classification

14. A Simple and Clinically Relevant Gait Score to Evaluate Functional Impairment in ASD

Rami Rhayem, MD, MS; Rami Rachkidi, MD, MS; Abir Massaad, PhD; Renaud Lafage, MS; *Virginie Lafage, PhD*; Elio Mekhael, MD, MS; Nabil Nassim, MD, MS; Ali Rteil, MD, MS; Maria Saadé, MS; Elma Ayoub, MD, MS; Celine Chaaya, MD, MS; Marc Boutros, MS; Georges El Haddad; Ibrahim Hamati; Moustapha Rteil; Gilles Prince; Guy Awad; Joe Azar; Marc Mrad; Mohamad I. Karam, PhD; Ismat Ghanem, MD, MS; Ayman Assi, PhD

Hypothesis
A simplified clinically relevant score can evaluate functional disability in ASD.

Design
Retrospective study of prospectively collected data.

Introduction
Patients with ASD are known to present with functional impairment during gait. The interpretation of 3D gait analysis (3DGA) remains challenging due to the extensive number of calculated parameters. The aim was to simplify functional evaluation in ASD by developing a clinically relevant gait score based on a reduced set of kinematic parameters.

Methods
175 primary ASD & 40 controls underwent bi-planar X-rays and filled the ODI questionnaire. They all underwent 3DGA to measure kinematics of the head (odontoid to hip axis angle with the vertical: ODHA), thorax, spinal segments, pelvis and lower limbs during walking, along with step length. The most 3 relevant kinematic parameters to describe ASD gait were identified using a principal component analysis. Then, an overall gait functional score (GFS) was attributed to each patient based on the deviation of these parameters from the normative values. Correlations between GFS, radiographic parameters, and ODI scores were analyzed.

Results
Kinematic ODHA (k-ODHA), pelvic tilt (k-PT, normalized to PI), and step length (normalized to height) were the

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most relevant gait parameters. A GFS=0 (normal k-ODHA, normal k-PT, N=55) was attributed to dynamically aligned patients; GFS=1 (normal k-ODHA, retroverted k-PT, N=21) for dynamically aligned patients following pelvic compensation; GFS=2 (forward k-ODHA, retroverted k-PT, N=33) for malaligned patients despite pelvic compensation; GFS=3 (forward k-ODHA, normal k-PT, N=66) for uncompensated malaligned patients (Fig.1). A modifier was added to the GFS when a patient's step length was reduced. The GFS was correlated to radiographic parameters (SVA=0.52, PI-LL=0.38) and ODI scores (total score=0.32; walking=0.4; personal care=0.30; all p<0.05).

Conclusion
The GFS is a simple & clinically relevant score to classify ASD patients depending on the severity of functional impairment. As patients walk while projecting their head forward, losing the ability to compensate by retroverting their pelvis, the GFS increases suggesting more severe dynamic malalignment with increased disability in daily life activities. Future studies will investigate changes in GFS after spinal realignment surgery.

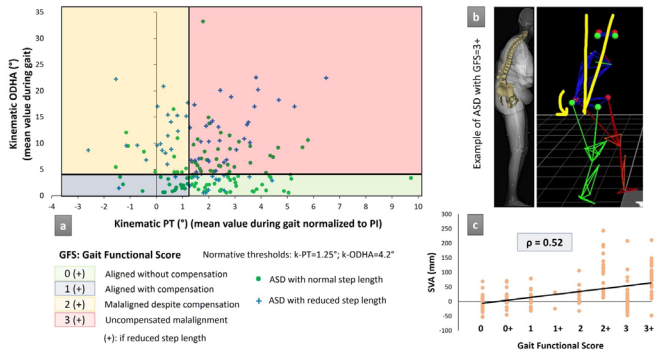

Fig.1-(a) Distribution of patients' GFS; (b) example; (c) correlation with SVA.

15. Three Gait Parameters Are Sufficient to Evaluate Functional Impairment in ASD

Elio Mekhael, MD, MS; Rami Rachkidi, MD, MS; Nabil Nassim, MD, MS; Maria Saadé, MS; Georges El Haddad; Marc Boutros, MS; Maria Karam; Emmanuelle Wakim; Maria Asmar; Mohamad I. Karam, PhD; Abir Massaad, PhD; Ismat Ghanem, MD, MS; *Ayman Assi, PhD*

Hypothesis
Gait kinematics of the pelvis, head & step length can better predict QOL scores than Xray parameters.

Design
Retrospective analysis of prospectively collected data.

Introduction
Recently, 3D gait analysis (3DGA) proved to predict QOL scores better than static radiographic evaluation in ASD. However, 3DGA provides multiple parameters that can be a burden to interpret by non-experts. A recent study showed that the most representative gait kinematics of ASD patients were the dynamic pelvic tilt (dPT), the forward projection of the head and thorax (dODHA) and walking step length (SL). The aim was to investigate if reducing 3DGA to these 3 parameters alone can still reflect deterioration of QOL scores in ASD.

Methods
197 ASD patients and 143 controls underwent low-dose full-body biplanar Xrays with 3D skeletal reconstruction, full-body 3DGA during walking, and completed QOL questionnaires: SF36 with the physical and mental components (PCS&MCS), ODI, Beck's depression inventory (BDI) and VAS for pain. A random forest machine learning model was used to predict QOL scores in 3 simulations: (1) Xray parameters (spinopelvic and global alignment);(2) dPT, dODHA and SL;(3) Xray parameters and dPT, dODHA and SL (fig.1a). The prediction accuracy was evaluated using 10-fold cross-validation and compared between simulations. The same methodology was applied on a subset of ASD patients followed (6m to 2y) postoperatively.

Results
Simulations 1, 2 and 3 had a median accuracy of 81, 85 and 86%, resp. Simulations 2 and 3 had comparable accuracies of prediction for all QOL scores and higher predictions compared to Simulation 1 (i.e., accuracy for PCS=86±3 vs 90±2 and 91±3% for simulations 1,2 & 3 resp., p<0.05;fig.1b). Similar results were obtained for 23 postoperative ASD patients.

Conclusion
Head and pelvis kinematics and step length are sufficient to predict QOL scores, even postoperatively, with higher accuracies than classic spinopelvic and global alignment parameters. While the latter play an integrating role in the surgical planning of ASD patients, coupling radiographic to functional evaluation would be optimal to provide a complete assessment pre & postoperatively. Future technologies should focus on capturing these 3 parameters alone to allow surgeons to easily access functional assessment, bypassing the complexity of the complete gait analysis process.

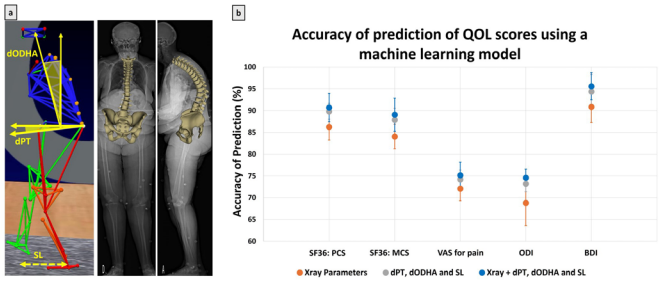

Fig1. (a) dPT, dODHA and SL; (b) accuracy of prediction of QOL scores in 3 simulations.

16. Identifying High-Risk Patients in Adult Spinal Deformity Surgery: Leveraging Predictive Analytics to Assess Drivers of Increase Risk of Surgical Complications

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Hypothesis
To identify baseline patient characteristics and surgical factors that predict which adult spinal deformity (ASD) patients are at elevated risk for surgical complications.

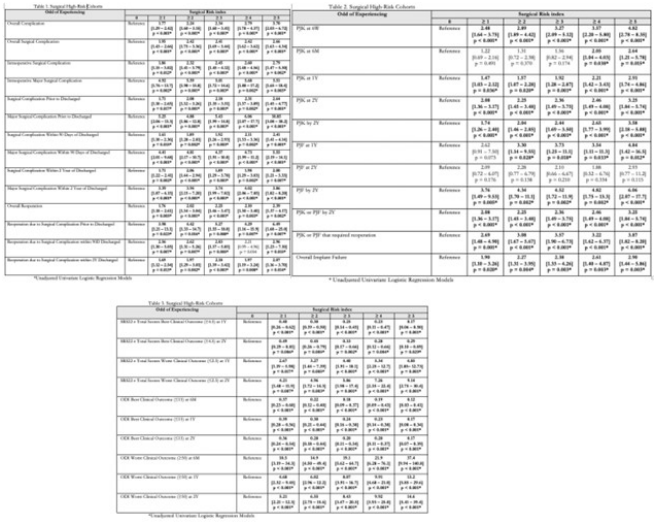
Design
Retrospective cohort study of a prospective ASD database.

Introduction
High-risk committees have recently been established in many hospitals to reduce operative risks through multidisciplinary collaboration. However, there remains limited consensus on which specific patient characteristics and surgical parameters warrant preoperative discussion, making it challenging to standardize risk assessment and optimize care pathways.

Methods
ASD patients meeting operative criteria (Cobb >20°, SVA >5 cm, PT >25°, or TK >60°) with available baseline and 2-year radiographic and HRQL data were included. Surgical risk was assessed based on surgical complications. High surgical risk was defined as experiencing a major surgical complication or revision surgery, also accompanied by negative clinical outcomes, specifically failure to meet the MCID for the ODI. A conditional inference tree machine learning model identified threshold cutoffs for continuous variables, while multivariable logistic regression models were used to develop predictive scores for both medical and surgical risk.

Results
464 ASD patients met inclusion criteria (Age: 60.5yrs, 80%F, BMI: 27.1 kg/m2, CCI: 1.7; mASD-FI: 6.8). 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, instrumentation removal, and >3 interbody fusions predicted poor outcome with an AUC of 93% and accuracy of 94%. As the number of risk factors increases, patients face significantly higher odds of experiencing intraoperative complications, major intraoperative complications, and overall surgical complications (Table 1), the odd of experiencing PJK (at all time point), PJF by 2Y increased, and the odds of achieving BCO in ODI (at 6M, 1Y, 2Y) and SRS-22r total scores (at 1Y, 2Y) decreased, whereas the likelihood of experiencing WCO in ODI (at 6M, 1Y, 2Y) and SRS-22r (at 1Y, 2Y) total scores increased. (Table 3)

Conclusion
Identifying patient-specific and surgical factors associated with a high risk of major complications and poor clinical outcomes enables surgeons to better profile patients who may benefit from multidisciplinary collaboration.



17. Modified Global Alignment and Proportion Scoring with Body Mass Index and Bone Mineral Density and Paraspinal Muscle (GABPM) for Improving Predictions of Mechanical Complications After Adult Spinal Deformity Surgery

Sung Hyeon Noh, MD

Hypothesis
This study aims to identify the factors associated with mechanical complications by analyzing muscle mass, metabolic indicators, and skeletal parameters.

Design
Retrospective study

Introduction
Mechanical complications following adult spinal deformity surgery remains a critical concern, with multiple factors potentially contributing to the need for reoperation. While previous studies have explored the impact of bone mineral density (BMD) and skeletal alignment, the role of muscle composition and metabolic factors remains unclear. This study aims to identify the factors associated with mechanical complications by analyzing muscle mass, metabolic indicators, and skeletal parameters.

Methods
A retrospective analysis was conducted on 293 patients who underwent spinal surgery. Patients were categorized based on whether they had mechanical complications. Independent variables included muscle mass parameters (Multifidus, Psoas, Quadratus, fat), BMD, weight, body mass index (BMI), and GAP score. Paraspinal structures were measured by MRI, using artificial intelligence. The ability of the Scoliosis Research Society (SRS)-Schwab classification, age-adjusted alignment goals, GAP score, modified global alignment and proportion scoring with BMI and BMD (GAPB), GAPB with

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paraspinal muscle volume (GAPBM) to predict mechanical failure was compared by calculating the area under the receiver operating characteristic curve (AUC).

Results
Larger multifidus and quadratus muscle mass were associated with a lower incidence of mechanical complications, while increased BMI and fat composition showed a positive correlation with mechanical complications. AUCs of the SRS-Schwab classification, GAP score, age-adjusted alignment goals, GAPB, and GAPBM were 0.579 (95% confidence interval [CI], 0.463-0.602), 0.808 (95% CI, 0.720-0.877), 0.588 (95% CI, 0.495-0.641), 0.875 (95% CI 0.828-0.941), and 0.903 (95% CI 0.858-0.951) respectively.

Conclusion
The GAPBM system, which includes paraspinal muscle and fat, showed improved predictability for predicting mechanical complications compared to the GAPB. Given these results, surgeons should keep in mind the importance of paraspinal muscle and fat as well as bone quality, BMI, and proportional alignment.

18. Incremental Benefit of Revision Surgery After Adult Spinal Deformity Corrective Surgery: At What Point Does the Value of Multiple Revisions Diminish

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Hypothesis
To assess impact of multiple revision surgery on patient outcomes.

Design
Retrospective.

Introduction
Incidence of revision surgery after surgical correction of adult spinal deformity (ASD) remains high. However, the benefits of multiple revision surgery on patient outcomes are not well-defined.

Methods
Operative ASD patients with BL and 2Y data, and ≥ 1 revisions included. Patients were stratified by number of revisions (R1, R2, or R3 defined as >2 revisions). BL demographic and surgical details were taken from timepoint of visit prior to revision surgery. Follow-up based on 2Y after final revision. Groups were propensity score matched (PSM) using many-to-one matching, while adjusting for differences at revision baseline. Radiographic parameters SVA, PI-LL, PT, and GAP were used to assess alignment post-revision via ANOVA testing. Multivariate analysis (MVA) assessed differences in outcomes after final revision surgery while controlling for relevant covariates.

Results
After PSM, 251 remained (Age: 60.40±14.17, 77% F, BMI: 27.97±5.87 kg/m2, CCI: 1.80±1.73) (R1: 108; R2: 108; R3: 36). Baseline deformity (SVA, PI-LL, PT, GAP) showed no significant differences between groups. 2 years after final revision surgery, those undergoing greatest number of revisions R3 demonstrating less improvement in deformity ($p<.05$). R1 and R2, as compared to R3, had greater difference between baseline and 2 year ODI scores, (-13.0 vs -13.9 vs -9.7, $p<.05$). Overall, patients undergoing multiple revision surgery were 84% less likely to reach MCID in ODI as compared to R1 (OR: .16 (.06-.54), p=.003), with R3 having 74% less chances of MCID in ODI [OR: .26 (.15-.46), $p<.001$]. Despite the inferior functional outcomes as measured by ODI scores, patient satisfaction measured by SRS scores were maintained from baseline to 2 years between revision groups. Complications increased with revisions, with R3 having the greatest rate compared to R1 and R2 ($p<.001$).

Conclusion
Given the costs and risks associated with revision surgery, the impact of re-intervention on patient outcomes is of significant importance. This study attempted to quantify the impact of multiple revision surgeries by comparing patient alignment and outcomes after each revision. Compared to those requiring only one revision, patient requiring multiple were had limited improvement in radiographic alignment.

19. The Impact of Osteoporosis on Patient Presentation in the Adult Spinal Deformity Population

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Hypothesis
Osteoporosis is highly prevalent in adult spinal deformity (ASD) patients and impacts severity of disease at presentation.

Design
Retrospective analysis of a prospectively enrolled database.

Introduction
Osteoporosis is commonly comorbid with ASD, creating a cyclical relationship in which each condition may synergistically contribute to the severity of a patient's clinical presentation. We hope to investigate osteoporosis's role in a patient's preoperative presentation.

Methods
Operative ASD patients ≥18Y with complete BL and 2Y data included. Osteoporosis (O) defined as an existing diagnosis at BL. High risk (HR) defined based on American Association of Clinical Endocrinologists (AACE) definitions including female ≥ 65Y and clinical features (steroids, CKD, alcohol

use, vit. D deficiency, limited mobility, diabetes). Non-osteoporotic (NO) defined as those with normal bone quality. Alignment assessed using the Global Alignment and Proportionality (GAP) score and the Sagittal Age Adjusted Score (SAAS). HRQLs: ODI, SF-36, and SRS-22r. ODI stratified by disability severity into quintiles.

Results
899 patients included: age 60.3±15.0Y, 74%F, BMI 27.5±5.8kg/m2, CCI 1.7±1.7. Cohort composition: O 165 (18.4%), HR 194 (21.6%), NO 540 (60.1%). 54% of patients who met AACE criteria did not have a formal diagnosis of osteoporosis. Differences between cohorts can be seen in Table 1. O was more likely to be considered severely frail (24.8% vs. 11.7%, p<.001). O and HR less likely to be GAP proportioned at BL (8.5%/6.7% vs. 19.8%, p<.001). O and HR more likely to be GAP severely disproportioned at BL (71.7%/73.0% vs. 51.2%, p<.001). When adjusting for BL age, BMI, gender, CCI, and mFI, HR/O were significantly less likely to be SAAS-matched at BL (OR: .646, p=.038). When adjusting for BMI, CCI, and mFI, HR/O were significantly less likely to be GAP-proportioned at BL (OR: .485, p=.003). When adjusting for those GAP proportioned and SAAS-matched at BL, HR/O were more likely to be severely disabled (ODI>60) (OR: 1.45, p=.041).

Conclusion
Osteoporosis affects ASD patients in many domains. These patients suffer from a poorer quality of life, have higher comorbidity burdens, and present with more severe deformity.

Variable	Non-Osteoporotic	High-Risk	Osteoporotic	p-value
Age (years)	54.0	71.7	67.7	<.001
Female (n)	333	194	134	<.001
BMI (kg/m^2)	27.2	28.7	26.9	.002
CCI	1.17	1.84	3.13	<.001
Peripheral Vasc. Disease	0.7%	3.6%	4.2%	.004
Smoker	8.4%	2.8%	4.4%	.016
Prior Spine Surgery	46.6%	54.4%	59.9%	.007
mFI Category				
Not-Frail	56.1%	41.2%	38.2%	<.001
Frail	32.2%	42.8%	37%	
Severely-Frail	11.7%	16.0%	24.8%	

Cohort Differences at Baseline

20. A Bone Optimization Rheumatology Clinic Increases Anabolic Bone Agent Use and Reduces Mechanical Complications in Adult Spinal Deformity Surgery

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Hypothesis
In osteopenic/osteoporotic patients undergoing adult spinal deformity (ASD) surgery, a bone optimization rheumatology clinic will increase anabolic bone agent use and decrease mechanical complications.

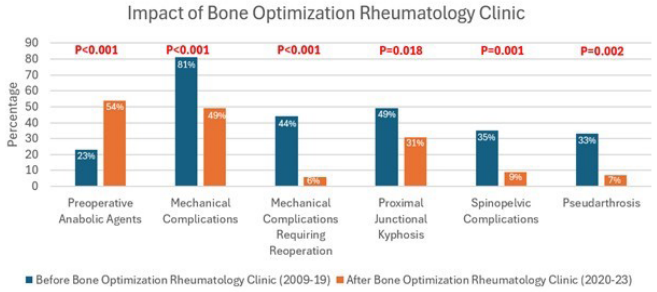
Design
Retrospective cohort study

Introduction
Though the use of anabolic bone agents has proven effective in ASD surgery, prescription and approval of these medications remains a challenge. In osteopenic/osteoporotic patients undergoing ASD surgery, we sought to determine the impact of a bone optimization clinic on: 1) prescription patterns of anabolic agents, 2) mechanical complications, and 3) reoperation.

Methods
A retrospective cohort study was performed for osteopenic/osteoporotic patients undergoing ASD surgery from 2009-23. The study period was binarized into before/after a bone optimization clinic was established (2009-19 vs. 2020-23). The primary outcomes were: 1) use of anabolic agents prior to surgery (Teriparatide, Abaloparatide, and Romosozumab-aqqg), 2) mechanical complications, and 3) reoperation. Univariate and multivariable regression controlled for age, sex, body mass index, and operative time were performed.

Results
Of 126 patients (mean age 68±10yrs; 86% female) undergoing ASD surgery with osteopenia (80%) or osteoporosis (20%), 91 (72%) were before the bone optimization clinic and 35 (28%) were after. Similar rates of osteoporosis in both groups were seen (pre-21% vs. post-17%, p=0.638). After the bone optimization clinic, more patients received preoperative anabolic therapy (54% vs. 23%, p<0.001) and for a longer duration (98±156 vs. 40±109 days, p=0.027). Overall mechanical complications decreased significantly (49% vs 81%, p<0.001) as did reoperation for mechanical complications (6% vs. 44%, p<0.001). Multivariable regression showed that a bone optimization clinic independently improved the use of preoperative anabolic agents (OR=5.3, 95%CI:2.1-13.4, p<0.001) and reduced the risk of mechanical complications (OR=0.2 95%CI:0.1-0.5, p<0.001) and reoperation for mechanical complications (OR=0.1, 95%CI:0.1-0.4, p<0.001)(Fig1).

Conclusion
In osteopenic/osteoporotic patients undergoing ASD surgery, a bone optimization clinic was independently associated with increased prescription rates and duration of anabolic bone agents, reduced mechanical complications, and reduced reoperation for mechanical complications.



Impact of Bone Optimization Clinic

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21. Loss of Patient-Reported Outcome Benefit over 8-Yr Follow-Up for Operatively Treated Adult Symptomatic Lumbar Scoliosis (ASLS) Patients Who Require Revision Surgery for Mechanical Complication‡

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Hypothesis
Revision surgery for mechanical complications following operative treatment for ASLS will not impact clinical outcomes over long-term follow-up.

Design
Prospective multicenter study

Introduction
Rates of revision surgery following operative treatment for ASLS remain high, with most revisions due to mechanical complications, including proximal junctional kyphosis (PJK) and pseudarthrosis/rod fracture (RF). Long-term impact of these revisions on clinical outcomes has not been well defined.

Methods
The ASLS study is a multicenter prospective study to assess operative vs nonoperative ASLS treatment, with randomized and observational arms. Patients were 40-80 yrs with ASLS (Cobb ≥30° and ODI ≥20 or SRS-22 subscore (SRS-SS) ≤4.0 in pain, function and/or self-image). Based on as-treated analysis combining randomized & observational arms, we analyzed surgical patients at risk for mechanical failure (PJK &/or RF) after long-segment PSF (thoracic spine to sacrum). Patients were grouped based on 0, 1, ≥2, or any revisions to assess for impact of revision on outcome (SRS-SS and ODI).

Results
160 of 183 operative patients (88.9%) were fused from the thoracic spine to the sacrum. Of these patients, 53 (33.1%) required 71 revisions for mechanical complications (25 for PJK,46 for RF), with 1, 2, and 3 revisions in 39, 10, and 4 patients, respectively. By 8 yrs post-surgery, patients had 38% risk of revision for mechanical complications. The mean time to the first and second revisions was 3.0 yrs (SD=2.1) and 4.8 yrs (SD=2.3), respectively. By 8 yrs, patients with 1 or more revision had significant negative impact on ODI (9.64, p=0.0008) and on SRS-SS (-0.29, p=0.0081, Table). Compared with patients requiring no revision, those with ≥2 revisions had the greatest impact on outcomes (ODI: 14.92, p=0.0043; SRS-SS: -0.45, p=0.235), with the impact exceeding minimum detectable measurement difference (MDMD) for both ODI (7) and SRS-SS (0.4).

Conclusion
By 8-yr follow-up, revision surgery for mechanical complications was required in 38% of operative ASLS patients, patients with 1 or more revisions had significant negative impact on ODI and SRS-SS scores, and this impact increased and exceed MDMD for both scores with ≥2 revisions. These findings emphasize the need for better techniques to reduce mechanical complications in ASLS surgery.

Table. Comparison of primary outcomes of adult symptomatic lumbar scoliosis patients operatively treated with thoracic to sacrum/pelvis instrumented fusion with and without PJK/RF-related revisions*

	Length of Follow-Up					
	2 Years No revision N=115 1 revision N=14 2 or 3 revision N=1 Any revision N=15		5 Years No revision N=79 1 revision N=22 2 or 3 revision N=5 Any revision N=27		8 Years No revision N=58 1 revision N=23 2 or 3 revision N=7 Any revision N=30	
	Mean Difference (95% CI)	P value	Mean Difference (95% CI)	P value	Mean Difference (95% CI)	P value
ODI						
Operative with no PJK/RF revision	Referent		Referent		Referent	
Operative with revision:						
1 PJK/RF revision	3.45 (-3.2, 10.1)	0.3093	4.74 (-1.81, 11.28)	0.1557	7.39 (1.39, 13.4)	0.0159
2 or more PJK/RF revisions	**	**	8.1 (-4.12, 20.31)	0.1935	14.92 (4.7, 25.14)	0.0043
Any (1 or more) PJK/RF revisions	3.35 (-3.16, 9.86)	0.3133	4.81 (-1.28, 10.91)	0.1213	9.64 (4.01, 15.26)	0.0008
SRS-22 subscore						
Operative with no PJK/RF revision	Referent		Referent		Referent	
Operative with revision:						
1 PJK/RF revision	-0.26 (-0.53, 0)	0.0501	-0.24 (-0.49, 0)	0.0499	-0.27 (-0.5, -0.04)	0.0231
2 or more PJK/RF revisions	**	**	-0.32 (-0.77, 0.13)	0.1598	-0.45 (-0.84, -0.06)	0.0235
Any (1 or more) PJK/RF revisions	-0.24(-0.5, 0.02)	0.0650	-0.27 (-0.5, -0.05)	0.0185	-0.29 (-0.51, -0.08)	0.0081

*ODI=Oswestry Disability Index; PJK=proximal junctional kyphosis; RF=rod fracture; SRS=Scoliosis Research Society; models included time points at 24, 30, 36, 42, 48, 60, 72, 84, 96 months.
**Only 1 patient with 2 or 3 revisions at this timepoint.

22. Which Surgical Approach Provides Better Correction of the Lumbosacral Fractional Curve: ALIF, TLIF, LLIF, or No-LIF?

Harsh Jain, MBBS; Omar Zakieh, MBBS; Anthony E. Bishay, BS; Jeremia Williams, BS; Soren Jonzzon, MD; Iyan Younus, MD; Tyler Zeoli, MD; Ranbir Ahluwalia, MD; Austin Montgomery, BS; Walter Navid, BS; Hani Chanbour, MD; Julian Lugo-Pico, MD; Amir M. Abtahi, MD; Byron F. Stephens, MD; Scott Zuckerman, MD, MPH

Hypothesis
Anterior lumbar interbody fusion (ALIF) provides greater correction of the lumbosacral fractional curve (LSF) compared to transforaminal lumbar interbody fusion (TLIF), lateral lumbar interbody fusion (LLIF) and no-interbody fusion (NO-LIF) in adult spinal deformity (ASD) surgery.

Design
Retrospective cohort study

Introduction
LSF correction is critical in optimizing coronal alignment in ASD surgery. In patients undergoing ASD surgery, we compared the LSF correction between: 1) all approaches (ALIF,TLIF,LLIF, and NO-LIF), and 2) among TLIFs, banana vs bullet cages.

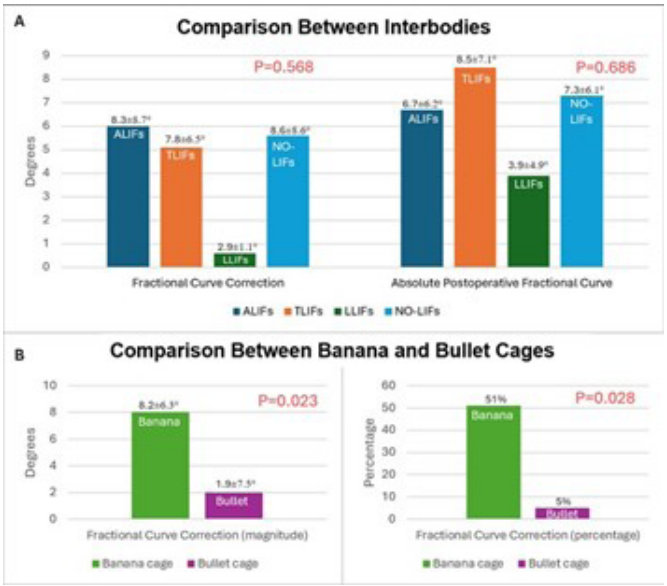
Methods
A retrospective cohort study was performed for patients undergoing ASD surgery from 2009-24. The LSF was defined as the angle between the sacrum and distal lumbar spine, depending on the most tilted lumbar vertebra. The cohort was divided into 4 groups: ALIF, TLIF, LLIFs and NO-LIF. TLIFs were subdivided into banana vs bullet cages. Preoperative/postoperative LSF correction was assessed as: 1) magnitude of change and 2) absolute postoperative values. Coronal malalignment (CM) was defined as coronal vertical

‡ = SRS Funded Research Grant

axis>3cm. Univariate and multivariable analyses controlling for age, sex, and total instrumented levels were performed.

Results
Of 221 patients (mean age:60±18 years, 31% males) undergoing ASD surgery, mean instrumented levels was 11±3. Mean preoperative/postoperative LSF was 13±10° and 7±6° with a mean change was 7±8°. Interbody approaches were: ALIFs 42(19%), TLIFs 28(13%), LLIFs 6(3%), and NO-LIF 145(66%). Preoperative/postoperative CM rates were 28% and 20%, respectively. No difference was seen between interbody groups in LSF correction or absolute postoperative LSF (Fig1A). Banana vs Bullet Cage: Among 28 patients undergoing TLIFs (50% banana vs 50% bullet), banana cages were associated with greater magnitude of correction(8±6° vs 2±7°, p=0.023) and percentage of correction (51% vs 5%, p=0.028) of the LSF (Fig1B). No difference was seen in absolute postoperative LSF(9±7° vs 7±7°, p=0.468). Multivariable linear regression confirmed banana cages led to greater LSF correction(β=6.5, 95%CI:0.3-12.7, p=0.040).

Conclusion
In ASD surgery, no difference in correction of the LSF or CM was seen with different interbody techniques; however, among TLIFs, banana cages were independently associated with improved LSF correction compared to bullet cages.



LSF correction with (A) different interbodies, (B) banana vs bullet cages

23. A Cautionary Tale Regarding Singular Angular Measurements for Realignment: Examination of the Benefits and Limitations Conferred by T1-Pelvic Angle

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Hypothesis
To elucidate the true value of T1PA in terms of sustainability, efficacy, and which specific patient populations find the benefits most pertinen

Design
Retrospective cohort

Introduction
T1 Pelvic Angle (T1PA) was introduced to address an important limitation to existing sagittal alignment schemas. Still, it may fall short in explicitly directing alignment goals.

Methods
Operative ASD patients ≥ 18 years were grouped into cohorts based on their postoperative T1PA (T1PA <10 or >30: unfavorable v. T1PA 10-30: favorable). Descriptive analyses and means comparison tests were applied to understand differences in baseline demographics and surgical metrics. The primary outcome of interest is mechanical complications.

Results
596 patients met inclusion criteria (mean age: 61.5±13.4, 78.8% female, mean BMI 27.8 8± 5.9 kg/m2, mean CCI: 1.9±1.8). In terms of surgical characteristics, the mean operative time was 379.8±133.3 mins, mean EBL was 1528.9±1480.7 mL, mean posterior levels fused was 11.2± 4.2, and mean LOS was 7.9±4.3 days. Postoperatively, 390 (67.1%) patients achieved a favorable T1PA, and 191 (32.9%) patients failed to register a favorable T1PA. Those adjusted to favorable T1PA demonstrated improvement in age-adjusted match at 1Y and 2Y (p<.001) and improvement in SVA at 2Y (p=0.023). Still, those with "favorable" T1PA demonstrated a significantly higher rate of PJK than those with unfavorable T1PA, (52.0% v. 48.0%, p=0.035). Especially in patients with a high thoracic deformity, achieving T1PA did not result in a significant difference in the rates of mechanical complications. It also failed to yield any significant difference for those with severe hyperlordotic relative lumbar lordosis. In terms of sustainability of the parameter itself, 69 patients (11.6%) who originally were deemed to have favorable T1PA no longer were within threshold at 1Y, with another 57 patients losing favorable T1PA by 2Y.

Conclusion
T1PA offers valuable perspective in terms of global alignment but falls short in acknowledging and adjusting for the great degree of variation in ASD patients, especially those with less "typical" deformities, such as those with extreme hyper-lordosis or a high thoracic apex, resulting in worse radiographic and mechanical outcomes. Integration with alternative alignment theories should be explored.

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24. Prediction of Postoperative Pelvic Tilt and T1 Pelvic Angle in Patients Undergoing Adult Spinal Deformity Surgery from Lower Thoracic Spine to the Pelvis

Christopher J. Nielsen, MD; Fatemeh Alavi, PhD; Jeffrey M. Hills, MD; Michael P. Kelly, MD; Stephen J. Lewis, MD, FRCS(C)

Hypothesis
In adult spinal deformity patients (ASD) with an upper instrumented vertebra (UIV) in the lower thoracic spine, postoperative pelvic tilt (PT) and T1 pelvic angle (T1PA) can be predicted using preoperative T1PA and planned surgical alignment measured by upper-instrumented vertebrae pelvic angle (UIVPA).

Design
Retrospective Cohort

Introduction
Despite surgical planning strategies in ASD surgery, restoring sagittal balance and predicting reciprocal changes remains difficult. T1PA is an accurate measure of sagittal alignment and is geometrically related to PT and T1 tilt (T1PA=PT+T1tilt). We aimed to determine if postoperative PT and T1PA could be predicted using preoperative and planned surgical alignments.

Methods
A consecutive series of patients undergoing fusion from low thoracic spine (T9-T12) to the pelvis were reviewed. Preoperative and first postoperative 3' radiographs were measured. A multivariable linear regression model was fit to predict postoperative PT and T1PA by preoperative PT and T1PA, as well as, pre and postoperative UIVPA. All preoperative spinopelvic and postoperative UIVPA measures were analyzed. The model was externally validated using 21 patients from a separate institution. Mean absolute error (MAE) was computed for the predicted postoperative PT and T1PA in both cohorts.

Results
110 (age 66.6 (SD 10.8), 64% female) were included in the initial model. Postoperative T1PA was significantly associated with postoperative UIVPA (r2=0.83, p<0.001) and preoperative T1PA (r2=0.45, p<0.001). Postoperative PT was strongly associated with predicted T1PA (β=0.68, p<0.001) and preoperative PT (β=0.33, p<0.001). External validation using 21 patients (age 63 (SD 9.2), 52% female) showed accurate T1PA and PT predictions with an MAE of 2° and 4.6°, respectively.

Conclusion
Postoperative PT and T1PA can be accurately predicted based on planned postoperative UIVPA, preoperative PT, T1PA and UIVPA in patients undergoing spinal fusion from the lower thoracic spine to the pelvis. Understanding the association of planned surgical alignment with postoperative PT and T1PA improves proposed patient-specific plans.

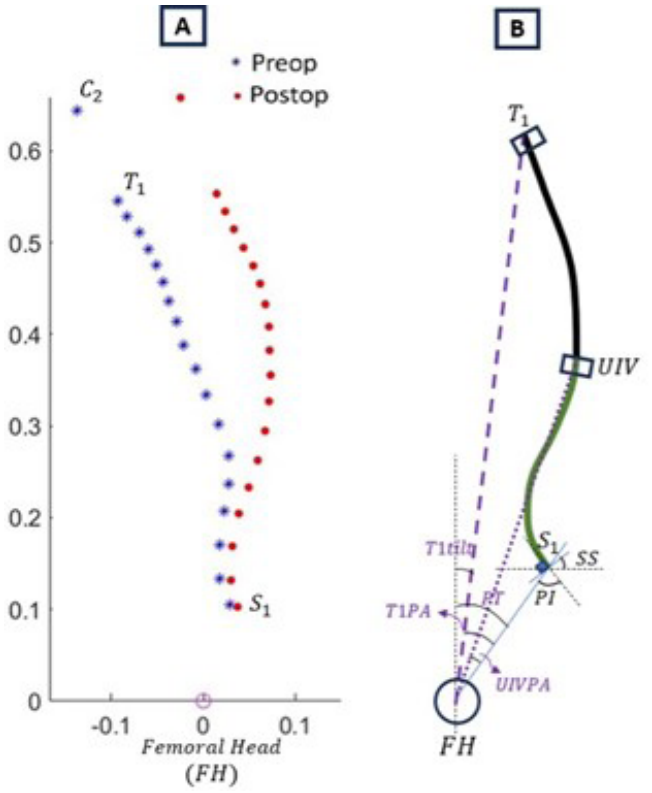

Figure 1. (A) Pre and postoperative sagittal alignment of a typical patient. (B) An illustration of spinal alignment parameters.

25. Are There Distinct Patterns of Clinical Deficit in Adult Spinal Deformity? A Discriminant Analysis of Health-Related Quality of Life Measures

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Hypothesis
Different patterns of HRQOL deficits exist in Adult Spinal Deformity (ASD) patients

Design
Retrospective review of a prospective multicenter database

Introduction
ASD includes a wide range of clinical presentations, with significant variability in patient-reported outcomes (PRO). Despite their widespread use, the multidimensional nature of these instruments can obscure distinct patterns of clinical deficits

Methods
A principal component analysis (PCA) was performed on the individual questions of three PROMs (SRS-22r, ODI, SF-36). The resulting factors were included in a cluster analysis to assign patients into homogeneous groups of outcomes

Results
The 1,506 ASD patients (72% F, 60.9±14.3yo) included had a SRS-22r score of 2.8±0.6, ODI of 45.4±17.4, SF-36 PCS of 30.6±9.5, and SF-36 MCS of 45.3±13.6. The PCA lead to 10 factors reflecting specific domains of HRQOL, including physical mobility, emotional distress, pain, social interaction, and body image perception (Figure 1). Cluster analysis of these 10 factors revealed six distinct patterns. Cluster A had the best clinical scores with minimal deficits across factors, and a large proportion of thoracic and double curves (53.3%). Cluster B and C had mild deformity and moderate disability, primariliy driven by physical limitations (Factors 1 & 3). Cluster C had additional deficits in emotional and mental health, and body image satisfaction (Factors 4, 5, 6). Cluster D had severe disability with pronounced physical deficits (Factors 1, 2, 3) and severe sagittal malalignment (52.9%). Cluster E had moderate disability with emotional distress (Factor 4) and body image dissatisfaction (Factor 6), with less sagittal malalignment (44.9%) than Cluster D. Finally, Cluster F had severe deficits across nearly all factors, including chronic fatigue (Factor 9) and physical limitations (Factor 3), and had the largest percentage of pure sagittal malalignment (58.9%)

Conclusion
Distinct patterns of HRQOL deficits exist across a heterogeneous ASD population. These findings provide actionable insights such as preoperative counseling and metal health support for patients with with body image dissatisfaction or emotional distress (Clusters C & E), or realignment procedures for patients with significant physical limitations and sagittal malalignment (Clusters D & F). This framework could inform the development of ASD specific instruments

Clusters Description	Cluster A (N=138)	Cluster B (N=266)	Cluster C (N=274)	Cluster D (N=287)	Cluster E (N=284)	Cluster F (N=257)
Factor 1: Physical Function Mobility & Daily Activity						
Factor 2: Physical Health Impact On Work & Daily Roles						
Factor 3: Physical Limitations						
Factor 4: Emotional Distress						
Factor 5: Emotional Impact On Role And Daily Activities						
Factor 6: Body Image & Appearance Satisfaction						
Factor 7: Bodily Pain & Well-Being						
Factor 8: General Health Status						
Factor 9: Chronic Fatigue & Low Energy Levels						
Factor 10: Social Interaction & Personal Care						

26. Muscle Gene Expression and Cellular Morphology in Individuals with Adult Spinal Deformity Who Develop Proximal Junctional Failure

Pearce B. Haldeman, BS; Camille Nosewicz, BS; Ethan Deller, BS; Robert K. Eastlack, MD; *Gregory M. Mundis Jr., MD*; Bahar Shahidi, PhD

Hypothesis
Paraspinal muscle morphology and associated gene expression provides insight into more personalized determinants of proximal junctional failure (PJF).

Design
Cross sectional analysis of prospectively collected data and biopsies.

Introduction
Proximal Junctional Failure (PJF) remains a prevalent complication in those who received posterior spinal fusion for correction of adult spinal deformity (ASD), and worse paraspinal muscle quality has been associated with increased risk of PJF. Our purpose is to characterize genetic pathways and cellular morphologic features of muscle in those who do and do not develop PJF.

Methods
34 individuals with ASD undergoing at least 4 level spinal fusion to the pelvis were consented for an intraoperative paraspinal muscle biopsy 3 levels below the upper instrumented vertebra (UIV). 16 individuals who required revision surgery due to failure at the proximal junction were classified in the PJF group and were sex- and level-matched to 18 without PJF. Differential gene expression using qPCR for 42 adipogenic/metabolic, atrophic, fibrogenic, inflammatory, and myogenic genes was compared between the PJF and non-PJF groups. Histologic measures of muscle fiber size, degeneration, and biopsy composition (% of fat, fibrosis, muscle) were compared between groups and associated with gene expression.

Results
Patients were 79% female with a BMI of 25(9). The PJF group trended toward older age (72(8) vs 63(18) yrs, (p=0.086). Follow up duration was 43 months (range: 30-59). In the PJF group, the myogenic gene ASB15 was 2.18 fold change (FC) downregulated (p=0.0080), and the age adjusted fatty metabolism gene FABP4 was significantly upregulated (FC=1.42, p=0.040) versus non-PJF patients. There were no differences in muscle fiber size p>0.77) between groups, but degeneration was slightly elevated versus normative standards. Greater collagen content correlated with expression of FABP4 (r=-0.44, p=0.016).

Conclusion
Paraspinal muscles in those with ASD who develop PJF demonstrate lower muscle growth and higher fatty metabolism gene expression, which is associated with a compositional phenotype of greater unorganized collagen deposition throughout the muscle, particularly in areas of fatty infiltra-

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tion. Future work may identify treatments that normalize these gene profiles.

27. Two-Year Revision Rate for Mechanical Complications Following Adult Spinal Deformity Surgery in Patients Treated with Personalized Interbody Implants

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Hypothesis
The revision surgery rate due to mechanical complications in adult spinal deformity (ASD) patients whose treatment included 3D planning and personalized interbody (PI) implants with minimum 2-yr follow-up will be lower than a similar, previously-published cohort treated without PI implants.

Design
Retrospective review of consecutive ASD patients compared with historical cohort

Introduction
Prior studies have shown that patients undergoing revision surgery due to mechanical complications had less radiographic improvement and worse patient-reported outcomes scores. The combination of 3D planning and PI devices has been shown to contribute to improved achievement of alignment goals; however, this has not previously been studied in the context of revision surgery due to mechanical complications.

Methods
Multicenter data on mechanical complications leading to reoperation were collected on 88 ASD patients with PI implants and minimum 2-year follow-up. This cohort was compared to a similar multicenter ASD cohort whose treatment did not include PI implants (Lafage, et al.; PMID: 38375636) using the same indications for reoperation. Statistical comparisons were performed, and significance levels assessed. Pre- and post-op lumbar alignment parameters were compared.

Results
In the Lafage et al. dataset, 144 of 997 patients (14.4%) required revisions due to mechanical complications at 2-years, consisting of revisions for implant failure (6.1%) and for radiographic imbalance (8.3%). The PI cohort showed significantly lower rates at 2-years ($p<0.05$), with 6 of 88 (6.8%) requiring reoperation, consisting of 1-rod breakage (1.1%) and 5 cases of PJK (5.7%, Table). In addition, the PI cohort showed significant post-operative improvement in lumbar sagittal parameters, with the achieved alignment closely matching the personalized 3D alignment plan (Table)

Conclusion
Patients receiving a 3D plan and PI device showed significantly reduced reoperation rates compared to the multicenter cohort, and a significant improvement in post-operative alignment versus pre-op. These findings suggest that achieving planned alignment targets with PI devices is associated with reduced need for revision surgery for mechanical complications. This reduced rate of revisions for mechanical complications may improve patient outcomes and reduce cost

Metric	Lafage, et al. (n=997)	Personalized Interbody Implants (n=88)	P-value
Patient Demographics			
- Mean age, yrs	60.4 ± 14.3	63.6 ± 11.1	0.041
- Female (%)	761 (76.3%)	62 (70.5%)	0.442
- Prior spine surgery	504 (50.5%)	40 (45.4%)	0.515
Surgical Characteristics			
- Posterior procedure (%)	987 (98.9%)	88 (100%)	0.824
- Interbody fusion (%)	618 (64.0%)	88 (100%)	<0.001
- Posterior (TLIF/PLIF)	486 (48.7%)	23 (26.5%)	<0.001
- Anterior (ALIF)	382 (38.3%)	43 (49.0%)	0.049
- Lateral (LLIF)	231 (23.2%)	23 (26.5%)	0.484
Complications and Reoperations			
- Reoperation rate (2-Yr) (%)	144 (14.4%)	6 (6.8%)	0.047
- Due to implant failure (%)	61 (6.1%)	1 (1.1%)	0.054
- Due to radiographic imbalance (%)	83 (8.3%)	5 (5.7%)	0.384

Parameter	Preop (Mean ± SD)	Plan (Mean ± SD)	Postop (Mean ± SD)	Preop vs. Postop
N=88				
LL (°)	40.0 ± 16.6	47.6 ± 15.3	48.9 ± 12.5	<0.001
PI-LL (°)	14.4 ± 15.5	6.8 ± 13.7	5.3 ± 12.3	<0.001
L4-S1 Lordosis (°)	34.4 ± 12.1	38.9 ± 11.1	38.2 ± 10.6	0.001
L1 Pelvic Angle (°)	11.8 ± 8.2	6.2 ± 6.6	7.7 ± 5.7	<0.001
IVLs (°) - ALIF (n=68)	10.2 ± 6.9	15.1 ± 4.8	14.9 ± 4.9	<0.001
IVLs (°) - LLIF (n=43)	3.3 ± 3.6	5.6 ± 4.1	7.4 ± 2.7	<0.001
IVLs (°) - TLIF (n=36)	10.8 ± 6.3	11.4 ± 4.4	10.7 ± 4.3	1.000
IVLs (°) - L1/L2 (n=11)	2.5 ± 2.6	5.8 ± 3.4	7.5 ± 2.6	0.012
IVLs (°) - L2/L3 (n=17)	2.9 ± 3.7	5.4 ± 4.3	6.9 ± 2.9	0.001
IVLs (°) - L3/L4 (n=16)	3.1 ± 3.5	6.2 ± 4.7	8.1 ± 3.0	<0.001
IVLs (°) - L4/L5 (n=43)	8.0 ± 4.9	11.9 ± 4.1	10.3 ± 3.5	0.006
IVLs (°) - L5/S1 (n=88)	12.8 ± 6.8	15.5 ± 4.9	16.0 ± 4.6	0.003

Table. The statistical analysis compares demographic, surgical, and postoperative outcomes between two cohorts using t-tests for continuous variables, a z-test for proportions, or Fisher's Exact Test. Preoperative, plan, and postoperative parameters were compared using repeated measures ANOVA followed by planned comparison.

28. Developing the First Pediatric Spine Frailty Index: Machine Learning Models Predict Key Complications

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Hypothesis
Machine learning algorithms could form the basis for a pediatric spine frailty index, predicting extended length of stay (LOS), intensive care unit (ICU) admission, and complications within 60 days after spine surgery

Design
Multicenter retrospective cohort from an international registry

Introduction
Ensuring safety and minimizing complications are critical for pediatric spine surgery. While spine surgery frailty indices predict risk in adults, they lack pediatric specificity, leaving

providers without an effective frailty measure. In this study, we leverage machine learning to develop risk stratification models that could serve as the foundation for a pediatric spine frailty measure.

Methods
A retrospective review of a multicenter database was performed for all patients who underwent index growth-friendly or fusion surgeries. Three outcomes – extended hospital length of stay (>5 days, 75th percentile), ICU admission (>1 day), and Modified Clavien-Dindo-Sink grade III+ complications within 60 days – were selected as likely factors in a frailty index. Factors with <1% occurrences and patients missing >20% of data were excluded, leaving 49 predictor variables. Isolation forest was utilized for complications within 60 days due to a low occurrence rate; neural networks were developed across other outcomes. Model performance was evaluated via sensitivity, specificity, and area under the receiver operating characteristic curve (AUC).

Results
1427 patients, 868 (61%) females and 559 (39%) males, aged 8.8 ± 3.5 years were included. 440 patients had extended LOS (30.8%), 466 had ICU admission (32.7%), and 36 had complications (2.5%). Of the neural network models, ICU admission registered an AUC of 0.77 and extended LOS scored 0.74. Isolation forest yielded 0.74 AUC for complications. Across all models the most frequently important predictors were etiology, presence of cardiac comorbidity, race, major cobb angle, and ASA level.

Conclusion
Our machine learning models provide a practical first step toward defining a pediatric spine frailty index and adequately predict prolonged LOS, ICU admission, and complications (AUC > 0.70 for all). Each model offers a risk stratification tool and can guide shared decision-making. Looking ahead, future research will explore methods to integrate these models into a single frailty framework, enabling a holistic and robust risk assessment for pediatric spinal surgery.

Model	Sensitivity	Specificity	AUC
ICU Admission (>1 day)*	0.70	0.74	0.77
Prolonged LOS (> 5 days)*	0.62	0.75	0.74
60 Day Complication**	0.40	0.85	0.74

*Neural network algorithms
**Anomaly detection-based isolation forest algorithm

Model performance

29. Pediatric Spine Frailty Index Predicts Morbidity and Mortality in Spinal Deformity Surgery

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Hypothesis
We hypothesized a comorbidity-based frailty index would predict morbidity and mortality in pediatric deformity surgery.

Design
Retrospective cohort.

Introduction
Frailty has been used in risk assessment in adult spine surgery, this is poorly studied in pediatric patients.

Methods
The NSQIP Pediatric database years 2016-2022 was used for this study. Patients were included in this study if they were 1) <18 years of age and 2) received posterior spinal fusion for spinal deformity. All spinal deformities were included. Years 2016-2021 were used as a derivation cohort and year 2022 was used as a validation cohort. Outcomes of interest were any adverse event, Clavien-Dindo IV adverse event, mortality, and extended length of stay. Univariable logistic regression analysis was used to identify potential variables associated with odds of any adverse event, followed by a multivariable logistic regression analysis using backward likelihood ratio backward selection method. Significant variables were used to create a frailty index. The frailty index was assessed using ROC curve analysis on each outcome of interest. The rates of the outcomes of interest were expressed as proportions and stratified by the frailty index score.

Results
There were 34,478 patients included in this study (Derivation cohort: n=28,377; Validation cohort: n=6,101). The frailty index included significant respiratory disease, gastrointestinal disease, neuromuscular disease, cognitive/developmental delay, seizure disorder, and asthma. In the derivation cohort, the area under the curve (AUC) for any adverse event, Clavien-Dindo IV adverse event, mortality, and extended length of stay were 0.77, 0.85, 0.91, 0.79, respectively. On external validation, the AUC for any adverse event, Clavien-Dindo IV adverse event, mortality, and extended length of stay were 0.72, 0.88, 0.90, 0.78, respectively. Increasing frailty index score was associated with increasing rate of all morbidity and mortality outcomes. The rate of any adverse event for a score of 0, 3, and 6 were 1.6%, 11.2%, and 22.5% respectively. The rate of extended length of stay for a score of 0, 3 and 6 were 1.5%, 13.5%, 25.9%, respectively.

Conclusion
The frailty index had good to excellent discrimination for morbidity and mortality on internal and external validation.

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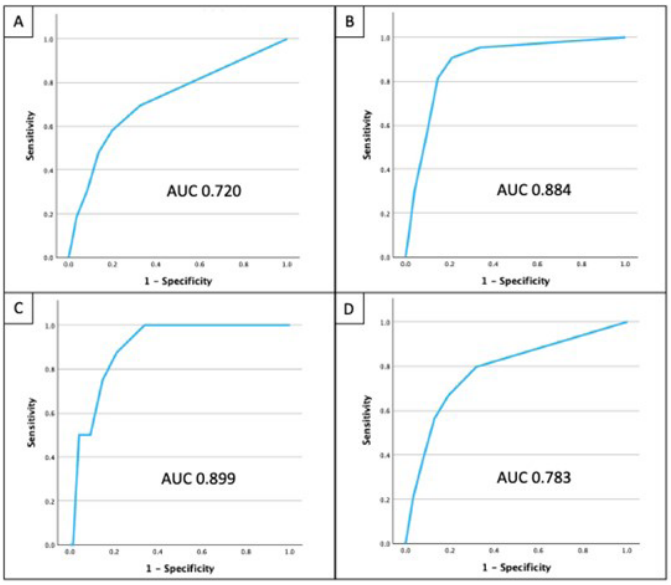

ROC curves for A) adverse event, B) CD Grade IV adverse event, C) mortality, and D) extended length of stay for the validation cohort.

30. The Natural History of Duchenne Muscular Dystrophy Scoliosis in Corticosteroid Era: A Mean 15-Year Follow-Up Study

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Hypothesis
Since the 2005 American Academy of Neurology guideline on corticosteroid use in Duchenne muscular dystrophy (DMD), the natural history of scoliosis in patients with DMD has changed.

Design
Retrospective case series study

Introduction
Scoliosis in DMD patients is associated with the timing of ambulation loss, and the curve often progresses as the disease deepens. Although previous studies have demonstrated that corticosteroid use significantly decreases the incidence of scoliosis and the necessity for surgical corrections, evidence of the natural history of DMD scoliosis with a long-term follow-up is still lacking. Therefore, this study aimed to clarify the natural history of DMD scoliosis in the corticosteroid era.

Methods
We reviewed consecutive DMD patients who received corticosteroid therapy with deflazacort before being diagnosed with scoliosis in a single tertiary center. We measured coronal Cobb angles from the annual whole spine anteroposterior radiographs in a sitting position. Information on the patient's motor function, the timing of ambulation loss, and whether the surgical correction of scoliosis was performed during the follow-up was also collected.

Results
A total of 140 patients with a mean follow-up period of 15.8±3.4 years were in this study. All patients became wheelchair-bound at a mean age of 13.1 years old. Scoliosis, defined as a Cobb angle > 10°, developed in 119 (85%) patients during the follow-up. Scoliosis occurred within three years after becoming a wheelchair-bound state in 98.3% of the patients. The curve types were categorized as follows: 1) long thoracolumbar curve in 55 (46%) patients, 2) lumbar curve in 50 (42%), and 3) thoracic curve in 14 (12%). During the follow-up, Cobb angle of 52 (44%) patients did not exceed 35°. Among the 67 (56%) patients with a curve exceeding 35° of Cobb angle, surgery was performed in 40 (34%) patients, while 27 (22%) patients were managed non-operatively. Of these 27 patients, 18 (67%) did not experience curve progression beyond 50°.

Conclusion
The current long-term follow-up study showed that scoliosis occurs within 3 years after the loss of ambulation in corticosteroid-treated DMD patients. Even in cases where the spinal curve exceeds a Cobb angle of 35°, conservative management without surgery can be considered.

31. Spinal Fusion Surgery in Cerebral Palsy: Complications, Reoperations, Clinical, and Radiographic Analyses with Minimum 5-Year Follow Up

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Hypothesis
Spinal fusion (SF) in patients with CP improves radiographic and quality of life outcomes over 5y, regardless of complications or UPROR

Design
Retrospective review of prospectively collected multicenter data

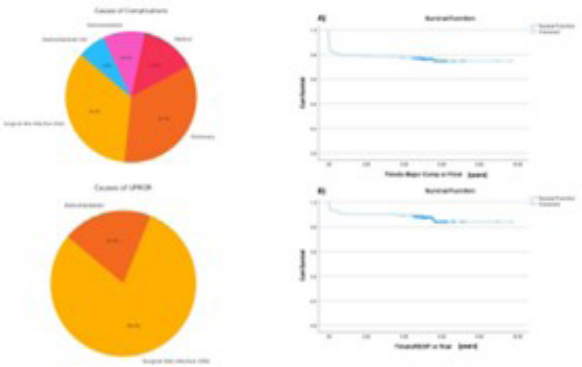
Introduction
Understanding outcomes of SF in children with CP beyond the short term is important to determine durability. This study aimed to report the complications, UPROR, radiographic, and clinical outcomes in children with CP undergoing SF with 5y f/up.

Methods
Patients with GMFCS IV/V CP from a multicenter database with minimum 5y f/up were included. Major Cobb angle, pelvic obliquity (PO), major complications, and UPROR were assessed. The Caregiver Priorities and Child Health Index of Life with Disabilities (CPCHILD) questionnaire was completed pre-, 2y, and 5y. Statistics: generalized estimat-

ing equation (GEE), repeated-measures ANOVA, and the Kaplan-Meier method.

Results
195 patients (13.3±2.7 years) were included. Preoperative Cobb angle (82.5±23.0) improved at 2y (29.5±16.1; p<0.001) and maintained at 5y (29.9±16.9). Preoperative PO (27.6±15.7) improved at 2 years (9.5±9.0; p<0.001) and maintained at 5y (9.9±9.7). 47 patients (24%) had major complications and 26 (13%) required UPROR. Causes of complications were SSI (n=19, 9%), pulmonary (n=19, 9%), medical (n=7, 3%), instrumentation (n=6, 3%), and GI (n=4, 2%). Causes of UPROR were SSI (n=24, 12%) and instrumentation (n=6, 3%). The probability of being free of complications/UPROR was >75% at 5y. CPCHILD scores significantly improved from pre- to 2y(p<0.001) and maintained at 5y. RM-ANOVA showed no significant differences in change of scores over time despite complications/UPROR and those with complications/UPROR showed no decline in CPCHILD scores.

Conclusion
SF demonstrates sustained, significant improvements in radiographic and HRQoL parameters at 5y in children with CP, even in the presence of major complications/UPROR. This large scale, multicenter study with high-quality data underscores the transformative impact of spinal fusion in this vulnerable population.



Characteristics of complications/UPROR and KM curves with an estimated probability >75% at 5y without complication/UPROR.

32. The Impact of Prognostic Nutritional Index (PNI) in Neuromuscular Scoliosis Deformity Correction

Subaraman Ramchandran, MD; Jesson James; Thomas Errico, MD; Stephen G. George, MD

Hypothesis
Surgical site infections following NMS deformity correction cannot be predicted by prognostic PNI scores

Design
Retrospective consecutive case series

Introduction
Postoperative infections are a significant complications following NMS deformity correction, influenced by pre-op comorbidities, poor nutritional status and poor wound healing. The PNI is a tool that combines serum albumin and total lymphocyte count and is used in several fields especially in oncology to predict survival rates. The impact of PNI in predicting infection following deformity correction in such a vulnerable NMS population needs to be explored

Methods
Consecutive NMS patients who underwent posterior spinal fusion were queried wit a minimum follow up of 2 years. Pre-operative demographic, nutritional, clinical parameters; intra-operative and post-operative variables were recorded and compared between patients with no surgical site infections (SSI) and those with any Deep SSI that needed revision. Pre-op PNI was calculated using the formula: PNI= 10 x Alb (g/dl)+ 0.005 X total lymphocyte count (cells/mm3). Rates of deep SSI were then plotted against increasing severity of malnutrition (Well nourished: PNI ≥ 38, moderately nourished: PNI 35-38, poorly nourished: PNI < 35)

Results
55 patients were included (mean age- 16 yrs, cerebral palsy was the most common diagnosis). All patients had fusion to pelvis. 9 patients (16.3%) had deep SSI (E coli was the most common organism). The mean preoperative albumin (3.4 vs. 4.1 g/dl), pre-albumin (6.4 vs. 21.3 g/dl), total lymphocyte (2208 vs. 2864 mm3) and PNI (48.2 vs. 54.1) were significantly lower in the infection group (p> 0.05 for all). No difference were noted wrt pre-op co-morbidities, number of co-morbidities, pre-op MRSA screening results, any intra or post-operative variables including Op time, EBL and post-op nutritional parameters. Amongst patients with Deep SSI,6 patients (66.6%) had moderate PNI, 2 patients (22.2%) had low PNI and 1 patient had normal PNI compared to non-infected patients where 91% had normal PNI.

Conclusion
PNI is an important prognostic tool that helps to predict post operative infections in Neuromuscular scoliosis patients independent of pre-operative co-morbidities and intra-operative factors.

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NMS patients	No deep SSI group (N=46)	Deep SSI group (N=9)	T value	df	P value
Age (years)	16.4 ± 4.2	16.5 ± 3.7	0.08	52	0.46
BMI	20.07±5.08	22.11± 5.21	1.09	50	.14
Weight (kg)	40.06±15.01	38.98±13.07	-0.20	51	.42
Length of stay	6.73±6.71	8.33±7.35	0.69	52	0.24
Operating Time (hours)	541.06±149.55	608.56±132.37	1.25	52	0.10
EBL	534.09±321.74	541.22±283.15	.06	52	0.47
WBC	8.82±4.74	7.89±4.96	-0.24	52	0.40
Lymphocyte %	33.70±16.60	38.61±15.91	0.81	52	0.20
TLC	2864.89±1329.6	2208.97±1075.2	0.89	52	**0.01**
Pre_op_Hgb	13.44±1.64	12.90±1.46	-0.90	48	0.18
Pre_op_Hct	40.51±4.87	38.33±3.96	-1.25	48	0.10
Pre_Albumin	4.15±0.64	3.389±1.17	-2.71	46	**0.005**
Pre_ Prealbumin	21.36±22.42	6.46±11.58	-1.92	44	**0.031**
Glucose	96.71±15.70	95.44±10.19	-0.23	48	0.41
Vit_D	51.29±38.64	46.89±24.71	-0.32	46	0.37
PNI Score	54.15±8.98	48.21±10.96	-1.71	46	**0.047**
No_ comorbidities	1.02±1.10	0.89±1.05	-0.33	52	0.37
Post_op_Hgb	11.02±1.61	10.38±1.74	-1.07	52	0.143
Post_op_Hct	32.88±4.73	31.53±5.19	-0.76	52	0.224
Post_op_ Albumin	3.77±1.12	3.19±0.80	-1.47	51	0.074
			Chi-square		P value
Female gender	16 (34.7 %)	6 (66.6%)	1.85		0.17
Any co-morbidities	9 (19.5%)	2 (22.2%)	0.09		0.76
Plastics closure	7 (15.2%)	1 (11.1%)	0.02		0.8
MRSA positive	2 (4.5%)	1 (11.1%)	0.0002		0.98
Seizure	22 (48.8%)	3 (33.3%)	0.23		0.62
Cardiac Co-morbidity	12 (26.6%)	2 (22.2%)	0.33		0.56
VP Shunt	5 (11.1%)	1 (11.1%)	0.17		0.67
Tracheostomy	4 (8.8%)	1 (11.1%)	0.24		0.62
G-tube	19 (42.2%)	4 (44.4%)	0.01		0.90

TLC- total lymphocyte count, PNI- Prognostic Nutritional Index

Comparison of NMS patients who developed deep SSI wrt pre-, intra-op and post-op parameters

33. Impact of Age at Time of Corrective Surgery on Outcomes in Neuromuscular Scoliosis: A Retrospective Cohort Study

Gregory I. Sacks, BS; Ryan S. Lebens, BS; James Barsi, MD

Hypothesis
Age at surgery will be correlated with outcomes of surgical correction for neuromuscular scoliosis

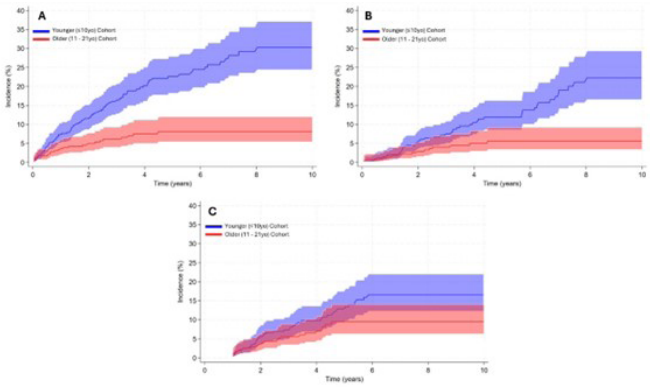
Design
Retrospective Cohort Study

Introduction
Neuromuscular scoliosis (NMS) refers to non-congenital spinal deformity secondary to musculoskeletal or neuromuscular diagnoses. There is controversy in the literature regarding optimal age of corrective surgery. We used a health network database to evaluate the impact of age at time of treatment on surgical outcomes.

Methods
The TriNetX Research Network was queried for patients ≤21 years old that underwent primary deformity surgery for treatment of NMS within the past 20 years. Patients were divided into two cohorts based on age at time of surgery: (1) ≤10 years old; (2) 11 – 21 years old. Confounding bias was controlled using propensity score matching. Outcomes were compared at several different time points following the procedure.

Results
The matched cohorts each included 426 patients. There was no significant difference in the incidence of infection or inflammatory reaction (P=0.889) or wound breakdown (P=1.000) between the two groups in the first year. Increased risk of pseudarthrosis (P=0.021; RR = 1.75, 95%CI 1.08 - 2.84) and device failure (P=.009; RR=1.84, 95%CI 1.15 - 2.94) between 1- and 10-years post-op were both significantly correlated with surgery at a younger age. Similarly, patients with younger age at time of surgery were at a 224% greater risk of undergoing revision (P<0.001; RR=3.24, 95%CI 2.11 - 4.97) within 10 years.

Conclusion
These results indicate that age at time of corrective surgery does not influence the risk of post-operative complications within the first year after surgery for patients with NMS. However, patients treated at ≤10 years of age are at significantly greater risk of long-term complications and necessity of future surgical revision. These findings are likely due to curve progression during adolescent growth, suggesting that waiting to correct deformities may reduce future medical burden for patients with neuromuscular scoliosis.



Cumulative Incidence Curves for A) Revision, B) Implant Failure, C) Pseudarthrosis, in the ≤10yo cohort (blue) and 11-21yo cohort (red). Shaded areas indicate 95% confidence intervals.

34. Outcomes of Posterior Spinal Fusion for Paralytic Scoliosis in Patients with Spinal Cord Injury

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Hypothesis
Patients with spinal cord injury (SCI) who require posterior spinal fusion (PSF) for progressive paralytic scoliosis are at a high risk for implant failure.

Design
Retrospective review of a single center database

Introduction
Paralytic scoliosis can occur in up to 100% of patients who

sustain an SCI before age ten. PSF to the pelvis is often required to correct pelvic obliquity and sitting balance. Paraplegic patients must perform repetitive trunk flexion for wheelchair propulsion, which may place increased strain on spinopelvic instrumentation. Few studies have evaluated the outcomes of this unique population.

Methods
Preop and minimum 2 year postop data of all SCI patients who underwent PSF for paralytic scoliosis at a single institution from 2009-2022 were analyzed.

Results
Thirty patients were identified. Mean followup was 4.4 years. Mean age at SCI was 4.3 years and mean age at PSF was 14.1 years. 90% (n=27) utilized a manual wheelchair. Coronal curve magnitude improved from a mean 74.6° to 15° (p<0.001) and mean pelvic obliquity from 15.2° to 4.8° (p<0.001) at latest followup. Mean estimated blood loss improved from 2371 mL in 2009-2012 to 1090mL from 2019-2023 (R2=0.33), while mean operative time did not significantly change over time. Seven patients (23%) required reoperation for L5/S1 pseudarthrosis a mean 3.7 years from index PSF. Patient undergoing reoperation vs. those that did not were significantly younger at the age of SCI (2.5 vs. 4.9 years, p=0.04) and had a higher BMI (27.0kg/m2 vs. 20.4kg/m2, p=0.04). All reoperation patients (n=7/7) used a manual wheelchair vs. n=20/23 patients who did not require reoperation, p=0.4. There were no other significant clinical or radiographic differences between the two groups.

Conclusion
30 patients with SCI underwent PSF to the pelvis a mean 10 years from their initial injury. 23% experienced rod fracture/nonunion at L5/S1 a mean 3.7 years postop. Nonunion patients had a significantly higher BMI compared to patients without implant failure and all used a manual wheelchair. Implant failure may be due in part to increased strain on instrumentation from repetitive trunk flexion required for wheelchair self-propulsion. We recommend preoperative weight optimization and consideration of supplementation with an L5/S1 interbody fusion to potentially reduce the stress on posterior instrumentation in this unique patient population.

	Reoperation (n=7)	No reoperation (n=23)	p-value
Age at Injury (yrs)	2.5 ± 1.7	4.9 ± 4.3	0.04
Age at Surgery (yrs)	13.5 ± 1.5	14.3 ± 1.5	0.25
Time from Injury to Surgery (yrs)	11.0 ± 1.7	9.8 ± 4.0	0.28
Preop Coronal Cobb (°)	75.4 ± 16.5	74.3 ± 24.4	0.9
Preop Coronal Balance (mm)	21.2 ± 10.1	30.2 ± 23.5	0.18
Preop Pelvic Obliquity (°)	14.8 ± 7.7	15.4 ± 9.9	0.89
Preop Thoracic Kyphosis (°)	35.2 ± 25.6	24.1 ± 18.3	0.25
Preop Lumbar Lordosis (°)	31.5 ± 27.5	27.1 ± 42.0	0.81
Preop SVA	10.9 ± 48.0	-1.3 ± 49.7	0.6
Latest Coronal Cobb (°)	20.5 ± 12.6	20.8 ± 12.4	0.61
Latest Coronal Balance (mm)	20.0 ± 17.6	11.9 ± 8.6	0.13
Latest Pelvic Obliquity (°)	4.5 ± 3.9	4.5 ± 4.6	0.7
Latest Thoracic Kyphosis (°)	29.6 ± 12.3	32.3 ± 12.7	0.96
Latest Lumbar Lordosis (°)	44.6 ± 13.7	43.6 ± 18.4	0.84
Latest SVA	-21.2 ± 43.7	-9.3 ± 40.2	0.46
BMI at Latest Followup	27.0 ± 6.0	20.4 ± 5.1	0.04
yrs: years			

35. Outcomes After Surgical Correction of Severe Scoliosis in Patients with Osteogenesis Imperfecta: A Prospective, Two-Year Minimum Follow-Up Study with Radiographic and Patient-Reported Outcomes

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Hypothesis
Modern surgical techniques for severe scoliosis in Osteogenesis Imperfecta (OI) patients improve both radiographic alignment and health-related quality of life (HRQOL).

Design
Single-center retrospective analysis of prospectively collected data.

Introduction
Surgical treatment for scoliosis in OI presents unique challenges due to severe curves and poor bone quality. While current techniques including cement-augmented pedicle screws have shown promising radiographic outcomes, comprehensive analysis of HRQOL remains limited.

Methods
This prospective study evaluated consecutive OI patients with thoracolumbar scoliosis undergoing posterior spinal fusion (2013-2022) with minimum two-year follow-up. Radiographic and patient-reported outcomes (SRS-22, CP CHILD, PROMIS) were assessed.

Results
The cohort included 35 patients (mean age 12.2±3.7 years, 50% female) with mean follow-up of 5.5±3.1 years. OI type 3 (severe) was most common (69%). Major and minor curvature showed significant improvement with correction rates of 56% and 55%, respectively (p<0.001). Other radiographic parameters showed significant improvement including AVT, LIV tilt, pelvic obliquity, and T10-L2 kyphosis (see Table). SRS-22 showed significant improvements in total score (3.6 to 4.1, p=0.002). Function, pain, and self-image domains achieved MCID with improvements from 3.6 to 4.1 (p=0.002), 3.8 to 4.3 (p=0.009), and 3.5 to 4.2 (p=0.001), respectively. Satisfaction domain also improved significantly (3.7 to 4.6, p<0.001). CP CHILD improved in positioning/transferring/mobility (69.9 to 73.6, p=0.04). PROMIS improved in fatigue (14.2 to 8, p=0.01), and pain (15.4 to 8.7, p=0.02). Regarding complications, one patient developed PJK and another sustained a femoral fracture one month postoperatively. No infections or neurological deficit were observed.

Conclusion
Modern surgical correction of severe scoliosis in OI patients achieved significant improvements in both radiographic parameters and patient-reported outcomes at two-year follow-up. The substantial improvements in curve correction combined with enhanced quality of life measures demonstrate the effectiveness of current surgical strategies in this

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challenging population. These findings provide valuable evidence for surgical decision-making and patient counseling regarding expected outcomes.

Parameters	Pre Op (Mean±SD)	Follow up (Mean±SD)	p.value
Major Cobb angle, °	72.3±15.1	32.2±17.4	<0.001*
Minor Cobb angle, °	53.8±13.9	24.1±12.1	<0.001*
AVT, mm	53.9±21.1	18.8±19.3	<0.001*
LIV tilt, °	25.9±10.3	10.2±6.8	<0.001*
Pelvic obliquity, °	9.9±6.0	6.9±1	0.04*
Coronal balance, mm	22.3±19.6	8.3±28.8	0.57
T1-T12 kyphosis, °	30.1±28.4	34.1±17.5	0.56
T10-L2 kyphosis, °	25.9±24.1	8.3±10.6	<0.001*
Lumbar lordosis, °	52.6±27.6	55.2±18.5	0.34

table

36. Correction Surgery for NF-1 Related Scoliosis Combined with Intraspinal Tumors: Is Tumor Resection Necessary?

Jun Qiao, PhD; Sai-hu Mao, PhD; Benlong Shi, PhD; Zhen Liu, PhD; Zezhang Zhu, PhD; Yong Qiu, PhD

Hypothesis
Resection of intraspinal tumor is not necessary during spine deformity correction for NF-1 related scoliosis

Design
A retrospective stud

Introduction
However, it is hard to radically resect tumors and high incidence of tumor recurrence would make the value of this procedure limited. In our hospital, we only perform correction surgery for those patients without neurological deficit. For patients with neurological deficit, we always choose spinal decompression rather than radical tumor resection. The objective of this study are to investigate outcomes and safety of correction surgery without resection of intraspinal tumor for NF-1 patients with spinal deformity and concomitant intraspinal tumor.

Methods
A retrospective analysis was conducted to identify a consecutive series of NF1 patients with intraspinal tumors who underwent correction surgery at our center between January 2000 and January 2022. Radiographic parameters were evaluated for coronal and sagittal spinal alignment combined with pelvic parameter: (1) curve angles of major thoracolumbar/lumbar curves and minor thoracic curves; (2) sagittal parameters included T5–T12 angle, T10-L2 angle, L1-S1 angle, and SVA.Whole spine MRs were performed for all the patients. The following parameters were determined: (1) level of tumor; (2) single or multiple tumors; (3) range of tumors; (4) tumor invasion rate: rate of maximum tumor area to spinal canal area at cross-section. Preoperative, postoperative and last follow-up neurologic function were analyzed using An American Spinal Injury Association (ASIA) neurologic examination.

Results
A total of 73 patients were included in the study, including 32 males and 41 females. Average age: 11.4 ± 3.7 years, postoperative AISA score increased by 1.7 grades while VAS score increased by 4.5 points. The tumor invasion rate was 63% before surgery and 36% after surgery. Coronal curve angle decreased from 68.3 °to 19.4 ° . Kyphosis decreased from 35.2 °to 12.2 °after surgery.

Conclusion
Correction surgery without resection of intraspinal tumor could achieve satisfactory spine deformity correction, and improvement of neurological function.

37. Proximal Junctional Kyphosis that Matters: Proximal Junctional Failure in Patients with Cerebral Palsy

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Hypothesis
Proximal junctional failure occurs at a lower rate in CP patients than reported

Design
Retrospective study that investigated the rate of Proximal Junctional Failure (PJF) in Cerebral palsy (CP) patients who underwent spinal fusion in a prospectively collected multicenter Harms registry of 494 patients, including radiographic imaging,post-surgical complications,levels fused,and proximal anchors used.

Introduction
Proximal junctional kyphosis (PJK) is a complication of posterior spinal fusion, especially neuromuscular scoliosis (NMS) population. PJK can lead to pain, neurological impairment, and mechanical instability. PJF is defined as PJK with (1) fracture of the UIV, (2) anterolisthesis, (3) new neurologic deficit, or (4) need for mechanical revision surgery. It is reported at a rate of 7% in the neuromuscular population.The aim of this study was to investigate the rate of true proximal junctional failure in patients with CP

Methods
Patients included were those who had spinal fusion, CP, and a minimum of two years of postoperative follow-up. There were 494 patients followed for (mean follow-up 5 years and with range of 12 years). Patients were screened for a PJK of ≥10° increase in the sagittal angle between the inferior endplates of the upper instrumented vertebra (UIV) and two vertebrae above, total of 83 patients (16.8%). They were further screened and evaluated based on post-operative radiographs, which were individually reviewed to detect all instances of failure, and complications as listed above. There were 17 revisions surgeries and of those only three had PJF.

Fischer's test was used to compare PJF rates based on fusion level and instrumentation.

Results
Of 494 patients, 3(0.6%) met the PJF criteria, representing 3.6% of PJK patients. Of 65 patients fused above T2, 1.54%(1/65) developed PJF. Of 430 fused T2 and below, 0.46%(2/430) developed PJF. No significant difference was noted(p=0.348). UIV anchor types included screws(175), wires(53), and hooks(264). PJF occurred in 0.57%(1/175) with screws,1.89% (1/53) with wires, and 0.38%(1/264) with hooks. No significant difference was noted (p=0.338). No patient developed myelopathy due to PJF.

Conclusion
This is the largest study cohort to report PJF. Our population demonstrates that there is a lower prevalence of PJF in CP than previously reported and that neither UIV level nor anchor type instrumentation seem to be a risk factor in developing PJF.

38. How Sagittal Alignment Changes Can Affect Independent Horizontal Gaze After Neuromuscular Scoliosis Correction

Sung Taeck Kim, MD; *Sam Yeol Chang, MD*; Hyoungmin Kim, MD, PhD; Bong-Soon Chang, MD, PhD; Jeuk Lee, MD; Ihnseok Chae, MD; Dong-Gune Chang, MD, PhD

Hypothesis
Changes in sagittal alignment after surgical correction of neuromuscular scoliosis (NMS) can make it difficult to maintain independent horizontal gaze in patients with neck flexor weakness.

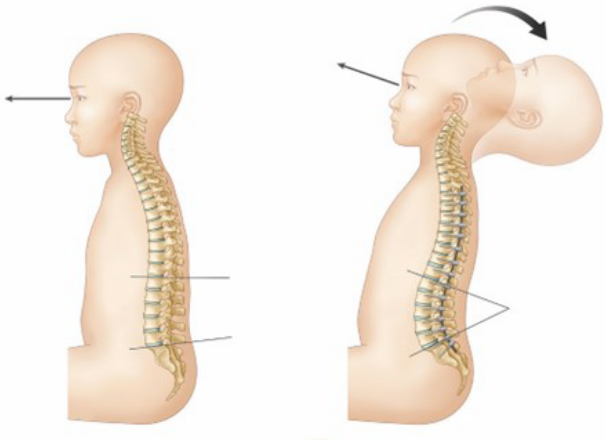
Design
A retrospective case series

Introduction
Neck flexor weakness is common in patients with neuromuscular diseases. When surgical correction for spinal deformity is performed for these patients, sudden changes in sagittal spinal alignment after surgery can cause difficulties in maintaining independent horizontal gaze. This study aimed to analyze the surgical and radiological factors associated with the ability to maintain an independent horizontal gaze following deformity correction surgery in patients with NMS.

Methods
We retrospectively reviewed consecutive patients with NMS who underwent surgical correction from 2013 to 2023 in a single tertiary center. Only patients who were able to maintain independent horizontal gaze in a sitting position before surgery were included in this study. We assessed whether the patient could maintain a horizontal gaze without a headrest after deformity correction. We measured the radiographic parameters such as cervical lordosis (CL), thoracic kyphosis (TK), lumbar lordosis (LL), chin-brow vertical angle (CBVA), C2-7 sagittal vertical axis (C2-7 SVA), and T1 slope before and after surgery to identify factors associated with the loss of head control.

Results
A total of 88 patients (male 57, female 31) with a mean age of 13.8 years were included in this study. After deformity correction, 31 (35%) patients could not maintain a horizontal gaze without a headrest. The group of patients who maintained horizontal gaze had a significantly greater postoperative CBVA (7.3°±10.6 vs. -5.9°±11.6, p=0.003) and C7-S1 SVA (67.0mm±46.5 vs. 29.3mm±40.1, p=0.001) than the group who could not. Logistic regression analysis showed that a greater increase of LL (odds ratio=1.018, p=0.039) and spinopelvic fixation (odds ratio = 3.520, p = 0.018) were associated with an inability to maintain horizontal gaze.

Conclusion
In this study, the loss of ability to maintain independent horizontal gaze after deformity correction for NMS was associated with a greater increase in lumbar lordosis and spinopelvic fixation. Maintaining preoperative sagittal balance is crucial for head control in patients undergoing deformity correction for NMS.



Loss of head control and horizontal gaze after deformity correction

39. Intraoperative Traction Does Not Improve Curve or Pelvic Obliquity Correction in a Matched Cohort of Patients with Neuromuscular Scoliosis

Alastair Sterns, BS; Jacquelyn Valenzuela-Moss, BS; Tyler Tetreault, MD; Tiffany N. Phan, BA; Efrain Amaro, BS; Gerard Williams, MD; Lindsay M. Andras, MD; *Michael J. Heffernan, MD*

Hypothesis
There will be no difference in curve or pelvic obliquity correction in patients with intraoperative traction (IOT) compared to controls (no IOT).

Design
Single-center, case-control study

Introduction
IOT is utilized as an adjunct to address large curves in neuromuscular scoliosis (NMS). Despite several reports highlight-

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ing the benefits of IOT, there remains significant variability in its use. Further, existing studies are limited by differences in preoperative curve severity. The purpose of this study was to evaluate the utility of IOT in a matched cohort at a high-volume NMS center.

Methods
A nested case control study was performed on a single-center retrospective database of NMS patients. Those diagnosed with cerebral palsy were pair-matched by age (±1 year), preoperative curve magnitude (±10), preoperative traction curve magnitude (±10°), and flexibility index (±5%). Independent t-tests or Wilcoxon rank-sum tests were used to analyze continuous variables between groups, depending on variable distribution. Fischer's Exact tests were used to compare categorical variables by group.

Results
Thirty-one unique case-control matches were identified for a total of 62 patients. IOT and No IOT groups were similar in terms of EBL 855 (IQR 500-1200) vs 800 (IQR 650-1350) cc (p=0.60), length of ICU stay 1.7 (IQR 1.0-2.7) vs 2.3 (IQR 1.7-3.1) days (p=0.14), BMI 18.0 (IQR 14-20) vs 15.5 (IQR 14-18) (p=0.10), sex distribution 54.8% vs 51.6% (p>0.99), changes in neuromonitoring signals 4/31 (13%) vs 3/31 (10%) (p>0.99), and number of osteotomies 5.5 (IQR 3-8) vs 4 (IQR 3-7) (p=0.44). Complication rate was 22.6% (7/31) for IOT and 16.1% (5/31) for no IOT (p=0.23). There were no statistical differences in surgical time 414 ±131 vs 397±133 min (p=0.64) or anesthesia time 551±136 vs 529±135 min (p=0.56). Both groups had similar postoperative curve magnitude 37° vs 42° (p=0.28) and percent curve correction IOT=60% vs no IOT=56% (p=0.30). Percent correction of pelvic obliquity was also similar 78% (IQR 67-90) vs 68% (IQR 60-91), p=0.18) between groups. (Table 1)

Conclusion
While IOT is safe, in contrast to previous literature, IOT was not associated with improved correction in a carefully matched cohort of NMS patients.

Variable	Cases (IOT, N=31)	Controls (No IOT, N=31)	p-value
Preoperative Measurements			
Age (years)	14 (IQR: 12-17)	14 (IQR: 13-16)	0.6805
Sex, male (N, %)	17 (54.8%)	16 (51.6%)	>0.999
Curve Magnitude (degrees)	88 (IQR: 80-106)	88 (IQR: 79-107)	0.7512
Traction Curve Magnitude (degrees)	65.3±17.5	66.3±17.6	0.8176
Flexibility Index (degrees)	29.5±12.7	29.2±12.6	0.9205
Pelvic Obliquity (degrees)	25 (IQR: 19-31)	23 (IQR: 11-35)	0.6984
Surgical and Post-Operative Measurements			
Residual Curve Magnitude (degrees)	36.9±17.0	41.6±17.1	0.2775
Percent Curve Correction (%)	60.1±16.9	56.0±14.3	0.3030
Number of Osteotomies (median)	5.5 (IQR: 3-8)	4 (IQR: 3-7)	0.4371
Estimated Blood Loss (ccs)	855 (IQR: 500-1200)	800 (IQR: 650-1350)	0.5980
Change in Neuromonitoring Signals (N, %)	4/31 (12.9%)	3/31 (9.7%)	>0.999
Surgical Time (minutes)	413.7±131.4	396.8±132.9	0.6388
Anesthesia Time (minutes)	550.6±135.8	529.2±134.7	0.5585
Operating In-Room Time (minutes)	530.6±132.9	500.1±125.0	0.3928
Residual Pelvic Obliquity (degrees)	4 (IQR: 1-12)	4 (IQR: 2-13)	0.5625
Percent Pelvic Obliquity Correction (%)	78.3 (IQR: 66.7-90.2)	68.3 (IQR: 60.2-90.5)	0.1841
Complications	7/31 (22.6%)	5/31 (16.1%)	0.2310

Results are presented as N(%) for categorical variables, mean±SD for variables meeting assumptions of normality, and median (IQR: p25-p75) for skew variables.

Table 1: Preoperative, Surgical, and Postoperative Measurements Between Groups

40. Intrathecal Baclofen Pumps Do Not Increase Complications Following Spinal Fusion in Non-Ambulatory Patients with Cerebral Palsy

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Hypothesis
Children with intrathecal baclofen pumps (ITBP) are at a higher risk for complications after fusion surgery compared to those without pumps.

Design
Retrospective cohort

Introduction
Children with non-ambulatory cerebral palsy (CP) often have neuromuscular scoliosis (NMS) that requires surgical correction. Many of these children also use ITBP to mitigate severe spasticity. The ITBP can complicate spine surgery due to the proximity of the pump and catheter to the surgical area. The aim of this study was to compare surgical outcomes and perioperative complications following spinal fusion between patients with and without ITBP.

Methods
This single-center, IRB-approved study included patients who underwent spinal fusion between 2001-2021. Eligibility criteria were diagnosis of CP and NMS, non-ambulatory, spinal fusion before 21 years of age, >2 years of follow up, and no prior spinal deformity surgery. Data were abstracted from the electronic medical record. Descriptive statistics were calculated for all variables across the total cohort and stratified by study group (ITBP or no ITBP). Perioperative complications and outcomes were compared between study groups using Fisher's exact tests or Mann-Whitney U tests (alpha level=0.05).

Results
Eligible patients (total: n=334, ITBP: n=163; no ITBP: n=171) were 14.0+3.5 years old and 59.6% were male. Patients with ITBP were not more likely to experience at least one complication compared to those without ITBP (p=.19). However, those with ITBP had significantly longer median surgery duration (ITBP: 444 min.; no ITBP: 391 min., p<.001) and significantly higher median percentage of blood loss during surgery (ITBP: 36%; no ITBP: 27%, p=.01) compared to those without ITBP (Table 1). Of the 163 patients with ITBP, 18 (11%) experienced an ITBP- or ITBP catheter-related complication.

Conclusion
Children with non-ambulatory CP with ITBP are not more likely to experience complications following spinal fusion surgery compared to those without ITBP. However, children with ITBP had longer surgery durations and a higher percentage of blood loss compared to those without ITBP. To our knowledge, this is the largest study on this topic to date. Our results will help improve counseling between providers,

patients, and caregivers as to the risks and outcomes of spinal fusion surgery in children with ITBPs.

Outcomes following spinal fusion	ITB Pump	No ITB pump	OR [95% CI]	p-value
	n=163	n=171		
At least one complication	88 (54.0%)	79 (46.2%)	1.37 [0.87, 2.15]	.19
Perioperative outcomes				
Length of ICU stay, days	2 (2)	2 (1)	-	.55
Length of hospital stay, days	7 (3)	7 (3)	-	.30
Duration of surgery, minutes	444 (148.8)	391 (157.5)	**56.0 [25.0, 84.0]**	**<.001***
Blood loss, %	36.3 (36.3)	27.2 (26.0)	**6.1 [1.7, 11.0]**	**.01***
Curve correction, %	60.8 (31.8)	60.0 (26.3)		.92

* indicates statistical significance.

Table 1. Complication and perioperative outcomes (n=334).

41. Socioeconomic Status Affects Severity of Neuromuscular Scoliosis at Time of Surgery

Margaret Crownover, BS; Suken A. Shah, MD; Petya Yorgova, MS; M. Wade Shrader, MD

Hypothesis
Lower socioeconomic status (SES), race, and public insurance status independently affect preoperative diagnosis severity for children with NMS

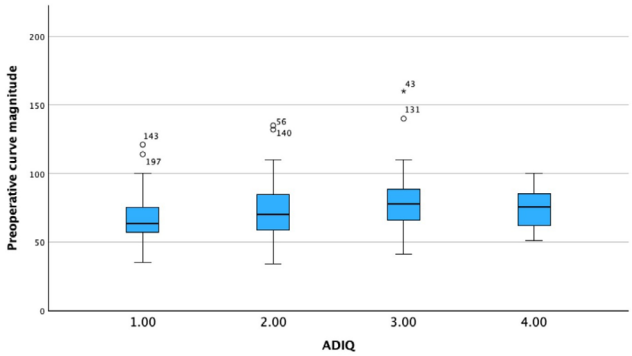
Study Design
Single institution retrospective chart review

Introduction
Pediatric patients with severe neuromuscular scoliosis (NMS) often require posterior spinal fusion (PSF) surgery. Curve magnitude, among other comorbidities, is a risk factor for worse postoperative outcomes, and social determinants of health can also have significant effects on patient outcomes.

Methods
We utilized the area deprivation index (ADI) and insurance type (private vs. public) to stratify groups for analysis. Higher ADI indicates higher socioeconomic deprivation. We studied 216 patients with NMS who underwent PSF >13 levels between 2015 and 2020 at our institution (112 [52%] female/104 [48%] male). The most common diagnosis was quadriplegic cerebral palsy (168 [78%]). Race slightly favored Caucasian (136 [63%]); more patients had private rather than public insurance (114 [53%] and 102 [47%], respectively).

Results
Patients with higher ADI had larger preoperative curve magnitudes (P = 0.002) and higher outpatient no-show rates (P < 0.001). They were more likely to be from single caregiver households (P = 0.031), publicly insured (P < 0.001), and non-White (P < 0.001). Publicly insured patients presented with more comorbidities (P = 0.029) and had higher outpatient no-show rates (P < 0.001) and mean ADI (P < 0.001). They were less likely to seek second opinions (P < 0.001) and more likely to be from single caregiver households (P < 0.001). Non-White patients had a higher mean ADI (P < 0.001), higher no-show rates (P < 0.001), were more likely to be publicly insured (P < 0.001), and presented with more comorbidities (P = 0.014).

Conclusion
SES has significant effects on patients with NMS, as those with lower SES and public insurance presented with greater preoperative curve magnitudes, more comorbidities, and higher outpatient no-show rates. Barriers to accessing subspecialty care (i.e., transportation, income limitations) and varying levels of health literacy likely affected these findings. Greater diagnosis severity at presentation may affect outcomes afforded by surgery and pose a higher risk of postoperative complications. Efforts should focus on identifying this population at risk preoperatively and providing education and resources to mitigate the effect of SES on diagnosis severity prior to PSF for NMS.



42. Neurofibroma Subtypes and Spinal Dural Ectasia: Key Factors Driving Rapid Scoliosis Progression in Neurofibromatosis Type 1 on Whole-Body Magnetic Resonance Imaging

Ji Uk Choi, MD; *Chang Ju Hwang, MD, PhD*

Hypothesis
The topographic features of neurofibromas significantly influence the progression rate of scoliosis in NF1 patients.

Design
Retrospective cohort study

Introduction
Neurofibromatosis type 1 (NF1) is often associated with scoliosis, where curve progression demonstrates significant heterogeneity. While previous studies have identified dystrophic features as risk factors, the role of neurofibroma subtypes, their specific anatomical location, and spinal dural ectasia in scoliosis progression remains unclear.

Methods
Among 1,936 genetically confirmed NF1 patients, 183 patients with scoliosis and complete whole-body magnetic resonance imaging (WBMR) data were analyzed. Patients were classified into rapid progression (angular velocity > 10°/year) and stationary groups. Neurofibromas were categorized by subtype (superficial, diffuse, deep localized/plexiform, MPNST) and location (intracurvature/extracurvature, apex-adjacent/non-adjacent, concave/convex). Dystrophic scoliosis was classified according to established radiographic

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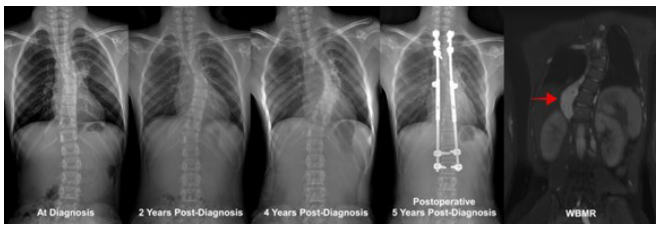
criteria. Logistic regression determined risk factors for rapid progression.

Results
The prevalence of NF1-associated scoliosis was 10.3% (199/1,936 patients) in our cohort. Among the 183 included patients, 21% demonstrated rapid progression. Deep localized/plexiform neurofibromas showed a significant correlation with rapid progression (OR: 3.2, $p < 0.01$), especially when located intracurvature on the convex side of the curve. In contrast, other neurofibroma subtypes including superficial, diffuse variants, and MPNST showed no significant association with progression rates. Spinal dural ectasia was identified in 13% of the study population and emerged as an independent risk factor for rapid progression (OR: 2.7, $p < 0.05$). Furthermore, patients presenting with more than three dystrophic features at initial diagnosis demonstrated substantially higher risk for rapid progression (OR: 4.1, $p < 0.01$).

Conclusion
This study identifies key predictive factors for rapid curve progression in NF1-associated scoliosis, specifically highlighting the significance of deep localized/plexiform neurofibromas on the convex side, along with the presence of spinal dural ectasia. These findings emphasize the role of WBMR in risk stratification for optimal treatment planning.



Serial spine radiographs and WBMR in NF1 patient with progressive scoliosis.

43. Impact of Cervical Alignment Parameters on Surgical Outcomes Following Posterior Cervical Fusion: A Multi-Center Comparative Analysis of T1–CL and TIA Correlations

Devender Singh, PhD; Eeric Truumees, MD; Morgan Laviolette, DPT; Qais Zai, MD; Vik Kohli, MD; Matthew Geck, MD; Rory R. Mayer, MD; John Stokes, MD; *Sara L. Paul PA-C*

Hypothesis
Cervical Mismatch has a significant effect on sagittal alignment and patient reported outcomes in long posterior cervical fusions

Design
Multi-center retrospective study

Introduction
Cervical sagittal alignment has a profound effect on spinal biomechanics, horizontal gaze, and functional outcomes. Increasing attention has been given to two parameters: the dynamic measure of T1 slope minus cervical lordosis (T1–CL), and the static anatomical parameter known as thoracic inlet angle (TIA). These parameters are emerging as predictive tools akin to lumbar PI–LL mismatch, offering insight into deformity correction and surgical planning. This study aimed to evaluate how both T1–CL and TIA affect radiographic and patient-reported outcomes (PROs) in patients undergoing multilevel posterior cervical or cervicothoracic fusions.

Methods
We conducted a retrospective, multi-center review involving 713 patients who underwent ≥3-level posterior cervical or cervicothoracic fusion terminating at C7, T1, or T2. The T1–CL cohort included 356 patients, and the TIA cohort included 357 patients. Demographic variables, radiographic measurements (T1 slope, cervical lordosis, sagittal vertical axis [SVA], cervical SVA [cSVA], and TIA), and patient-reported outcomes (Visual Analog Scale [VAS] and Oswestry Disability Index [ODI]) were analyzed over a two-year follow-up period. Patients were stratified based on percentile distribution of T1–CL values and correlation strength between TIA and alignment parameters was assessed.

Results
A strong correlation was found between T1–CL and SVA ($r = 0.76$), VAS ($r = 0.65$), and ODI ($r = 0.62$). Patients with T1–CL values in the range of 21.7° to 34° demonstrated significantly better outcomes, including mean SVA of 20.6 mm, VAS score of 3.2, and ODI of 32.6 at two years. In contrast, patients with greater mismatch exhibited progressively worse alignment and PROs. TIA remained largely unchanged postoperatively but exhibited strong correlations with T1 slope ($r^2 = 58.4$) and cSVA ($r^2 = 63.4$). However, its association with VAS and ODI was weak, suggesting limited direct predictive utility for symptom severity.

Conclusion
T1–CL, as a dynamic parameter, is closely associated with cervical sagittal alignment and clinical outcomes following posterior cervical fusions. In contrast, TIA serves as a static anatomical reference useful in surgical planning but less directly predictive of patient-reported symptoms. These findings underscore the importance of minimizing T1–CL mismatch intraoperatively while considering TIA for preoperative planning to optimize functional recovery and alignment.

44. Delineation of Alignment Goals for Adult Cervical Deformity Correction for Optimal Clinical and Functional Outcomes

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Hypothesis
Specific radiographic alignment targets will be associated with optimal clinical/functional outcomes in cervical deformity (CD) patients.

Design
Retrospective analysis of a prospectively enrolled database.

Introduction
Surgical correction of CD can restore alignment and function but carries higher risk of complications and subsequent failure. It remains unclear which baseline and postoperative radiographic parameters correlate with improved HRQL metrics and minimized complications.

Methods
Operative CD patients with a UIV>C7 and with BL and ≥ 2Y radiographic/HRQL data included. CD defined as ≥1 of: C2-C7 lordosis<-15°, TS-CL>35°, segmental cervical kyphosis>15° across any three vertebrae between C2-T1, C2-C7 SVA>4 cm, McGregor's slope>20°, or CBVA>25°. An optimal outcome defined as no DJF and meeting Virk et al.'s criteria for good clinical outcome [≥2 of NDI <20 or meeting MCID, mild myelopathy (mJOA≥14), NRS-Neck≤5 or improved by ≥2 points from BL]. Regression analysis and Chi-squared Automatic Interaction Detector (CHAID) identified BL and 3-month postoperative radiographic thresholds predictive of an optimal outcome.

Results
340 patients met inclusion criteria (57.5±10.8 years, 48% F, 29.1±6.6 kg/m2, CCI 0.81±1.2) and underwent surgery (levels fused=5.0±3.6, EBL=496 mL, OR time=277 min). Mean BL radiographic parameters: SS=35.5°, PT=18.5°, PI-LL=-0.3°, SVA=0.1 mm, T2-T12 kyphosis=-37.3°, T1S=29.2°, C2-C7 lordosis=-6.1°, TS-CL=29.4°, C2S=30.7°, cSVA=29.0 mm, C2-T3=-10.6°, and C2-T3 SVA=53.5 mm. Mean BL HRQLs: NRS back=6.0, NRS neck=7.3, NDI=56.3, mJOA=12.9, and EQ5D=5.8. At 1Y, 79 patients (23.2%) met optimal outcome criteria, and 55 (16.2%) met criteria at 2-3Y. Regression analysis with CHAID identified these radiographic thresholds predictive of an optimal outcome: BL T1S≤18.3° (OR=3.2, 95%CI [1.63-6.27], p<.001), 3M T1S≤31° (OR=16.3, 95%CI [1.94-145.95], p = 0.012), and 3M C7-S1 SVA≤ 38° (OR=44.4, 95%CI [4.55-432.22], p = 0.001).

Conclusion
This study suggests novel baseline radiographic thresholds and postoperative realignment goals associated with favorable functional/clinical outcomes in patients undergoing surgery for CD.

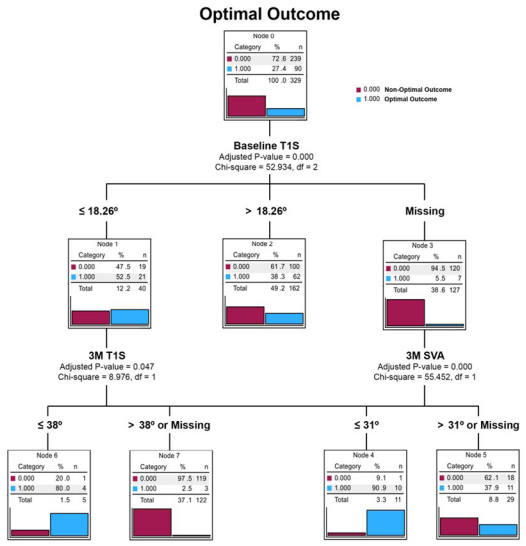

Figure 1: CHAID Tree of Thresholds for Optimal Outcomes

45. Innovative Coronal Plane Parameters for Cervical Spine Deformity: Significance of Coronal Plane Horizontal Gaze

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Hypothesis
Innovative coronal parameters correlate with conventional metrics and may better predict sagittal alignment and outcomes

Design
Prospective Multicenter Study

Introduction
Cervical deformity (CD) often involves both coronal and sagittal malalignment. Conventional metrics like the C2-C7 Coronal Cobb Angle (CCA) fail to fully capture coronal malalignment in severe cervical kyphosis. This study introduces innovative coronal parameters to enhance the evaluation of cervical coronal alignment

Methods
A multicenter CD database was analyzed. Conventional metrics included C2-7 Sagittal Cobb angle (SCA), C2-7 SVA, C7-S1 CVA, T1 slope, and chin-brow vertical angle (CBVA). Innovative parameters included Bilateral Orbits-Coronal Angle (BOCA), Bilateral Clavicle-Coronal Angle, Bilateral Iliac Crest-Coronal Angle, Bilateral Hip-Coronal Angle, Nasion-T1 CVA, and Nasion-S1 CVA. HRQoL measures (NRS, NDI, mJOA, PROMIS) were evaluated. Correlations were done to

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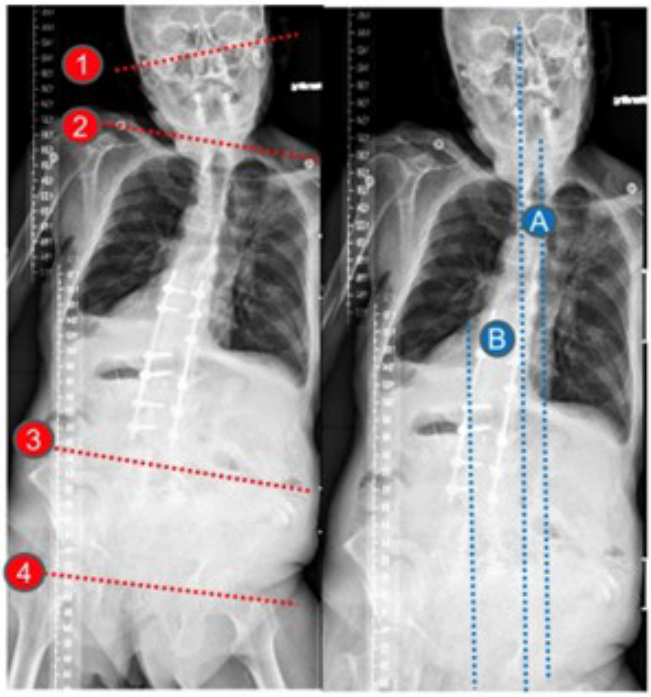
assess relationships between the radiographic parameters. Multivariate analysis was done to evaluate impact of correcting these innovative parameters on postoperative sagittal alignment.

Results
A total of 140 patients (female 62%, mean age 64) were analyzed. 12.2% had a BOCA >10°, and 17.8% had a CCA >10°. BOCA significantly correlated with CCA (r 0.2; p 0.01), C2-7 SVA (r 0.26, p<0.01). Nasion-T1 correlated with SCA (r 0.2; p 0.02), T1 slope (r 0.2; p 0.016) and C7-S1 SVA (r 0.17, p 0.036). Nasion-S1 correlated with T1 slope (r 0.19, p 0.02), C2-7 SVA (r 0.27, p<0.001) and C7-S1 CVA (r 0.66, p < 0.001). In patients with cervical kyphosis, BOCA demonstrated a stronger correlation with C2-7 SVA (r 0.28; p 0.005) and CBVA (r 0.52, p 0.023) compared to CCA (r 0.14; p 0.088, r=0.43, p 0.047 respectively). No significant correlation was found between the innovative parameters and HRQoL measures. On multivariate analysis, BOCA correction was a significant predictor of postoperative C2-7 SVA (p 0.008), and Nasion-S1 correction was a significant predictor of postoperative T1 slope (p 0.043).

Conclusion
BOCA, Nasion-T1, and Nasion-S1 CVA correlated with conventional coronal and sagittal cervical spine parameters. These innovative parameters may be valuable adjuncts for evaluating coronal cervical deformity in patients with severe cervical kyphosis. Future studies should be conducted on the clinical relevance of surgical correction of these innovative coronal parameters.



The innovative coronal plane parameters, 1) Bilateral Orbit-Coronal Angle (BOCA), 2) Bilateral Clavicle-Coronal Angle, 3) Bilateral Iliac Crest-Coronal Angle, 4) Bilateral Hip-Coronal Angle, A) Nasion-T1 Coronal vertical axis, B) Nasion-S1 Coronal Vertical Axis

46. Optimizing Modifiable Health Conditions Prior to Adult Cervical Deformity Surgery Associated with Fewer Complications

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Hypothesis
Preoperatively optimizing modifiable health conditions lead to better perioperative and postoperative outcomes in operative adult cervical deformity (ACD) patients.

Design
Retrospective

Introduction
While benefits to surgical outcomes from optimizing comorbidities prior to surgical ACD correction is hypothesized, this has not yet been studied.

Methods
ACD patients with available 2Y data included. Preoperative optimization for osteoporosis was assessed by treatment with an FDA approved drug prior to surgery. Patients were divided into 2 groups: those who had preoperative rehabilitation [Prehab] and those who did not [no Prehab]. Prehab consisted of cognitive behavioral therapy and physical therapy with core, paraspinal and leg strengthening. Nutritional status assessed by ranking patients into quartiles (Q1-Q4) by baseline BMI. Q1 (low BMI) and Q4 (high BMI) were considered not optimized. Patients stratified by optimization in all three groups (Opt) or non-optimized. ANCOVA and logistic regression analyses assessed outcomes while accounting for surgical and demographic differences between groups.

Results
347 patients (57.9±12.1 years, 48%F, 29.0±6.82kg/m2) included. Optimized patients were less female (43% vs. 52%, p=.038) and had fewer levels fused (4.14±3.50 vs. 5.21±4.15, p=.002), shorter length of stay (3.96±3.94 vs. 5.12±8.18 days, p=.044), less operative time (261.9±166.6 vs. 315.8±189.7 mins, p=.002), and lower EBL (502.8±950.6 vs. 679.0±965.5 mL, p=.039). Optimized patients trended towards being younger (p=.199) and having fewer osteotomies (p=.314) but this was not significant. When comparing means for perioperative outcomes and cost, optimized patients experienced fewer minor complications (9.12% vs. 16.5%, p=.010. However, optimized patients were similar to not optimized patients when comparing mean rate of reoperations and reaching MCID for mJOA at 2 years (all p>.05). A stepwise regression model was significant higher odds of reaching MCID for NDI for optimized patients when controlling for gender, levels fused, operative time, and EBL (OR: 1.406 [1.169-1.691], p<.001. Optimized patients had

lower odds of overall complications at 2 years (OR:.45 [1.02, 1.89], p=.009) with lower rates of DJK and DJF development (p<.05).

Conclusion
Patients undergoing corrective cervical deformity surgery benefit from preoperative optimization, emphasizing its importance in surgical planning.

47. Predictors of Achieving Neck Disability Index Minimum Clinically Important Difference Following Cervical Deformity Surgery

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Hypothesis
Patients with higher neck disability index (NDI), improved sagittal alignment, and fewer comorbidities are more likely to achieve minimum clinically important difference (MCID) as measured by NDI.

Design
Retrospective review of a prospective multicenter cervical adult spinal deformity (ASD) database.

Introduction
Cervical deformity surgery often treats pain and disability by correcting spinal alignment with goals and outcome measures that are not well understood.

Methods
Patients undergoing cervical deformity surgery with a minimum of one year follow-up were included. All patients had baseline and one year NDI scores. Patients met MCID with an improvement of NDI by 7 between baseline and one year as previously established. Baseline demographics, comorbidities, and both baseline and one-year spinopelvic parameters were evaluated for statistical significance (p<0.05) on a univariable logistic regression analysis. Significant variables, in addition to baseline NDI, were analyzed in a multivariable logistic regression model by backwards selection with AIC minimization.

Results
A total of 122 patients were included with a median (IQR) age of 62 (56,69) and 62% were female. Of the 122 patients included, 72 (59%) achieved NDI MCID at one year. Predictors of achieving MCID on univariate analysis included a lower Charlson Comorbidity Index (CCI) total score (OR 0.70, p=0.03), depression as a comorbidity (OR 2.9, p=0.02), lower C2 tilt at one year f/u (OR 0.92, p=0.02), and a greater difference between 1yr postoperative C2-C7 SVA and pre-operative C2-C7 SVA (OR 0.98, p=0.0495). On multivariable logistic regression analysis with an AUC of 0.74, predictors of achieving MCID included a lower CCI (OR 0.62, p=0.03), depression as a comorbidity (OR 3.1, p=0.059), a greater reduction in C2-C7 SVA at one year f/u compared to baseline (OR 0.97, p=0.055), and baseline NDI (OR 1.02, p=0.24).

Conclusion
The best-fit multivariate model included higher baseline NDI, a greater reduction in C2-C7 SVA, patient-reported baseline depression, and lower CCI as important factors in predicting NDI MCID. These variables can be considered during patient counseling and alignment planning to optimize patient pain and disability.

	[ALL]	MCID = 0	MCID = 1	Odds Ratio	CI Lower	CI Upper	P-Value
	N=122	N=50	N=72	Univariate Analysis			
Baseline NDI	47.0 [32.5;61.5]	45.0 [30.0;57.5]	48.0 [38.0;62.0]	1.0205	0.9995	1.0433	0.0616
One Year NDI	38.0 [16.0;54.0]	51.0 [38.0;63.5]	26.0 [12.0;40.0]	335259551.4000	2.91E+240	Inf	0.9958
Difference Baseline NDI minus One Year	10.0 [0.00;21.0]	-4.00 [-9.50;0.00]	18.0 [12.0;26.0]	1.8148	0.8632	3.8479	0.1168
Charlson Total Score	0.50 [0.00;1.00]	1.00 [0.00;2.00]	0.00 [0.00;1.00]	0.6993	0.4921	0.9477	**0.0302**
Depression	37 (30.3%)	9 (18.0%)	28 (38.9%)	2.8990	1.2595	7.1868	**0.0157**
Diabetes Mellitus	12 (9.84%)	8 (16.0%)	4 (5.56%)	0.3088	0.0784	1.0435	0.0677
Steroid Use	6 (4.92%)	5 (10.0%)	1 (1.39%)	0.1268	0.0065	0.8192	0.0632
T1 slope minus cervical lordosis 1yr	28.1 [19.7;35.0]	30.1 [22.6;40.6]	26.9 [19.5;33.7]	0.9743	0.9443	1.0035	0.0902
T1 Spinopelvic Inclination 1yr	-4.74 [-7.63;-1.15]	-2.54 [-7.12;0.71]	-5.06 [-8.23;-2.44]	0.9339	0.8685	0.9978	0.0509
C2 Spinopelvic Inclination 1yr	-0.23 [-3.87;3.04]	2.28 [-3.50;6.05]	-1.01 [-4.22;0.73]	0.9192	0.8520	0.9853	**0.0216**
C2-C7 SVA Pre	48.0 [26.8;65.6]	53.5 [26.8;66.8]	47.2 [31.3;63.5]	1.0002	0.9850	1.0155	0.9818
C2-C7 SVA 1yr	40.3 [26.7;53.4]	45.4 [32.8;59.4]	39.4 [25.6;48.3]	0.9775	0.9536	1.0003	0.0602
C2-S1 SVA 1yr	45.4 [11.8;115]	98.3 [14.7;120]	38.9 [10.6;72.4]	0.9947	0.9888	1.0004	0.0750
C2-C7 SVA 1yr minus Pre	-6.42 [-19.82;3.64]	-2.50 [-14.61;11.4]	-11.41 [-21.04;2.72]	0.9753	0.9501	0.9992	**0.0495**
T1 slope minus cervical lordosis 1yr minus Pre Percent Diff	-27.09 [-45.33;3.82]	-28.60 [-42.02;9.76]	-24.96 [-48.54;-1.05]	1.0008	0.9975	1.0048	0.6078
Cervical Lordosis C2 to C7 1yr minus Pre Percent Diff	-89.34 [-146.18;-3.33]	-83.45 [-175.32;-4.20]	-103.01 [-145.31;-8.41]	0.9998	0.9988	1.0007	0.7265

48. Reduced Preoperative Cervical Spine Flexion-Extension Range of Motion is Associated with the Development of Upper Thoracic Proximal Junction Kyphosis in Adult Spinal Deformity Patients

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Hypothesis
Cervical range of motion (c-ROM) is significantly associated w/ the development of symptomatic PJK/PJF(S-PJK/PJF)

Design
Retrospective analysis of a single-center database of ASD pts instrumented to the pelvis with a UIV of T1-T4

Introduction
The development of PJK/PJF following ASD surgery persists despite the numerous risk factors that have been identified. It is currently unknown whether flexion-extension(Flex-Ex) dynamic cervical XRs may be a risk factor.

Methods
151 ASD pts instrumented to the pelvis and treated w/ an UIV from T1-T4, all of whom had preop Flex-Ex C-spine XRs, were stratified into 3 groups: No-PJK, asymptomatic PJK(A-PJK), S-PJK/PJF. XR measurements included c-ROM, flexion, extension, and cSVA. Demographics and radiographic parameters were compared between groups and a multivariable regression model was built to discern the association between cervical parameters and the development of PJK/PJF.

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Results
Mean age, BMI, and female composition was 59.6yrs, 25.1, and 88.7%, respectively. The pts separated into those w/ No-PJK(N=111,73.5%), A-PJK(N=21, 13.9%) and S-PJK/PJF(N=19, 12.6%). There were no differences between the groups in terms of age, BMI, gender, instrumented levels(TIL), and UIV. However, S-PJK/PJF consisted of more pts w/ osteoporosis/osteopenia (S-PJK/PJF: 68.4% vs A-PJK: 23.8% vs No-PJK: 52.3%, p=0.014). S-PJK/PJF had significantly less flexion(7.7 vs A-PJK: 19.9 vs No-PJK: 19.5, p<0.01) and ROM(39.2 vs A-PJK: 53.1 vs No PJK: 52.8, p<0.01) but greater T1-slope (39.0 vs A-PJK: 26.0 vs No-PJK: 27.5, p<0.01) and cSVA (31.6mm vs A-PJK: 21.8 vs No-PJK: 19.9,p<0.01) induced by greater TK(50.1 vs A-PJK: 33.9 vs No-PJK: 35.9, p=0.015). Multivariable analysis adjusting for preop T1-Slope, cSVA, TK, and ΔPJA(p<0.0001, AUC=0.85) discerned preop cervical ROM to be significantly associated w/ the development of S-PJK/PJF (OR=0.96, p=0.02). ROC analysis also identified a cut-off value of 48.2o w/ 68.4% of S-PJK/PJF pts falling under this threshold of ROM compared to 35.6% of No-PJK/A-PJK pts (p<0.01).

Conclusion
Decreased preop c-ROM was significantly associated w/ the development of S-PJK/PJF in ASD pts with an UT UIV. Thus, we recommend obtaining preop Cervical Flex-Ex XRs to provide a quick and easy method to offer additional information that may aid in shared decision making of S-PJK/PJF risks postop

Table 7. Unadjusted and Adjusted logistic regression analyses for radiographic parameters associated with the development of symptomatic PJK

	Univariate Analysis		Multivariate Analysis	
Variables	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Preoperative Cervical Range of Motion (ROM)				
Preop Cervical ROM	0.96 (0.93 – 0.99)	**0.0039**	0.96 (0.93 – 0.99)	**0.0226**
Preop T1 Slope	1.06 (1.03 – 1.11)	**0.0010**	1.05 (0.99 – 1.03)	0.1118
Preop cSVA	1.04 (1.01 – 1.07)	**0.0069**	1.01 (0.97 – 1.05)	0.5657
Preop TK	1.03 (1.01 – 1.06)	**0.0064**	1.01 (0.98 – 1.05)	0.5448
Δ PJA	1.04 (1.00 – 1.08)	**0.0368**	1.07 (1.02 – 1.12)	**0.0102**
Model Diagnostics				
Model p-value	<0.0001			
AUC	0.85			
G-o-F test p-value	0.7434			
C-ROM Cut-off value	48.2°			
Preoperative Flexion				
Preop Cervical Flexion	0.94 (0.90 – 0.98)	**0.0013**	0.95 (0.90 – 0.99)	**0.0308**
Preop T1 Slope	1.06 (1.03 – 1.11)	**0.0010**	1.03 (0.97 – 1.09)	0.35611
Preop cSVA	1.04 (1.01 – 1.07)	**0.0069**	1.04 (1.00 – 1.08)	0.0747
Preop TK	1.03 (1.01 – 1.06)	**0.0064**	1.00 (0.96 – 1.04)	0.9947
Δ PJA	1.04 (1.00 – 1.08)	**0.0368**	1.07 (1.02 – 1.12)	**0.0106**
Model Diagnostics				

49. Impact of T1 Slope-Cervical Lordosis Discrepancy on Sagittal Vertical Axis and Patient-Reported Outcomes Following Posterior Cervical Fusion: a Multi-Center Retrospective Analysis

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Hypothesis
There is no significant association between T1 slope (TS) -cervical lordosis (CL) discrepancy greater than 17° and Sagittal Vertical Axis (cSVA) exceeding 4 cm, nor does an Sagittal Vertical Axis (cSVA) > 4 cm correlate with poorer patient-reported outcomes.

Design
Mutli-center retrospective study

Introduction
The relationship between T1 slope (TS) and cervical lordosis (CL) mirrors the established correlation between pelvic incidence (PI) and lumbar lordosis (LL) in assessing spinal alignment and predicting functional outcomes in patients undergoing spinal surgeries. Understanding these parameters is crucial as they influence disability and pain outcomes post-surgery. The dual purpose of this study was to- 1) Evaluate whether a TS-CL discrepancy greater than 17° predicts a cSVA greater than 4 cm in patients undergoing mutli-level posterior cervical fusion for stenosis and myelopathy, 2) investigate if an SVA > 4 cm correlates with higher patient-reported outcomes.

Methods
356 patients who underwent posterior cervical fusion involving a minimum of three levels for stenosis and myelopathy were studied. Inclusion criteria required the surgical level to be caudal to C7 and a minimum follow-up period of two years.

Results
The cohort had a mean age of 63 ± 12 years, with 52.6% being male and a mean BMI of 28.7 ± 6.4. The most frequently treated levels were C3-C7 (42.3%). A significant correlation was observed between TS-CL discrepancy greater than 17° and cSVA greater than 4 cm (r = 0.71). Specifically, 72.6% of patients with TS-CL > 17° exhibited an SVA > 4 cm. Furthermore, patients with SVA > 4 cm reported higher mean pain scores (VAS = 4.6± 2.9 vs. 3.6± 1.6, p>0.05) and disability scores (ODI = 43.2±23.6 vs. 36.6±18.2,p>0.05) compared to those with lower SVAs.

Conclusion
The findings substantiate that a TS-CL discrepancy greater than 17° is associated with an increased cSVA exceeding 4 cm in patients undergoing mutli-level posterior cervical fusion. Moreover, patients with higher SVA demonstrated poorer outcomes in terms of pain and disability, as indicated by VAS and ODI scores. These results underscore the importance of preoperative evaluation of TS-CL discrepancy to optimize surgical planning and enhance postoperative outcomes related to spinal alignment and patient-reported quality of life.

50. The Preliminary Observation of Curative Effect of Posterior Atlantoaxial Lateral Mass Joint Cage Graft Fusion and Internal Fixation in the Treatment of Irreducible Atlantoaxial Dislocation

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Hypothesis
no

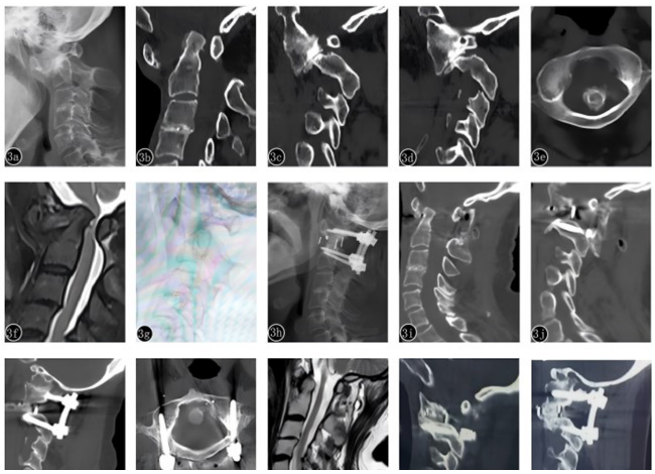
Design
To investigate the clinical efficacy of posterior atlantoaxial lateral mass joint cage graft fusion and internal fixation for the treatment of IAAD,comparing with the transoral release posterior restoration and fixation fusion procedure

Introduction
no

Methods
IAAD treated with posterior atlantoaxial lateral mass joint cage graft fusion and internal fixation(56 cases) and transoral pharyngeal release posterior restoration and fixation fusion (30 cases, control group) in our department from January 2018 to January 2024 were retrospectively analyzed. Recording the operation time, intraoperative bleeding, hospitalization time and complications . JOA score was used to evaluate nerve functional restoration, atlantodental interval(ADI), vertical distance from odontoid process to Chamberlain's line(DOCL), cervicomedullary angle(CMA), and clivus-axial angle(CAA) were measured to evaluate the reduction of atlantoaxial dislocation preoperatively, postoperatively and at final follow-up; assess lateral mass joint cage and the posterior implant fusion.

Results
All patients had good internal fixation position, satisfactory adequate reduction of decompression, and significant relief of symptoms, without aggravation of vertebral artery injury and spinal cord injury. Operation time, blood loss, and hospital stay in cage and control group. JOA postoperative and last follow-up were significantly improved compared with preoperative surgery. ADI, DOCL, CMA and CAA and the last follow-up improved significantly in both groups (P <0.05). There were no statistical differences between the groups in JOA, ADI, DOCL, CMA, and CAA (P> 0.05). Only one incision infection in the cage group; 3 incision infection in the control group (2 oropharynx and 1 posterior route) and 1 cerebrospinal fluid leakage. Internal fixation was stable during the follow-up period, bone fusion at the last follow-up, and no loss of joint space height in the cage group.

Conclusion
Posterior atlantoaxial lateral mass joint cage graft fusion and internal fixation for treating IAAD has similar efficacy compared with transoral release posterior restoration and fixation and fusion, but with the addition of implant fusion sites, which can be more effectively fused, avoiding transoral surgery, and reducing operative time, bleeding, hospitalization time and complications



43yF

51. Extension of Fusion to Cervical Spine Vs. Upper Thoracic Spine for the Management of Proximal Junctional Kyphosis

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Hypothesis
Extension of fusion to the cervical spine for upper thoracic proximal junctional kyphosis (PJK) may increase complications because it anchors less stable spinal segments compared to stopping at the upper thoracic spine.

Design
Prospective multicenter study

Introduction
Revision surgery for PJK requires extending fusion to cranial spinal segments. Unlike extensions to the lower thoracic segments which are less mobile, crossing the cervicothoracic junction involves highly mobile cervical segments, which may increase complications. This study compares outcomes of extending fusion to the cervical spine vs. upper thoracic spine

Methods
Multicenter prospective cervical deformity database was analyzed, focusing on patients with thoracic PJK revised with extension of fusion to either the cervical spine or upper thoracic spine (UT; T1- T2). Cervical upper-instrumented vertebra (UIV) patients were subdivided into lower cervical (LC; C4-7) and upper cervical (UC; Occiput-C3). Demographics, surgical metrics, radiographic measurements, 2 Year HRQLs, complications, and revision rates were analyzed

PODIUM PRESENTATION ABSTRACTS

Results
A total of 51 patients were included, with a mean age of 60.4 ± 12.9 years, and 91% were female. Of those, 12 patients were in the UT group (Preoperative UIV n: 8 at T1-4, 2 at T5-8, 2 at T9-12), 20 in the LC group (Preoperative UIV n: 18 at T1-4, 2 at T9-12), and 19 in the UC group (Preoperative UIV n: 14 at T1-4, 1 at T5-8, 4 at T9-12). Demographics and Charlson Comorbidity Index were similar across groups. EBL, operative time were similar while levels fused were more in the UC, followed by LC and the UT group. All groups had similar radiographic measurements, including change in proximal junctional angle. Instrumentation failure was higher in LC group (25%, vs. 0% in UC and 8% in UT p=0.03). Reoperation rate was 0% in UT, 30% in LC and 10.5% in UC (p=0.071) and recurrent PJK was 0% in UT, 15% in LC and 10.5% in UC (p=0.427). Postoperative radiographic and HRQols were similar across the groups at 2 years

Conclusion
Stopping fusion at the upper thoracic spine (T1-2) did not increase complications or reoperation rates compared to extending fusion to the cervical spine. However, LC UIV (C4-7) had higher instrumentation failure, recurrent PJK, and revision rates than UC (C2-3) and UT groups. Crossing cervicothoracic junction may not be beneficial to avoid junctional level complications

Preoperative UIV	UC	LC	UT	Total	P-value
T1-4	14 (73.68%)	18 (90.00%)	8 (66.67%)	40 (78.43%)	0.309
T5-8	1 (5.26%)	0 (0.00%)	2 (16.67%)	3 (5.88%)	
T9-12	4 (21.05%)	2 (10.00%)	2 (16.67%)	8 (15.69%)	
Total	19 (100.00%)	20 (100.00%)	12 (100.00%)	51 (100.00%)	
Operative	**UC**	**LC**	**UT**	**Total**	**P-value**
UIV	C1, C2, C3	C4, C5, C6, C7	T1, T2	52	
EBL	998.68 ± 873.39	900.00 ± 833.67	1612.50 ± 1624.69	1104.41 ± 1096.51	0.3464
Op time	410.63 ± 171.78	288.80 ± 134.79	324.17 ± 123.96	342.51 ± 154.61	0.0695
LOS	8.74 ± 6.16	5.70 ± 2.79	6.75 ± 4.35	7.08 ± 4.76	0.2997
Levels Fused, Median [IQR]	8 [7.0 - 9.0]	4 [3.0 - 7.0]	3 [2.5 - 3.5]	6 [3.0 - 8.0]	**0.0001**
HRQOL	**UC**	**LC**	**UT**	**Total**	**P-value**
Baseline NDI	43.55 ± 21.67	50.28 ± 16.54	47.21 ± 21.96	47.03 ± 19.43	0.6782
Baseline EQ5D Index	0.73 ± 0.06	0.71 ± 0.06	0.76 ± 0.07	0.73 ± 0.06	0.1018
Baseline EQ5D VAS	50.79 ± 29.12	52.75 ± 23.46	53.57 ± 31.59	52.07 ± 26.57	0.9534
2 Year NDI	24.37 ± 20.03	40.00 ± 23.36	24.00 ± 23.05	31.27 ± 22.86	0.0689
2 Year EQ5D Index	0.76 ± 0.09	0.79 ± 0.12	0.82 ± 0.11	0.78 ± 0.11	0.4642
2 Year EQ5D VAS	67.95 ± 20.87	67.00 ± 25.11	72.00 ± 17.89	67.98 ± 22.20	0.9669
Radiographic	**UC**	**LC**	**UT**	**Total**	**P-value**
Baseline Cervical Coronal Cobb	5.30 ± 3.27	10.88 ± 10.73	N/A	7.88 ± 7.86	0.184
Baseline C2-7 SVA	54.91 ± 18.38	53.06 ± 16.81	44.91 ± 15.18	52.42 ± 17.22	0.3866
Baseline Sagittal C2-7 Cobb	15.27 ± 19.91	12.87 ± 15.65	17.79 ± 10.65	14.68 ± 16.64	0.6988
Baseline T1 Slope	52.91 ± 17.45	50.09 ± 16.83	42.65 ± 10.38	49.96 ± 16.29	0.2212
Preop PJA	21.2 ± 13.7	24.7± 10.8	18.2 ± 11.7	21.9 ± 12.1	0.3
Change in PJA	9.4 ± 7.9	8.7 ± 9.4	10.7 ± 7.8	9.5 ± 8.4	0.55

52. Comparative Performance of the ESSG-ADSCI and ISSG-SII in a Single-Center Adult Spinal Deformity Database

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Hypothesis
This study aims to compare the performance of ESSG-ADSCI and ISSG-SII in a single-center ASD database.

Design
retrospective, single-center study

Introduction
In 2018, the ESSG and ISSG introduced their respective surgical complexity indices—the "Adult Deformity Surgery Complexity Index"(ESSG-ADSCI) and the "Surgical Invasiveness Index"(ISSG-SII). However, their performance has not been thoroughly evaluated or directly compared in the literature.

Methods
Operative ASD patients with complete baseline and 2-year follow-up data. Patients were analyzed to compare the predictive performance of two surgical complexity indices: the ESSG-ADSCI and the ISSG-SII. The primary outcomes assessed were intraoperative blood loss, operative time, and LOS. Secondary outcomes included the occurrence of surgical, medical, and intraoperative complications, as well as adverse events, reoperations, and complications occurring before discharge, within 90 days, and beyond 90 days of discharge. To evaluate the predictive performance of the indices, ROC curves were generated, and AUC analysis was performed. A sub-analysis of patients treated before 2017, aligning with the development of the ESSG-ADSCI and ISSG-SII, was performed to evaluate the consistency of these findings across different time periods.

Results
693 patients(mean age: 61 years; 77% female; BMI: 27kg/m^2) met the inclusion criteria. The ISSG-SII (mean: 90.0 ± 38.1) and ESSG-ADSCI(mean: 19.3 ± 7.5) were found to be a significant independent predictor of LOS, operative time, and EBL ($p < 0.001$). The ISSG-SII outperformed the ESSG-ADSCI in predicting overall surgical complications (AUC: 0.645 vs. 0.597, $p = 0.018$), blood loss greater than 1500 mL (AUC: 0.687 vs. 0.604, $p < 0.001$), and surgery duration over 240 minutes (AUC: 0.705 vs. 0.658, $p = 0.036$). However, there was no significant difference between the indices in predicting LOS beyond seven days (AUC: 0.687 vs. 0.654, $p = 0.103$). A sub-analysis of patients treated before 2017 reveals comparable outcomes, reinforcing the consistency of these findings across different time periods.

Conclusion
Both the ESSG-ADSCI and ISSG-SII demonstrate independent predictive value for key surgical outcomes, including length of stay, operative time, and blood loss in ASD surgery. However, the ISSG-SII consistently outperforms the ESSG-ADSCI in predicting surgical complications, excessive blood loss, and prolonged operative time.

Table 1 AUC summary corresponding to complications, reoperations, and adverse events of ESSG-ADSCI and ISSG-SII.

	ESSG-ADSCI	ISSG-SII	p-value
Any complications	AUC: 0.647	AUC: 0.663	0.462
Any Surgical complications	AUC: 0.597	AUC: 0.645	**0.018***
Any Medical complications	AUC: 0.598	AUC: 0.586	0.641
Any Reoperation	AUC: 0.514	AUC: 0.555	0.088
Any Adverse Events	AUC: 0.584	AUC: 0.571	0.593
Any Intra-op complications	AUC: 0.607	AUC: 0.636	0.226
Any Intra-op Surgical Major Complication	AUC: 0.629	AUC: 0.687	0.202
Any Intra-op Surgical Minor Complication	AUC: 0.596	AUC: 0.631	0.304
Any complications before discharge	AUC: 0.583	AUC: 0.612	0.254
Any complications within 90 days of discharge	AUC: 0.548	AUC: 0.565	0.428
Any complications beyond 90 days of discharge	AUC: 0.552	AUC: 0.596	**0.048***

Table 2

AUC summary corresponding to blood loss, length of stay, and surgical time prediction of ESSG-ADSCI and ISSG-SII.

	ESSG-ADSCI	ISSG-SII	p-value
Overall Cohort			
Blood loss (<>1500 mL)	AUC: 0.604	AUC: 0.687	**<0.001***
Duration of surgery (<>240 min)	AUC: 0.658	AUC: 0.705	**0.036***
Extended LOS (<>7days)	AUC: 0.654	AUC: 0.687	0.103
Patient's Year of Surgery Prior to 2017			
Blood loss (<>1500 mL)	AUC: 0.592	AUC: 0.681	**<0.001***
Duration of surgery (<>240 min)	AUC: 0.649	AUC: 0.701	**0.049***
Extended LOS (<>7days)	AUC: 0.634	AUC: 0.669	0.128

53. Incidental Durotomies Do Not Impact Long Term Neurologic Function After Adult Spinal Deformity Surgery

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Hypothesis
Patients with incidental durotomies achieve comparable recovery of neurologic function to patients with no incidental durotomies after adult spine deformity surgery

Design
Prospective multicenter Study

Introduction
Incidental durotomies (ID) are a common complication in adult spinal deformity surgery (ASD) and are often associated with technical challenges during the procedure. This study aims to compare long-term neurologic recovery in patients with and without ID.

Methods
A prospective multicenter ASD database was utilized for this analysis. Patients with and without ID were compared with respect to demographics, operative variables and neurologic outcomes at baseline, 1 year, and 2 years. A multivariate analysis was performed to compare lower-extremity motor scores (LEMS), neurologic complications and length of stay (LOS) between the cohorts.

Results
A total of 1,452 patients were identified with a mean age of 60 ± 14 years; 72.7% were females. 121 patients (8.3%) experienced ID. Patients with ID were more likely to have undergone revision surgery (p < 0.001) and had higher Charlson Comorbidity Index (CCI) scores (p = 0.029). Patients with ID had higher estimated blood loss (EBL), longer operative time, more frequent three-column osteotomies, and longer LOS (all p < 0.001). At 1 year and 2 years postoperatively, patients with ID and those without ID had similar LEMS (48.9, 49.3; p 0.23, 49.4, 49.5; p 0.59 respectively). Neurologic, medical, and surgical complication rates did not differ significantly between the two groups but patients with ID had a higher rate of inpatient return to the operating room, 50% of which was for a durotomy repair (1.95% vs 4.96%, p = 0.04). They also more frequently reported leg numbness at 1 year (p=0.042), and 2 years (p=0.043) postoperatively. On multivariate analysis adjusting for age, frailty, three-column osteotomies, and revision surgery there were no differences between both cohorts in LEMS, neurologic complications and LOS.

Conclusion
Patients with incidental durotomies experience similar LEMS at 1 year and 2 years postoperatively compared to patients without incidental durotomies. They also have similar LOS and neurologic complications; however, they continue to have higher rates of leg numbness at 2 years postoperatively.

Operative Variables	No ID	ID	P-Value	
EBL (cc), Median (IQR)	905(350-1800)	1625(900-3000)	<0.0001	
OP time(min), Median (IQR)	351(262-443)	419(335-523)	<0.0001	
Levels Fused, Median (IQR)	10(8-13)	11(10-16)	0.0004	
3CO				
No	1129(84.82%)	70(57.85%)	<0.0001	
Yes	202(15.18%)	51(42.15%)		
LOS (days), Mean (SD)	7.5(4.7)	9.1(7.5)	0.0014	
LEMS	No ID	ID	P-Value	
Baseline, Mean (SD)	48.97(2.6)	48.85(2.4)	0.5794	
1 Year, Mean (SD)	49.3(2.94)	48.86(3.44)	0.227	
2 Year, Mean (SD)	49.4(1.97)	49.52(1.68)	0.5901	
Leg Numbness (1 Year)	No ID (n=1039)	ID (n=90)		
No	586(56.40%)	32(35.56%)	<0.0001	
Yes	453(43.60%)	58(64.44%)		
Leg Numbness (2 Year)	No ID (n=804)	ID (n =76)		
No	464(57.71%)	32(42.11%)	0.011	
Yes	340(42.29%)	44(57.89%)		
Complications	Category	No ID	ID	P-Value
Bowel bladder incontinence	Absent	1,327 (99.70%)	119 (98.35%)	0.083
	Present	4 (0.30%)	2 (1.65%)	
Epidural hematoma	Absent	1,331 (100.00%)	120 (99.17%)	0.083
	Present	0 (0.00%)	1 (0.83%)	
Motor deficit	Absent	1,273 (95.64%)	112 (92.56%)	0.168
	Present	58 (4.36%)	9 (7.44%)	
Nerve Root Injury	Absent	1,329 (99.85%)	120 (99.17%)	0.23
	Present	2 (0.15%)	1 (0.83%)	
Radiculopathy	Absent	1,235 (92.79%)	114 (94.21%)	0.711
	Present	96 (7.21%)	7 (5.79%)	
Spinal Cord Injury	Absent	1,323 (99.40%)	119 (98.35%)	0.2
	Present	8 (0.60%)	2 (1.65%)	
Sensory Deficit	Absent	1,307 (98.20%)	117 (96.69%)	0.285
	Present	24 (1.80%)	4 (3.31%)	
ALL Neurologic Complications	Absent	1,159 (87.08%)	100 (82.64%)	0.164
	Present	172 (12.92%)	21 (17.36%)	

Table 1: Comparison of operative factors, length of stay, LEMS, leg numbness and neurologic complications between patients with incidental durotomies and no incidental durotomies.

54. Thoracic Segmental Degeneration Severity in Adult Spinal Deformity (ASD) Patients: Impact on Baseline Alignment and Compensation

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PODIUM PRESENTATION ABSTRACTS

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Hypothesis
ASD patients with thoracic spine degeneration will exhibit altered alignment morphology associated with their degenerative thoracic disease.

Design
Retrospective analysis of thoracic spine degeneration in prospectively collected data.

Introduction
Thoracic spine degenerative disc disease can alter its flexibility, thus impacting its ability to compensate at baseline.

Methods
ASD patients with no prior surgery who underwent thoracolumbar fusion were included. Thoracic spine (T1-L1) degeneration was assessed radiographically using Kellgren-Lawrence (KL) grading. Thoracic spine was segmentalized based on Lafage criteria (T1-T5, T5-T9, and T9-L1) and arc degeneration was defined as >2 levels with KL grade 3+ in the arc. Global thoracic spine degeneration was defined as >1 degenerated arcs. Patients with no degenerated levels in the thoracic spine served as controls. Thoracic compensation and global spinopelvic alignment changes were compared.

Results
Among 272 patients, mean age was 65.1 years, 74% were female, and mean CCI was 1.9. In this cohort, 19, 81, and 100 patients had T1-T5, T5-T9, and T9-L1 arc degeneration, respectively, which corresponded to 151 degenerated and 72 control patients (Figure 1). Degenerated patients were older (65.7 vs 62.6 years), and had smaller T9SPi (-11.4° vs -8.1°), higher TK (36.1° vs 27.6°), higher TL kyphosis (11.7° vs 5.7°), minimal expected thoracic compensation via hypokyphosis (0.7° vs 8.8°), lower PI-LL mismatch (15.9° vs 24.1°), and higher LL (38.6° vs 32.3°) ($p<0.05$), but similar SVA, PT, and L1-L4 and L4-S1 lordosis ($p>0.05$). Sub-analyses by arcs revealed that caudal arcs were more commonly degenerated than cranial arcs, with the degenerated arc(s) contributing most predominantly to the global TK ($p<0.01$).

Conclusion
More than 1 in 3 ASD patients had degenerative thoracic disease, most commonly in the lower two arcs of kyphosis (T5-L1). This degenerative pattern was associated with a decrease in expected thoracic compensation by hypokyphosis and compensatory increase in lumbar lordosis. Preoperative surgical planning should account for these compensatory mechanisms to achieve adequate correction in the thoracolumbar region.

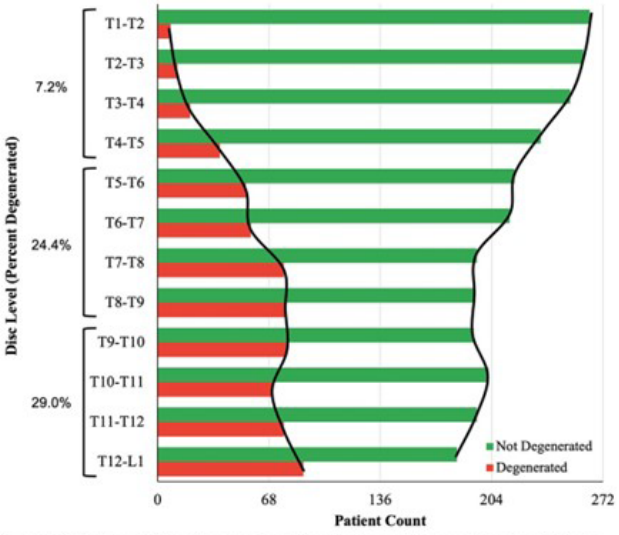

Figure 1. Distribution of Kellgren-Lawrence-based thoracic degeneration across thoracic spinal levels.

55. Older Adult Idiopathic Scoliosis Patients Have Greater Improvement in Self-Image Compared to Younger Adult and Adolescent Idiopathic Scoliosis Patients Following Posterior Spinal Fusion

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Hypothesis
Age is an important factor affecting self-image scores following posterior spinal fusion for idiopathic scoliosis

Design
Retrospective case series

Introduction
The relationship between spine deformity and self-image is complex and incompletely understood. Few studies have evaluated how self-image differs between adolescent and adult idiopathic scoliosis patients.

Methods
Single-center retrospective review of a consecutive series of adult (AdIS) and adolescent (AIS) idiopathic scoliosis patients treated with posterior spinal fusion (PSF). Patient reported SRS-22 Self-Image, radiographic, and perioperative outcomes were recorded pre-operatively and 2-year postoperatively. Patients were grouped according to age; AIS (<18 years), young adults (yAdIS, 18–40 years) and older adults (oAdIS, >40 years).

Results
176 patients were included: 54 AIS (mean age 15.8 years), 47 yAdIS (mean age 25.2 years), and 74 oAdIS (mean age 56.54 years). Similar preop major curve magnitude between AIS vs yAdIS vs oAdIS (58 vs 61 vs 63, $p=0.0863$). At two-

years, AIS pts had similar curves to yAdIS but smaller curves than oAdIS patients (16 vs 19 vs 21, p=0.0104) with similar correction (41 vs 40 vs 39, p=0.6476). There was lower EBL (560 mL vs 918 mL vs 1392 mL, p<0.0001), shorter OR times (4.3 hrs vs 5.8 hrs vs 8 hrs, p<0.0001), fewer levels fused (9.6 vs 11.7 vs 16.4) and pelvic instrumentation (0% vs 15% vs 87%, p<0.0001) in AIS vs yAdIS vs oAdIS pts. AIS patients had better preoperative self-image scores than yAdIS or oAdIS (3.5 vs 3.1 vs 2.5, p<0.0001). However, at two years postop there were no significant difference in self-image scores between AIS vs yAdIS vs oAdIS (4.4 vs 4.3 vs 4.2, p=0.1230). In addition, greater improvement (1 vs 1.2 vs 1.7, p<0.0001) and proportion achieving MCID (43% vs 62% vs 69%, p=0.0088) were seen in the oAdIS patients.

Conclusion
Although AIS pts had better preop SRS self-image and subtotal scores as compared to yAdIS and oAdIS patients, oAdIS pts had the greatest improvement in their self-image and subtotal scores such that at 2 years postop, AIS, yAdIS and oAdIS pts had similar self-image and SRS-22r sub total scores, despite more surgical morbidity for the oAdIS pts.

					Tukey's post-hoc Pairwise Comparison		
	AIS (n=54)	yAdIS (n=47)	oAdIS (n=75)	p-value	AIS vs yAdIS p-value	AIS vs oAdIS p-value	yAdIS vs oAdIS p-value
Baseline PROMS							
SRS-22r Self-Image	3.5 (0.7)	3.1 (0.8)	2.5 (0.7)	**<0.0001**	**0.0298**	**<0.0001**	**0.0003**
SRS-22r Sub-Total	4.1 (0.5)	3.7 (0.6)	3.2 (0.5)	**<0.0001**	**0.0004**	**<0.0001**	**<0.0001**
Two Year PROMs							
SRS-22r Self-Image	4.4 (0.6)	4.3 (0.6)	4.2 (0.7)	0.1230	0.5023	0.1016	0.7203
SRS-22r Sub-Total	4.5 (0.4)	4.3 (0.4)	4.1 (0.6)	**<0.0001**	0.0551	**<0.0001**	0.0871
Magnitude of Improvement							
SRS-22r Self-Image	1 (0.8)	1.2 (0.8)	1.7 (1)	**<0.0001**	0.3882	**<0.0001**	**0.0187**
SRS-22r Sub-Total	0.4 (0.4)	0.6 (0.4)	0.9 (0.6)	**<0.0001**	0.1146	**<0.0001**	**0.0034**
MCID Achievement							
SRS-22r Self-Image	23 (42.6)	29 (61.7)	52 (69.3)	**0.0088**			
SRS-22r Sub-Total	20 (37.0)	23 (48.9)	54 (72.0)	**0.0003**			

AIS= Adolescent Idiopathic Scoliosis, yAdIS= young Adult Idiopathic Scoliosis, oAdIS=older Adult Idiopathic Scoliosis

56. Predictors and Dynamics of Self-Image in Adult Spinal Deformity: A Cluster Analysis Approach

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Hypothesis
Self-Image (SI) reflects psychosocial, functional, and external factors, with limited correlation to radiographic parameters in adult spinal deformity (ASD)

Design
Cluster analysis of a prospective multicenter ASD registry

Introduction
Traditionally, adolescent scoliosis has been associated with impaired SI, with ASD primarily linked to pain and functional limitations. The complexities of SI in older populations remain underexplored. Few studies have comprehensively assessed SI patient's accepted symptom state (PASS) in ASD, considering predictors and dynamics linked to age and magnitude of deformity

Methods
We analyzed 710 surgically treated ASD patients with >2years follow-up, grouping them into three clusters: C1 (younger patients with coronal deformity), C2 (adults with moderate deformity and disability), and C3 (adults with severe deformity and disability). Machine learning models were constructed to predict both baseline and postoperative SI PASS+ (SI > 3.3). Predictors included PROMs (ODI, SRS22, SF36), radiographic alignment, demographics, and surgical factors

Results
Preoperatively only 13% of patients reported acceptable SI (PASS+): 28% in C1, 24% C2, and 1% C3 p<0,001. Age, ODI, pain, social function accounted for over 50% of the predictive model variance for baseline SI, compared to <40% for radiographic parameters (mainly sagittal deformity) (AUC:75%). Two years post-surgery, 64% of patients normalized SI (85% in C1, 68% C2, 52% C3 p<0,001). C3 patients exhibited the greatest relative improvement in SI (65x vs. 3x in C1 and C2). ODI and SF-36 contributed to over 66% of the predictive model variance for SI at 2years, while radiographic parameters explained 30% (AUC:85%). Among patients with preoperative unacceptable SI (PASS-), 61% normalized SI postoperatively (81% in C1, 64% C2, 52% C3, p<0,001). ODI and SF-36 dimensions of pain and function were the strongest predictors, while radiographic parameters, such as the lumbosacral curve(C2) and largest Cobb angle(C1), played smaller roles(AUC:79-94%)

Conclusion
ASD significantly affects SI across all ages, with 87% of patients reporting unacceptable baseline SI and only 61% achieving normalization post-surgery. Function, pain, and mental health have a greater impact on SI than radiographic deformity. Older more disabled patients exhibit poorer baseline SI and greater improvement, yet lower normalization rates. The effects of ASD on SI require more attention

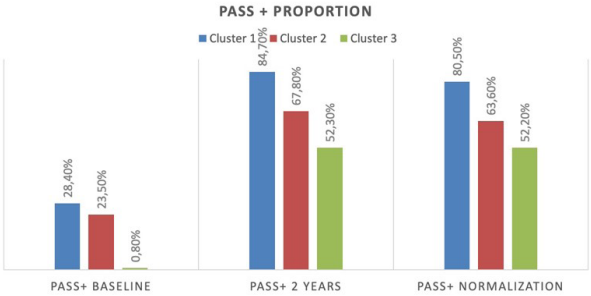

Figure 1: Proportion of patients in each cluster achieving the Patient-Acceptable Symptom State (PASS) at **(a)** baseline and **(b)** two years post-surgery. **(c)** illustrates the proportion of PASS-negative patients (PASS−) who transitioned to PASS-positive (PASS+) after surgery.

PODIUM PRESENTATION ABSTRACTS

57. Predicting the Unpredictable: Modeling Post-Operative Spinal Alignment in Adult Deformity Surgery

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Hypothesis
Geometric-statistical modeling can accurately predict post-operative sagittal alignment

Design
Retrospective analysis of a multicenter registry of adult spinal deformity (ASD) patients.

Introduction
Predicting post-operative sagittal alignment in ASD surgery remains complex due to reciprocal changes across spinal segments. Current analyses of individual alignment parameters lack comprehensive predictive models. This study evaluates a geometric-statistical approach for predicting post-operative thoracic alignment and its influencing factors

Methods
A multicenter ASD database of 523 patients (mean age 64±10 years; BMI 28.2±5.8; 79% female) with fusions to the pelvis and UIVs at T2-4 (UT) or T9-11 (LT) and 2-year follow-up was analyzed. Thoracic kyphosis (T1-T12, T1-T4, T5-T8) and vertebral pelvic angles (VPAs: T1PA, T4PA, T9PA, L1PA) were primary outcome measures. Multilinear regression models predicted post-operative alignment based on pre-operative parameters and surgical factors. Prediction errors were normalized to S1 superior endplate width.

Results
Pre-operative sagittal profiles showed 38.8% type L, 38.0% type N, and 21.0% type D patients with moderate-to-severe deformities. Significant sagittal alignment changes occurred between pre-op and 2-year follow-up ($p < 0.05$). VPAs decreased at most levels but increased at L4PA. Prediction models achieved high accuracy for VPAs (R^2: 0.8-1; RMSE <3°) and moderate accuracy for thoracic Cobb angles (R^2: 0.46-0.7; RMSE ≤10.5°). UT UIV patients exhibited lower prediction errors for T1 positioning (median error: 21.2% vs. 56.4% for LT, $p < 0.001$). More than 90% of UT patients had T1 within 50% of the S1 width on the anteroposterior axis. LT UIV patients demonstrated greater variability, with 25% overestimating and 25% underestimating reciprocal changes (Figure). LT patients with anterior prediction errors exhibited steeper PJK angles (-27° vs. -16°, $p < 0.001$), while posterior errors correlated with older age (67 vs. 64 years, $p < 0.023$).

Conclusion
Geometric-statistical modeling provides excellent predictive accuracy for VPAs and moderate accuracy for thoracic Cobb angles, supporting its utility in surgical planning. UT UIV placement yields more consistent outcomes with fewer prediction errors. The variability in LT outcomes underscores the need to integrate thoracic flexibility and muscular evaluation into future predictive models.

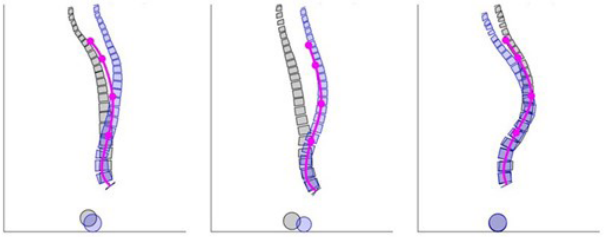

Figure 1: Schematic examples of patients with Lower Thoracic UIV and T1 position predicted either too anterior (left), properly predicted (middle) or predicted too anterior (right). The grey schematic represents pre-operative alignment, Bleu real 2-year post-operative alignment, and Purple the predicted shape based on pre-operative alignment and sagittal correction

58. Where Does Most of the Coronal and Sagittal Correction of Main Thoracic and Thoracolumbar Curves Come from in Adult Idiopathic Scoliosis (ADIS) Surgery?

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Hypothesis
A substantial amount of correction is obtained after positioning and PCOs

Design
Retrospective, single surgeon case series of 50 AdIS pts

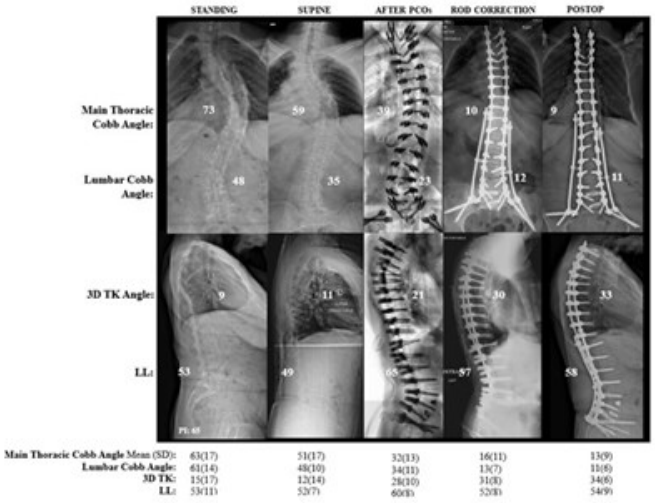
Introduction
The relative effect of intraoperative positioning with posterior column osteotomies(PCOs) and rod application on deformity correction is not clearly defined among Adult Idiopathic Scoliosis(AdIS) pts. This is the first study to quantify the impact of PCOs with positioning and rod placement on thoracic and thoracolumbar/lumbar correction in AdIS.

Methods
AdIS pts with both structural main thoracic (MT) and thoracolumbar/lumbar curves (TL/L) were assessed at preop, intraop, and postop in both the coronal/sagittal planes. Measurements included Cobb angles, thoracic kyphosis (TK), lumbar lordosis (LL), and pelvic incidence (PI) (Fig. 1). A "3D TK" was used to determine the true TK, based on the axial rotation of Cobb angles (Newton et al, 2015). Paired T-tests were used.

Results
For MT curves, the Cobb angle decreased from 63±17 preop upright, to 51±17 preop supine, to 32±13 after positioning/PCOs, to 16±11 after rod correction and 13±9 postop upright ($p<0.001$). Thus, 66% improvement in the MT curve occurred by positioning/PCOs alone while 34% occurred by

rod correction. 3D TK increased from 15±17 preop upright and 12±14 preop supine, to 28±10 after positioning/PCOs (p<0.001), to 31±8 after rod correction (p=0.08), to 34±6 postop upright (p=0.04). Thus, 80% of increased TK was due to positioning/PCOs while 20% from rod correction. For TL/L curves, Cobb angle decreased from 61o±14 preop upright, to 48±10 preop supine, to 34±11 after positioning/PCOs, to 13±7 after rod correction and 11±6 postop upright (p<0.001). Thus 56% improvement in TL/L curves occurred by positioning/PCOs while 44% after rod correction. LL changed from 53±11 preop upright, to 60±8 intraop after positioning/PCOs (p=0.02), to 52±8 after rods in the context of a mean PI 53±10 with preop/postop PI-LL mismatch -0.3±14/-0.7±8.

Conclusion
For both main thoracic and thoracolumbar/lumbar curves, most of the coronal correction occurs after positioning/PCOs as opposed to rod correction (main thoracic: 66% vs 34% (thoracolumbar: 56% vs. 44%). Surprisingly, positioning/PCOs is kyphogenic and restores most of the TK (80%) vs. rod placement (20%). In contrast, positioning/PCOs increases lordosis for the lumbar spine and may be adjusted after rod placement.



59. A Tale of Two Planes: The Impact of Coronal Deformity on Sagittal Alignment in Adult Spinal Deformity

Pawel P. Jankowski, MD; Max Fisher; Kyriakos Chatzis, BS; Peter Tretiakov, BS; Tobi Onafowokan, MBBS; Francesca Totis, MD; Dean Chou, MD; Praveen V. Mummaneni, MD, MBA; Renaud Lafage, MS; Virginie Lafage, PhD; Peter G. Passias, MD

Hypothesis
Patients with severe coronal deformity will have worse sagittal correction and more complications.

Design
Retrospective review of a prospectively enrolled database.

Introduction
Adult spinal deformity (ASD) impacts both sagittal and coronal alignment, yet the role of coronal deformity in achieving sagittal alignment and its link to postoperative complications is underexplored.

Methods
ASD Patients ≥18Y with complete BL and 2Y data included. Sagittal parameters: SAAS criteria, sagittal vertical axis (SVA), and vertebral-pelvic angles. Coronal parameters: maximum Cobb angle (MCA), pelvic obliquity (PO), sacral obliquity (SO), C7 plumb line (PL), leg length discrepancy (LLD), and coronal inclination (Inc). Patients were stratified into three groups for each coronal parameter: Low (L): 0-25th, Moderate (M): 25th-75th, and Severe (S): 75th-100th percentiles. Multivariate analysis (MVA) was used to control for BL sagittal deformity and demographic factors.

Results
800 included (60.9±14.6y, 75%F, 27.4±5.7kg/m2, CCI 1.7±1.7). Surgical characteristics: OR time 346mins, LOS 7.6days, EBL 1299mL, levels fused 10.6. BL Radiographics: MCA 38.2±21.7°, PO 2.5±2.0°, SO 4.6±3.6°, PL 34.9±32,9mm, LLD 8.4±7.0mm, and Inc 3.7±3.6°. Differences in coronal parameters found in Table 1. At BL, 29.9% met PT, 13.1% met PI-LL, and 22.1% met SVA goals. At 6W postoperatively, 26.2% met PT, 22.8% met PI-LL, and 29.7% met SVA goals. Those in S for MCA were 1.7x less likely to achieve PI-LL alignment at 6W than L (1.71, [1.1, 2.8], p=.039). At 1Y, the M and S MCA cohorts were 1.7x (1.68, [1.1, 2.6], p=.024) and 1.8x (1.75, [1.1, 3.0], p=.041) less likely to meet SVA goals compared to L. Similarly, the M PL group were 1.8x less likely to achieve PT alignment at 2Y (1.82, [1.1, 3.0], p=.023). The S MCA group was 1.9x more likely to experience a major complication (1.93, [1.2, 3.2], p=.011) and 1.8x more likely to experience a minor complication (1.78, [1.1, 2.8], p=.011) compared to L. Additionally, those in S for PO had a 1.7x increased likelihood of a major complication compared to L (1.74, [1.1, 2.8], p=.024).

Conclusion
Severe coronal deformity decreases the likelihood of achieving sagittal alignment and increases the risk of complications, emphasizing the need for targeted preoperative strategies to address coronal deformity and optimize surgical outcomes.

Parameter	*Cohort*		
	L (n=200)	M (n=400)	S (n=200)
MCA (°)	12.8±4.2	36.0±9.7	67.6±11.8
PO (°)	0.4±0.3	2.1±0.8	5.2±1.7
SO (°)	0.9±0.5	4.0±1.3	9.5±3.0
PL (mm)	6.0±3.5	26.9±9.4	80.0±34.0
LLD (mm)	1.4±0.9	7.0±2.5	18.1±5.7
Inc (°)	0.6±0.3	2.8±1.0	8.6±3.8

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Table 1: Baseline Coronal Parameters Based on Severity Cohort

60. Vertebral Pelvic Angles Accurately Predict Risk of Proximal Junctional Kyphosis in Long Segment Fusion for Adult Spinal Deformity Surgery

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Hypothesis
Vertebral pelvic angles (VPAs) will differ in patients developing proximal junctional kyphosis (PJK) following adult spinal deformity (ASD) surgery.

Design
Retrospective Cohort Study

Introduction
VPAs account for the relative position of each vertebra with regard to the pelvis and are independent of patient position, making them a radiographic parameter of interest in preop planning and intraop assessment of optimal spinopelvic alignment for preventing PJK.

Methods
ASD patients (age≥18) undergoing min 5 level PSIF were included. VPAs were measured at preop and immediate postop visits and included C2PA, T1PA, T4PA, T10PA, and L1PA (the angle between the center of the vertebral body and the midpoint of the S1 superior endplate, intersecting at the femoral heads). The primary outcome was the rate of PJK at two years follow up. PJK was defined by two criteria: (1) a postop proximal junctional sagittal Cobb angle ≥ 10° and (2) at least 10° greater than the preop measurement.

Results
266 patients (Mean age: 57.5±12.5yo, 74.8% female, mean follow up: 24.6±13.7 months) were included in this study. On average, constructs consisted of 13.0±4.2 levels with 92 (34.6%) and 174 (65.4%) patients with UIV in the cervical/upper thoracic and thoracolumbar region, respectively. 45/266(16.9%) patients developed PJK with 17/45(37.8%) being symptomatic. Patients demonstrated similar baseline characteristics and alignment in PJK and no-PJK groups (Table). Postop VPAs showed moderate/strong correlation with PT (r2-C2PA: 0.366, T1PA: 0.651, T4PA: 0.662, T10PA: 0.628, L1PA: 0.562) and PI (0.314, 0.499, 0.514, 0.571, 0.595). Otherwise, VPA measurements correlated weakly with TK, LL, and SS (r2<0.4). Postop, there were no differences in the magnitude or change for all VPAs between PJK and no-PJK groups. However, for patients with min UIV of T5, subgroup analysis demonstrated differences in PJK vs. no-PJK groups for the change of C2PA (no-PJK: 0.7±10.3, PJK: 8.5±17.8, P=0.002), T1PA (6.6±10.0, 11.7±16.8, P=0.039), T4PA (5.8±9.6, 10.8±15.2, P=0.032) from preop to postop (Table).

Conclusion
We found that in ASD, overcorrection of C2PA, T1PA, and T4PA with UIV in the cervical/upper thoracic region increases the risk for PJK. This is the first study showing these VPAs are reliable in planning, executing correction and performing intraoperative assessment to minimize the risk of PJK.

		No PJK		PJK		
		Mean	Standard Deviation	Mean	Standard Deviation	P-Value
Age		56.9	12.8	60.2	10.8	0.102
Gender (Count, %)	Female	167	75.6%	32.0	71.1%	
	Male	54	24.4%	13.0	28.9%	0.530
BMI		26.4	5.5	25.4	4.7	0.071
TIL		13.1	4.3	12.5	3.7	0.389
UIV Category (Count, %)	Lower T	74	33.5%	18.0	40.0%	
	Upper T	147	66.5%	27.0	60.0%	.402
Preop C2PA		19.5	13.1	24.0	18.6	0.060
Preop T1PA		23.2	12.6	26.2	16.9	0.189
Preop T4PA		19.4	11.8	22.8	17.1	0.121
Preop T10PA		12.9	11.3	15.6	14.8	0.169
Preop L1PA		10.4	10.5	11.6	12.6	0.503
Preop TK		33.9	21.4	34.5	16.9	0.858
Preop LL		27.2	17.8	28.2	15.8	0.735
Preop SS		28.2	13.7	29.3	26.1	0.685
Preop PT		27.4	11.6	31.6	14.6	0.039
Preop PI		55.7	18.0	60.9	27.5	0.110
Subgroup Analysis: Cervical/Upper Thoracic UIV						
Postop C2PA		17.5	7.2	17.7	7.0	0.908
C2PA Diff (Pre-Post)		0.7	10.3	8.5	17.8	0.002
Postop T1PA		15.3	7.3	14.9	7.7	0.841
T1PA Diff (Pre-Post)		6.6	10.0	11.7	16.8	0.039
Postop T4PA		12.0	7.5	11.2	6.9	0.632
T4PA Diff (Pre-Post)		5.8	9.6	10.8	15.2	0.032
Postop T10PA		8.2	6.9	8.7	7.0	0.769
T10PA Diff (Pre-Post)		2.3	7.8	5.5	13.0	0.095
Postop L1PA		9.6	6.7	8.9	6.6	0.646
L1PA Diff (Pre-Post)		-1.3	6.9	1.0	10.6	0.160
Postop T4L1PA		7.2	7.5	9.8	9.5	0.118
Postop PJA		6.5	6.2	12.7	6.9	<0.001
Postop TK		42.1	13.0	43.1	11.8	0.714
Postop LL		38.1	20.4	30.2	13.6	0.054
Postop SS		32.6	13.3	32.6	13.1	0.987
Postop PT		20.1	9.9	22.2	10.1	0.310
Postop PI		52.7	16.8	54.8	17.6	0.559

61. Are We Getting Better at Achieving Alignment in Minimally Invasive Adult Spinal Deformity Surgery?

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Hypothesis
To characterize the evolution of MIS in achieving optimal alignment in ASD patients

Design
Retrospective cohort review of a prospectively enrolled database,

Introduction
Advancements in minimally-invasive surgery (MIS) technologies and techniques are continually metamorphosing,

chipping away at the shortcomings in terms of attaining the same degree of alignment in open adult spinal deformity (ASD) surgeries. It is well accepted that MIS techniques minimize invasiveness with improved complication profiles, but specific evaluation of the sustainability of different alignment schemas has yet to be investigated.

Methods
operative ASD patients ≥18 years with complete baseline (BL) up to 2 year (2Y) demographic, radiographic, and health-related quality of life data were included. MIS surgeries over a 10-year time period (2009-2020) were ranked into halves: Early (E) v. Recent (R). Descriptive, means comparison, and regression analyses were applied to characterize and identify basic differences between cohorts.

Results
261 patients over a period of 10 years underwent MIS interventions (mean age: 64.9±12.9 yrs, 65.4% female, mean BMI 28.4 kg/m2, mean CCI: 1.9 ±1.6, operative time: 332.2±129.7 mins, mean EBL: 866.2±1120.1, mean LOS 6.3 3.6). The usage of MIS steadily increased, with a large increase after January 2016. E cohort consisted of 96 patients (36.8%) while the R consisted of 165 patients (63.2%). The R cohort undertook more patients with severe SVA deformity than years prior (56.5% v. 43.5%). R demonstrated significantly greater improvements in PI-LL (54.3% v. 45.7%, p=0.028) and SVA by 2Y (50.6% v. 49.4%, p=0.003) as well as Schwab improvement at 2Y. There was a significant difference in attainment of ideal alignment via the traditional alignment schema (GAP/SAAS/Roussouly) at 2Y (53.5% v. 46.5%, p=0.011). In a deep dive into segmental alignment, there were significant improvements over time in attainment of appropriate segmental alignment at L2-L3 and L3-L4 (p<.009, both). Clinically, this manifested as greater rates of attaining Y2 MCID in PCS (63.2% v. 36.8%, p=0.047).

Conclusion
MIS alignment is incrementally improving in sagittal spinopelvic and segmental alignment all the while attempting to address increasingly more severe deformity cases. Its increasing prevalence and efficacy lends itself to a larger population of patients who may benefit from its advantages.

62. How Changes in Segmental Lordosis Impact L1-Pelvic-Angle After Adult Spinal Deformity Surgery?

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Hypothesis
Changes in segmental lordosis at the L4/5 and L5/S1 are associated with greater decreases in L1-Pelvic-Angle (L1PA) compared to changes at the L1/2, L2/3, and L3/4 in adult spinal deformity (ASD) surgery.

Design
Retrospective cohort study

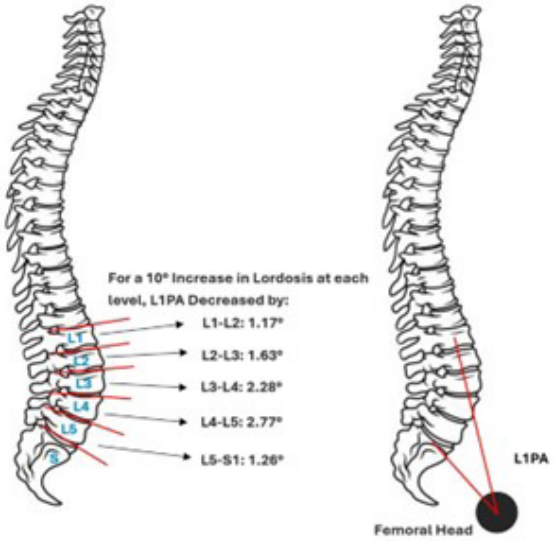
Introduction
Achieving target L1PA is heavily influenced by segmental lordosis changes during ASD surgery. In patients undergoing ASD surgery, we aimed to evaluate the impact of segmental lordosis changes at each lumbar level on the postoperative L1PA

Methods
A retrospective cohort study was performed for patients undergoing ASD surgery from 2009-24. Inclusion criteria were: ≥5-level fusion and sagittal/coronal deformity. The primary exposure variable was change in segmental lordosis at each lumbar level (L1/2, L2/3, L3/4, L4/5, L5/S1). The primary outcome was the change in L1PA. Univariate and multivariable analyses controlling for segmental lordosis change at each level were performed

Results
Of 204 patients undergoing ASD surgery, the mean age was 59±19 years and 66 (32%) were males. The mean postoperative L1PA was 12±9° from the preoperative mean L1PA of 14±11°. L1-L2: The mean change in lordosis at L1/2 was 7±6°. For a 10° increase in L1/2 lordosis, the L1PA decreased by 1.17° (β=0.12,95%CI:-0.01-0.24,p=0.071). L2-L3: The mean change in lordosis at L2/3 was 8±7°. For a 10° increase in L2/3 lordosis, the L1PA decreased by 1.63° (β=0.16,95%CI:0.05-0.24,p=0.005). L3-L4: The mean change in lordosis at L3/4 was 9±8°. For a 10° increase in L3/4 lordosis, the L1PA decreased by 2.28° (β=0.23,95%CI:0.12-0.33,p<0.001). L4-L5: The mean change in lordosis at L4/5 was 9±8°. For a 10° increase in L4/5 lordosis, the L1PA decreased by 2.77° (β=0.28,95%CI:0.18-0.38,p<0.001). L5-S1: The mean change in lordosis at L5/S1 was 11±11° and 8° respectively. For a 10° increase in L5/S1 lordosis, the L1PA decreased by 1.26° (β=0.13,95%CI:0.05-0.20,p<0.001) (Figure 1).

Conclusion
Changes in segmental lordosis at the L4-5 level were associated with greatest decrease in L1PA following ASD surgery. Surprisingly, lordosis change at L5/S1 did not heavily influence L1PA. These findings suggest that focusing on adding lordosis at the L4/5 levels will result in the greatest decrease in L1PA.

PODIUM PRESENTATION ABSTRACTS



Change in L1PA with change in 10°segmental lordosis at each lumbar level

63. What Degree of Malalignment Justifies Performance of Three Column Osteotomy in Revision Lumbar Spinal Fusion?

Alan H. Daniels, MD; Tobi Onafowokan, MBBS; Max Fisher; Peter Tretiakov, BS; Kyriakos Chatzis, BS; Jamshaid Mir, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Justin S. Smith, MD, PhD; Breton G. Line, BS; Bassel G. Diebo, MD; Jeffrey L. Gum, MD; Themistocles S. Protopsaltis, MD; Kojo D. Hamilton, MD, FAANS; Thomas J. Buell, MD; Alex Sorocea-nu, MD, FRCS(C), MPH; Justin K. Scheer, MD; Robert K. Eastlack, MD; Jeffrey Mullin, MD; Gregory M. Mundis Jr., MD; Naobumi Hosogane, MD, PhD; Mitsuru Yagi, MD, PhD; Michael P. Kelly, MD; Paul Park, MD; Pierce D. Nunley, MD; Dean Chou, MD; Praveen V. Mummaneni, MD, MBA; David O. Okonkwo, MD, PhD; Neel Anand, MD; Eric O. Klineberg, MD; Khaled M. Kebaish, MD; Richard Hostin, MD; Munish C. Gupta, MD; Han Jo Kim, MD; Christopher P. Ames, MD; Lawrence G. Lenke, MD; Christopher I. Shaffrey, MD; Shay Bess, MD; Frank J. Schwab, MD; Peter G. Passias, MD

Hypothesis
The extent of malalignment in revision surgeries for complex spinal deformity can justify the use of 3CO.

Design
Retrospective cohort multicenter study

Introduction
While the use of three column osteotomy (3CO) in complex spinal deformity is associated with improved outcomes and acceptable complication rates, we have yet to compare outcomes after 3CO based on varied degrees of preoperative malalignment and determine when 3CO is warranted.

Methods
Revision complex spinal deformity patients who were fused from at least L1 and proximal to S1 and below with available baseline and 1 year (1Y) follow-up were isolated. Patients were stratified by whether they had 3CO (3CO+) and those that did not (3CO-). 3CO- cohort was further assessed based on development of complications and regional failure. Analysis controlled for age, gender, BMI, CCI, frailty, baseline deformity (PT, PI-LL, TPA, C7-PL), and levels fused. Multivariable regression determined which sagittal parameters were predictive of good outcomes. Conditional inference tree (CIT) was used to determine thresholds.

Results
132 CADS patients met inclusion, with no significant difference in age, gender, BMI, CCI, and frailty. Deformity at baseline was significantly worse in 3CO+. Despite fewer levels fused in 3CO+ (10.7 vs 13.3, p<.05) cohort, there was higher EBL (2.2L vs 1.2L, p<0.001), increased rates of massive blood loss (13% vs 1%, p=0.008), LOS (9.9 vs 6.6 days, p<0.001), SICU admission (87±35% vs 60±49%, p=0.007), discharge to SNF or rehab. Differences amongst cohorts in 1Y radiographic alignment, with 3CO- cohort having worse PT (24.2° vs 19.6°, p=0.008) and TPA (21.5° vs 16.3°, p=0.01). Parameters predictive of mechanical complications were: increasing PT (OR: 1.325 [1.003-1.750], p=.048) and increasing TPA (OR: 1.064 [1.012-1.119], p=.016). Thresholds values for baseline deformity associated with favorable outcomes in 3CO+ were: PT <15.3° (p=0.047), PI-LL <47.5° (p=0.026), TPA <33.2° (p=0.047).

Conclusion
The use of three-column osteotomy in revision complex spinal deformity surgery is associated with improved alignment by 1 year relative to those that did not. Threshold values for radiographic parameters were found to be PT <15.3°, PI-LL <47.5°, and TPA <33.2° being associated with favorable outcomes when using a 3CO.

64. Lumbar Lordosis Distribution in Adult Spinal Deformity: Targets Based on Pelvic Morphology

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Hypothesis
Thresholds for realignment of the lumbar lordosis distribution index (LDI) based on variations in pelvic morphology will lead to better outcomes.

Design
Retrospective.

Introduction
The LDI is an important constituent of achieving adequate correction of adult spinal deformity (ASD). While previous literature has evaluated LDI, targets can vary based on pelvic morphology that remains to be evaluated in the ASD population.

Methods
Operative ASD patients fused from at least L1 and proxi-

mal to the pelvis with two-year follow-up were included. Patients were stratified into three categories based on pelvic incidence (PI) [P1: PI<45°, P2 PI 45-60°, P3 PI >60°]. LDI was assessed based on: L4-S1 lordosis/L1/S1 lordosis. LDI based on Lafage et al and GAP were evaluated. Thresholds were determined by conditional inference tree (CIT) analysis.

Results
334 patients met the inclusion criteria. Overall, 49% had mechanical complications, with 32% considered major and 22% undergoing reoperation for mechanical complications. 54% had PJK, while 13% developed PJF. No difference in mechanical complication rate when meeting Lafage LDI (48 vs 49%, p=.8) or GAP LDI targets (46 vs 51%, p=.4). CIT analysis determined thresholds based on PI (all p<.05). PJK rates were reduced in P1 (low PI) if LDI was corrected to >0.6. While those in P2 (mid PI), with PT <23° had reduced rates of early PJF when LDI was corrected to >0.4. In P3 (high PI) with preoperative PT <48°, reduced rates of PJF if postoperative LDI was <85%, while reduced major mech comp with LDI <68.

Conclusion
Correction of lumbar lordosis distribution based on pelvic morphology reduced rates of PJK and PJF. Reduced rates of PJK were seen with thresholds for LDI correction of at least 60% for low PI, and lower than 85% in those with high IP.

65. Will my Sagittal Spinal Alignment Be Change After Total Hip Arthroplasty? An Analysis by Presence and Absence of Sagittal Spinal Deformity

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Hypothesis
Changes in spinopelvic alignment during standing and sitting in patients undergoing total hip arthroplasty (THA) will differ between those with and without co-existing thoracolumbar deformities.

Design
A retrospective review of patients ≥18 years undergoing unilateral THA for hip osteoarthritis with seated and standing radiographs taken pre- and post-THA.

Introduction
Hip osteoarthritis limits hip motion, fixed flexion contracture may contribute to a positive sagittal balance in standing. The prior dogma of always performing THA prior to spinal alignment correction has been questioned in recent years through demonstration of the effect of spinal alignment on acetabular orientation. However, the effect of THA on sagittal spinopelvic alignment remains relatively unanswered. This study investigates changes in spinopelvic alignment during standing and sitting in patients undergoing THA with- and without thoracolumbar deformities.

Methods
Alignment was assessed at baseline and post-THA in both standing and sitting positions, with patients grouped into three categories: Normal alignment (NA), Thoracolumbar (TL) Deformity (TLD) (PI-LL mismatch >10° and/or TPA>20°), or Apparent Deformity (AD) (PI-LL<10° and TPA<20°, but SVA>50mm). Sub-analysis compared the anterior vs posterior THA approach on alignment in both postures.

Results
Of 192 patients, 64 had TLD, 39 AD, and 89 NA. Overall, patients displayed a reduction in standing SVA (45mm to 34.1mm, p<0.001) and increase in PT (14.6˚ to 15.7˚, p=0.03) post-THA. SVA reduced more (-29.0mm vs -16.3mm vs 0.9mm, p<0.001) in AD compared to NA and TLD. This change in SVA was driven by significant differences in PT recruitment (DPT +4.9deg AD vs +0.26 TLD vs +0.04 NA, p< 0.001) The changes in alignment were no different between anterior and posterior approaches to the hip. No effect was noted in standing alignment for regional spinal alignment (PI, LL or TK) or global spinal alignment (TPA) in either standing or sitting. No difference was noted in sitting sagittal alignment pre- and post-THA in any cohort.

Conclusion
THA results in SVA reduction by increasing PT only in patients with AD (ie SVA>50mm, but no TLD). THA did not result in regional or global spinal alignment changes in standing or sitting postures, nor any significant standing alignment changes in patients with NA or TLD.

Standing Spinopelvic Parameters Between Spinopelvic Alignment Cohorts

	Spinopelvic parameter	Normal Alignment	TL Deformity	Apparent Deformity	P-value
	n = 192	89 (46.4%)	64 (33.3%)	39 (20.3%)	
Baseline	PI-LL mismatch (°)	-6.28	19.19	-0.62	<.001
	Spinopelvic Tilt (°)	10.87	23.28	8.90	<.001
	Lumbar Lordosis (°)	-56.71	-40.09	-52.26	<.001
	T1-Pelvic Angle (°)	7.65	24.61	13.62	<.001
	Thoracic Kyphosis (°)	37.27	29.69	40.52	<.001
	Pelvic Incidence (°)	50.43	59.28	51.64	<.001
	SVA (mm)	9.81	73.35	78.97	<.001
Post-operative	PI-LL mismatch (°)	-6.42	16.36	0.59	<.001
	Spinopelvic Tilt (°)	10.91	23.53	13.80	<.001
	Lumbar Lordosis (°)	-56.77	-42.90	-52.41	<.001
	T1-Pelvic Angle (°)	7.79	23.06	14.44	<.001
	Thoracic Kyphosis (°)	37.60	31.46	39.76	0.001
	Pelvic Incidence (°)	50.35	59.26	52.99	<.001
	SVA (mm)	10.66	57.02	49.93	<.001
Delta	Δ PI-LL mismatch (°)	-0.14	-2.83	1.20	0.025
	Spinopelvic Tilt (°)	0.04	0.26	4.90	<.001
	Δ Lumbar Lordosis (°)	-0.06	-2.82	-0.15	0.092
	Δ T1-Pelvic Angle (°)	0.14	-1.55	0.82	0.084
	Δ Thoracic Kyphosis (°)	0.33	1.77	-0.76	0.102
	Δ Pelvic Incidence (°)	-0.08	-0.01	1.35	0.456
	Δ SVA (mm)	0.86	-16.33	-29.04	<.001

66. Three Stages of Lower Extremity Compensation in ASD Patients with Sagittal Malalignment

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PODIUM PRESENTATION ABSTRACTS

Hypothesis
Machine learning(ML) clustering of lower extremity(LE) compensation provides deeper understanding into how LE adapts with disease severity.

Design
Retrospective, single center.

Introduction
Preop LE compensation contributes to suboptimal ASD correction, as it reciprocally adjusts with alignment changes & shifts CoG. Current understanding of compensation remains correlational, lacking a holistic analysis of pelvis, hip, knee, & ankle interplay.

Methods
Patients with sagittal malalignment(T1PA >20° &C7 SVA >3 cm) & 2Y radiographic follow-up were included. A k-means clustering ML algorithm analyzed LE compensation, including sacrofemoral angle(SFA/hip extension), knee flexion(KFA), ankle flexion(AFA) & pelvic shift(PS). Three clusters—low(L-PS), moderate(M-PS),& high(H-PS) PS—emerged(silhouette scores:0.59, 0.56, 0.55). Cluster differences & 2Y PROs were assessed via ANOVA with pairwise comparisons. Correlation between ΔT1PA & ΔLE compensation was evaluated(Pearson R, P Value).

Results
144(L-PS), 179(M-PS), & 93(H-PS) patients were included. L-PS had highest SFA/AFA but lowest KFA/PS, while H-PS showed the opposite. Preop PT was comparable across cohorts(30.0 vs 29.9 vs 31.6). SFA decreased(210.0 vs 205.75 vs 200.75; P<0.0001), KFA increased(6.51 vs 10.07 vs 17.36; P<0.0001), & PS rose significantly(16.65 vs 66.14 vs 126.92; P<0.0001) from L-PS to M-PS & H-PS. H-PS showed most severe baseline malalignment, demonstrating increased PI-LL(24.64 vs 31.49 vs 44.32; P<0.0001), driven by declining LL(-33.05 vs -25.19 vs -11.61; P<0.0001). TK decreased(39.59 vs 36.41 vs 31.81), while T1PA increased(29.81 vs 33.84 vs 41.14; P<0.0001). In the L-PS cohort, changes from pre- to postop SFA(R=0.42, P<0.0001) & AFA(R=0.46, P<0.0001), but not PS(R=0.16, P=0.1573), correlated with ΔT1PA. Conversely, in H-PS patients, changes in PS(R=0.55, P<0.0001) & KFA(R=0.48, P=0.0008), but not SFA(R=0.22, P=0.1367) or AFA(R=0.26, P=0.0813), correlated with ΔT1PA. ΔPT was similar between cohorts. Preop & 2Y SRS Activity & ODI were worse in H-PS(P<0.005). At 2Y, PS & KFA independently predicted worse PROs after adjusting for baseline PROs, preop T1PA, & ΔT1PA.

Conclusion
LE compensation in ASD progresses in three stages: mild cases show hip extension & ankle flexion while severe cases exhibit marked pelvic shift & knee flexion with minimal ankle flexion. These changes correlate with sagittal alignment improvements & are independently associated with PROs.

	Low Pelvic Shift [N=144]	Moderate Pelvic Shift [N=179]	High Pelvic Shift [N=93]	P Value (L-PS vs. M-PS)	P Value (M-PS vs. H-PS)	P Value (L-PS vs. H-PS_
Baseline Alignment						
Pelvic Tilt [PT]	29.99 (0.67)	29.92 (0.56)	31.57 (1.02)	0.7674	0.1588	0.1101
PI - LL	24.64 (1.28)	31.49 (1.01)	44.32 (1.68)	<0.0001	<0.0001	<0.0001
L1- S1 Lumbar Lordosis [LL	- 33.05 (1.82)	- 25.19 (1.19)	- 11.61 (1.97)	0.0003	<0.0001	<0.0001
Thoracic Kyphosis [TK]	39.59 (1.92)	36.41 (1.28)	31.81 (2.13)	0.1684	0.0661	0.0072
T1 Pelvic Angle [T1PA]	29.81 (0.56)	33.84 (0.6)	41.14 (1.1)	<0.0001	<0.0001	<0.0001
Two-Year Alignment						
Pelvic Tilt [PT]	22.7 (0.79)	22.97 (0.62)	24.11 (1.25)	0.7852	0.4153	0.3402
PI - LL	5.1 (1.14)	6.9 (0.88)	11.91 (1.72)	0.2145	0.0107	0.0012
L1- S1 Lumbar Lordosis [LL	- 52.33 (1.39)	- 50.18 (0.95)	- 45.03 (1.89)	0.2043	0.0163	0.0022
Thoracic Kyphosis [TK]	50.68 (1.65)	52.18 (1.13)	50.65 (1.81)	0.4546	0.4733	0.9892
T1 Pelvic Angle [T1PA]	18.19 (0.74)	19.62 (0.64)	22.61 (1.13)	0.1448	0.0227	0.0014
Preoperative LE Compensation						
Sacrofemoral Angle [SFA]	210.2 (0.75)	205.75 (0.58)	200.75 (1.19)	<0.0001	0.0002	<0.0001
Knee Flexion Angle [KFA]	6.51 (0.66)	10.07 (0.54)	17.36 (0.93)	<0.0001	<0.0001	<0.0001
Ankle Flexion Angle [AFA]	7.34 (0.36)	5.89 (0.29)	6 (0.51)	0.0019	0.8649	0.0323
Pelvic Shift [PS]	16.65 (1.9)	66.14 (1.18)	126.92 (3.37)	<0.0001	<0.0001	<0.0001
Two-Years LE Compensation						
Sacrofemoral Angle [SFA]	208.41 (0.97)	203.71 (0.85)	201.3 (1.54)	0.0388	0.1744	0.0064
Knee Flexion Angle [KFA]	3.46 (0.72)	6.21 (0.7)	9.5 (1.29)	0.0064	0.0282	<0.0001
Ankle Flexion Angle [AFA]	5.66 (0.4)	5.76 (0.41)	6.15 (0.67)	0.854	0.6247	0.5317
Pelvic Shift [PS]	8.69 (4.19)	26.93 (3.62)	50.61 (6.09)	0.0012	0.0013	<0.0001
Correlation Between Δ T1PA and Δ LE Compensation [Pearson R Value, P Value]						
Pelvic Tilt [PT]	0.58 (<0.0001)	0.68 (<0.0001)	0.80(<0.0001)			
Sacrofemoral Angle [SFA]	0.42 (0.0001)	0.39 (<0.0001)	0.22 (0.1367)			
Knee Flexion Angle [KFA]	0.31 (<0.0001)	0.37 (<0.0001)	0.48 (0.0008)			
Ankle Flexion Angle [AFA]	0.46 (<0.0001)	0.08 (0.3682)	0.26 (0.0813)			
Pelvic Shift [PS]	0.16 (0.1573)	0.58 (<0.0001)	0.55 (<0.0001)			

67. Outcomes of Vertebral Body Tethering in AIS: A Prospective, Multi-Center Study

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Hypothesis
Curve correction on first erect post-operative imaging is associated with higher rates of successful correction at final follow-up

Design
Prospective Cohort

Introduction
VBT for AIS is becoming increasingly popular as an alternative to traditional fusion. There is limited post-approval, prospective, multi-center data available on this procedure

Methods
All patients with AIS who underwent VBT between 2019 and 2022 were prospectively enrolled from 9 institutions. Radiographic and clinical data were compared preoperatively, at first erect (FE), and at final follow-up with minimum of 2 years. Success was defined as major Cobb of ≤ 35° at latest follow-up and no fusion surgery.

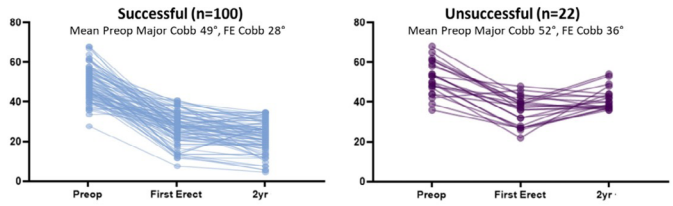
Results
127 patients were enrolled (79.5% female), with mean follow up of 2.4 years. Mean age at surgery was 12.9±1.4 years. Most patients had hand bone age of Sanders 4 or lower (93/112,83.0%). Lenke 1 curves were the most prevalent (58.4%), followed by Lenke 6 (13.4%). In average 7.6±1.7 levels were tethered, with 23 patients (18.25%) having bilateral tethers and 19 patients (14.96%) with double-row tethers. Mean operative time was 247 min, with mean 93 mL EBL. The average length of stay was 3.4 days. Preop mean major Cobb was 50±8°, with mean initial correction at FE of 29±8°(% correction,39±18%). At 2-year follow up, mean major Cobb angle was maintained at 26±11° (mean 45±23% correction). Patients who had a mean FE major Cobb ≤35° were 88% successful compared to only 60% success rate in those with >35° on FE(p=0.0021). Regression analysis controlling for all the demographics showed FE major Cobb

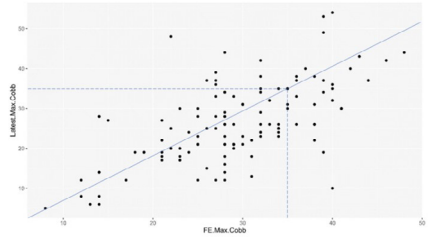
is significantly associated with success at final follow up (p<0.001, adjusted R^2=0.30). For every 1° increase in FE major Cobb, the final major Cobb increases by 0.8° (p<0.001, adjusted R^2=0.44) 4 patients (3%) had major complications (CSF leak, hemothorax/pleural effusions requiring sedated thoracocentesis). 15 patients (11.8%) needed reoperation due to overcorrection(6.3%), screw pullout(0.8%), cord breakage(0.8%), while 5 patients(3.9%) eventually underwent posterior fusion.

Conclusion

This is the first prospective, multi-center study to assess the outcomes of AIS patients who underwent VBT following FDA approval in August 2019. VBT shows promise, but optimal results may depend on careful patient selection & surgical technique. A FE major Cobb angle of ≤ 35° was associated with 88% success rate compared to only 60% success for those with poor correction.

	FE Cobb ≤ 35°	FE Cobb > 35°	p-value
Age at surgery	12.9 ± 1.3	13.0 ± 1.6	0.658
Preop Cobb	48.5 ± 7.9	53.2 ± 8.1	**0.005***
BMI	19.1 ± 3.7	19.3 ± 4.1	0.748
Risser	1.2 ± 1.2	1.03 ± 1.4	0.579
Sanders	4.2 ± 1.7	3.8 ± 1.9	0.257
Time to latest follow-up	2.4 ± 0.4	2.5 ± 0.5	0.210





68. Surgical Outcomes and Complications for Patients Undergoing Vertebral Body Tethering with a 5-8 Year Follow-Up

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Hypothesis

Vertebral body tethering (VBT) has acceptable complication rates while maintaining satisfactory curve correction at a minimum follow-up of 5 years. Tether breakages, depending on the timing of their occurrence, do not exert a significant impact on the postoperative curve progression.

Design

Prospective single center cohort study.

Introduction

VBT aims to gradually correct scoliosis, using patients' growth, while preserving spine motion. We report outcomes and surgical complications at a minimum of 5 years (range 5-8 years) post VBT in skeletally immature patients.

Methods

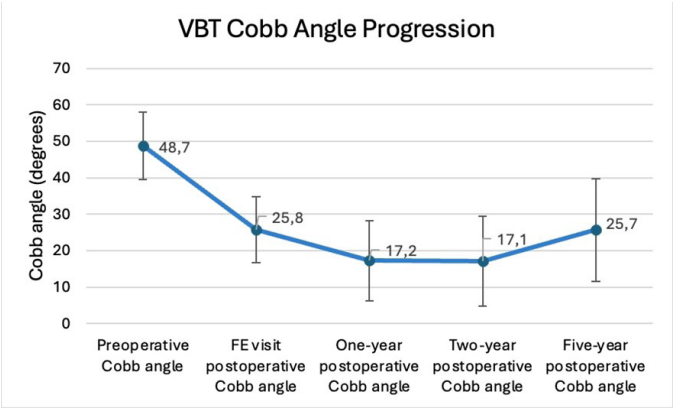
We reviewed 74 idiopathic scoliosis patients who underwent VBT at a single centre, with a minimum of five-year follow-up. Patients had preoperative, first erect, one-year, two-year and five-year X-rays. Postoperative data at each of these visits were analyzed. Interval increases of ≥5° in coronal curve angle from the smallest postoperative measure prompted segmental interscrew angle measurements to detect tether breakage, suspected with a ≥5° increase.

Results

All 74 patients were skeletally immature, mean age at surgery is 11.8±1.3 years and the mean follow-up time is 63.4±8.4 months. VBT was performed on an average of 7.4 vertebral levels. Instrumented Cobb angle was 48.7°±9.2° preop, 17.1°±12.3° at the 2-year postop and 25.7°±14.0° at the 5-year postop. Unplanned Return to the Operating Room (UPROR) occurred in 12 patients (16.2%). Four patients needed either partial or complete release of the tether due to overcorrection, 2 patients needed revision of VBT due to curve progression, 4 patients required posterior spinal fusion (PSF) due to curve progression. One patient needed revision of VBT followed by PSF. Two patients developed a small dural tear recognized postoperatively and treated with a blood patch. Forty-nine patients (66%) had a suspected broken tether at the last follow up. The mean time of the 1st tether breakage is 38.1±15 months. Without UPROR, 66% (49/74 pts) had a curve <40° at a minimum of 5 years postop after a single surgical event.

Conclusion

In our cohort 66% (49 patients) had a suspected radiological tether break after 5 years and 7% (5 patients) required PSF. VBT offers a significant correction in the coronal and transverse planes postoperatively with a reoperation rate of 16.2 %.



PODIUM PRESENTATION ABSTRACTS

69. Are Complications Higher for Lumbar or Bilateral Vs. Thoracic Vbt at 2-Year Follow Up? A Large, Single-Institution Retrospective Review

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Hypothesis
Lumbar, thoracic, and bilateral VBT will have similar curve correction and surgical outcomes, and rates of major complications and reoperations.

Design
Retrospective review.

Introduction
VBT for AIS is increasingly being used in the lumbar spine to preserve mobility. While anecdotal reports from surgeons suggest variations in complications & outcomes among single thoracic(T), single thoracolumbar/lumbar(TL/L), and bilateral (B) tethering, these observations have largely been supported only by separate, small case series. We aim to comprehensively assess these complications & outcomes at a single high-volume center.

Methods
A single-center retrospective review was completed on all AIS patients who underwent VBT between 2015 & 2022. All surgeries were done by the same surgical team. Radiographic & clinical data were compared at preop, first erect (FE), and final follow-up with minimum of 2 years to assess complications & outcomes. TL/L tether was defined as VBT with LIV below the L2. The interscrew angle, which serves as diagnostic indicator of tether breakage, were obtained automatically through a validated deep-learning model.

Results
145 patients met the inclusion & exclusion criteria with mean follow-up of 2.8±0.5 years. Anova showed the 3 cohorts have similar demographic in terms of age at surgery (p=0.163), Sanders bone age (p=0.303), Risser stage (p=0.367), BMI(p=0.567), and max Cobb Angle at preop (p=0.519), but not the numbers of instrumented levels (p<0.001). Adjusting for the levels, Analysis of Covariance showed that both the tether approach (p<0.001) and no. of levels (p=0.02) significantly impacted the OR time, particularly for bilateral tethers. EBL (p=0.79) and length of stay (p=0.39) was stable across the groups. TL/L group has the highest percentage of correction at FE follow up compared to other types (p=0.0004), and the lowest max Cobb angle at 2-year follow up (p=0.0008). Fisher's exact test showed no difference between the 3 groups in terms of tether breakage (p=0.54), major complications (p=0.63), and reoperations (p=0.79).

Conclusion
There were no significant differences in tether breakage, major complications, or reoperations among the 3 approaches. Exclusive of OR times, the outcomes between T, TL/L, and bilateral VBT also demonstrate notable similarity. Compared to other groups, TL/L achieved the lowest max Cobb angle at FE & final follow-up.

	Single T (n=102)	Bilateral (n=20)	Single TL/L (n=23)	p-value
Age at Surgery	13.1 ± 1.7	13.4 ± 1.6	13.9 ± 1.8	0.163
Sanders	4.0 ± 1.2	3.8 ± 0.8	4.4 ± 1.1	0.303
Risser	1.3 ± 1.4	0.8 ± 1.2	1.6 ± 1.7	0.367
BMI	20.0 ± 3.7	18.9 ± 3.0	19.2 ± 3.2	0.567
# Levels Instrumented	7.5 ± 0.9	11.2 ± 0.4	6.5 ± 1.1	<0.001*
Max Cobb at Preop	51 ± 10	54 ± 8	51 ± 7	0.519
Operative Time (min)	210.4 ± 68.4	409.1 ± 109.3	224.3 ± 52.6	<0.001*
EBL (mL)	163 ± 144	210 ± 155	116 ± 109	0.785
Length of Stay	3.3 ± 0.9	3.4 ± 0.9	2.9 ± 1.2	0.394
% Correction at FE	41 ± 13%	45% ± 14%	55 ± 17%	0.0004*
Max Cobb at final FU	28 ± 13	28 ± 8	20 ± 11	0.0008*
Tether breakage	28 (27.4%)	7 (35%)	8 (34.7%)	0.536
Reoperation	11 (10.7%)	3 (15%)	2 (8.7%)	0.793
Complication	5 (4.9%)	2 (10%)	1 (4.3%)	0.63

70. Six Modes of Failure for Vertebral Body Tethering (VBT)

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Hypothesis
VBT failures occur in recognizable patterns.

Design
Retrospective multicenter review of surgical outcomes of VBT to identify failure modes with a subsequent poll completed by experienced VBT surgeons.

Introduction
Historically, VBT has had a higher failure rate than PSF. Causes of failure vary. Meaningful analysis requires separating failures into recurring patterns with similar outcomes.

Methods
A retrospective multicenter study data review of patients treated with VBT included patients with a minimum 4 years follow up. Failures were defined by a >39 degree residual curve or revision to fusion. A thorough review of radiographic and clinical data revealed different modes of failure. A poll containing all failures was created and completed by 9 experienced VBT surgeons to determine primary/secondary modes of failure. Results of the poll were evaluated with chi-square for combinations of failure modes.

Results
26/325 patients met criteria. 6 modes of failure identified: 1)Undercorrection or failure to modulate (U) 2)Wrong LIV or UIV (IV) 3)Overcorrection(O) (4)Poor indications(P) 5) Early Tether rupture (<2years)(E) 6)Sagittal plane anomaly(S). 99.6% (233/234) of responses fell into one of the 6 modes, as opposed to "other". 77% (20/26) of cases reached a majority agreement for primary failure mode (69% agreement (55-100%)). Of those that did not, 5/6 reached majority agreement when including top secondary mode choice. U and IV were most commonly identified primary modes

of failure. U for 8/26 cases (31%). IV 7/26 cases (27%). Chi-square analysis revealed combinations of primary and secondary failure modes that occurred more frequently than expected were: U (1°) + IV, SR: 4.15 ($p<0.01$), P(1°) + U(2°), SR: 4.11 ($p<0.01$), O (1°) + P (2°), SR: 3.95 ($p<0.01$), P (1°) + O (2°), SR: 3.07 ($p<0.01$).

Conclusion
6 modes of failure were identified following VBT surgery. U and IV were found as the most common primary and secondary causes of failure. Chi squared analysis demonstrated higher than expected coupling of certain modes of failure. Segregating patient outcomes into failure modes with similar mechanisms and characteristics will provide critical insight for surgical indications and improve surgical decision making, ultimately also assessing the utility and impact of VBT revisions.

Failure Mode	Abbreviation
Undercorrection or failure to modulate	U
Wrong LIV or UIV	IV
Overcorrection	O
Poor indications	P
Early tether rupture	E
Sagittal planed anomaly	S

Example of an AIS case with too proximal of an LIV which led to adding on, Failure Mode 2, despite significant modulation. Fused after 4 year follow up.

71. What Happens to Broken Thoracic and Lumbar Vertebral Body Tethers After Skeletal Maturity?

Steven W. Hwang, MD; *Amer F. Samdani, MD*; Wasilat Dosunmu, BS; Samantha Murray, BS; Emily Nice, BS; William Purtill, BA; Terrence G. Ishmael, MBBS; Joshua M. Pahys, MD

Hypothesis
Most broken vertebral body tethers (VBT) do not progress past skeletal maturity.

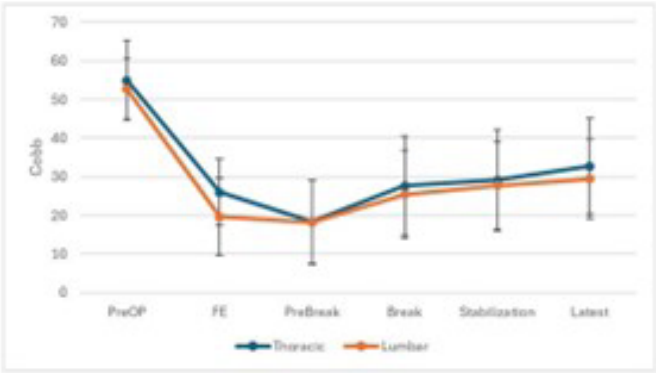
Design
Retrospective single center

Introduction
Broken VBTs are one of the most problematic issues related to the surgery; however, we do not understand the long-term effects of a break.

Methods
We reviewed all AIS patients with a single row VBT and at least 2 year follow-up spanning skeletal maturity (Sanders 7 or Risser 5) with interscrew angle confirmed breaks (≥5° change) between any post-op 6 month interval. We divided patients into thoracic or lumbar curves for analyses.

Results
78/177 (44%) thoracic patients had 115 breaks; 46 a single break with 80% occurring below the apex. The mean age at surgery was 12.8±1.5 yrs with a mean follow-up of 76±20 mos. Pre-op Cobb was 55±10° which corrected to 26±9° on first erect (FE) and 18±11° prior to break. After the initial break, the curve progressed to 28±13° and at last follow-up was 33±12°. The mean time from index surgery to break was 35±16 mos [11-105m]. The mean increase in Cobb per break was 9±8° and stabilized by 7±11 mos after with progression of 1±4° by last follow-up. Of the 32 with multiple breaks, the second break occurred a mean 14±6 mos after the initial one with an additional loss of 5°. 22 patients underwent revision surgery and had larger pre-op curves (58 vs 54°), larger prebreak curves (21 vs. 17°) and larger curves at break (32 vs. 25°) They were less skeletally mature at break and had larger curves prior to revision (38 vs. 31°) ($p<0.05$ for all). 39/57 (68%) lumbar patients had 58 breaks; 15 patients had multiple breaks with 76% occurring periapically. The mean age at surgery was 12.7±1.1 yrs with a mean follow-up of 68±19 mos. Pre-op Cobb was 68±19° which corrected to 20±10° on FE and 19±11° prior to break. After the initial break, the curve progressed to 25±11° and at last follow-up was 27±13°. The mean time from index surgery to break was 37±20 mos [6-101 mos]. The mean increase in Cobb per break was 7±7° and stabilized by 14±15 mos after with progression of 2±5°. Of the 15 with multiple breaks, the second break occurred a mean 20±16 mos after the initial one with an additional loss of 6°. Only 1 patient had a revision.

Conclusion
Thoracic and lumbar VBT curves may progress after a break for 7 or 14 months, respectively. Patients with multiple breaks were more likely to undergo revision, but only 1 lumbar patient had revision surgery.



72. Understanding Overcorrection Risk Factors in Anterior Vertebral Body Tethering

Alyssa E. Capasso, BS; Juan D. Rodriguez-Rivera, BS; Stefan Parent, MD, PhD; Tenner Guillaume, MD; Kenneth M. Cheung, MD, MBBS, FRCS; Kevin Smit, MD; Walter H.

PODIUM PRESENTATION ABSTRACTS

Truong, MD, FRCS(C), FAOA; *Juan Carlos Rodriguez-Olaverri, MD*; Pediatric Spine Study Group

Hypothesis
Skeletally immature patients with radiographic evidence of large growth potential who have smaller and more flexible scoliotic curves are more likely to experience overcorrection at 2 years follow-up.

Design
Retrospective analysis of a prospective multicenter database.

Introduction
Vertebral Body Tethering (VBT) is a fusionless alternative treatment to adolescent idiopathic scoliosis (AIS) and juvenile idiopathic scoliosis (JIS) that allows for growth-modulation. Patients with more growth remaining benefit from VBT, as it harnesses the remaining spinal growth to drive correction of the deformity. Nonetheless, patients with greater growth potential also carry increased risk of overcorrection.

Methods
Patients aged ≤ 16 diagnosed with AIS or JIS who underwent isolated anterior VBT with minimum 2 years follow up were included. Overcorrection was identified by centralized radiographic readings, and as correction of the spine in the opposite direction of the initial curve (negative Cobb angle). Independent samples t-test and χ2 test were used to compare outcomes between groups; significance set at p<0.05.

Results
296 patients were included, and 15 patients met overcorrection criteria. In the overcorrected group vs not overcorrected groups, findings included mean preop height (147.79cm ± 8.24cm vs 156.76cm ± 9.24cm, p<.001), mean change in height from preop to 2 years (12.14cm ± 4.74cm vs 5.56cm ± 3.54cm, p<.001) mean Risser score (.00 ± .00 vs. 1.03 ± 1.391, p<.001) mean preop flexibility (52.07° ± 14.16° vs. 39.03 ± 19.68, p<.001), mean pre-index major cobb angle (44.79° ± 9.61° vs 52.17° ± 9.17°, p<.001) and frequency of open triradiate cartilage (53.3% vs 16.9%, p<.001). Patients with a preop cobb angle of ≤ 45° had an increased frequency of overcorrection (64.3% vs. 21.8%, p<.001). Of the 15 overcorrected patients 9 (60.0%) underwent revision. Overcorrected patients that underwent revision had a mean major cobb angle of -22.43° ± 7.3°ranging from -16° to -38°, at an average of 1.3 ± .82 years following the index surgery.

Conclusion
Overcorrected patients had shorter preoperative height, lower Risser scores, open triradiate cartilage, smaller preoperative Cobb angles, and greater preoperative flexibility. Identifying these risk factors allows surgeons to optimally select candidates and intervention time for VBT, minimizing the risk of overcorrection while maximizing potential for effective spinal deformity correction.

Table 1: Demographics, Growth Potential and Skeletal Immaturity Characteristics

		No-Overcorrection		Overcorrection	p-value
	N=281		N=15		
Age	281	12.50 ± 1.58	15	11.67 ± 1.34	0.023
Female (%)	250	250 (89.0%)	12	12 (80.0%)	0.289
Height (cm)					
Preoperative	229	**156.76 ± 9.24**	13	**147.79 ± 8.24**	**<.001**
Postoperative	225	**157.60 ± 9.27**	15	**149.87 ± 8.11**	**<.001**
Postop Δ 2 Years	189	**5.56 ± 3.54**	15	**10.44 ± 4.73**	**<.001**
Risser Score	281	**1.03 ± 1.391**	15	**.00 ± .00**	**<.001**
Sander's Score	101	4.18 ± 1.763	-	-	-
Triradiate Cartilage					
Open		**46 (16.9%)**		**8 (53.3%)**	**<.001**
Closed		**226 (83.1%)**		**7 (46.7%)**	
Preop Flexibility (%)	199	**39.03 ± 19.68**	12	**52.07 ± 14.16**	**0.025**
Pre-Index Lenke Type					0.560
1		180 (69.2)		10 (66.7%)	
2		23 (8.8%)		3 (20.0%)	
3		14 (5.4%)		0 (0.0%)	
4		2 (0.8%)		0 (0.0%)	
5		25 (9.6%)		2 (13.3%)	
6		16 (6.2%)		0 (0.0%)	
Number of Levels Tethered	281	6.98 ± 1.56	15	6.60 ± .910	0.154
Tether Type					0.225
Single		238 (84.7%)		15 (5.9%)	0.101
Double		43 (15.3%)		0 (0.0%)	
Major Cobb Angle (°)					
Preoperative	271	**52.17 ± 9.17**	14	**44.79 ± 9.61**	**0.004**
Postoperative	269	**37.02 ± 8.69**	15	**28.36 ± 4.23**	**<.001**
Postop Δ 2 Years	225	**1.83 ± 10.78**	15	**-17.60 ± 23.79**	**0.007**
Preoperative Major Cobb Angle >45° and ≤ 45°					**<.001**
≤ 45°		59 (21.8%)		9 (64.3%)	
> 45		212 (78.2%)		5 (35.7%)°	
Minor Cobb Angle (°)					
Preoperative	269	**37.02 ± 8.69**	14	**28.36 ± 4.23**	**<.001**
Postoperative	274	**25.75 ± 8.74**	15	**20.07 ± 5.83**	**0.014**
Postop Δ 2 Years	222	.52 ± 8.09	15	-2.60 ± 21.68	0.218

73. Lumbar Tether Successfully Avoids Fusion in 85% of Patients at Two Year Follow Up – A Multicenter Study

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Hypothesis
Vertebral Body Tethering (VBT) in skeletally immature adolescents will allow most patients to avoid lumbar fusion with a modest complication and reoperation rate

Design
Multicenter retrospective cohort from an international spine registry

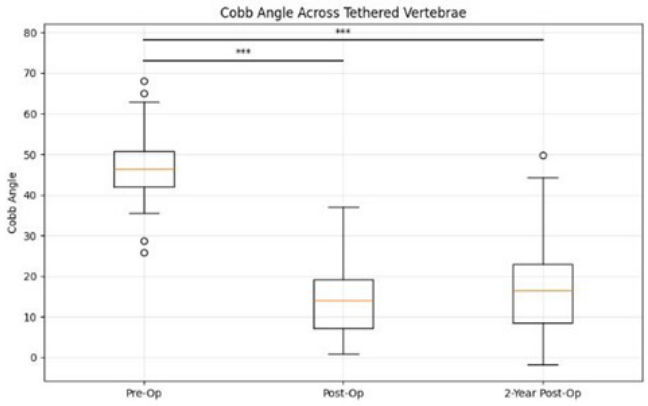
Introduction
VBT has emerged as a promising motion-preserving alternative to spinal fusion in select scoliosis cases. While thoracic VBT has been the focus of most research, lumbar VBT potentially offers a unique advantage by preserving motion at lower spinal segments and avoiding fusion to distal lumbar vertebrae. This study presents the largest cohort of patients with isolated lumbar tether and 2-year follow-up.

Methods
We identified 35 patients with an isolated lumbar tether and minimum 2-year follow up. Descriptive statistics on demographics, radiographic outcomes, and complication rates were performed. Wilcoxon Signed-Rank Test and paired

t-tests were used to identify significant changes in Cobb angles.

Results
The mean age of our cohort at index surgery was 13 ± 1.8 years, with a median Sanders score of 3 [1-7]. Average follow up was 1.9 ± 0.3 years. Approximately 77% of patients were female; 16 patients were instrumented to L3, and 18 to L4. Lumbar Cobb decreased from 51° ± 9° preoperatively to 25° ± 12° postoperatively ($p < 0.001$) with some loss of correction to 31° ± 15° at 2-years ($p = 0.006$). The tethered Cobb decreased from 47° ± 8° preoperatively to 15° ± 10° postoperatively ($p < 0.001$) and to 18° ± 13° at 2-years ($p = 0.133$); however, only 24% of patients experienced >5° of regression within 2-years. Additionally, 27 patients (82%) had tethered Cobb <30° at 2 years. Complications leading to unplanned return to operating room (UPROR) occurred in 14% of patients: over-correction (n=2), screw fracture (n=1), tether breakage (n=1), and hemothorax (n=1). Five patients (14%) required conversion to fusion, on average 1.8 ± 0.3 years post-index. Among patients instrumented to L3 vs L4, 12.5% and 5.6% required revision within 2 years, respectively ($p = 0.915$)

Conclusion
Lumbar VBT achieves initial curve correction that is maintained across the tethered region, with some loss of correction at 2 years but an overall 82% rate of tethered Cobb <30°. Overall, 86% of patients in this cohort did not require fusion, but longer follow-up is required to determine long-term efficacy and outcomes following lumbar VBT.



Cobb Angle Across Tethered Vertebrae

74. Surgical Treatment of Lenke Type 5 Curves Using Vertebral Body Tethering with Double Screw-Double Cord Fixation: Clinical and Radiological Outcomes over a Minimum 5-Year Follow-Up

Sepehr Asadollahmonfared, MD; Inas M. Daadour, MD; Hamisi M. Mraja, MD; Selmin E. Arsoy, BS, PT ; Sinan Kahraman, MD; Selhan Karadereler, MD; *Meric Enercan, MD*; Azmi Hamzaoglu, MD

Hypothesis
Vertebral Body Tethering (VBT) with the Double Screw-Double Cord (DS-DC) fixation technique minimizes tether breakage and achieves satisfactory clinical and radiological outcomes in skeletally mature AIS patients with Lenke Type 5 curves.

Design
Retrospective

Introduction
The DS-DC fixation in VBT is designed to reduce tether breakage risk while maintaining spinal flexibility and preserving lumbar motion. This study evaluates the radiological and clinical outcomes of Lenke Type 5 AIS pts treated with DS-DC fixation, focusing on tether integrity over a minimum 5 yrs f/up.

Methods
24 AIS pts treated with DS-DC fixation, 16 with at least 5 yrs of f/up were included. Coronal and sagittal parameters were assessed preoperatively, at first erect, and at follow-up. Tether breakage was defined as an interscrew angle change >5°. Clinical outcomes were measured using SRS-22r scores.

Results
16 pts(12F,4M),mean age 16yrs(13–23) and mean f/up 69 months(62–76). All pts had Sanders scores>5. The mean instrumented levels were 5.8 (5–7). TL/L curve improved from 45° to 9° (80% correction) at first erect and 18° (60% correction) at final f/up. Spontaneous correction of main thoracic curve improved from 17° to 8° at first erect and was maintained at 10° during f/up. Tether breakage (TB) occurred in 8 pts(50%) at a mean of 31 months(26–45m). These pts had 40% loss of correction in TL/L curve (mean:26°). Pts in TB group had similar lumbar lordosis (LL) but higher pelvic incidence(PI) and pelvic tilt(PT) values compared to non-TB group (62/56 vs 2/9) preoperatively. Lumbar AVT was higher in TB group at early postop (13.5vs9.5mm) and worsened significantly at the final f/up (28vs10mm). Both groups had similar LL at early postop; however, LL in TB group returned to preop values after tether breakage, whereas non-TB group maintained the corrections. SRS22r total and satisfaction scores were similar for TB and non-TB group (4.3/4.5 vs 4.4/4.6) but self-image score was lower in TB group (3.9 vs 4.2) at f/up.

Conclusion
DS-DC fixation technique demonstrated a 50% tether breakage rate over minimum 5yrs f/up. Tether breakage was more common in pts with higher PI (> 60) and predominantly occurred after 30 months. Tether breakage resulted in a loss of correction in both sagittal and coronal planes and negatively affected self-image scores in TB group(3.9 vs 4.2).

PODIUM PRESENTATION ABSTRACTS

75. Location of Tensioned Cord in Double Row Vertebral Body Tethering Constructs Significantly Affects Flexion Extension and Lateral Bending Range of Motion: A Cadaveric Biomechanics Study

A. Noelle Larson, MD; Amy A. Claeson, PhD; Vijay N. Permeswaran, PhD

Hypothesis
Cord tension and location of VBT screws impacts both the amount and plane of ROM reduction.

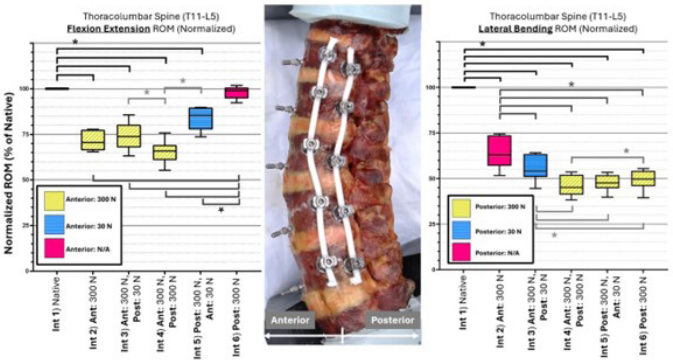
Design
Cadaveric

Introduction
VBT is emerging as a motion preserving procedure for treatment of adolescent idiopathic scoliosis. Screws and a tensioned cord are implanted laterally with VBT to apply corrective forces on the growing spine, preventing further curve progression. A secondary row of implants is now used by some clinicians to apply greater corrective forces, especially in the thoracolumbar spine. In this cadaveric biomechanics study, we investigate the impact of a secondary row on spinal range of motion (ROM).

Methods
Six thoracolumbar (T11-L5) specimens were tested with an MTS spine simulator while optoelectronic markers measured ROM. Each specimen was tested in the native state to assess baseline ROM. Then two rows of VBT screws were implanted at T12-L4, with one screw placed slightly posteriorly and the other slightly anteriorly. Experimental interventions (INT) included: INT2 anterior cord 300N; INT3 primary anterior 300N, secondary posterior 30N; INT4 anterior and posterior cords 300N; INT5 primary posterior 300N, secondary anterior 30N; and INT6 posterior cord 300N. A one-way ANOVA assessed statistical differences between interventions (α=0.05).

Results
One cord tensioned to 300N posteriorly (INT6) did not affect flexion extension (FE) ROM. Introducing a second cord anteriorly at 30N tension (INT5) significantly decreased ROM from 98% to 84% of native ($p<0.05$). When the secondary anterior cord was also tensioned to 300N (INT4), FE ROM decreased to 65% of native ($p<0.05$). When the anterior cord was tensioned primarily to 300N, with (INT3) or without (INT2) a secondary cord tensioned to 30N posteriorly, FE ROM was significantly reduced ($p<0.05$) but still maintained 71% and 74% of native ROM. In lateral bending (LB), the presence of a posterior cord tensioned to 300N resulted in significant reductions in ROM ($p<0.05$, INT4: 46%, INT5: 48%, INT6: 49%). LB ROM was significantly greater without a 300N posterior cord ($p<0.05$, INT2: 64%, INT3: 56%), though still significantly reduced from native ($p<0.05$).

Conclusion
Cord tension and location of VBT screws impact both the amount and plane of ROM reduction; screws placed anteriorly have greater effect on FE ROM, while screws placed posteriorly have greater effect on LB ROM.



76. Sagittal Spinal Alignment 2 Years After Anterior Vertebral Body Tethering

Jun Ouchida, MD; Peter O. Newton, MD; Vidyadhar V. Upasani, MD; Carrie E. Bartley, MA; Michael P. Kelly, MD

Hypothesis
Anterior Vertebral Body Tethering (AVBT) preserves physiologic maturation of sagittal spinal alignment.

Design
Retrospective cohort

Introduction
AVBT is a surgical option for patients with progressive idiopathic scoliosis with remaining growth potential. It relies on growth modulation for coronal curve correction through an anterior, convex tether. The sagittal plane develops during this growth phase, with changes to pelvic incidence and the corresponding spine shape. The effect of AVBT on the developing sagittal plane is unknown. The vertebral pelvic angles describe the shape of the spine with respect to pelvic tilt. We evaluated sagittal alignment using the T4-L1-Hip Axis, examining lumbar alignment (L1PA) and thoracic alignment (T4-L1PA).

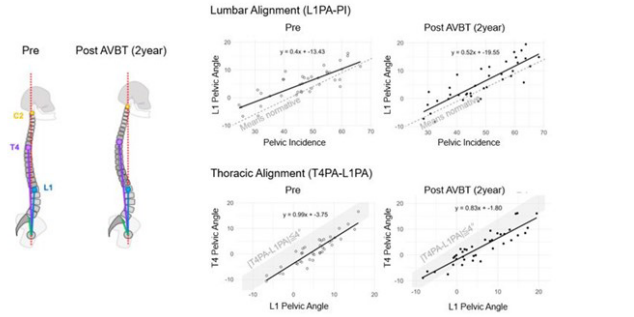
Methods
Patients with idiopathic scoliosis who underwent AVBT were included. Preoperative and 2-year postoperative radiographs were reviewed, recording coronal scoliosis parameters, sagittal pelvic parameters, and sagittal pelvic angles (PA) from T1 to L5. Linear regression models were fit for both L1PA and T4PA against pelvic incidence. A regression for T4PA against L1PA was performed. All values are presented as median (interquartile range), with significance set at $p < .05$. R2 measured model fit for linear regression.

Results
Thirty-eight patients were identified with median age: 11 years, interquartile range: 11-13 years, 87% Risser 0, 80% Sanders ≤3. The main thoracic curve significantly improved from 50.3° (45.3-57.8) to 28.4° (15.7-35.7) ($p<.001$) 2 years after AVBT. PI and PT increased with skeletal growth. At 2 years after surgery L1PA was estimated by the regression

L1PA = 0.5*PI – 19.6 (R^2 = .73). T4PA was estimated by the regression T4PA = 0.8*L1PA – 1.8 (R^2 = .82).

Conclusion
On average, patients treated with AVBT developed normal L1PA and T4-L1PA measures indicative of normal lumbosacral and thoracolumbar harmony. Growth modulation in the coronal plane did not negatively affect maturation of a normal sagittal profile, a concern in AVBT surgeries.

Maintenance of the entire spine alignment (T4-L1-Hip Axis) through reciprocal interaction of thoracic and lumbar arcs after AVBT (left). Post-operative thoracic (lumbar) alignment follows the means normative formula—L1PA=0.5×PI–21 as previously reported (right).



77. Clinical and Radiological Outcomes of Hybrid Technique in the Management of AIS with Double Major Curves over a Minimum 5 Years Follow Up

Inas M. Daadour, MD; Sepehr Asadollahmonfared, MD; Hamisi M. Mraja, MD; Halil Gok, MD; Sinan Kahraman, MD; Selhan Karadereler, MD; *Meric Enercan, MD*; Azmi Hamzaoglu, MD

Hypothesis
Hybrid technique; Combination of posterior pedicle screw fixation-fusion for thoracic curve and VBT with Double Screw Double Cord (DS-DC) fixation for TL/L will restore physiologic thoracic kyphosis, preoperative cervical sagittal malignment and will preserve spinal flexibility and lumbar motion in AIS pts with double major curves (DMC). DS-DC fixation will minimize the tether breakage problem.

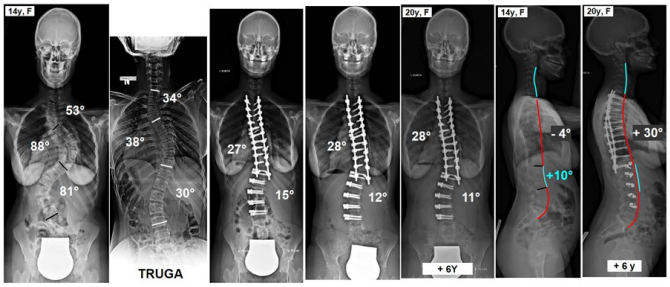
Design
Retrospective

Introduction
Hybrid technique has become a viable option for the surgical treatment of AIS with double major curves. In this study, we aimed to evaluate the efficacy of the Hybrid Technique in restoring ideal sagittal and coronal alignment in pts with DMC and assess tether integrity over 5 yrs f/up.

Methods
AIS pts treated with HT with a minimum 5 yrs f/up were included. Coronal and sagittal parameters were measured on preop, first erect and f/up x-rays. >5° interscrew angle change is accepted as tether breakage (TB) for VBT. SRS22r was used for clinical assessment.

Results
45(34F,11M) pts,mean age 14(11-17)yrs and f/up was 69(62-88)months.Mean MT 49° was corrected to 9° at f/up (84%CR). Mean TL/L of 51° was corrected to 15° at f/up (84%). TK of 25° restored to 9°. 30(66%)pts had cervical kyphotic alignment preoperatively. Among these 30pts, 26(87%)pts had improved cervical alignment postoperatively. Ponte osteotomy was performed in 6 pts with preop lordotic thoracic alignment. Preop. 12 pts presented with TL kyphosis. T10-L2 kyphosis improved from 16° to 2°. Tether breakage(TB) occurred in 14 pts (29%) at 39 months(28–49), resulting TL/L curve progression to 24°,T10-L2 kyphosis declined to 5°; LL returned to preoperative values. Pts with TB had larger preop TL/L curve (56°vs49°) and higher LL (60°vs53°) than non-TB pts 2 pts (4%) required revision surgery due to TB at 35.3 months. Overcorrection occurred in 6 pts (13%) but did not require any additional surgery. SRS-22r total scores were similar between TB and non-TB groups (4.1vs4.3),but satisfaction scores were lower in the TB group (3.8vs4.2).

Conclusion
In our study, 87% of the pts with preop cervical kyphosis had improved postop cervical alignment with Hybrid technique. Tether breakage rate was 29% and overcorrection rate was 13% over minimum 5 yrs f/up.TB occurred at a mean of 3 yrs or later following surgery. SRS22r total scores did not show any difference but TB lowers SRS satisfaction score (3.8vs4.2).



78. Does Vertebral Body Tethering Cause Coronal Hypermobility of Adjacent Non-Instrumented Levels?

Hans K. Nugraha, MD; Todd A Milbrandt, MD, MS; A. Noelle Larson, MD

Hypothesis
In contrast to the hypermobility observed after fusion surgery, VBT preserves the coronal arc of motion in the distal uninstrumented segments of AIS patients without causing hypermobility.

Design
Retrospective Cohort

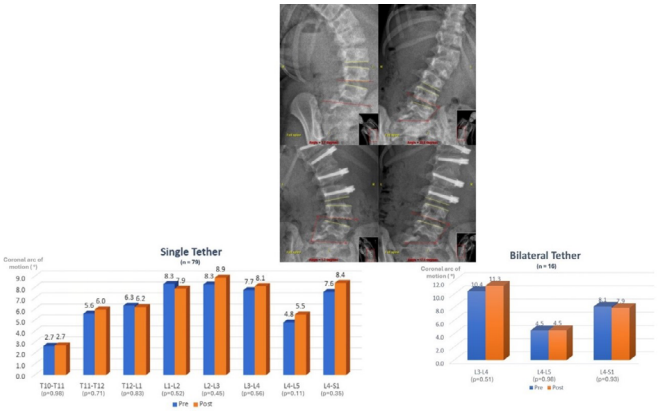
Introduction
Fusion into the lumbar spine with LIV of L2 and below can result in hypermobility of the unfused segments, potentially contributing to early disc and joint wear and subsequent degenerative arthritis. VBT is a motion-preserving surgery for scoliosis, but no data is available about its effect on disc motion for the uninstrumented segments distal to the LIV.

PODIUM PRESENTATION ABSTRACTS

Methods
A single-center retrospective review was completed of scoliosis patients who underwent VBT. All patients were evaluated with preoperative standing side-bending in a low-dose slot scanner in accordance with authors' institutional protocol. Patients are instructed to achieve maximum effort on side bending, and rotation in the transverse plane minimized. The bending radiographs are routinely made at authors' institution at 1 year postoperatively to assess cord integrity. To evaluate the coronal arc of motion, radiographic measurement of the intervertebral angles was measured at each level from the disc directly distal to LIV to S1. As described in the previous literature, this method demonstrates an excellent intrarater reliability with ICC of 0.86 and a standard error of measurement of 2°.

Results
In total, there were 2,086 segments measured. Sixteen patients had bilateral tether procedures and were analyzed separately. Compared to preoperative values over the same levels, paired t-test showed no significant difference in all coronal arc of motion over the segments distal to the LIV in either single or bilateral group (p=0.11-0.98). A further subanalysis was done for the single-tether group to assess for a possible relationship between each additional distal instrumented vertebrae and coronal arc of motion of segments distal to the LIV. Repeated one-way analysis of variance showed that there was no relationship between LIV and changes in coronal arc of motion in all levels (p=0.07-0.71).

Conclusion
This is the first study to assess the impact of VBT on the coronal arc of motion distal to the LIV. Normal segmental motion on lateral bend was preserved on the non-instrumented segments following VBT. In contrast to fusion, VBT might be protective against adjacent segment disease and early arthritis reported with long fusions.



79. Revolutionizing Digital Transformation in Adolescent Idiopathic Scoliosis Screening: AI-Assisted Holistic Motion Analysis Via a Smartphone Camera for Scalable, Cost-Effective Screening

Dong Chen, MS, BS; Huili Peng, MS; *Kenneth M. Cheung, MD, MBBS, FRCS*

Hypothesis
Adolescents with idiopathic scoliosis (AIS) can be effectively screened out by AI-assisted holistic motion analysis with a smartphone camera.

Design
Prospective study

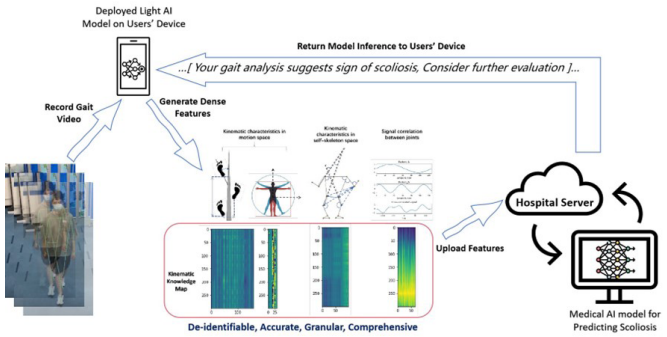
Introduction
Traditional AIS screening methods, such as Adam's forward bending test, Scoliometer and Moire topography, require medical professionals and patient undressing. Capitalizing on artificial intelligence (AI) advancements and scoliosis-specific gait patterns, this study introduces a scalable, noninvasive and cost-effective AIS screening system via smartphone motion analysis, significantly advancing the digital transformation of AIS screening.

Methods
Figure 1 shows the overall workflow. Adolescents under 18 years old were recruited at hospitals where biplanar spinal X-rays were taken for each subject. Additionally, gait videos were recorded, with subjects instructed to walk at their natural pace. These videos were then processed using a hospital-deployed medical AI model, which utilized user-derived kinematic features to transform the gait videos into structured, de-identified holistic gait patterns. The performance of this AI-assisted screening system for AIS was benchmarked against the gold standard, the measured Coronal Cobb Angle (CCA) from X-ray images.

Results
718 adolescents participated in this study. Gait videos from 568 subjects, including 389 AIS (CCA: 22.8°±11.0°) and 179 healthy controls (HC) whose CCA under 10°, were segmented into 1136 non-overlapped clips for training. An independent cohort of 150 adolescents was a hold-out testing group comprising 105 AIS (CCA: 25.2°±10.8°) and 45 HC. Compared to published traditional AIS screening programs (TP), which aim to detect CCA ≥ 10°, our screening workflow demonstrated superior performance in sensitivity 79.6% (AI) vs 64.7% in Hong Kong, 71.1% in the U.S. and 40.5% in Italy (TP) and positive predictive value 87.2% (AI) vs 76.5% in Hong Kong, 29.3% in the U.S. and 77.3% in Italy (TP). Additionally, the AI system achieved an overall accuracy of 78%, with sensitivity of 79.6% and specificity of 74.5%.

Conclusion
This study shows the potential of AI-assisted AIS screening via smartphone-based gait analysis. It provides a scalable, noninvasive and cost-effective solution suitable for

high-throughput environments without undressing and demanding professional input.



[1] Luk KD, et al. Clinical effectiveness of school screening for adolescent idiopathic scoliosis: a large population-based retrospective cohort study. *Spine (Phila Pa 1976)*. 2010;35(17):1607-1614.
[2] Dunn J., et al. Screening for Adolescent Idiopathic Scoliosis: Evidence Report and Systematic Review for the US Preventive Services Task Force. JAMA. 2018;319(2):173-187.
[3] Scaturro D, et al. Adolescent idiopathic scoliosis screening: Could a school-based assessment protocol be useful for an early diagnosis?. J Back Musculoskelet Rehabil. 2021;34(2):301-306.

AI-assisted AIS screening workflow

80. Generative Artificial Intelligence System for Radiation-Free Evaluation of Scoliosis: A Model Development and Validation Study

Zhong He, MD; Xiaodong Qin, PhD; Neng Lu, MS; Yi Chen, MD; Zhen Liu, PhD; Yong Qiu, PhD; Wu-Jun Li, PhD; *Zezhang Zhu, PhD*

Hypothesis
Our advanced deep learning system is expected to optimize the screening model for adolescent idiopathic scoliosis (AIS) by enabling the prediction of X-ray images through 2D photos. Its improvements in conditional Generative Adversarial Networks (cGAN) are anticipated to surpass existing models.

Design
Retrospective study.

Introduction
This study aims to develop and validate a smartphone-based system using deep learning technology, capable of generating virtual X-ray images (VXI) from two-dimensional Red Green Blue (2D-RGB) images captured by a smartphone or camera to assist spine surgeons in the rapid, accurate, and non-invasive assessment of AIS.

Methods
We included 2397 patients with AIS and 48 potential patients with AIS. Participants data included standing full-spine X-ray images captured by radiology technicians and 2D-RGB images taken by spine surgeons using a smartphone camera. We developed a deep learning model based on cGAN called Swin-pix2pix to generate VXI on retrospective training (n=1842) and validation (n=100) dataset, then validated the performance of VXI in quantifying the curve type and severity of AIS on retrospective internal (n=100), external (n=135), and prospective test datasets (n=268).

Results
Our Swin-pix2pix model generated realistic VXI, with the mean absolute error (MAE) for predicting the main and secondary Cobb angles of AIS significantly lower than other baseline cGAN models, at 3.2 and 3.1 degrees on prospective test dataset. The diagnostic accuracy for scoliosis severity grading exceeded that of two spine surgery experts, with accuracy of 0.93 in main curve and 0.89 in secondary curve. For main curve position and curve classification, the predictive accuracy of the Swin-pix2pix model also surpassed that of the baseline cGAN models, with accuracy of 0.93 for thoracic curve and 0.97, achieving satisfactory results on three external datasets as well.

Conclusion
Our developed Swin-pix2pix model holds promise for using a single photo taken with a smartphone or camera to rapidly assess AIS curvature and severity without radiation, enabling large-scale screening. However, limited data quality and quantity, a homogeneous participant population, and rotational errors during imaging may affect the applicability and accuracy of the system, requiring further improvement in the future.

81. Classification of Adolescent Idiopathic Scoliosis Curvature Using Unsupervised Machine Learning

Chang Ju Hwang, MD, PhD; *Sehan Park, MD*; Jae Hwan Cho, MD, PhD; Dong-Ho Lee, MD, PhD

Hypothesis
Can unsupervised machine learning suggests its own classification system for adolescent idiopathic scoliosis?

Design
Retrospective image analysis study based on machine learning

Introduction
Existing adolescent idiopathic scoliosis (AIS) classification systems, such as King and Lenke, have limitations in accurately describing curve variations, particularly long C-shaped curves or curves with distinct characteristics. Unsupervised machine learning offers an opportunity to refine classification and enhance clinical decision-making. The current study was conducted to propose a novel classification system for AIS curvature using unsupervised machine learning and evaluate its reliability and clinical implications.

Methods
A total of 1,156 AIS patients undergoing deformity correction surgery were analyzed. Standard posteroanterior radiographs were segmented using YOLO v8 and U-net algorithms. Contrastive learning was employed for unsupervised clustering, with clusters ranging from 3 to 10. Cluster quality was assessed using t-SNE and Silhouette scores. Clusters were defined based on consensus among spine surgeons. Interobserver reliability was evaluated using kappa coefficients.

Results
Six clusters were identified, reflecting variations in structural curve location, single (C-shape) versus double (S-shape) curves, and thoracolumbar curve characteristics. Cluster reliability was moderate (kappa 0.701–0.731). Silhouette score was 0.308, with t-SNE demonstrating distinct clustering patterns. The classification highlighted differences not captured by Lenke classification, such as thoracic curves

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confined to the thoracic spine versus those extending to the lumbar spine.

Conclusion
Unsupervised machine learning successfully categorized AIS curvatures into six distinct clusters. This approach identified meaningful patterns, including unique variations in thoracic and lumbar curves, which may inform surgical planning and prognostic assessments. Further studies are needed to validate clinical applicability and improve clustering quality.

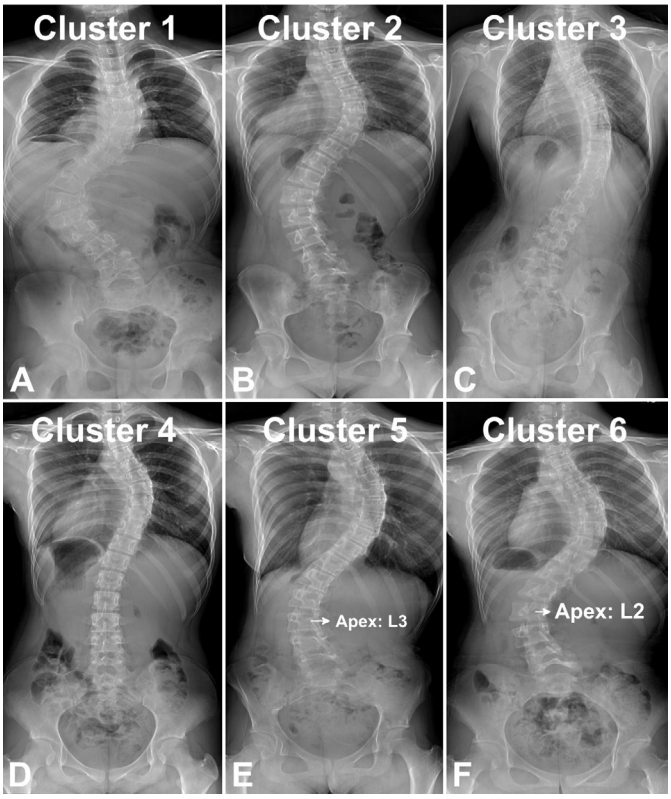


Figure. Definition of clusters (A) Cluster-1. Lumbar main single curve (B) Cluster-2. Lumbar main double curve (C) Cluster-3. Thoracic main long-C curve (D) Cluster-4. Thoracic main short C-curve (E) Cluster-5. Thoracic main double curve with small lumbar curve (F) Cluster-6. Thoracic main double curve with large lumbar curve

82. Characteristics and 10-Year Postoperative Course of Back Pain in Patients with Thoracic Adolescent Idiopathic Scoliosis §

Masayuki Ohashi, MD, PhD; Kei Watanabe, MD, PhD; Toru Hirano, MD, PhD; Kazuhiro Hasegawa, MD, PhD; Hideki Tashi, MD; Yohei Shibuya, MD; Masayuki Sato, MD; Mio Kubota, MD, PhD; Hiroyuki Kawashima, MD, PhD

Hypothesis
Patients with thoracic AIS treated surgically often experience back pain (BP), with its location potentially influenced by radiographic parameters or surgical procedures.

Design
Prospective observational study

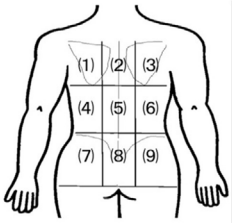
Introduction
Patients with AIS report BP more frequently than healthy individuals. However, previous research has been limited by heterogeneous curve types, insufficient information on pain localization, and cross-sectional study designs. To address these gaps, we conducted a prospective 10-year follow-up study of thoracic AIS patients who underwent posterior spinal fusion (PSF).

Methods
Inclusion criteria included: (1) Lenke type 1 or 2 curves, (2) treatment with PSF, (3) availability of 10-year follow-up data, and (4) preoperative and postoperative collection of SRS-22 scores and back pain questionnaires at 1, 2, 5, and 10 years (Figure).

Results
Forty-five patients (40 females; Lenke type 1/2=23/22 pts; mean age at PSF=15.2 years; F/U rate=71%) were included. Coronal curve corrections were significant following PSF (upper thoracic, 33.8 deg to 20.4 deg; main thoracic, 60.1 to 23.9; lumbar, 33.9 to 14.1). The point prevalence of BP ranged from 12.2% to 17.8% preoperatively and at follow-up visits, while the lifetime prevalence of BP increased from 48.9% preoperatively to 55.6-71.1% postoperatively. Regarding the location of the most severe BP (lifetime prevalence; Table), the middle back was the most common preoperatively (28.9%). However, the lifetime prevalence of upper back pain increased to 26.7% within one year postoperatively and remained stable over the subsequent 10 years. Conversely, lower back pain (LBP) showed a significant increase more than 5 years post-PSF and became the most frequent location at 10 years (33.3%). LBP at 10 years was significantly associated with the LIV at L3 compared to L2 or above (63.6% vs. 23.5%, p=0.026). Patients with a lifetime prevalence of BP had significantly worse 10-year SRS-22 scores across all domains (p<0.02), except for satisfaction (p=0.08), compared to those without BP.

Conclusion
Over 65% of patients experienced BP up to 10 years after PSF for thoracic AIS, with the location of severe BP shifting during the follow-up period. Our findings emphasize the importance of preserving lumbar motion segments during surgery to prevent or reduce LBP, which emerged as the most common pain type with a lifetime prevalence at the 10-year follow-up.

§ = Hibbs Award Nominee – Best Clinical Paper



Question

-Do you have any pain in your back now?	(Yes / No)
-Do you have any pain in your lower back now?	(Yes / No)
-Have you had any pain in your back before?	(Yes / No)
-Have you had any pain in your lower back before?	(Yes / No)

Please circle the number of the area that is, or was, most painful.
(Please select only one.)

Table: Location of the most severe back pain with the lifetime prevalence [cases (%)]

Level	Region	Preop		PO1Y		PO2Y		PO5Y		PO10Y	
Upper back	1	0 (0%)	2 (4.4%)	5 (11.1%)	12 (26.7%)	5 (11.1%)	13 (28.9%)	4	11 (24.4%)	2 (4.4%)	12 (26.7%)
	2	1 (2.2%)		1 (2.2%)		3 (6.7%)		4		6 (13.3%)	
	3	1 (2.2%)		6 (13.3%)		5 (11.1%)		3		4 (8.9%)	
Middle back	4	2 (4.4%)	13 (28.9%)	0 (0%)	13 (28.9%)	1 (2.2%)	11 (24.4%)	1	6 (13.3%)	0 (0%)	3 (6.7%)
	5	6 (13.3%)		10 (22.2%)		8 (17.8%)		4		2 (4.4%)	
	6	5 (11.1%)		3 (6.7%)		2 (4.4%)		1		1 (2.2%)	
Lower back	7	1 (2.2%)	7 (15.6%)	1 (2.2%)	5 (11.1%)	1 (2.2%)	8 (17.7%)	2	8 (17.7%)	4 (8.9%)	15 (33.3%)
	8	5 (11.1%)		4 (8.9%)		4 (8.9%)		5		9 (20%)	
	9	1 (2.2%)		0 (0%)		3 (6.7%)		1		2 (4.4%)	
No pain		23 (51.1%)		15 (33.3%)		13 (28.8%)		20 (44.4%)		15 (33.3%)	

83. The More You Use the Brace, the Better the Results: the Dose-Response Curves Between 18 and 23 Hours/day Brace-Wearing in 687 Braist-Matched Children §

Stefano Negrini, MD; Greta Jurenaite, MD; Fabio Zaina, MD

Hypothesis
A dose-response curve exists also for brace wear >18 hours/day (h/d)

Design
Secondary analysis of a retrospective study from a prospective database

Introduction
The Brace Adolescent Idiopathic Scoliosis Trial (BrAIST) dose-response curve (outcome: end-of-treatment [EoT] <50°) drives many to prescribe braces no more than 18 h/d. The SOSORT Guidelines add three other outcomes: improvement >5°, no progression >5° and EoT<30° (to avoid health issues in adulthood)

Methods
The cohort was prospectively recruited in 15 years, with patients using thermal sensors in the last 10. The braces (SOSORT-SRS-POSNA classification) included: 1) anterior closure 3D push-up TLSO, monocot rigid or bivalve highly-rigid; 2) for thoracolumbar and lumbar curves, the LSO version, or a ventral closure fronto-transverse plane detorsion monocot rigid LSO. Our protocols prescribe increasing brace rigidity and h/d (range 18-24) with a worsening prognosis. We subgrouped for brace rigidity and h/d prescribed, reported or recorded. We developed four dose-response curves for the SOSORT outcomes using BrAIST methods. We checked baseline differences among h/d quartiles (ANOVA), and calculated the percentage (95% confidence intervals) of participants for each outcome (chi2 test). For the outcome EoT<30°, we considered the rate change of participants <30° between start and EoT

Results
We included 670 consecutive patients (413 with thermosensors), 30±6 °Cobb, 83% females, age 13.0±1.3, Risser 1±1. The highest h/d quartiles showed the best °Cobb results even if they included (in agreement with our protocols) statistically significantly worse patients for °Cobb, ATR, and TRACE. The dose-response curves were statistically significant for EoT<30° and improvement outcomes. EoT<50° and no progression outcomes showed a high success rate (98% and 87%, respectively) and no dose-response effect

Conclusion
In a BrAIST-matched population with brace prescription >18 h/d, we found a dose-response effect for the most ambitious outcomes (improvement and EoT<30°), even if the higher h/d quartiles included the most demanding scoliosis. The high success rate for no progression and EoT<50° in this population reduces/abolishes the clinical importance of the dose-response curve. Our results support changing the 18 h/d brace prescription paradigm

	Patients	Wearing time	TRACE	ATR	Cobb start	Compliance	Change °Cobb	Improved	Not progressed	Change in rate <30°	End <50°	Legenda differences
	number	hours/daily	%	degrees	degrees	%	degrees	%	%	%	%	
Total	413	18.8±4.2	49.2±14.7	10±3.2	30.1±5.6	91±14%	-2.7±7.2 @	42% (37-47)	87% (84-91)	+22.0% (18-26) @	98% (96.6-99.3)	@ Pre-Post
First quartile	104	13.3±3.7 *§	47.3±13.3 †	9.5±3 ‡	29.6±5.7 §	73±16% *§	-1.2±7.3 @	36% (27-45)	87% (80-93)	+8% (3-13) ‡ @	99% (97.1-100)	* vs 1
Second quartile	103	17.9±0.8 *‡	46±15 *	9.8±3.1	28.4±5.4 *	93±6% *‡	-2.5±6.9 @	39% (3-48)	83% (76-90)	+6% (1-11) ‡ @	100%	† vs 2
Third quartile	103	21±0.9 *†	50.5±14.8 †	10.2±3.2	30.1±5.4 †	97±5% *§	-3.3±6.2 @	44% (34-54)	90% (84-96)	+21% (13-29) † @	98% (95-100)	‡ vs 3
Fourth quartile	103	23.2±0.8 *†	53±14.8 *	10.6±3.5	32.5±5.1 *	101±4% *†	-3.9±8.2 @	49% (39-59)	89% (83-95)	+31% (22-40) * @	96% (92-100)	§ vs 4

Data and curves in the thermosensors subgroup

84. Disease Modifying Treatment (DMT) Does Not Mitigate Scoliosis in Spinal Muscular Atrophy (SMA) §

Taylor M. Adams, BS; Lennert Plasschaert, MD; Patricia E. Miller, MS; Basil Darras, MD; *Brian D. Snyder, MD, PhD*

Hypothesis
H1) DMT (Spinraza, Ridsiplam, Zolgensma) prevents scoliosis initiation and progression in SMA. H2) Earlier DMT initiation (0-5y/o) mitigates spine deformity better than later (>5 y/o) intervention.

Design
Single-center retrospective study of SMA patients (SMN1 gene deletion chromosome 5q) evaluated 1975 – 2024 with serial spine radiographs over ≥2 consecutive years; compare scoliosis initiation and progression for treated (+DMT) vs. untreated (-DMT) patients.

Introduction
DMTs for SMA have improved survival and motor function, but their impact on mollifying spine deformity remains unclear. This study investigates whether DMTs mitigate scoliosis in SMA patients.

§ = Hibbs Award Nominee – Best Clinical Paper

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Methods
Scoliosis (Cobb) was measured on serial sitting spine X-rays. Changes in Cobb from baseline were analyzed using linear mixed modeling (LMM) with interaction terms for length of follow-up and +/- DMT, adjusted for age at presentation. Equivalence testing (two one-sided tests) evaluated for ΔCobb ≥10°/yr between treatment groups. Scoliosis progression from baseline over time was assessed using LMM based on age of DMT initiation (≤5 y/o vs. >5 y/o).

Results
Of 204 patients, +DMT=172 (84%), -DMT=32 (16%). For +DMT patients, mean age at presentation = 2.9 yrs; 56% male; 84% received Spinraza. Serial X-rays between baseline and ≥2-yrs f/u were available for 64 +DMT and 22 -DMT. Younger patients with ≤ 3SMN2 copies had accelerated curve progression, increasing 3.5° more per year than older patients (p=0.02) (Fig1B). Equivalence testing (within ±5°/yr margin) showed similar changes in scoliosis (Fig. 1 C) for +DMT vs -DMT (effect est=-0.62; 95% CI=-3.6-2.3). Among +DMT patients, 42% initiated DMT ≤5 y/o, while 58% started >5 y/o (Fig 1D).

Conclusion
The null hypotheses are proven: 1) DMT had no impact on the initiation or progression of scoliosis in SMA children; 2) paradoxically earlier DMT initiation (ages 0-5) was associated with accelerated scoliosis progression compared to later intervention. Thus, although DMTs improves survival and functional mobility, they do not mitigate spine deformity, regardless of age at initiation. Survival bias may influence these results, pre-DMT (2016), mostly children with ≥3 SMN2 copies survived, while post-DMT symptomatic infants (<3 SMN2 copies) received early treatment. The rapid progression of scoliosis in young children with <3SMN2 copies may indicate an inherent SMA skeletal phenotype.

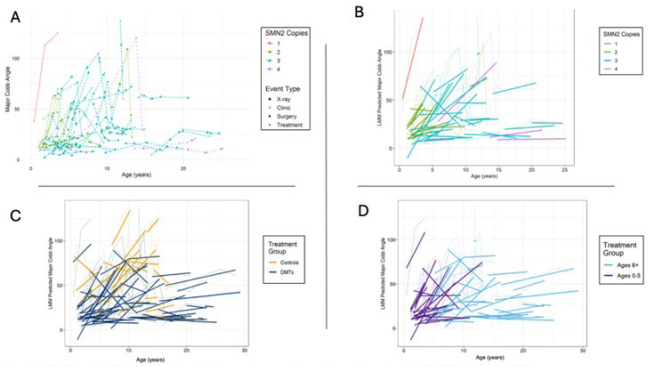


Fig. 1. A) Spaghetti plot major Cobb angle vs. Age of each patient, stratified by SMN2 rescue gene copy number. **B)** Spaghetti plot of fit lines to consecutive Cobb measurements for each patient over time, as function of age, stratified by SMN2 copy number. **C)** Spaghetti plot of fit lines to consecutive Cobb measurements for each patient over time, as function of age, for +DMT and -DMT patients. **D)** Spaghetti plot of fit lines to consecutive Cobb measurements for each patient over time, as function of age, evaluating age +DMT initiated.

85. Wait to Operate: Surgery Demonstrated No Pulmonary Benefit Compared to Non-Operative Treatment in EOS Patients §

Amy L. McIntosh, MD; Charles E. Johnston, MD; Tiffany Thompson, BS; JP Rathbun, BS; Chan-Hee Jo, PhD; Karina A. Zapata, PhD, PT, DPT

Hypothesis
Surgical intervention results in equivalent pulmonary function tests (PFT) compared to non-operative treatment (non-op) in Early Onset Scoliosis (EOS).

Design
Retrospective cohort

Introduction
Spinal deformity and Thoracic Insufficiency are indications for surgical EOS treatment, but effects on pulmonary function are unknown when compared to non-op treatment.

Methods
EOS patients with PFTs from 2004-23 and most recent ≥2yr follow-up (f/u) were reviewed. Pts were grouped into surgical (pre-op and post-op PFTs) and non-op treatment. A poor outcome was defined as either final FVC <80% or if initial FVC was <80%, then a deterioration of FVC% >10% at f/u.

Results
197 patients (102 non-op, 95 surgical) averaged 5.2 yrs f/u. The surgical group consisted of 61 definitive fusion (DF) and 34 growth friendly (GF) constructs. The non-op group had observation (68), casting (27), bracing (4), and halo application (3). Surgical patients were older than non-op (9.7 vs 7.2 yr, p<.001), had larger baseline curves (71° vs 36°, p<.001), larger coronal deformity angular ratios (CDAR: 8.9 vs 5.6, p<.001), and worse baseline FVC% (55 vs 70%, p<.001). Etiology, gender, curve location (87% thoracic), and final curve magnitudes did not differ between groups. Both the surgical and non-op groups FVC% worsened by 7% at final f/u (62% to 55%, 77% to 70%, p<.02). Within the surgical group, FVC% worsened for GF constructs (63% to 50%, p=.001) but not for DF (61% to 58%). Multivariate regression analysis found that lower baseline FVC% (OR 1.04, 95% CI 1.02-1.05), and idiopathic dx (OR 3.11-3.52, 95% CI 1.22-10.48) had a lower risk of poor outcomes. Surgical vs non-op treatment, age, curve magnitude, and CDAR were not risk factors. A subgroup of 37 surgical and 37 non-op patients matched by curve magnitude, CDAR, and baseline FVC% also found similar FVC% decline at final f/u (-5% vs -6%; Table).

Conclusion
Regardless of surgical correction to similar cobb magnitudes as non-op cases, PFTs did not improve. Sadly, both surgical and non-op groups, demonstrated equivalent FVC% decline (7%) during 5 yr f/u. A subgroup analysis of surgical vs non-op patients matched by baseline curve magnitude corroborated these findings. Notably, within the surgical group, FVC% worsened for GF constructs (63% to 50%, p=.001) but not for DF (61% to 58%). Documenting PFT benefit from EOS surgical treatment remains elusive.

§ = Hibbs Award Nominee – Best Clinical Paper

	Non-Operative (n=102)	Surgical (n=95)	P-value
Baseline age (yrs)	7.2±1.5	9.7±2.7	**<.001**
Baseline curve (°) (range)	36±18 (9-97)	71±21 (16-131)	**<.001**
CDAR	5.6±3.1	8.9±3.2	**<.001**
Baseline PFTs			
FVC (L)	1.1±0.4	1.2±0.7	.445
FVC % (range)	77±25 (23-143)	62±27 (17-148)	**<.001**
Final curve (°) (range)	**38±22** (2-93)	**37±17** (3-93)	.758
Final PFTs			
FVC (L)	2.2±0.9	1.9±0.8	**.008**
FVC % (range)	70±20 (16-120)	55±19 (11-107)	**<.001**
FVC% change: Baseline to Final	-6±18	-7±22	.556
% Pts with Poor Outcomes	28%	32%	.630
Matched Subgroup			
	Non-Operative (n=37)	Surgical (n=37)	P-value
Baseline age (yrs)	7.2±1.5	9.7±2.7	**<.001**
Baseline curve (°) (range)	**55±14** (40-97)	**53±10** (16-84)	.541
CDAR	7.8±2.8	6.8±2.1	.243
Baseline PFTs			
FVC (L)	1.0±0.4	1.2±0.7	**.018**
FVC % (range)	69±26 (23-134)	65±22 (18-105)	.473
Final curve (°) (range)	56±16 (24-80)	35±13 (9-71)	**<.001**
Final PFTs			
FVC (L)	1.8±0.8	1.9±0.8	.197
FVC % (range)	63±20 (16-105)	55±19 (11-107)	.465
FVC% change: Baseline to Final	-6±17	-5±15	.910
% Pts with Poor Outcomes	24%	35%	.309

Sx v. Non-op

86. Trunk Motion for Adolescent Idiopathic Scoliosis After Posterior Spinal Fusion Compared to Single Vs. Dual Cord Anterior Vertebral Body Tethering at Two Year Follow-Up §

Joshua M. Pahys, MD; Amer F. Samdani, MD; Steven W. Hwang, MD; Terrence G. Ishmael, MBBS; Spencer Warshauer, MS; Robert Courter, PhD; John P Gaughan, PhD; Ross Chafetz, PhD

Hypothesis
Trunk motion will be reduced with posterior spinal fusion (PSF) vs. vertebral body tethering (VBT) with each more caudal lowest instrumented vertebra (LIV). Single cord VBT (SC-VBT) vs. dual cord VBT (DC-VBT) will not impact trunk motion

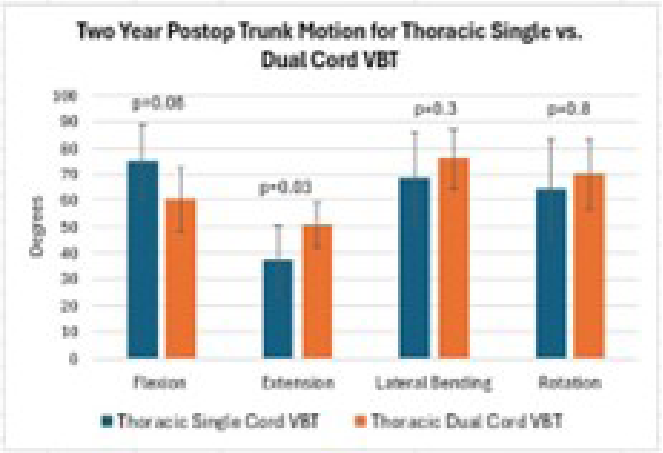
Design
Single center retrospective review of a prospectively collected consecutive series of AIS patients

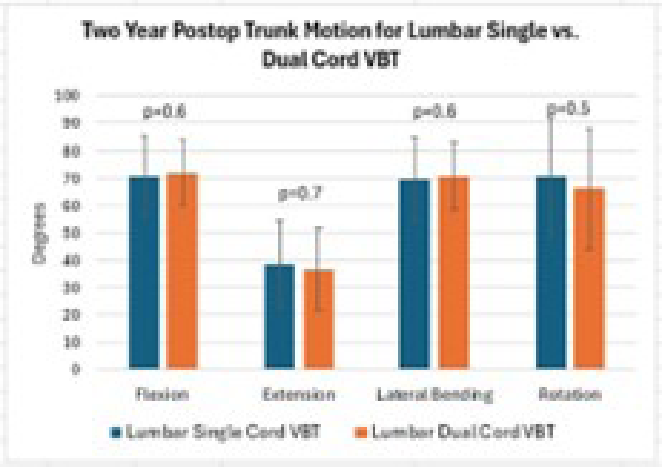
Introduction
Previous studies have shown a greater loss of trunk motion with each additional caudal LIV after PSF vs. VBT. This is the largest study to date (n=226) to evaluate trunk motion before/after PSF vs. VBT, as well as the potential impact of single vs. dual cord VBT constructs using an established computerized 3D motion capture system.

Methods
All skeletally immature AIS patients underwent trunk motion analysis (flexion/extension, side bending, and rotation) from 2016-present before PSF (n=109) or VBT (n=117) and 2 years postop. Patients were divided into four groups based on LIV (<L1, L2, L3, and L4). Subanalysis of VBT patients were divided into SC vs. DC VBT constructs of both the thoracic (SC: n=86; DC: n=3) and lumbar spine (SC: n=34; DC: n=8).

Results
Patients were stratified by LIV: <L1(VBT n=81; PSF n=59), L2(VBT n=6; PSF n=16), L3(VBT n=17; PSF n=23), L4(VBT n=13; PSF n=11). Preop trunk motion was similar for PSF and VBT patients. PSF patients had a significant loss of trunk ROM in all planes at 2 years postop with each additional caudal LIV (ex. flexion: LIV<L1: 15% loss vs. LIV L4: 39% loss, p<0.001). VBT patients had comparatively lower loss of ROM in all planes at 2 years postop with each additional caudal LIV (ex: flexion LIV<L1: 10% loss vs. LIV L4: 21% loss, p<0.001). There was no significant difference in motion for all planes with SC (n=120) vs. DC (n=19) VBT constructs of either the thoracic or lumbar spine at 2 years postop.

Conclusion
This is the first study to evaluate trunk motion for single vs. dual cord VBT constructs. We found no difference in trunk motion for single vs. dual cord thoracic VBT constructs or single vs. dual cord lumbar VBT constructs. VBT patients experienced significantly less motion loss compared to PSF at 2 years postop. PSF patients lost significant motion in all planes which increased with each additional lowest instrumented vertebra (LIV) from L1 to L4. Differences were modest (<8°) between PSF vs. VBT for LIV<L1 in all motions except rotation (18°).





§ = Hibbs Award Nominee – Best Clinical Paper

PODIUM PRESENTATION ABSTRACTS

87. Sagittal Malalignment in ASD Seems to Be Related to Frontal Instability During Gait §

Georges El Haddad; *Rami Rachkidi, MD, MS*; Marc Boutros, MS; Maria Karam; Maria Asmar; Emmanuelle Wakim; Moustapha Rteil; Ibrahim Hamati; Gilles Prince; Jean-Pierre Saad; Yamen Beyh; Mohamad I. Karam, PhD; Ismat Ghanem, MD, MS; Abir Massaad, PhD; Ayman Assi, PhD

Hypothesis
ASD patients with sagittal malalignment have increased frontal instability during gait.

Design
Retrospective analysis of prospectively collected data.

Introduction
ASD patients are known to present with functional impairments during gait that might increase their risk of falls. The aim was to evaluate gait stability in ASD and its relationship with spinal malalignment and QOL.

Methods
124 ASD patients and 30 controls underwent biplanar radiographs with calculation of spinopelvic and global alignment parameters such as sagittal vertical axis (SVA), T1-pelvis angle (TPA), and frontal Cobb. They all filled the SF-36 with its physical component (PCS) and performed 3D gait analysis to calculate full-body kinematics. The angle between the body center of mass and the foot center of pressure with the vertical (CoM-CoP) was calculated in the frontal and sagittal planes during gait to evaluate dynamic stability. Patients were classified as ASD-unstable or ASD-stable based on the corridor of normality of the CoM-CoP angle. Kinematics, radiographic parameters and PCS were compared between groups.

Results
All ASD had a normal CoM-CoP angle in the sagittal plane. However, in the frontal plane, 24 ASD were classified as ASD-unstable and 100 as ASD-stable (range of motion of CoM-CoP:14 vs 8°,p<0.01;fig.1). While the 2 groups had a similar pelvic incidence (PI=52°), ASD-unstable had a higher SVA (70 vs 15mm) & TPA (25 vs 15°;all p<0.05) compared to ASD-stable. The frontal Cobb was similar between the 2 groups (Cobb=17°). During gait, ASD-unstable had an increased dynamic sagittal ODHA (angle between odontoid to hip axis with the vertical: 8 vs 5°), frontal ODHA sway (4 vs 1°), external foot progression (14 vs 9°), with a decreased step length (0.51 vs 0.56m) and pelvic obliquity (4 vs 8°). They also had decreased PCS (33 vs 39; all p<0.05). Frontal CoM-CoP was correlated with SVA (r=0.25) & PCS (r=-0.36).

Conclusion
Sagittal malalignment in ASD seems to be related to frontal instability during gait. In order to reduce their frontal sway, unstable patients tended to reduce their frontal pelvic mobility and walk with an external foot progression to increase their base of support. This gait pattern seems to be adopted to gain stability and reduce the risk of falls. Future work should evaluate the impact of spinal re-alignment surgery on frontal instability during gait.

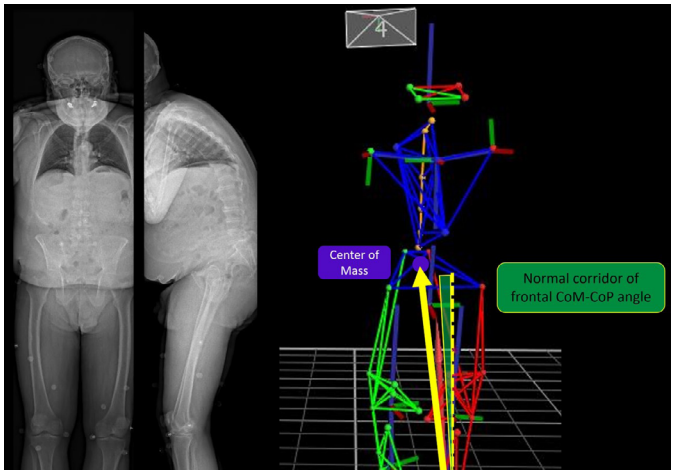


Fig.1-Increased CoM-CoP angle during gait in ASD with sagittal malalignment.

88. Accelerated Biological Aging in Patient with Adults Spinal Deformity: The Impact of Modifiable Lifestyle Factors on Phenotypic Age †

Mitsuru Yagi, MD, PhD; Norihiro Isogai, MD, PhD; Ryosuke Maruiwa, MD; Ryo Mizukoshi, MD; Haruki Funao, MD, PhD; Retsu Fujita, PhD

Hypothesis
Adult spinal deformity (ASD) will be linked to accelerated health decline, potentially affecting biological age.

Design
Cross sectional study

Introduction
Aging is a complex process influenced by genetic, environmental, and lifestyle. While chronological age is a straightforward metric, it does not fully capture biological aging. This study evaluates the association between Phenotypic Age (PhenoAge) and ASD in a Japanese and explores the impact of modifiable lifestyle factors on biological aging.

Methods
This study included data from 10,205 Japaneses who underwent comprehensive health examinations. Propensity matching was performed to assess associations between PhenoAge and conditions such as cancer, DM, and renal disease. A separate cohort of 309 Osteoarthritis (OA) and 161 ASDs were analyzed to compare the biological age to healthy cohort. The impact of modifiable lifestyle factors on PhenoAgeAccel was assessed using linear regression. Additionally, a longitudinal analysis was conducted among individuals who participated in health exams in both 2020 and 23, to evaluate changes in PhenoAgeAccel over time.

Results
Japanese individuals had a mean PhenoAgeAccel of -8.0±4.0y, significantly lower than their chronological age (p<.01). PhenoAge outperformed chronological age in predicting DM (AUC=.79 vs .72; p=.01) and renal disease (AUC=0.74 vs. 0.67; p<0.01). ASDs exhibited a higher Phe-

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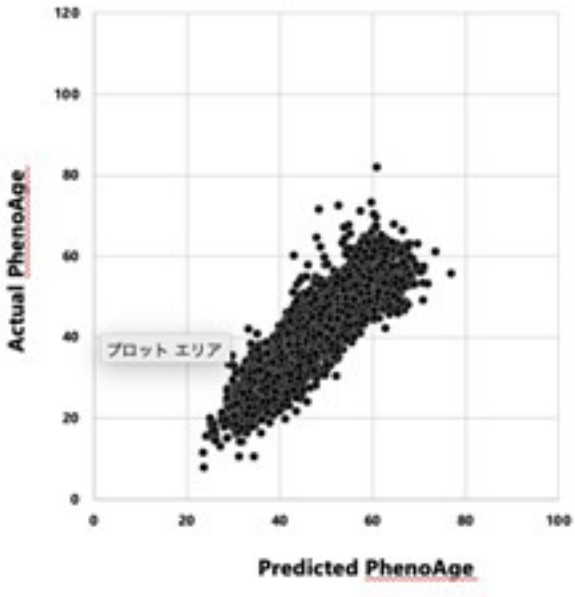
noAge compared to controls in the PSM cohort (62.5±17.1 vs 58.3±13.5y; p=.02). Elevated CRP and WBC levels in ASD patients indicated systemic inflammation (CRP: 0.5±1.3 vs 0.2±0.4 mg/dL; p<.01; WBC: 6.4±2.3 vs 5.0±1.3 x 103/µL; p<.01), while no difference was found for OAs. Lifestyle factors such as smoking (β=0.6; p<.01) and obesity (β=1.5; p<.01) were significantly associated with increased PhenoAgeAccel, while physical activity reduced it (β=-0.2; p=0.03). The longitudinal analysis showed that the non-risk group exhibited an improvement in PhenoAgeAccel (-0.5y), whereas the risk group experienced a decline (0.5y) over 3-years.

Conclusion
ASD patients exhibited accelerated biological aging, emphasizing the importance of managing systemic inflammation. The longitudinal findings further suggest that lifestyle interventions can help maintain or even improve biological age, emphasizing the importance of modifiable factors in promoting healthier aging.



Elastic Net Analysis of Actual and Predicted PhenoAge

89. The Sodium-Glutamate Antagonist Riluzole Improves Outcome After Acute Spinal Cord Injury: Results from Riscis Randomized Controlled Trial Using a Global Statistical Analytic Technique †

Michael G. Fehlings, MD, PhD, FRCS(C)

Hypothesis
In the current study, the authors sought to analyze he results of RISCIS trial by applying a multivariable nonparametric global statistical test that integrates three measurement scales representing the multi-dimensional health state of the patient after treatment

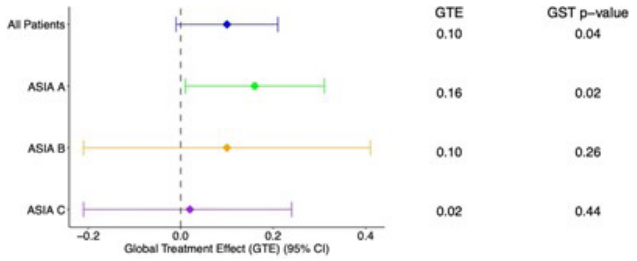
Design
Analysis of the prospective randomized controlled RISCIS trial (NCT01597518).

Introduction
In spinal cord injury (SCI) trials, a single scale typically serves as the primary measure of intervention, limiting the study's power to detect the true effect of intervention, especially when outcomes are highly heterogenous. It is essential to concurrently consider functional and quality of life measures for more comprehensive outcome assessment.

Methods
A total of 131 randomized patients in RISCIS were included. We used a combined assessment at six months using total AIS motor score (to measure neurological status), Spinal Cord Independence Measure (SCIM) (to measure functional status) and SF-36 PCS (to measure quality of life). A global statistical method employing the modified O' Brien's rank sum type test was used to compute for a global treatment effect (GTE).

Results
Riluzole was given to 65 patients, while 66 received placebo drug. Individual unadjusted mean difference (MD) at 6 months showed favorable outcomes in the riluzole group compared to placebo for total AIS motor score [MD 2.86 (-6.79 – 12.52), p = 0.2864], SCIM [MD 6.02 (-2.47 – 14.51), p = 0.0921], and SF-36 PCS [MD 2.0 (-2.25 – 6.24), p = 0.1372]. Using GST to simultaneously assess TOTM, SCIM, and SF-36 PCS, a higher rank sum was observed in the riluzole group [median rank sum (IQR) =207 (166-246) in riluzole vs 185.20 (146-236) in placebo, p = 0.04). Subgroup analysis revealed the greatest treatment benefit among ASIA A patients (GTE = 0.16, p=0.02). Riluzole was associated with a 55% higher probability of global improvement at 6 months compared to placebo.

Conclusion
A multidimensional representation of SCI outcomes can enhance the power to estimate treatment effects. Riluzole demonstrated a global beneficial effect in acute traumatic SCI when considering motor recovery, functional ability, and health related quality of life.



Global Treatment Effect (GTE) stratified based on ASIA group. GTE values (diamond figure) represent the probability of preferred outcome in the riluzole group

† = Hibbs Award Nominee – Best Basic Science/Translational Paper

PODIUM PRESENTATION ABSTRACTS

90. Spinal Growth Regulation by Interfering Chondrocytes Function in Growth Plate is a Potential Treating Method for Scoliosis: Preliminary Study in Piglets †

Zhaoquan Zhang, MD; Zhibo Song, MD; Yingsong Wang, MD; Zhi Zhao, MD; Ni Bi, MD; Jingming Xie, MD; Tao Li, MD; Li Zhang, MD; Ying Zhang, MD; Zhiyue Shi, MD

Hypothesis
As an important factor for the progression of scoliosis, spinal growth is achieved by the number increase and volume change of chondrocytes in growth plate (GP). Interfering scoliotic concave spinal growth by inducing chondrocytes apoptosis in GP can prevent scoliosis progression.

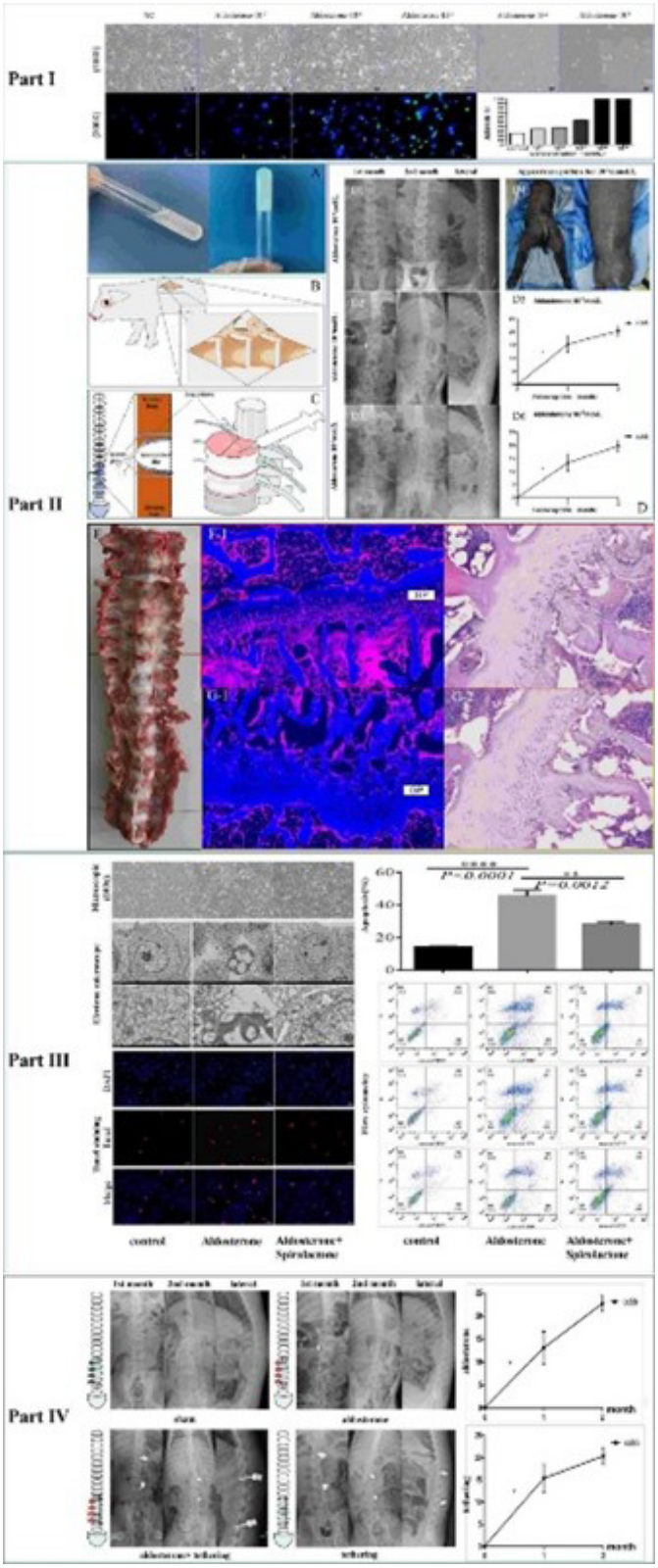
Design
Experimental study

Introduction
Our team previously proved inducing chondrocytes apoptosis in GP through microwave can treat scoliosis, however, no more study focused on using drug to regulate spinal growth.

Methods
Aldosterone can induce chondrycyte apoptosis, effective concentration were selected through cell co-culture. 3 selected doze of aldosterone were then loaded on poloxamer407 and injected in unilateral GP of piglets to observe which one built greatest scoliosis. Further prove the apoptosis inducing effect by using spiralectrone to block aldosterone at optimal concentration of aldosterone. At last, the ability of addosterone to build and prevent scoliosis were both tested in piglets.

Results
Part I: Aldosterone can effectively (> 50% death rate) induce chondrocytes apoptosis when concentration reaches 10-5mol/L. Part II: Then poloxamer loaded with aldosterone at concentration of 10-5, 10-4 and 10-3mol/L were injected in unilateral GP at T12 to L4. Scoliosis were built in 10-4 and 10-3mol/L groups, 10-4mol/L created the greatest scoliosis. HE and Tunnel staining proved the GP cell number decreased in the region underwent aldosterone injection. Part III: Spiralectrone successfully blocked 10-4mol/L aldosterone induced chondrocytes apoptosis. Part IV: Aldoterone 10-4mol/L and tethering alone both built scoliosis over 20° after surgery. Scoliosis failed to occur in sham group. When performing tethering and aldosterone injection at opposite site of GP at same time, scoliosis was also not observed.

Conclusion
Inducing chondrocyte apoptosis in GP can alter spinal growth, which can be a potential treating method for scoliosis in growing spine.



Part I: Aldosterone reaches induce chondrocytes apoptosis. Part II. Inject Aldosterone to GP built scoliosis. Part III. Spirolactone blocked the cell death caused by aldosterone. Part IV. Aldosterone build and prevent scoliosis.

† = Hibbs Award Nominee – Best Basic Science/Translational Paper

PODIUM PRESENTATION ABSTRACTS

91. The Unseen Waves: Ultrasonic Osteotomy Devices Can Affect Bone Healing and Central Nervous System Function †

Zonglin He, MBBS, MPhil; Meiru An, MS, BS; Dong Chen, MS, BS; Kenneth M. Cheung, MD, MBBS, FRCS

Hypothesis
Ultrasonic osteotomy devices (UODs), despite their precision in bone cutting, might compromise bone healing and influence neural integrity through thermal or mechanical stress.

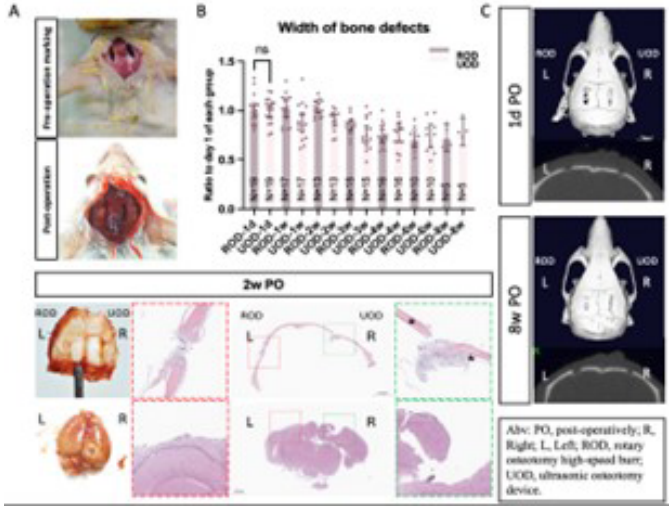
Design
Bone healing and functional experiment using split calvarial model.

Introduction
With UODs gaining popularity in spine surgery, the extent of their soft tissue sparing capabilities and their influence on bone healing remain poorly understood. This study aimed to compare UODs with conventional high-speed burrs (HSBs) in their effects on bone healing and neural integrity using an established murine skull bone defect model.

Methods
The study was carried out using 2 brands of UODs and a commonly available HSB. Bone defects were created in the two sides of the skulls of mice (using the split calvarial model). A thermal camera was used to monitor heat generation during the procedure. Bone healing and neural tissue damage was assessed via micro-CT imaging and histology. Motor function of the mice were tested using the established "cylinder test", in which the number of times the respective forelimb reaching out to the wall of a cylinder is an indication of the respective parietal lobe function. Mice were followed for 8 weeks to bone healing prior to sacrifice.

Results
A total of 24 mice were used. There were no postoperative mortality. Micro-CT imaging showed similar healing patterns between UOD and HSB groups. Thermal camera recorded marked temperature fluctuations during the UOD osteotomy not seen with HSB. Histology revealed that both UOD and HSB groups exhibited healing via cartilage intermediates. However, the bone structure adjacent to UOD defects is less compact and organized compared to HSB. Surprisingly, UOD-treated sides showed structural brain tissue damage, and this was confirmed on functional testing of the mice with increased clumsiness on the respective side.

Conclusion
While UODs are effective for cutting bone, caution is necessary when used near neural tissues due to potential damage. This study avoided direct blade contact with neural tissues, suggesting that any harm may stem from heat or ultrasound waves. Further research on UOD use in surgeries involving both delicate bone and neural structures is essential.



A. Split calvarial model, left defects by HSB, right by UOD; B. Coronal defect width quantification; C. Reconstructed micro-CT at 1d and 8w PO. D. Skull and brain tissue histology.

92. Do Mechanical Complications Decrease when Ideal L1PA Values Are Obtained in Adult Spinal Deformity Patients Undergoing Lumbopelvic Fixation? A Study with Mean 13 (5-26) Years Follow Up

Sinan Kahraman, MD; Hamisi M. Mraja, MD; Sepehr Asadollahmonfared, MD; Ahmet H. Olcar, MD; Mustafa Bugra Ayaz, MD; Inas M. Daadour, MD; Serkan Devran; Selhan Karadereler, MD; Meric Enercan, MD; Azmi Hamzaoglu, MD

Hypothesis
Achieving ideal L1PA is essential for prevention of mechanical complications in adult lumboplevic fixations

Design
Retrospective

Introduction
Recent studies have emphasized the significance of L1 pelvic angle (L1PA)in restoration of sagittal balance and prevention of mechanical complications(MC).The ideal L1PA value is PI/2-20 ±5˚and these studies have reported the failure to reach to ideal L1PA value led to higher rates of MC and revisions.We aimed to investigate the relationship between L1PA versus MC in pts who underwent ASD surgery

Methods
194 pts who underwent lumbopelvic fixation between 1998-2019 due to sagittal alignment disorders and had min 5 yrs f/up included.Pts who required implant based reoperations and PJK or PJF were placed in the MC group, whereas those who did not develop any MC were placed in non-MC group.The congruency between L1PA and T4PA was investigated.Pelvic and global sagittal parameters were analyzed with respect to the development of MC.

Results
Mean f/up was 13 yrs (5-26). In 48% of the pts (n=95)

† = Hibbs Award Nominee – Best Basic Science/Translational Paper

PODIUM PRESENTATION ABSTRACTS

L1PA was in normal limits,and mean deviation was 2.86°. In the remaining 99 pts(52%) the L1PA was not within ideal limits,mean deviation was 10.08°.There was a significant correlation between L1PA and T4PA in all pts,both preop and final f/up. 35 of the 194 pts(37%) developed MC. MC group and non-MC group had significant differences with respect to restoration of lumbar lordosis, correction of PT,and the reach of L1PA and T4PA to target values. In non-MC group, ideal L1PA was achieved in 54% (n=85) of the pts, and in MC group 72% (n=26) of the pts were outside the ideal limits of L1PA. Non ideal L1PA values were found to be correlated with the development of MC (p<0.05).In non-MC group, deviation from the ideal L1PA value was significantly lower compared to the MC group(p<0.05)

Conclusion
Mechanical complications developed in 37% (35 pts) of ASD pts who underwent lumbopelvic fixation, and in 72% (26 pts) of the pts ideal L1PA could not be achieved. Overall, in 158 out of 194 pts MC did not developed,ideal L1PA was achieved in 85 pts(54%),and could not in 46% of pts.The presence of ideal L1PA value in more than half of the pts shows the importance of achieving ideal sagittal alignment in the thoracal, thoracolumbar and lumbar spine with respect to the prevention of mechanical complications.

93. Spinal Shape Assessed by Vertebral Pelvic Angles Can Correspond to Variable Thoracic and Lumbar Curvatures

Renaud Lafage, MS; Daniel Bass, BS; Themistocles S. Protopsaltis, MD; Jonathan C. Elysee, BS; Breton G. Line, BS; Shay Bess, MD; Alan H. Daniels, MD; Bassel G. Diebo, MD; Robert K. Eastlack, MD; Munish C. Gupta, MD; Richard Hostin, MD; Khaled M. Kebaish, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; David O. Okonkwo, MD, PhD; Peter G. Passias, MD; Christopher P. Ames, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Virginie Lafage, PhD; International Spine Study Group

Hypothesis
Specific vertebral pelvic angle mismatches, such as T4-L1PA, can arise from distinct combinations of spinal curvatures

Design
Retrospective review of a multicenter database

Introduction
Vertebral Pelvic Angles have gained importance in understanding sagittal spinal alignment, yet their complex association with classic spinopelvic parameters is not necessarily straightforward. This study aims to clarify the relationship between VPAs, spinal curvature, and pelvic morphology.

Methods
A database of 1,355 ASD patients with preop sagittal imaging and 973 patients with 2-year follow-up was reviewed. Outcome measures included VPAs (C2PA, T1PA, T4PA, T9PA, L1PA) and standard spino-pelvic alignment parameters. Preop bivariate correlations and multilinear regression models assessed VPA's relationship with pelvic incidence (PI), lumbar lordosis (LL), thoracic kyphosis (TK), & VPA mismatch. Postop analyses evaluated alignment correction by correlating changes in LL and TK with VPA and mismatch. Graphical analyses using isolines illustrated VPA's variability across alignment profiles

Results
The cohort (60.9±14.2 yo; 74% F) exhibited significant variability in alignment. Preop, larger PI and TK correlated with larger VPAs, while larger LL correlated with smaller VPAs (all p<0.001). Quadratic regressions accurately predicted VPAs based on PI, LL, & TK (r^2>0.9, RMSE<3.9°), though mismatch models showed lower accuracy (r^2=0.452-0.675). Graphical analysis revealed identical mismatch values correspond to distinct alignment profiles; for example, a T4-L1PA of 5° for a PI of 55° could align with LL=60°|TK=60° or LL=40°|TK=20°. At 2 years, LL and TK increased significantly (+12.4° and +13.4°, p<0.001), with VPA decreasing across most levels (e.g., T9PA: -4.5°, p<0.001). Changes in LL & TK strongly correlated with VPA adjustments; LL increases reduced VPA, while TK increases elevated VPA and mismatch. Multivariate regression confirmed that maintaining stable VPA mismatch required concurrent LL and TK adjustments

Conclusion
While VPA measurement offers a robust framework for describing spinal alignment, its relationship with spinal curvature is non-linear and multifaceted. Constant mismatch between VPAs does not imply uniform vertebral shapes, highlighting the need for caution in interpretation. These findings provide critical insights into sagittal alignment and underscore the complexity of using VPA in clinical assessments.

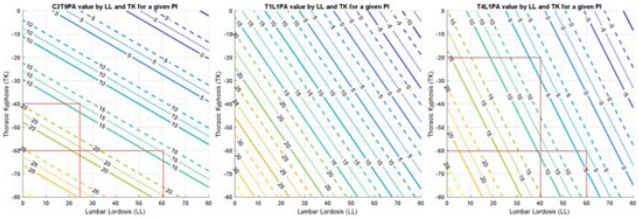


Figure 1: Isolines for C2T9PA (left), T1L1PA (middle) and T4L1PA (right) across LL and TK value for 3 values of PI (35: solid line; 55: dotted line; 75: dashed line). Interpretation: oblique lines represent constant value of VPA for variable LL and TK values.

94. Early Postoperative T4PA-L1PA Malalignment in Lower Thoracic to Pelvis Fusions is Associated with PJK

Sarthak Mohanty, BS; Zeeshan M. Sardar, MD; Fthimnir Hassan, MPH; Justin L. Reyes, MS; Erik Lewerenz, BS; Joseph M. Lombardi, MD; Ronald A. Lehman, MD; *Lawrence G. Lenke, MD*

Hypothesis
Early(6W) T4PA-L1PA mismatch is associated with PJK in adult symptomatic lumbar scoliosis(ASLS) patients undergoing PSF from T9 or lower to the pelvis.

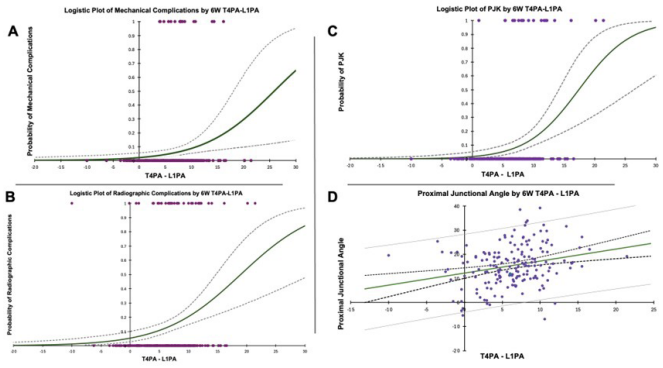
Design
Retrospective, single center cohort.

Introduction
PJK/F rates in thoracolumbar fusions to the sacrum/pelvis for ASLS remain high at 28.8% & 34.8%, respectively. UIV selection typically targets the horizontal, neutral, or stable vertebra in the lower thoracic spine. The impact of T4 & L1 pelvic angles on sagittal plane complications in this population remains unclear.

Methods
Three cohorts were defined based on 6W T4PA-L1PA following spinopelvic fusion from T9-L1 to the pelvis & followed for 2Y: <4°, 4°–8° (+1SD), & >8° (+2SD). Logistic regression models assessed associations between 6W T4PA-L1PA mismatch & (Fig 1A) implant-related complications, (Fig 1B) radiographic complications(adjacent segment disease, PJK, pseudarthrosis, symptomatic sagittal or coronal malalignment), & (Fig 1C) PJK alone, adjusting for PI, correction magnitude of PT, PI-LL, LL, & L1PA. Univariate regression identified patient factors associated with worse 6W T4PA-L1PA malalignment.

Results
210 patients: 59(28.1%) T4PA-L1PA<4°, 83(39.5%) 4°-8°, & 68(32.4%) >8° were included. Implant complications were lowest in the T4PA-L1PA <4°[1(1.69%) vs. 8(9.64%) vs. 9(13.2%), P=0.043], with multivariable models identifying 6W T4PA-L1PA mismatch as an independent predictor of implant complications [OR: 1.13, 95% CI: 1.01–1.27, P=0.034]. Radiographic complications [4(6.78%) vs 13(15.66%) vs 16(23.88%),P<0.0001], particularly PJK [1(1.69%) vs 6(7.23%) vs 13(19.4%), P<0.0001], were most frequent in patients with >8° mismatch. Each degree T4PA-L1PA increase was associated with 1.26 higher odds of PJK [95% CI: 1.12-1.42, P<0.0001]. T4PA-L1PA mismatch linearly correlated with 2Y proximal junctional angle(Fig 1D) (B=0.50°; 95% CI: 0.22-0.78;P=0.001). Risk factors for worse 6W T4/L1PA mismatch included older age (P<0.0001), higher BMI (P=0.0214), lower preop SS (P<0.0001), higher preop PT (P=0.0002), lower preop LL(P=0.0106), greater preop TK(P=0.0128), caudal apex of TK(P<0.0001), higher preop T1PA(P=0.0021), & reduced preop flexibility in TK(P=0.0077).

Conclusion
Early postop T4-L1PA malalignment predicts long-term PJK in lower thoracic-to-pelvis ASLS fusions. Risk factors for early T4-L1PA mismatch include older age, higher BMI, elevated preop PT, & stiff kyphotic thoracic spines with caudal apices.



95. Rethinking Sagittal Alignment: The Value of Evaluating Spinal Shape in Conjunction with T4-L1PA Measurement to Prevent Proximal Junctional Failure

Renaud Lafage, MS; Max Kohn, BS; Themistocles S. Protopsaltis, MD; Emil Haikal, MD; Breton G. Line, BS; Shay Bess, MD; Alan H. Daniels, MD; Bassel G. Diebo, MD; Robert K. Eastlack, MD; Munish C. Gupta, MD; Richard Hostin, MD; Khaled M. Kebaish, MD; Eric O. Klineberg, MD; Gregory M. Mundis Jr., MD; David O. Okonkwo, MD, PhD; Peter G. Passias, MD; Christopher P. Ames, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Virginie Lafage, PhD; International Spine Study Group

Hypothesis
T4-L1PA guidelines can reduce proximal junctional failure (PJF) rates

Design
Retrospective review of adult spinal deformity (ASD) database

Introduction
The T4-L1 Axis (T4-L1PA) predicts mechanical complications in long fusions to the sacrum. However, its role in preventing severe proximal junctional kyphosis (PJK) and its applicability to lower thoracic-pelvis fusions remain unclear. This study aims to validate T4-L1PA guidelines in patients with long fusions and evaluate its utility in thoracolumbar fusions while accounting for PJA changes

Methods
ASD database was reviewed for patients with pan-lumbar fusions to the ilium, upper instrumented vertebrae (UIV) between T1-T12, and a minimum 2-year follow-up. Postop PJF was defined as (1) revision surgery requiring proximal extension or (2) severe radiographic PJK (ΔPJA >22° and proximal junctional angle >28°). Patients were categorized based on adherence to L1PA (0.5 × PI -19 ± 2°) and T4-L1PA (-3° to 1°) guidelines, stratified by UIV position (upper thoracic [UT]: T2-4; lower thoracic [LT]: T9-11). Nine combinations of L1PA and T4-L1PA categories were analyzed for failure rates, graphically illustrated by median spinal shape (Figure)

PODIUM PRESENTATION ABSTRACTS

Results
Among 672 patients (64 ± 9 years; 78% female; BMI: 28.2 ± 5.7 kg/m²), 17% experienced PJF at 2 years (7.9% revision; 9.7% severe PJK). Postop alignment improvements were significant (PI-LL mismatch decreased from 21.3° to 1.3°, p < 0.001). Mean postop L1PA exceeded normative values (6.8° vs. 4.3°, p < 0.001). Patients with UT UIVs had higher failure rates when L1PA was overcorrected (25.3%) versus matching (12.7%) or undercorrected (10.7%, p < 0.025). In contrast, failure rates across T4-L1PA groups were similar (p = 0.075). The lowest PJF incidence (5%) occurred when L1PA exceeded guidelines (i.e. undercorrected) and T4-L1PA fell within -3° to 1°, whereas the highest (44%) occurred with L1PA and T4-L1PA below guidelines (i.e. overcorrected). LT UIV patients showed no significant variation in PJF rates across all T4-L1PA groups (p = 0.148)

Conclusion
Evaluating spinal alignment as a composite of pelvic angles advances sagittal alignment understanding. T4-L1PA guidelines effectively reduce PJF in long fusions. Adjusting L1PA thresholds toward less correction may further improve outcomes. For LT UIV, additional measures are required to delineate alignment differences accurately

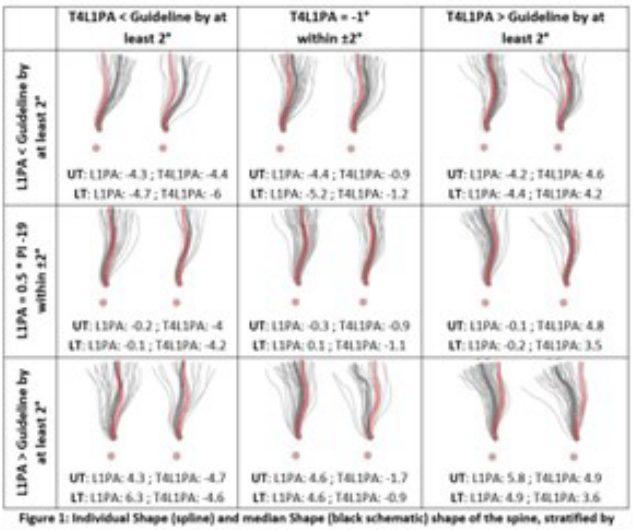


Figure 1: Individual Shape (spline) and median Shape (black schematic) shape of the spine, stratified by guidelines for L1PA (lines) and T4-L1PA (columns). Median shape according to these guidelines is represented for each of the nine combinations (red schematic)

96. Reciprocal Change, Redefined: Postoperative T4L1PA Mismatch in Lower Thoracic Fusions

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Hypothesis
Reciprocal changes after LT fusions, as described by T4L1PA mismatch, will vary based on thoracic flexibility.

Design
Retrospective cohort study

Introduction
T4L1PA mismatch has been proposed as an alignment target to minimize mechanical failure after adult spinal deformity (ASD) surgery in upper thoracic (UT) to pelvic fusions. The role of T4L1PA in lower thoracic (LT) to pelvis fusions is an active area of research.

Methods
ASD patients with preop supine and standing XRs who underwent fusion from T9-T12 to pelvis were included, excluding those with prior thoracic fusions. Postop sagittal alignment was evaluated on discharge XRs. L1PA offset was calculated as the difference between the measured and PI-based expected L1PA. Ideal range for T4L1PA was defined using published values that have been shown to minimize mechanical complications after UT to pelvis fusions (Hills et al., JBJS 2024). Patients were categorized as pre/post op "matched" (T4L1PA within range) and "mismatched" (T4L-1PA out of range). Thoracic flexibility (TF), defined as preop supine-to-standing T4-T12 Cobb angle (CA) ratio (lower ratio ~ higher flexibility) was tested for associations with T4L1PA. Multiple logistic regression analysis was performed to evaluate the independent effects of variables on postop T4-L1PA mismatch.

Results
Of 103 patients, 87 met inclusion criteria (70% F) with a mean age 65.6 (±8.1) years, BMI 26.7 (±5.5) kg/m² and follow-up of 1.9 (±0.92). Only 10 patients preop and 13 patients postop were T4L1PA matched (M). The preop mismatched (MM) group had greater TF (lower ratio) (0.87 vs. 1.35, p=0.01) and a higher preop L1PA offset (6.66 vs 7.93, p=0.6) . 8 patients (80%) went from preop M to postop MM, which was associated with increased TF (0.76 vs. 0.99, p=0.04). While preop T4L1PA showed no association with TF, increased postop T4L1PA trended toward a linear relationship with TF (p= -0.20, p=0.07). Multiple logistic regression analysis showed that TF was associated with postop T4L1PA MM (p=0.005) (Table).

Conclusion
Increased TF is associated with pre- and postop T4L1PA mismatch. Patients with high TF with a matched preop T4L1PA axis are likely to become mismatched postoperatively. The clinical consequences of these changes will require further long-term follow-up.

	Univariate Logistic Regression Results				Multiple Logistic Regression Results			
Variable	Odds Ratio	Lower 95% CI	Upper 95% CI	P-value	Odds Ratio	Lower 95% CI	Upper 95% CI	P-value
Age	1.061	0.987	1.144	0.109	1.032	0.930	1.145	0.546
BMI	1.057	0.938	1.215	0.389	0.991	0.839	1.188	0.917
CCI	1.094	0.761	1.762	0.665	1.285	0.589	3.612	0.568
3CO	0.621	0.176	2.526	0.473	0.371	0.057	2.560	0.291
PI	0.977	0.930	1.021	0.345	0.992	0.918	1.071	0.835
Preop L1PA offset	1.023	0.949	1.120	0.589	1.019	0.871	1.202	0.814
Preop T4-L1PA mismatch	1.120	1.019	1.249	**0.027**	1.067	0.926	1.244	0.380
Postop L1PA offset	1.054	0.953	1.194	0.372	1.003	0.805	1.272	0.982
TF in T4-T12	0.380	0.154	0.864	**0.023**	0.269	0.074	0.851	**0.030**
TF in T10-L2	1.012	0.591	1.572	0.960	1.122	0.551	1.968	0.737

Logistic regression results for postop T4-L1PA mismatch, highlighting significant associations

97. Evolution of Sagittal Plane Metrics: Moving Beyond PI-LI Mismatch

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Hypothesis
Pelvic Incidence–Lumbar Lordosis (PI-LL) mismatch exhibits significant variability and nonlinearity in normal individuals, warranting a more individualized approach to sagittal alignment analysis.

Design
Cross-sectional cohort.

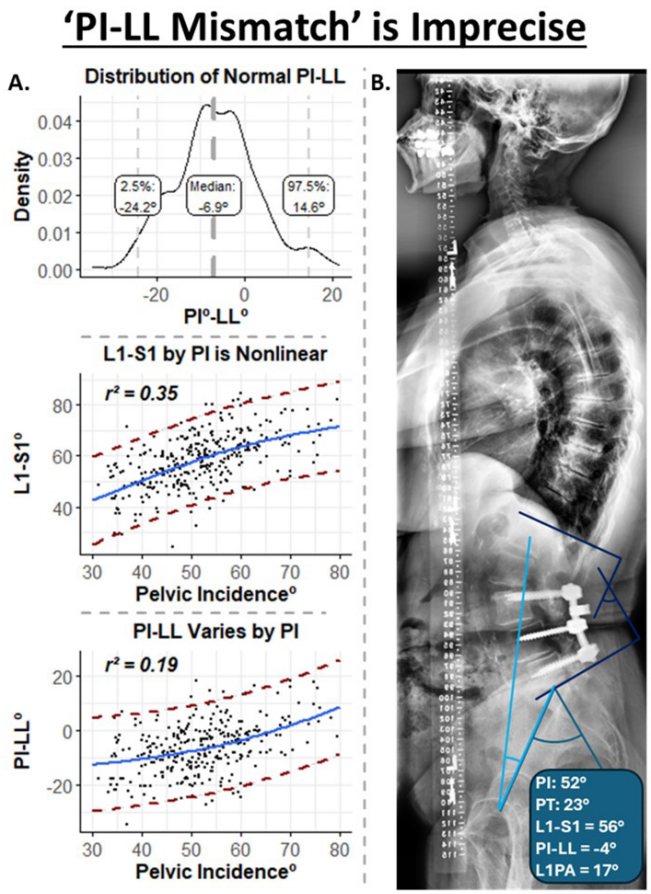
Introduction
PI-LL mismatch is a cornerstone in evaluating sagittal spinal alignment, surgical planning, and spinal deformity research. Recent sagittal alignment studies challenge the validity of PI-LL mismatch as a comprehensive metric. We sought to define normal PI-LL mismatch in an asymptomatic population with no spinal deformity or degeneration, critically evaluate its limitations, and propose a framework for more individualized metrics in sagittal alignment analysis.

Methods
A multinational cohort of asymptomatic volunteers ages 18-40, with no radiographic evidence of disk degeneration or scoliosis was studied. Radiographic measurements were obtained from full spine radiographs (EOS Imaging, SA, France). Normality of PI-LL distribution was assessed using the Shapiro-Wilk test and a normal 95th% range was defined. Variations in PI-LL mismatch by demographic factors were analyzed, and nonlinear regression was used to examine the relationships between PI and LL.

Results
Of 319 volunteers included, 192 (60%) were female and median age was 37 (IQR, 27-47). Median PI was 52° (45-58), pelvic tilt was 12° (8-16), and LL was 59° (52-65). PI-LL mismatch was normally distributed (Shapiro-Wilk, p = .08), with a mean of -7° and a 95th% range between -24° to +15°.

PI-LL mismatch was not significantly correlated with age (r = 0.13) or BMI (r = -0.01), and no differences between sex were observed (p = 0.4). The PI and LL relationship was relatively weak (r2 = 0.35) and nonlinear (Fig 1). PI-LL mismatch was associated with PI (r2 = 0.19).

Conclusion
PI-LL mismatch demonstrates a wide range of normal, with a weak and nonlinear relationship between PI and LL. These findings highlight the limitations of PI-LL mismatch as a sagittal alignment metric, particularly when constrained to a 10° threshold. Advancing adult spinal deformity care requires a shift in clinical practice and research toward more precise, individualized alignment targets that account for segmental and regional alignment, minimizing misclassification and enhancing surgical planning accuracy.



A) Normal PI-LL distribution is wide, and relationship is weak and nonlinear. B) Preoperative patient with 'normal' PI-LL mismatch requiring compensatory mechanisms.

98. Optimizing Free Hand Sacro-Alar-Iliac (SAI) Screw Placement for Pelvic Retroversion: Utilizing the Safety Margin

Se Jun Park, MD; Hyun Jun Jang, MD; Bong Ju Moon, MD, PhD; Jeong Yoon Park, MD, PhD; Sung Uk Kuh, MD, PhD;

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Dong Kyu Chin, MD, PhD; Keun Su Kim, MD, PhD; Kyung Hyun Kim, MD, PhD

Hypothesis
Ideal trajectory of SAI screw change according to the patient's pelvic parameter and identification of safety margin when inserting the SAI screws in real patients

Design
Retrospective

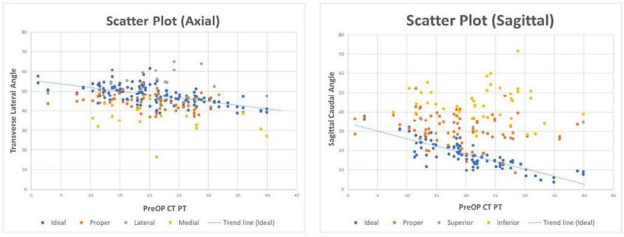
Introduction
Since the introduction of SAI screw, various entry points and trajectories have been documented. However, only limited studies have examined how to modify the optimal trajectory of SAI screws based on individual pelvic parameters. Our study aimed to investigate the relationship between the SAI screw trajectory and the patient's pelvic orientation, with the goal of determining the ideal trajectory for each patient according to their unique pelvic parameters. In addition, we evaluated how these theoretical optimal angles can be applicable in actual patients

Methods
The study enrolled 101 patients who underwent SAI screw insertion. Pelvic tilt (PT), sacral slope (SS), pelvic incidence (PI), optimal transverse lateral angle (OTA), and optimal sagittal caudal angle (OSA) were measured using pre-operative CT images. Post-operative CT images were used to measure the actual inserted screw angles in each plane and were evaluated whether it was properly inserted. Angle difference between the inserted screws in real patients and the optimal ideal angles were analyzed for comparison between the properly inserted group and the malposition group in each plane

Results
There was a significant negative correlation between the pelvic parameters and the optimal angles in the axial plane (PT: r=-0.62, p<0.001, SS: r=-0.23, p=0.005, PI: r=-0.59, p<0.001) and in the sagittal plane (PT: r=-0.84, p<0.001, PI: r=-0.43, p<0.001). There was a significant screw angle°-Optimal angle° difference between the properly inserted group with the medial(p<0.001) and lateral violation groups(p<0.001) in the axial plane. In the sagittal plane, only the inferior violation group(p<0.001) had significant angle difference with the properly inserted group. Cut off value of properly inserting SAI screw angle from the optimal angles were 1.45°laterally (AUC=0.97, p<0.001), 7.9°medially (AUC=0.97, p<0.001) in the axial plane and 18.4°inferiorly (AUC=0.89, p<0.001) in the sagittal plane using the ROC curve analysis.

Conclusion
Optimal transverse lateral and sagittal caudal angle of SAI screw are inversely related with pelvic tilt. By understanding the pelvic anatomy and utilizing the safety margin, it can help reduce malposition of SAI screws.

Figure. Scatter plot of ideal angles and actual inserted sacral-alar-iliac screw angles according to pelvic tilt



OTA: Optimal transverse lateral angle, OSA: Optimal sagittal caudal angle, PT: Pelvic tilt
Lateral: Lateral violation, Medial: Medial violation, Proper: Properly inserted screws without lateral/medial violation
Superior: Superior violation, Inferior: Inferior violation, Proper: Properly inserted screws without superior/inferior violation

Table. Difference of screw angle°-optimal angle° between properly inserted group and malposition group

Angle Difference°	Groups	N	Mean(SD)	Overall p-value	Post-hoc analysis (Bonferroni correction)		Confidence interval 95%	
					P	L(S)	Lower	Upper
Screw°-OTA°	Proper	73	-3.02(3.20)		ref		-3.77	-2.28
	Lateral	22	8.95(6.62)	<0.001*	<.001*	ref	6.02	11.89
	Medial	18	-12.99(5.61)		<.001*	<.001*	-15.78	-10.20
Screw°-OSA°	Proper	52	12.37(7.56)		ref		10.26	14.47
	Superior	4	13.90(8.60)	<0.001*	>.999	ref	0.22	27.58
	Inferior	27	25.19(7.10)		<.001*	0.018*	22.38	27.99

OTA: Optimal transverse lateral angle, OSA: Optimal sagittal caudal angle, SD: standard deviation, *: p<0.01

Figure. Model for Sacral-Alar-Iliac screw placement safety zone

99. Pelvic Fixation for Adult Spine Deformity: Two Year Results from an International, Multicenter, Randomized Trial

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Hypothesis
Simultaneous placement of a standalone osseointegrative fusion implant adjacent to an S2AI screw during multilevel spinal fusion will reduce postoperative SI joint pain

Design
Prospective, randomized controlled trial conducted at 29 centers in the US, EU, and AUS

Introduction
Pelvic fixation is used during multilevel spinal fusion to the sacrum, to improve fusion rates at the lumbosacral junction, reduce mechanical failures, and maintain surgical correction of alignment. Additionally, pelvic fixation may reduce the incidence of postoperative sacroiliac joint (SIJ) pain, which has been reported to occur in up to 30% of patients. We sought to determine the clinical benefit of simultaneous placement

of a standalone osseointegrative fusion implant adjacent to an S2AI screw during multilevel spinal fusion

Methods
222 patients undergoing surgery for adult spinal deformity to the pelvis were enrolled and randomized to S2AI alone (control) or S2AI plus a triangular titanium fusion implant (TTI). Randomization was stratified based on planned upper instrumented level (UIV) and preoperative of SIJ pain. Patient reported outcomes (PROs), SIJ pain, and adverse events were assessed postoperatively at months 1, 6, 12 and 24. The study's primary clinical endpoint is onset of new SIJ pain by 2 years

Results
At baseline, 16% were diagnosed with SI joint pain. There were no differences between groups across demographic factors, planned UIV, or SIJ pain. No spinopelvic parameters were predictive of SIJP at baseline. On average, 8 (3.4 SD) levels were fused, 75% received an interbody cage at L5/S1, and 48% had previous lumbar spinal fusion. At 2 years, new onset of SIJ pain was higher in the control group, 9.6% vs 1%, p=0.02, with no difference across groups on other PROs. The overall incidence of L5-S1 rod fracture was low (4%) with no difference between groups. S2AI screw breakage was higher in the control group 3.5% v 0.9%. Tulip dislodgement was observed in 2 control and no TTI patients

Conclusion
SI joint pain is common in patients with adult spinal deformity. Concurrent placement of TTI with S2AI screws during multilevel spine fusion surgery is safe and associated with a marked reduction in the incidence of postoperative SI joint pain. TTI placement reduced the rate of S2AI screw breakage, tulip failure, and set screw dissociation

100. Rethinking Spinal Reconstruction: The Impact of Patient-Specific Implants on Thoracolumbar Deformity Surgery

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Hypothesis
Patient-specific implants will have superior outcomes in adult spinal deformity (ASD) corrective surgery.

Design
Retrospective analysis of a prospectively enrolled database.

Introduction
While the use of individualized, custom rods in thoracolumbar fusion for ASD has increased in popularity, the differences in complication profiles and alignment remain to be investigated.

Methods
Operative ASD patients aged ≥18Y with a UIV≥T1, a LIV≥S1, ≥5 levels fused, and complete BL and 2Y data included. Cohorts stratified based on use of patient-specific (PS+) rods or standard rods (PS-). Additionally, patients were stratified into thoracolumbar (TL) fusions (UIV≥T9) and upper thoracic (UT) fusions (UIV≤T8). Thoracic Decompensation: T1PA>20°, TK>60°, and SVA>5cm. Cervical Decompensation: cSVA>4cm and TSCL>20°.

Results
Of the 425 included (64.2±11.0Y, 71%F, 27.5±5.4kg/m2, CCI 1.1±1.7): 30.6% (130) PS+, 69.4% (295) PS-. Additionally, 50.6% (215) TL fusions and 49.4% (210) UT fusions. Surgical details: OR Time 409±139mins, EBL 1426±1173mL, 13.0±3.8 levels fused, LOS 7.7±4.2d. At BL, there were no differences in age, gender, BMI, CCI, radiographics, or SAAS categories. Surgically, PS+ had shorter OR times (383 v 421mins, p=.019) and lower EBL (1146 v 1549mL, p<.001), but longer LOS (8.6 v 7.4d, p=.014) and more levels fused (13.9 v 12.6, p=.001). PS+ also had more UT cases (62.3 v 43.7%, p<.001). Radiographically, PS+ had less thoracic decompensation at 1Y (5.4 v 14.2%, p=.008) and at 2Y (0.8 v 6.4%, p=.011). PS+ also had less cervical decompensation at 2Y (0.8 v 6.8%, p=.008). PS+ had fewer new cases of PJK at 2Y (3.8 v 14.6%, p=.001) and fewer revisions for implant failure (0.0 v 3.1%, p=.044). PS+ had fewer symptomatic radiographic complications (3.1 v 9.2%, p=.026) and fewer radiographic complications (3.8 v 10.5%, p=.023). Additionally, PS+ had fewer postoperative sensory deficits/neuropathies (1.5 v 7.1%, p=.019). In MVA controlling for OR Time, LOS, EBL, and levels fused, PS+ was less likely to have an AE related to spine intervention (0.36, [0.16, 0.81], p=.014). In a subanalysis of UT fusions, PS+ had fewer neurologic deficits in a lower extremity (8.6 v 21.7%, p=.013).

Conclusion
Patient-specific implants demonstrate meaningful advantages in surgical efficiency, maintenance of alignment, and complication reduction, highlighting their potential to enhance outcomes in ASD corrective surgery.

101. Golden Responders: Which Early Onset Scoliosis Patients Have Improved PFTS 2 Years After Surgical Intervention?

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Hypothesis
Early onset scoliosis (EOS) patients will have improved/stable Pulmonary Function Tests (PFTs) ≥2 years after surgery. Growth-friendly (GF) and definitive fusion (DF) treatment types will have similar outcomes.

Design
Retrospective review, large multi-center database

Introduction
Patients with EOS undergo surgical treatment for spinal deformity and thoracic insufficiency; however, data on its effect on pulmonary function is limited. This study examines

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surgically treated EOS patients to identify variables associated with changes in PFTs at ≥2-year follow-up.

Methods
Retrospective review of EOS patients with PFTs prior to index surgical intervention and ≥2 years follow up. Clinical, radiographic, and PFT data were collected. Forced vital capacity (FVC) ≥80% defined normal lung function. Lung dysfunction was categorized by FVC%: mild 70-79%, moderate 50-69%, severe 35-49% and very severe <35%. Logistic regression analysis identified variables associated with a good outcome, defined as FVC ≥80% or if final FVC <80%, then stable/improve FVC > 10%. A poor outcome was defined as FVC <80% or, or deterioration in FVC >10%.

Results
215 patients (191 GF, 24 DF) averaged 46±21 months follow-up. Etiology included (N) neuromuscular (29%), (I) idiopathic (27%), (C) congenital (24%), and (S) syndromic (20%). At index surgical procedure, average age was 8.4±2.4 years, major Cobb 74°±21.9° and FVC 67%. In total 33% had FVC≥80%, 13% demonstrated mild, 24% moderate, 18% severe and 11% very severe lung dysfunction prior to index surgery. At final follow up, only 22% of patients had FVC≥80% (p<0.001). Good PFT outcomes were identified in I (32%) vs. N (24%), C (23%) and S (21%), (p=0.04). 92% of DF vs. 60% GF patients had good PFT outcomes (p=0.003). Etiology, sex, race, Cobb angle/kyphosis and ambulatory status were not significant variables. Regression analysis revealed that the I subtype (OR 0.28, 95% CI 0.11-0.68) and higher initial FVC (OR 1.02, 95% CI 1.01-1.03) had a lower risk of poor outcomes. GF treatment had a 9-fold increased risk of a poor outcome (OR 9.1, 95% CI 2.3-62.4) compared to DF.

Conclusion
At index surgical procedure only 33% of EOS patients had a FVC ≥ 80%. This decreased to 22% at final follow up. Patients with an idiopathic etiology, higher baseline FVC%, and those who had definitive fusion at index surgery are more likely to have normal, stable or improved PFTs.

Lung Dysfunction Severity	Pre-Index Surgery	≥2-yr follow-up	p-value
Normal (FVC ≥80%) GF DF	33% (n=72) n=62 n=10	22% (n=47) n=36 n=11	<0.001
Mild (70-79%) GF DF	13% (n=29) n=27 n=2	14% (n=30) n=29 n=1	0.882
Moderate (50-69%) GF DF	24% (n=52) n=49 n=3	29% (n=63) n=58 n=5	0.198
Severe (35-49%) GF DF	18% (n=39) n=33 n=6	16% (n=35) n=32 n=3	0.586
Very severe (<35%) GF DF	11% (n=23) n=20 n=3	19% (n=40) n=36 n= 4	0.002

Lung Dysfunction

102. Point of Care Spirometry – A Prospective Comparison Vs. Laboratory Spirometry for Children with Early Onset Scoliosis ‡

Klane K. White, MD; Sungmin Kim, BS; Amy L. McIntosh, MD; Brian D. Snyder, MD, PhD; Kevin Smit, MD; Megan E. Johnson, MD; Patrick J. Cahill, MD; Viral V. Jain, MD; Gregory Redding, MD; Pediatric Spine Study Group

Hypothesis
POC spirometry testing in a pediatric spinal deformity clinic is feasible and reliable relative to standard formal pulmonary function laboratory spirometry for patients with early onset scoliosis (EOS).

Design
A multi-center prospective study. The order of POC and laboratory spirometry testing was randomized for each study patient.

Introduction
Spirometry (also known as pulmonary function testing) measures Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), and the ratio of FEV1/FVC to evaluate for restrictive and obstructive lung disease. Point of Care (POC) spirometry is performed in clinic and allows spinal deformity surgeons to obtain pulmonary function data immediately. Development of protocols for POC spirometry and validation for use in the spine deformity ambulatory clinic setting has not previously been done.

Methods
All centers were provided with a POC spirometer of the same make. EOS patients performed POC and laboratory spirometry for a minimum of 3 acceptable trials on same day. FVC (L) values normalized to arm span were compared between POC and laboratory spirometry test results using regression analysis.

Results
27 subjects were assessed. 23 subjects (12 females, 11 males) with a mean age of 12.1 years (range, 7-19 years) were included in the study while 4 subjects were excluded due to uninterpretable spirometry results (2 POC and 2 laboratory spirometry). Subjects had the following classification of early onset scoliosis (C-EOS): Congenital: 7 (30%), Neuromuscular: 5 (22%), Syndromic: 1 (4%) and Idiopathic: 10 (44%). Regression analysis suggests a strong correlation between laboratory and POC FVC (r2 =0.99). FEV1/FVC regression demonstrates a weaker correlation (r2 =0.44).

Conclusion
In this EOS population, early results of this prospective evaluation of POC spirometry suggest that this may be a viable technique for monitoring pulmonary outcomes in a pediatric spinal deformity clinic. Further validation is required, particularly at larger lung volumes, and with second generation training of a broad variety of clinic staff.

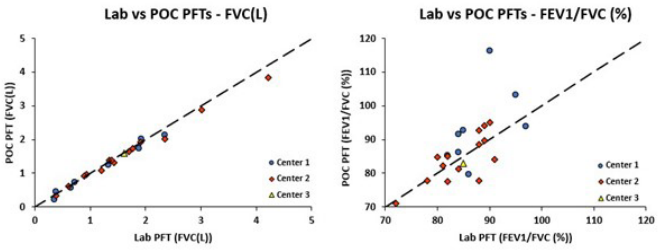


Figure 1. Plots representing the correlation between POC and laboratory spirometry with EOS.

103. No Improvement in Longitudinal Pulmonary Function After Surgery for Early Onset Scoliosis

Scott Yang, MD; Michael Trask, BS; Natalie Maharaj, BS; Apeksha Gupta, MS, MPH; Anna Faino, MSc; Sean Pirkle, MD; Kelson Adcock, BS; Jennifer M. Bauer, MD, MS; Burt Yaszay, MD; Gregory Redding, MD

Hypothesis
Surgery alters pulmonary function in children with early onset scoliosis.

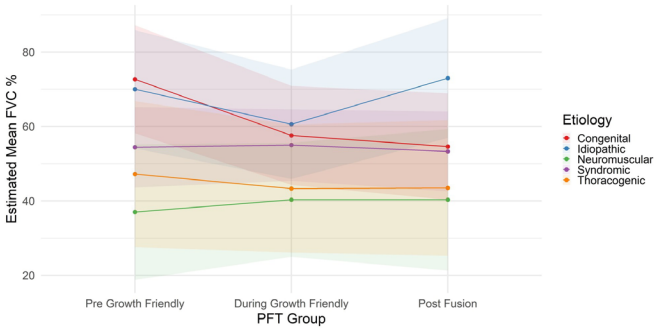
Design
Retrospective Case Series

Introduction
Longitudinal pulmonary outcomes after surgical treatment of early onset scoliosis (EOS) are not well reported. Prior understanding of pulmonary function after surgical treatment of EOS is limited to a few studies, none of which report on multiple serial pulmonary function tests (PFTs) during treatment. This study aims to evaluate change in serial PFTs in children with EOS post-surgery.

Methods
All patients who had surgical treatment of EOS and repeated PFT data were included in this single center retrospective review. PFT measures included forced vital capacity (FVC) and FVC % predicted. To determine if the time since surgery impacted PFTs, a random effects mixed model was used adjusting for age at each PFT, sex, race, scoliosis etiology, and stage of treatment. Predicted marginal means were calculated (LSMEANS) and Bonferroni adjusted p-values were reported. Spearman correlation was utilized to analyze relationship between radiographic measures (Cobb angle, T1-T12 length) and PFTs.

Results
51 patients with EOS were included (mean age 7.2 years at index surgery). The index distraction-based construct was 29 (57%) vertical expandable prosthetic titanium rib implant, 12 (23%) traditional growing rod, and 8 (18%) magnetically controlled growing rod. 23 patients (45%) underwent final fusion. Median duration from the first to the most recent PFT was 44 months. The random effects model predicted no significant change in FVC or FVC% over time since surgery. When changes in PFTs were analyzed by scoliosis etiology, there was no significant change in FVC or FVC % predicted after surgical treatment with any etiology except in congenital scoliosis where FVC% predicted significantly decreased by 15% and 18% after growth friendly treatment and fusion respectively compared to before surgery (Adj. p=0.005). T1-T12 length significantly correlatedly moderately with FVC (rho=0.46, p<0.0001), but not FVC%. Cobb angle did not significantly correlate with PFT measures.

Conclusion
EOS surgery did not improve pulmonary function, but at best prevented further pulmonary decline in children except in congenital scoliosis who had worsening function over time. Cobb angle and spinal length measurements do not correlate significantly with percent predicted lung volumes.



Mean FVC% by Scoliosis Etiology and Treatment Phase

104. 10 Year Experience with MCGR: Are We Moving the Needle on Early Onset Scoliosis?

Michelle C. Welborn, MD; Daniel Bouton, MD

Hypothesis
We hypothesized that increased preop Cobb, increased kyphosis, and age at implantation would be associated with increased UPROR

Design
IRB approved retrospective single site study

Introduction
Complications associated with MCGR range from 0-100% and ave 44% in the published literature, with UPROR occurring in 9-57% of patients. The purpose of this study was to evaluate the long-term outcomes of MCGR, to evaluate those factors associated with unplanned return to the or (UPROR) vs those that successfully achieved full length

Methods
99 patients underwent MCGR were placed at a single institution between 2014-2025. Exclusion criteria: <1 year follow-up, and previous instrumentation or revision surgery. 81 patients were included 35 in the Halo gravity traction (HGT) group and 47 in the nonHGT group. Demographic, medical and radiographic data were assessed for outcomes including deformity correction, complications and revision surgery.

‡ = SRS Funded Research Grant

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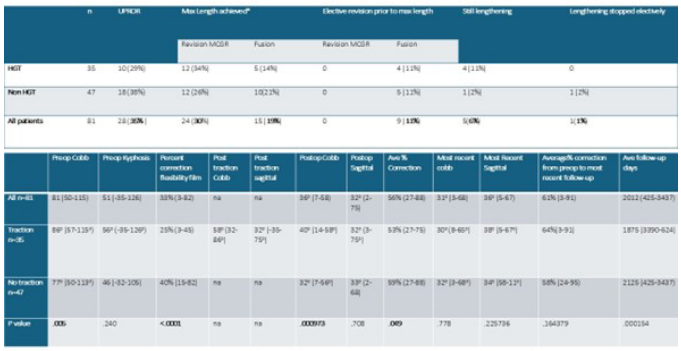
Univariate, multivariate and regression analysis were used to correlate outcomes and assess risk of complications

Results
Ave F/u was 2012 days, 1875 in the HGT group and 2125 days in the nonHGT group. Ave time to revision surgery was 1123 days, 1063 in the UPROR group and 1395 in the nonUPROR group. Ave curve improvement was 56% at implantation (53% HGT, 59% nonHGT) and 61% at final fu (64% HGT group and 58% nonHGT group). UPROR occurred in 28 pt, 29% of the HGT pt and 38% of the nonHGT pt. male gender was positively correlated with UPROR OR 1.68. HGT was negatively correlated with UPROR OR 0.61. Weight at time of surgery was not associated with UPROR p=.32708, nor was actuator length OR 1.09, curve magnitude p=0.0895, curve flexibility p=0.674 or kyphosis p=.799

Conclusion
Complications associated with MCGR remain high with UPROR occurring in 35% of primary MCGR at long-term follow-up. Determining who is at risk of UPROR continues to be challenging. Increased risk of UPROR was associated with male gender. Decreased UPROR was associated with preop HGT. Despite that MCGR remains a powerful tool for pt with EOS with an ave time to revision surgery of 1123 days and an ave 61% curve improvement at most recent follow-up. Ultimately, better knowledge of MCGR outcomes may improve pt education, surgical timing and decision-making



	n	UPROR	Max Length achieved*		Elective revision prior to max length		Still lengthening	Lengthening stopped electively
			Revision MCGR	Fusion	Revision MCGR	Fusion		
HGT	35	10(29%)	12 (34%)	5 (14%)	0	4 (11%)	4 (11%)	0
Non HGT	47	18(38%)	12 (26%)	10(21%)	0	5 (11%)	1 (2%)	1 (2%)
All patients	81	28(35%)	24 (30%)	15 (19%)	0	9 (11%)	5(6%)	1(1%)

	Preop Cobb	Preop Kyphosis	Percent correction flexibility film	Post traction Cobb	Post traction sagittal	Postop Cobb	Postop Sagittal	Ave % Correction	Most recent cobb	Most Recent Sagittal	Average% correction from preop to most recent follow-up	Ave follow-up days
All n=81	81 [50-115]	51 [-35-126]	33% [3-82]	na	na	36° [7-58]	32° [2-79]	56% [27-88]	33° [3-68]	36° [5-67]	61% [3-91]	2012 [425-3437]
Traction n=35	86° [57-135°]	56° [-35-126°]	25% [3-45]	58° [32-84°]	32° [-35-75°]	40° [14-58°]	32° [3-75°]	59% [27-75]	30° [3-65°]	38° [5-67°]	64% [3-91]	1875 [3390-624]
No traction n=47	77° [50-113°]	46 [-32-105]	40% [15-82]	na	na	32° [7-59°]	33° [2-68]	59% [27-88]	32° [3-68°]	34° [58-12°]	58% [24-95]	2125 [425-3437]
P value	.006	.240	<.0001	na	na	.000973	.708	.069	.778	.225736	.164379	.000164

105. Traditional Vs Magnetically Controlled Growing Rods for Idiopathic Early-Onset Scoliosis: Outcomes at 5-Year Follow-Up

Antti J. Saarinen, MD, PhD; John M. Flynn, MD; George H. Thompson, MD; John B. Emans, MD; Peter F. Sturm, MD; Paul D. Sponseller, MD, MBA; Pediatric Spine Study Group; *Ilkka J. Helenius, MD, PhD*

Hypothesis
Patients with idiopathic early-onset scoliosis (EOS) treated with magnetically controlled growing rods (MCGRs) have a lower risk of complications and revision surgeries compared to those treated with traditional growing rods (TGRs), while achieving similar deformity correction, thoracic height gain, and health-related quality-of-life (HRQoL) outcomes.

Design
Retrospective cohort study using an international database.

Introduction
Growing rods are commonly used in the surgical treatment of EOS. Traditional growing rods (TGRs) require repeated surgical lengthenings, whereas MCGRs enable non-invasive lengthening with an external device. The comparative clinical, radiographic, and HRQoL outcomes in patients with idiopathic EOS treated with TGRs versus MCGRs remain unclear.

Methods
An international database was searched for patients with idiopathic EOS (major curve >30°) treated with either TGRs (n=54) or MCGRs (n=38) between 2002 and 2018. Preoperative major curve was 77° ± 22° in the TGR group and 67° ± 22° in the MCGR group (p=0.04). HRQoL was assessed using the Early-Onset Scoliosis 24-Item Questionnaire (EOSQ-24). Outcomes were evaluated at 5-year follow-up. The incidence of complications and revision surgeries was analyzed using a Poisson regression model, reported as risk ratios (RR) with 95% confidence intervals (CIs).

Results
At 5-year follow-up, mean major curves were 46° ± 18° in the TGR group and 38° ± 15° in the MCGR group (p=0.03). Median major curve correction was 35% (IQR 32%) in the TGR group and 31% (IQR 31%) in the MCGR group (p=0.24). Annual thoracic growth was a median of 4.1 mm (IQR 4.7) in the TGR group and 3.2 mm (IQR 5.6) in the MCGR group (p=0.29). Patients treated with TGRs had higher rates of complications (2.1 per patient vs. 1.0 per patient, RR 2.1, 95% CI 1.3–3.2) and revision surgeries (2.0 per patient vs. 0.9 per patient, RR 2.2, 95% CI 1.4–3.4) compared to those treated with MCGRs. Both groups achieved maximum HRQoL scores in domains of pulmonary function, transfer, physical function, daily living, and financial impact, with no significant differences in other measured domains.

Conclusion
In patients with idiopathic EOS, treatment with MCGRs was associated with a lower risk of complications and revision surgeries compared to TGRs. Both treatment groups achieved similar deformity correction, thoracic height gain, and HRQoL outcomes.

Characteristic	MCGR n=38		TGR n=54		P
	N (%)	Median (IQR)	N (%)	Median (IQR)	
Age at surgery, years	6.4 ± 1.7		6.4 ± 2.1		.83
Female gender	24 (63)		37 (69)		
Growth-friendly treatment period, years		5.1 (0.8)		5.7 (2.9)	.004
Preoperative height, cm	111 ± 14		110 ± 17		.81
Preoperative weight, kg	20 ± 6.6		21 ± 9.3		.53
Preoperative bracing	15 (39)		28 (52)		
Number of lengthenings		15 (7)		5 (3.5)	<.005
Lengthenings per year		2.9 (1.4)		1.0 (0.5)	<.005
No. of surgical procedures		2 (2)		7 (5)	<.001
Achieved final fusion within 5 years	20 (53)		32 (59)		

Table

106. Pelvic Fixation for Early Onset Scoliosis: Comparative Risks of Complications and Unplanned Return to the Operating Room (UPROR)

Rayyan Abid, BA; Susan Wager, MD; *Christina K. Hardesty, MD*; Pediatric Spine Study Group

Hypothesis
Galveston fixations demonstrate the greatest risk of both UPROR and complications.

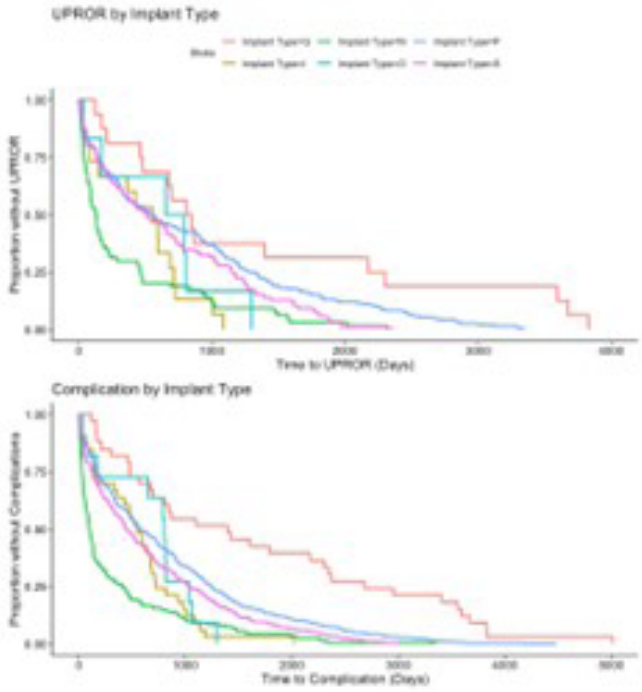
Design
Retrospective analysis of a multicenter database.

Introduction
Pelvic fixation is most commonly used for children with early onset scoliosis (EOS) who exhibit significant pelvic obliquity or require long spinal fusions that anchor to the pelvis. While pelvic fixations help mitigate the risk of complications by improving lumbosacral stability, they often carry their own risk of morbidity. Currently, there is a paucity of data regarding variation in outcomes of EOS patients who receive different pelvic implant types. We aimed to compare rates of UPROR and complications following pelvic fixation among multiple implant types.

Methods
We identified 297 EOS patients who underwent growth friendly treatment, had at least 2 years of follow-up from graduation, and received instrumentation to the pelvis at the index growth friendly procedure. Demographic information, date and type of index GF procedure, and pelvic radiographs were collected, and implant types included Iliac Only Screw (I), Pelvic Hook (P), Galveston (G), S2AI Screw (S), Other (O), or none (N). A chi-square test was performed to determine if implant type was significantly associated with UPROR and complications. Kaplan Meier Analysis was performed to model rates of UPROR and complications over time (Fig 1).

Results
Chi-square tests determined that pelvic fixation type was significantly associated with UPROR and post-operative complications. In 20 unique procedures, type G experienced the 16 UPRORs (80%) and 33 complications (165%). Type N demonstrated 64 (15%) UPRORs and 187 complications (44%) in 425 procedures. Type I had 15 UPRORs (32%) and 33 complications (70%) in 47 procedures, type P had 192 UPRORs (51%) and 460 complications (42%) in 377 visits, and type S had 86 UPRORs (25%) and 219 complications (39%) in 341 procedures. Patients with type I experienced the earliest UPROR and complications while type G UPROR and complications occurred latest.

Conclusion
Type G had the greatest rates of complications and UPROR but generally experienced them at the latest time points. N was least frequently associated with both UPROR and complications, and type I complications occurred earliest. These outcomes should be considered when managing pelvic alignment in children with neuromuscular scoliosis.



107. What Are the Incidence and Risk Factors for Complications in Growth-Friendly Constructs in Congenital Scoliosis?

Sanjana Davuluri; Scott J. Luhmann, MD; *Amer F. Samdani, MD*; Lindsay M. Andras, MD; Megan E. Johnson, MD; Paul D. Sponseller, MD, MBA; Jaime A. Gomez, MD; John T. Smith, MD; Mark A. Erickson, MD; John B. Emans, MD; Pediatric Spine Study Group; Steven W. Hwang, MD

Hypothesis
Complications associated with growth-friendly constructs in congenital scoliosis have diminished over time.

Design
Retrospective cohort study from a multicenter database.

Introduction
Growth-friendly (GF) constructs are used to manage early-onset congenital scoliosis (CS) by controlling deformity

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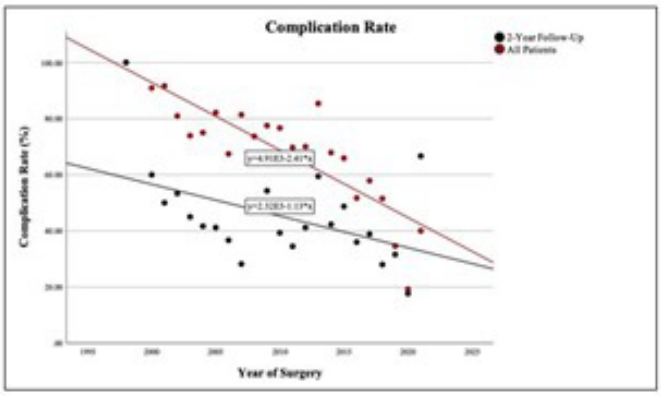
while allowing spinal growth. We examined risk factors that contributed to complications and outcomes.

Methods
Demographic, radiographic, and surgical factors of 655 CS patients who underwent treatment with GF constructs between 1997-2021 were compared. Statistical analyses (t-tests, Chi-square tests, logistic regression, and correlation analyses) were used to identify significant predictors of complications.

Results
446/655 patients (68%) experienced 1329 complications with a mean follow-up of 27±11 months. Mean age at surgery was 5.7±3.2 years and mean Cobb angle was 69±21° pre-op and 51±20° post-op (26% correction). Complications occurred at a mean of 47±40 months post-op. Complication rates have diminished over time at a 10.5% decrease per year (OR=0.895, p<0.05), from approximately 91% in 2000 to 19% in 2020. When limiting to 2-year follow-up only, complication rates have decreased over time as well, by 2.5% per year, though not significantly (p=0.142). Patients with complications were younger (5.1±3.1 vs. 6.9±3.5, p<0.05), and had lower T1-T12, L1-S1, and T1-S1 heights and greater kyphosis (p<0.05). VEPTR (74.1%) and traditional growing rods (TGR) (69.1%) had the highest rates of complication, while magnetically controlled growing rods (MCGR) had the lowest (47.2%, p<0.05). The most common complication types were Instrumentation-related (44.2%) and Infection/Wound (22%). Age at surgery differed significantly across complication types, with older patients experiencing Progression and proximal/distal junctional kyphosis (PJK/DJK) (p<0.05). Infection/Wound complications were associated with short constructs and smaller L1 S1 heights (p<0.05). VEPTR was associated with reduced likelihood of multiple complications (p<0.05). 225 patients had definitive fusion surgery, with the most common complications afterward being Intraoperative (including neuromonitoring changes and dural tears) and PJK/DJK (p<0.05).

Conclusion
Younger age, smaller T1-T12, L1-S1, and T1-S1 heights and higher sagittal kyphosis were associated with higher complication rates; however, complication rates have declined 10.5% each year.



108. Postpone and Posterior if Possible: Comparison of Surgical Approaches for Hemivertebrectomy

Brandon Yoshida, MD; Jacquelyn Valenzuela-Moss, BS; Tyler Tetreault, MD; Tishya Wren, PhD; Purnendu Gupta, MD; Joshua M. Pahys, MD; Michael G. Vitale, MD, MPH; Amer F. Samdani, MD; Lindsay M. Andras, MD; Pediatric Spine Study Group; *Michael J. Heffernan, MD*

Hypothesis
We hypothesized no differences in outcomes or complication profiles between surgical approaches for hemivertebrectomy.

Design
Retrospective Review

Introduction
Although the posterior-only approach has gained favor, there is minimal literature comparing surgical approaches for hemivertebrectomy (HV). The purpose of this study was to compare the anterior-posterior (AP) vs posterior-only (PO) approach to hemivertebrae resection.

Methods
An international pediatric spine database was queried for all patients diagnosed with congenital scoliosis between the ages of 0-18 years who underwent hemivertebrectomy. Patients were grouped by surgical approach of AP or PO. Demographics, radiographic measurements, and complications were analyzed. Modified Clavien-Dindo Sink Classification (MCDS) was used to categorize complication severity. Logistic regression was used to determine odds of requiring additional surgery by age and approach.

Results
A total of 90 patients underwent HV including 75 PO and 15 AP. Trends in the use of PO versus AP showed similar rates of use between 2001-2012 while the PO approach became the primary method after 2013 (Figure 1). Age at index HV increased over time (Median age 4 years in 2014 to 8 years in 2021 (p=0.009). Preoperative curve magnitude was similar between groups (p=0.269), however, median age was higher in the PO group (5.8 vs 3.8 years, p=0.017). Mean OR time was similar (336±109 vs 323±153, p>0.05). Patients who underwent HV under the age of 5, regardless of approach, had 2.86 greater odds of reoperation (OR 2.86; 95% CI [1.19, 6.84], p=0.016). A greater proportion of the AP group required growth friendly treatment after the index HV (35.7% vs 12.2%, p=0.042) at a median of 4.8 years. For the overall cohort, the complication rate was 40%, with 50% categorized as MCDS IIIb. There were no differences in cardiac, GI, or pulmonary complications. Implant failure rate was higher in the anterior-posterior group (33.3% vs 20.0%), while the rate of incidental durotomy (2.7% vs 6.7%) and neurologic injury (4.0% vs 6.7%) were not significantly different between groups (p>0.05).

Conclusion
This large international study confirmed the trend towards posterior-only approach for hemivertebrectomy over the last

10 years. Older age at time of HV (>5 years) and PO approach were associated with less reoperations.

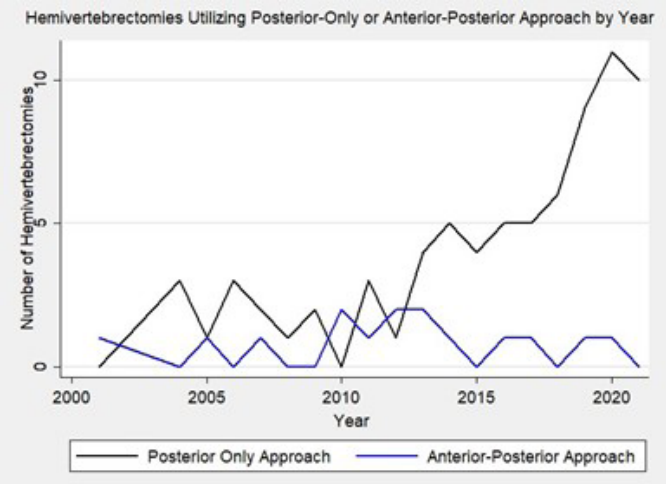


Figure 1: Number of Hemivertebrectomies by Year and Approach

109. Is There a Role for Bracing/casting in the Treatment of Early Onset Congenital Scoliosis?

Kenneth A. Shaw, DO; Jaime A. Gomez, MD; John T. Smith, MD; Sumeet Garg, MD; Mark A. Erickson, MD; Michael G. Vitale, MD, MPH; Lindsay M. Andras, MD; *Megan E. Johnson, MD*

Hypothesis
Bracing/casting of EOS patients with congenital scoliosis will delay surgical intervention when compared to patients who do not receive treatment.

Design
Retrospective cohort study from a multicenter database.

Introduction
Bracing/casting has not traditionally been thought of as an effective treatment strategy for patients with early onset congenital scoliosis. The purpose of this study was to look at the role of bracing/casting in preventing or delaying surgical treatment in this patient population.

Methods
A review of 239 patients with congenital scoliosis who underwent surgical treatment (either growth friendly or final fusion) from 2003-2019 was conducted. Demographic, radiographic and surgical data was collected and compared. Statistical analysis was performed to differences between patients who underwent bracing/casting vs. those who did not.

Results
The mean age at surgical intervention was 7.8±4.3 years. 60.7% of patients were female. 56/239 patients underwent bracing (N=34, 60.7%) or spinal casting (N=22, 39.3%) prior to surgical intervention, Table 1. Children undergoing brace/cast treatment presented at a significantly younger age (5.0±3.7 years vs 7.8±4.4 years, P<0.001) with casting patients presenting significantly younger than brace patients (C:2.6±1.8, B:6.3±3.8 years; P<0.001). Brace/cast intervention delayed surgical intervention a mean 2.1±2.2 years, with a significantly longer delay for casting patients vs bracing (C:2.9±2.6 years, B:1.7±1.9 years; P=0.05). There was no difference in age at the time of surgical intervention between cohorts(brace/cast: 7.2±4.0 vs 7.9±4.4; P=0.2). There was a mean increase in coronal magnitude of 7.1±14.2° and maximal kyphosis of 6.9±20.8° with no difference between cast vs brace patients. There was a mean gain of 46.3±47.8 kg in the brace/cast cohort from presentation until surgical intervention. There was no difference in coronal or sagittal plane deformity magnitude between the patient cohorts at any time point.

Conclusion
In this series of congenital EOS patients, the utilization of pre-surgical brace/cast intervention allowed for a mean 2.1-year delay from presentation until surgical intervention with casting providing a greater delaying capacity than brace intervention. Further research with patient matching is needed to ascertain the true impact of pre-surgical intervention.

Variable	Brace/Cast (N=56)	No Treatment (N=183)	P Value
Presenting Age (yrs)	5.0±3.7	7.8±4.4	**<0.001**
Presenting Coronal Magnitude (°)	56.0±21.6	59.2±18.3	0.3
Presenting Max Kyphosis (°)	47.3±25.5	45.9±23.4	0.7
Presenting Weight (kg)	18.8±10.9	54.6±35.7	**<0.001**
Presenting BMI	17.1±2.7	18.3±3.9	0.06
Age at Treatment (yrs)	7.2±4.0	7.9±4.4	0.2
Preoperative Coronal Magnitude(°)	62.7±20.2	59.2±18.3	0.2
Preoperative Max Kyphosis (°)	52.9±19.4	45.9±23.4	0.06
Preoperative Weight (kg)	46.8±36.9	54.6±35.7	0.2
Preoperative BMI	17.3±2.9	18.3±3.9	0.09
Treatment *Fusion* *GFI*	 66.1% (N=37) 33.9% (N=19)	 61.2% (N=112) 38.8% (N=71)	

Table 1

110. Growth Preserving Anterior Release and Posterior Distraction-Based Growing Systems for Early Onset Scoliosis (EOS): A Propensity Matched Cohort Study

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Hypothesis
The study showed that at 2 years, GPAR and PDBGS provides a superior reduction in coronal curve correction angles, T1-T12 and T1-S1 height gain, without an increase in complications compared to PDBGS alone. This is the first study

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on GPAR in PDBGS and further work is required before advising on the benefits and risks of this procedure.

Design
A retrospective study at a single tertiary centre that deals with paediatric deformity for the region between 1998 to 2022. Included 32 patients who underwent PDBGS for treatment of progressive EOS with or without GPAR. Patients were divided into two groups. Group A patients underwent an GPAR and PDBGS. Group B patients were propensity matched and underwent PDBGS alone.

Introduction
Investigate effects of growth preserving anterior release (GPAR) with posterior distraction based growing systems (PDBGS) on spinal and chest growth and complications in the treatment of early onset scoliosis (EOS).

Methods
Retrospective propensity matched cohort study at a tertiary paediatric deformity unit, involving 32 patients treated with GPAR and PDBGS (group A) or PDBGS alone (group B). Matching criteria included preoperative coronal curve magnitude, implant type, and diagnosis. Lengthening procedures occurred every 6 months. Outcomes included coronal curve correction angle, complications, T1-S1, and T1-T12 heights.

Results
In group A (n=16, 7M:9F, mean age 60 months), mean preoperative coronal curve magnitude reduced by 38o (SD 10o, range 14o-51o) at 2 years. T1-S1 and T1-T12 heights increased by 4.8cm (SD 3, range 1-9.7) and 4.9cm (SD 1, range 3-7) respectively. In group B (n=16; 6M:10F, mean age 77 months), mean preoperative coronal curve magnitude reduced by 26o (SD 10o, range 12.6o-41.9o) at 2 years. T1-S1 and T1-T12 heights increased by 4.2cm (SD 2, range 1.3-7.6) and 2.8cm (SD 1, range 1.9-4.2) respectively. When comparing Groups A and B, there was significantly greater reduction in coronal curve correction angle ($p<0.001$), T1-S1 ($p<0.001$), and T1-T12 height gain ($p<0.001$) in Group A at 2 years. Four patients in Group A and five in Group B experienced complications. There were no cardio-respiratory complications.

Conclusion
Patients in the GPAR group demonstrated superior coronal curve correction and T1-S1 and T1-T12 height gains at two years without increased complications. Effects at final fusion were not evaluated.

111. Prevalence of Spinal Deformities in Myelomeningoceles Treated in Utero and Postnatally Using 3D EOS Panoramic X-Ray Technology

Vinicius de Meldau Benites, MD; Vinicius Santos Baptista

Hypothesis
In utero myelomeningocele (MMC) correction surgery reduces the prevalence of acquired scoliosis and improves spinal and pelvic parameters compared to postnatal correction.

Design
Retrospective-prospective Cohort Study

Introduction
This study aims to analyze the prevalence of spinal deformities in patients who underwent in utero myelomeningocele (MMC) correction surgery, comparing them to patients who underwent postnatal correction surgery.

Methods
This study included patients who underwent either in utero or postnatal surgery at Hospital São Paulo between 2006 and 2021. Patient selection was conducted retrospectively, while EOS imaging acquisition was performed prospectively. Only patients younger than 18 years at the time of EOS radiography were included. Clinical and radiological data were collected, including birth parameters, need for a ventriculoperitoneal shunt, urinary and fecal continence, and postnatal complications. Radiographic evaluation included the presence of scoliosis, Cobb angle, pelvic parameters, and sagittal balance. Statistical analysis compared both groups, considering significance at $p<0.05$.

Results
This study analyzed 70 patients who underwent either in utero (n=47) or postnatal (n=23) surgery. The groups were homogeneous in terms of age (p=0.089) and gender (p=0.725); however, the in utero group had lower birth weight (p=0.024) and gestational age (p=0.004). The need for a ventriculoperitoneal shunt (p=0.001), the incidence of acquired scoliosis (p=0.020), and the urinary continence rate (p=0.009) were significantly lower in the in utero group. Cobb angle did not differ between the groups. Other evaluated postnatal complications showed no statistical differences, except for axial pelvic rotation (p=0.024).

Conclusion
In utero surgery provides advantages over postnatal surgery in reducing the incidence of acquired scoliosis and certain postnatal complications, contributing to a better prognosis for these patients.

Table 1. EOS Data

	In utero	Postnatal	p-value
General Data			
Confirmed scoliosis on EOS, n (%)	23 (48.93)	16 (69.56)	0.128
Acquired scoliosis, n (%)	5 (10.63)	8 (34.78)	0.020
Mean Cobb angle, degrees (SD)	25.25 (24.11)	25.62 (30.79)	0.967
Type of Scoliosis			
Proximal thoracic	4 (17.39)	7 (43.75)	-
Thoracolumbar	17 (73.91)	8 (50.00)	-
Lumbar	3 (13.00)	1 (6.25)	-
Other Parameters			
Cervical lordosis, degrees (SD)	12.76 (11.12)	8.57 (16.94)	0.286
Thoracic kyphosis, degrees (SD)	46.13 (13.84)	42.17 (19.95)	0.397
Lumbar lordosis, degrees (SD)	50.30 (23.45)	41.47 (29.58)	0.219
Sagittal Vertical Axis, mm (SD)	22.00 (24.23)	25.00 (34.72)	0.731
Coronal Vertical Axis, mm	8.00 (32.21)	3.00 (45.68)	
Pelvic incidence, degrees (SD)	49.80 (12.63)	54.95 (16.47)	0.195
Sacral slope, degrees (SD)	36.44 (22.09)	29.95 (22.17)	0.255
Pelvic tilt, degrees (SD)	14.38 (18.49)	25.04 (26.27)	0.090
Pelvic obliquity, mm (SD)	10.46 (13.03)	12.21 (20.69)	0.713
Pelvic axial rotation, degrees (SD)	-0.72 (7.28)	2.95 (5.77)	0.024
Mismatch, degrees (SD)	0.57 (22.76)	13.47 (34.44)	0.112
Mismatch Classification			
Hyperlordosis, n (%)	16 (34.04)	3 (13.04)	-
Hypolordosis, n (%)	12 (25.53)	9 (39.13)	-
Normal, n (%)	19 (40.42)	11 (47.83)	-
Sagittal imbalance, n (%)	39 (82.97%)	19 (82.60)	1.000

112. Connective Tissue Disease Patients Do Not Have Higher Rates of PJK Compared with Idiopathic EOS Following Growth Friendly Instrumentation

Kenneth A. Shaw, DO; John T. Smith, MD; Paul D. Sponseller, MD, MBA; Joshua M. Pahys, MD; George H. Thompson, MD; Pediatric Spine Study Group; Brandon A. Ramo, MD

Hypothesis
Children with CTD undergoing GFI would have higher rates of PJK at 5 year follow-up

Design
Retrospective review of a multicenter EOS database

Introduction
Proximal junctional kyphosis (PJK) is a condition frequently encountered in children with early onset scoliosis (EOS) undergoing growth-friendly instrumentation (GFI). Previous studies have identified risk factors but have not compared how this compares between children with connective tissue disease (CTD) and idiopathic EOS (iEOS).

Methods
Patients with EOS undergoing GFI with a minimum of 5 years follow-up were identified and isolated to those with CTD (Marfan, Loeys-Dietz, Ehlers-Danlos, Soto, Larsen) and idiopathic etiologies. PJK was defined as requiring revision surgery or as having >10 degree change in proximal junctional angle (PJA). Surgical factors and implant variables were recorded. Radiographic parameters and complication development were compared between groups.

Results
A total of 253 children (mean 5.7 years, 57% female) were identified (CTD:49, iEOS:204). A total of 58 patients developed PJK (23%) with only 11 (18.9%, 4% of total cohort) undergoing revision surgery at 5 years following implantation. There were no surgical factors or radiographic variables associated with the development of PJK. In comparing the CTD and iEOS cohorts, there was no difference in PJK (CTD:26.5%, iEOS:22.1%; P=0.5). Additionally, there were no significant differences in patient variables or preoperative or 5-year follow-up radiographic parameters, although there was a trend toward greater increased in PJA over treatment in CTD patients (CTD: 2.4±13.9° vs -0.01±9.9°; P=0.089). CTD patients gained a mean 26.6±20.7mm vs 26.9±21.7mm (P=0.8) of thoracic height. There was no difference in the overall complication rate but CTD patient did experience a greater number of complications/patient (3.1 vs 2.0; P=0.004)

Conclusion
PJK is a pervasive complication in EOS, occurring in 23% of patients undergoing GFI. Having an underlying CTD did not increase the risk of PJK development within 5 years of treatment.

113. Cured Patients with Early Onset Idiopathic Scoliosis (EOIS) After Serial Casting Are at Risk of Recurrence at Intermediate Follow-Up

Rayyan Abid, BA; Abigail Manning, BS; Craig M. Birch, MD; Peter F. Sturm, MD; Ying Li, MD; Michal Szczodry, MD; Michael P. Glotzbecker, MD; Pediatric Spine Study Group

Hypothesis
Serial casting may serve as an alternative to surgery for patients with EOIS.

Design
A retrospective query of the Pediatric Spine Registry.

Introduction
Serial casting is an effective non-operative technique for EOIS patients. Serial casting limits curve progression while preserving spinal growth, delaying or even eliminating the need for surgery. Some patients with EOIS can be "cured" with curve reduction under 15°. Patients cured with casting are typically braced for approximately 1 year. However, no long-term studies have defined whether "cured" patients maintain a small curve over time or if they are at risk of needing further treatment due to curve progression. We examined if casting patients remained "cured" over time following their treatment.

Methods
We identified 40 patients with EOIS who were treated with serial casting, achieved a curve under 15° and for whom we had a minimum of 2 years of follow-up after completing casting. Failure was defined as an increase >6°, resulting in a Cobb angle >15° at any point during follow-up, requiring cast/brace treatment after cessation of initial cast/brace, or undergoing surgery. Average Cobb angle at the time of cure was 11.1°. A Kaplan Meier survival analysis was used to identify failure rates over time.

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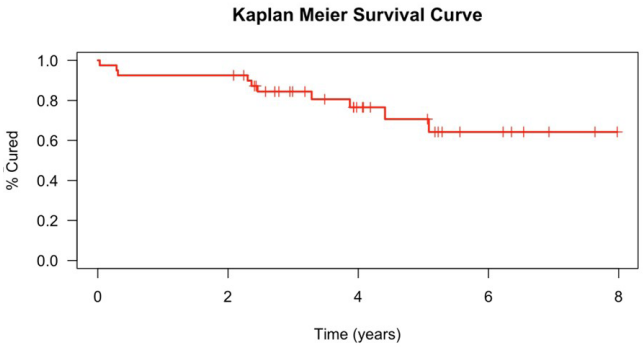
Results
Of 40 patients, 10 (25.0%) met our criteria for failure. Mean follow-up time was 4.3 years. 3 patients (7.5%) completed bracing and were later re-braced while 2 patients (5.0%) required surgery. The mean curve magnitude of the patients who failed was 27.4°, with an average increase of 15.6°. At 5.08 years, the probability of successful treatment is 64.2%. Of those who "failed", the median time to failure was 2.4 years. 14 patients (35.0%) were braced for >2 years following casting. Patients with successful treatment were braced for a median of 1.4 years while patients with "failed" treatment had a median brace time of 1 year.

Conclusion
While EOIS patients may be "cured" with serial casting, this may not be sustained. At intermediate follow-up, 25% of "cured" patients had curve progression and 12.5% required a second treatment. Many patients continue bracing after casting for an extended period of time even after achieving a small curve. The percentage of "failures" likely will increase with longer follow-up through skeletal maturity, and patients need to be closely monitored after completion of casting/bracing.



114. A Novel Peek Rib Plate for Growth Modulation for Spine Deformity Correction of the Immature Rib Cage in Early-Onset Scoliosis: A Porcine Model ‡

Hong Zhang, MD; Brad Niese, PhD; Daniel J. Sucato, MD, MS

Hypothesis
Reinforcing the convex ribs at the apex of deformity in early-onset thoracic scoliosis (EOS) with a Polyetheretherketone spring rib plate (PEEK-SRP) will modulate rib and spinal growth, reduce the rib hump deformity, and correct spinal deformities.

Design
Prospective, controlled study in a translational porcine EOS model.

Introduction
The pliability of the immature rib cage makes it susceptible to spinal deformities in EOS. This study aims to design and evaluate a PEEK-SRP (Fig) for reinforcing and shaping the immature rib cage, with the goal of correcting the rib hump and spinal deformities while preserving thoracic spine growth in an immature scoliosis porcine model.

Methods
Fifteen one-month-old pigs underwent thoracic nerve root transection to induce right thoracic scoliosis. After 1.5 months of curve progression, animals were assigned to three groups: Untreated Group (UG, n=6): Observed without intervention; Treated Group (TG, n=6): PEEK-SRP implanted at three ribs on the convex apical levels (Fig.1d); and Sham Group (SG, n=3): Underwent the same surgical procedures as TG without the PEEK plate implantation. Animals were followed for an additional 2.5 months before radiographic analyses at euthanasia.

Results
Initial scoliosis induction resulted in mean Cobb angles of 58°±10 in UG (p=0.04), 42°±11 in TG, and 27°±24 in SG. Over a 2.5-months follow-up, Cobb angles increased to 71°±13 (22±14% progression) in UG and 61°±6 (126±81% progression) in SG, whereas TG showed a reduction to 35°±15 (17±19% correction) (p=0.001). A 67% improvement of the rib hump index occurred in TG (0.8±0.3) vs. UG (2.4±0.7) (p=0.0005) and SG (2.3±1.8) (p=0.0187). The apical vertebral rotation in TG (5.9°±5.5) was reduced by 80% and 58% compared to UG (30°±8.6) (p=0.0002) and SG (13.9°±6.4) (p=0.0104), respectively. TG demonstrated a 44% increase in convex thoracic area and a 45% improvement in rib-vertebra angle difference (RVAD) compared to UG (p<0.05). Thoracic spine growth in TG (7.3±2.2 mm/week) was not different with the UG (5.9±1.4 mm/week) and SG (5.3±1.9mm/week) (p=0.19).

Conclusion
PEEK-SRP effectively modulated rib and spinal growth in a porcine thoracic EOS model, reducing Cobb angle, rib hump, and vertebral rotation while enhancing thoracic volume and preserving thoracic spine growth. These findings suggest PEEK-SRP as a promising growth-friendly intervention for EOS correction.

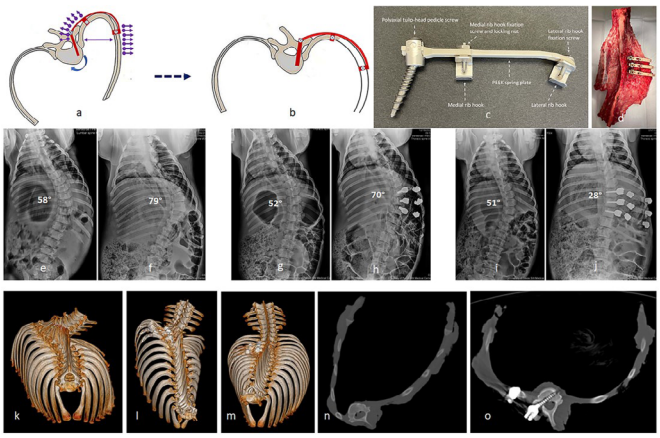


Fig. 1: **(a-b)** Schematic diagrams of right thoracic scoliosis with apical vertebral rotation and thoracic rib hump. Strengthening the ribs at the convex apex **(a)** can prevent the progression of the rib hump and scoliosis and, in some cases, achieve partial correction **(b)**. **(c)** Lateral view of the PEEK-SRP implants, which include a rectangular flat PEEK plate providing an elastic spring function during bending, a polyaxial tulip-head pedicle screw fixed to the apical vertebra on the convex side to allow multidirectional accommodation of the PEEK plate, and two rib hooks with fixation screws that secure the hooks and PEEK plate medially and laterally along the length of the rib. **(d)** Immediate postoperative image showing the placement of PEEK-SRP implants across three levels at the convex apex in an early-onset scoliosis pig model. **(e-f)** Untreated group: A 58° right thoracic scoliosis was induced **(e)**, which progressed to 79° after 2.5 months **(f)**. **(g-h)** Sham group: A 52° right thoracic scoliosis was induced **(g)**, progressing to 70° after 2.5 months post-sham surgery **(h)**. **(i-j)** Treated group: A 51° right thoracic scoliosis was induced **(i)**, improving to 28° (45% correction) 2.5 months after PEEK-SRP implantation **(j)**. **(k-m)** Top-down views of 3D-reconstructed CT images illustrating rib hump differences between untreated **(k)**, sham **(l)**, and treated **(m)** groups. **(n-o)** Axial CT images of the apical vertebra, showing differences in vertebral rotation and rib cage deformity between the untreated **(n)** and treated **(o)** cases.

‡ = SRS Funded Research Grant

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115. Tell Me Your Triradiate is Closed Without Telling Me It's Closed: Assessment of Surrogate Radiographic Factors for Prediction of Triradiate Closure

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Hypothesis
Triradiate closure will be predictable using other measures of skeletal maturity.

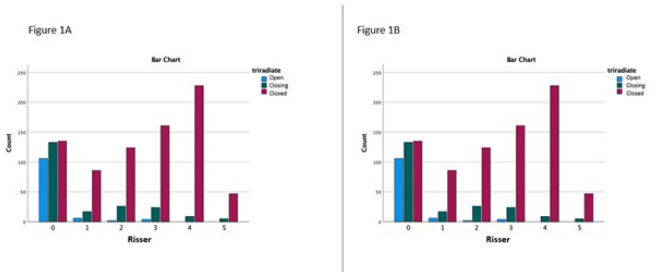
Design
Prospective diagnostic study

Introduction
Closure of the triradiate cartilage (TRC) is an important skeletal maturity marker indicating the decline of the peak growth phase. It can be used for clinical decisions regarding bracing and surgery for patients with idiopathic scoliosis (IS). A typical PA scoliosis x-ray should include a view of the TRC, but this may not always be the case from centers with less experience treating IS patients. Our goal was to use surrogate maturity markers such as Risser and Sanders bone age to assess for the likelihood of TRC closure.

Methods
We used a multicenter prospectively collected group of patients who were non-operatively treated for AIS. We identified 529 patients (72.8% female) with 1139 unique x-ray measurements of TRC closure. TRC closure was categorized as either open (1), closing (2), or closed (3). We also assessed Risser sign, menarche for girls, and Sanders bone age for each encounter. Standardized data collection methods, crosstabulation, and non-parametric statistics were used to assess bone age by stage of the TRC.

Results
Spearman rank correlation showed a high degree of correlation between TRC status and other maturity metrics such as Risser (0.517; p<0.001), Sanders (0.479; p<0.001), and menarche (0.393; p<0.001). Only 11% of patients with open TRC had a Risser sign >0 and only 5% >1. 4% of patients still had a closing TRC at Risser 4 (figure 1A). Sensitivity of >Risser 1 to predict completely closed TRC was 0.717 and specificity was 0.785. Only 2.2% of patients with open TRC were >Sanders 3. 91% of patients had completely closed TRC ≥Sanders 4 (figure 1B). Using this cutoff, the sensitivity of Sanders was 0.385 and specificity was 0.905. All patients with open TRC were premenarchal, but 30% of patients with closed TRC were also premenarchal. Sensitivity of menarche for closed TRC was 0.701 and specificity was 0.835.

Conclusion
Assessing for closed TRC is clinically important but remains elusive. Sanders bone age had a high degree of specificity resulting in a higher chance of ruling in skeletal maturity, whereas menarche and Risser had more favorable sensitivity making them better at ruling out skeletal maturity. Our bar charts illustrate that Sanders bone age seems more descriptive of the progression to skeletal maturity.



116. A Novel and Safe Surgical Strategy to Correct Extremely Severe Potts Deformity from Pathological to Physiological Kyphosis

Junlong Zhong, MD; Zhenhai Zhou, MD, PhD; Jiachao Xiong, MD, PhD; *Kai Cao, MD, PhD*

Hypothesis
Surgery for extremely severe Potts kyphosis more than 130°is much more challenging. A novel surgical strategy with two-stage procedures: preoperative halo-pelvic traction (HPT) after partial internal kyphus resection in stage one combined with PVCR in stage two, can allow this extremely severe kyphosis to be corrected effectively and safely.

Design
Retrospective study.

Introduction
Potts kyphosis more than 130°cannot be corrected adequately by conventional one-stage PVCR surgery. Much residual kyphosis and sagittal imbalance may result in implant failure in the long run. The authors developed a novel and safe surgical strategy mentioned above to correct this extremely severe kyphosis effectively and safely.

Methods
Pts with extremely severe Potts kyphosis underwent the new two-stage surgical procedures were included. Local kyphosis(LK), CL, TK, LL, PI, PT, SS, SVA, the spine length were compared among preop.,post-HPT, postop. and at final F/U. Operative time, EBL and complications were recorded. ASIA scales were used for neurological evaluation and SRS-22 were used for HRQOL evaluation.The follow-up is at least 2 years.

Results
Seventeen males and 12 femals with 47.2±8.5 ys were reviewed. The LK was corrected from 139.1±9.1°to 33.2±14.3°. The CL, TK, LL, PT, PI, SS were changed from 8.8±10.4, -13.9±7.9, 79.8±19.3, 14.3±7.3, 51.8±5.9 and 38.2±4.9 °to 7.2±9.4, 8.6±13.4, 42.5±11.0, 15.0±9.7, 51.2±7.5 and 37.5±5.9 °at final F/U, respectively. The SVA was -1.1±2.6 cm and improved to -0.5±1.9 cm at last follow-up. The spine length was improved from 37.7±7.1 cm to 48.1±5.5 cm at final F/U.Neurological function was significantly improved at final F/U compared with the preoperative.SRS-22 were also distinctively improved at final F/U. The incidence of complications was 41.3%. The HPT traction

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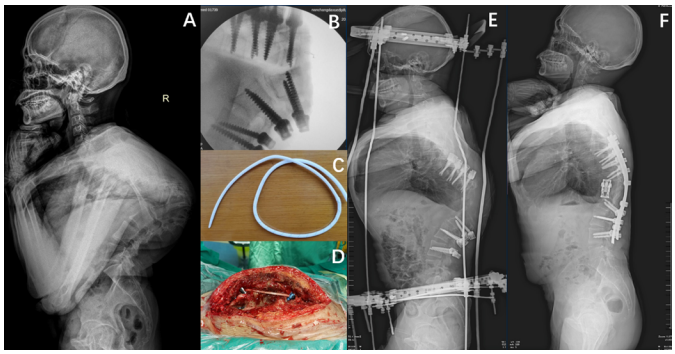
time was 34.4±11.7 days. The total EBL was 2060.0 ± 220.5 ml and the operative time was 480.8±70.6 mins.

Conclusion
This novel two-stage surgical strategy is an effective and safe option to correct extremely severe Potts deformity from pathological to physiological kyphosis. An adequate decompression, satisfied correction and sagittal realignment could be achieved by this novel surgery.



X-ray of preop.(A), Partial internal kyphus resection(IKS)(B), Strong tension-resistant soft PET cord(C) connecting screws across the IKS site to prevent over-traction(D), X-ray of post-HPT(E) & final F/U(F).

117. Finite Vertebral Osteotomy for Angular Kyphotic Deformity in Upper-Middle Thoracic Spine: A Comparative Study with Posterior Vertebral Column Resection

Jiahao Zhang, MD; Yan Zeng, MD

Hypothesis
The primary objective of surgical intervention for angular kyphotic deformities in the upper-middle thoracic spine is spinal cord decompression rather than maximal deformity correction.

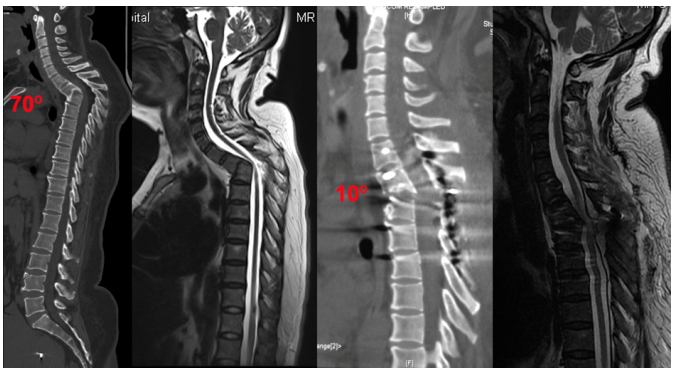
Design
Retrospective cohort study.

Introduction
The novel finite vertebral osteotomy(FVO) technique addresses upper-middle thoracic kyphotic deformities characterized by moderate cosmetic deformity but severe spinal cord compression. Its surgical rationale lies in achieving 360° neural decompression through circumferential osteotomy at the kyphotic apex followed by direct closure of the osteotomy site, thereby restoring spinal cord tension equilibrium.

Methods
62 consecutive patients undergoing posterior osteotomy with ≥24-month follow-up (2005-2022) were analyzed. Cohorts included 32 FVO patients and 30 PVCR controls. Radiographic parameters (focal kyphosis angle, spinal-pelvic alignments) and clinical outcomes (Frankel scale, JOA scores) were compared.

Results
The FVO cohort demonstrated superior intraoperative outcomes compared to PVCR controls, with significantly reduced blood loss (1100 mL vs. 1850 mL, $p<0.05$), shorter operative duration (308 vs. 412 minutes, $p<0.05$), and decreased hospitalization (9.5 vs. 14.2 days, $p<0.05$). Radiographic analysis revealed substantial kyphosis correction in FVO patients, decreasing from 78.6°±14.2° preoperatively to 32.0°±14.4° postoperatively, maintaining 35.8°±22.0° at final follow-up (mean correction rate 60%±20%, $p<0.05$). Neurological recovery was significantly enhanced in the FVO group, evidenced by higher Frankel scale improvement rates (81.8% vs. 62.5%, $p<0.05$), though both groups showed significant thoracic JOA score progression. Notably, the PVCR group exhibited higher revision surgery rates (20% vs. 3.1%) due to instrumentation failure during follow-up.

Conclusion
Compared with PVCR, the FVO technique achieves sufficient decompression of the spinal cord and provides moderate deformity correction. It reduces surgical time, intraoperative blood loss, and length of hospital stay, while also minimizing the incidence of postoperative internal fixation failure and revision surgeries.



A female patient with post-tuberculosis angular kyphosis underwent FVO, and the focal kyphosis was corrected from 70 degree to 10 degree.

118. Does L5-S1 Interbody Fusion Provide Additional Biomechanical Benefit in Setting of Multipoint Pelvic Fixation with Quad Rods Across the Lumbosacral Junction?

Robert Rudy, BS; Anna Sawa, PhD; Sarah McBryan, MS; Luke Mugge, MD; Katherine Thielen, BS; Temesgen G. Assefa, MD; David W. Polly Jr., MD; Juan S. Uribe, MD; Brian P. Kelly, PhD; Jay D. Turner, MD

Hypothesis
Multipoint pelvic fixation with quad rods obviates the biomechanical need for interbody fusion at the lumbosacral junction

Design
Biomechanics study in human cadavers

Introduction
Long segment constructs that span the lumbosacral junc-

tion commonly include interbody fusion at L5-S1 to add biomechanical support and to enhance fusion. However, the importance of adding L5-S1 interbody in the setting of more robust distal fixation with multipoint pelvic fixation and quad rods is not well understood.

Methods
Standard nondestructive flexibility tests (7.5 Nm) were performed on 7 cadaveric specimens (L1-pelvis) to assess intervertebral flexibility (ROM), rod strains, and screw bending moments along a posterior fusion construct (PSR) spanning L2-S. In this study, cadavers with multipoint pelvic fixation with 4 total S2AI screws and 4 rods spanning the lumbosacral junction were evaluated without and subsequently with addition of L5-S1 anterior fusion (ALIF). Data were analyzed using t-tests.

Results
The addition of ALIF caused a significant decrease in S1 screw bending moment during axial rotation ($p<0.026$). Specimens with the ALIF showed a significant reduction in L5-S1 rod strain during extension ($p=0.014$), and lateral bending (LLB: $p=0.013$; RLB: $p=0.024$). ALIF addition also significantly reduced the primary S1-S2 rod strain during lateral bending ($p<0.022$), axial rotation ($p<0.002$) and compression ($p=0.002$) as well as significantly reduced accessory rod strains at S1-S2 during flexion ($p=0.007$), extension ($p=0.026$) and compression ($p=0.009$).

Conclusion
Even in specimens with 4 rods spanning the lumbosacral junction, addition of an ALIF cage significantly reduced rod strain in both the primary and accessory rods at the lumbosacral junction. When maximal biomechanical support is required across the lumbosacral junction, use of L5-S1interbody fusion should be considered, even in setting of robust distal fixation with quad rods.

119. Low Pelvic Incidence in Scheuermann's Kyphosis Should Be Considered in Surgical Thoracic Kyphosis Correction

Riley Sevensky, BS; *Zeeshan M. Sardar, MD*; Justin L. Reyes, MS; Oluwademilade Tega, BA; Fthimnir Hassan, MPH; Josephine R. Coury, MD; Joseph M. Lombardi, MD; Lawrence G. Lenke, MD

Hypothesis
In Scheuermann's Kyphosis (SK), TK and PI are interdependent factors in surgical intervention.

Design
Retrospective review

Introduction
SK typically presents with postural abnormality or back pain in adolescents or young adults. It has been hypothesized that surgical correction of thoracic kyphosis (TK) should be based on PI. This study will identify differences in radiographic and functional parameters of surgically managed SK patients with regards to PI.

Methods
The HARMS Study Group database contained SK patients with surgery from 2006 to 2011 [n=97]. Existing preoperative and 2-year postoperative radiographic images, data, and PROMs were obtained; supplemental parameters were measured. Unpaired two-tailed t-tests and chi-squared tests were utilized.

Results
Of the SK cohort, we included only patients with available pelvic data [n=53]. Mean age at surgery was 15.9, baseline TK (T1-T12) was 74.1, lumbar lordosis (LL, L1-S1) was -69.6, and PI was 40.2. Of all patients, 34 [64.2%] had a PI<45° (G1), 15 [28.3%] had a PI of 45°–60° (G2), and 4 [7.5%] had a PI>60° (G3). Due to limited subjects, G3 was excluded from subgroup analyses. Between G1 and G2, preoperative TK, postoperative TK, and surgical correction of TK did not differ. Preoperative LL and proximal LL (pLL, L1-L4) were greater in G2; distal LL (dLL, L4-S1) did not differ. Postoperative LL, pLL, and dLL did not differ. With PI, G2 had higher PT and SS. Pre- and postoperative TK-PI mismatch were lower in G2. Preoperative SRS pain, general function, and total scores were higher in G1; self-image, mental health, and satisfaction scores did not differ. Postoperative SRS scores were not different between groups. Rates of any junctional kyphosis (JK), proximal JK, and distal JK did not differ between G1 and G2. Of all SK patients, 50.9% had any JK, 18.9% had PJK, and 35.8% had DJK. Those with PJK at 2-years had lower TK correction [-3.7 vs -21.8; $p=0.004$] and greater postoperative TK-PI mismatch [26.4 vs 11.4; $p=0.021$] than those without.

Conclusion
PI for surgical SK patients was low. TK and TK correction was similar regardless of PI. Patients with moderate PI had lower preoperative SRS pain and general function scores but postoperative scores similar to patients with lower PI, indicating that surgery may equalize PROMs. Patients developing PJK had a lesser degree of TK correction and higher postoperative TK-PI mismatch.

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HARMS SK by PI group			
Group	**Group 1 (G1)**	**Group 2 (G2)**	***p-value***
Group description	**PI < 45°**	**45° ≤ PI ≤ 60°**	
Total n	34	15	
Baseline demographics			
Age at time of surgery (years) [mean±SD]	15.8 (±1.9)	16.2 (±1.4)	0.496
Sex [n,%]			0.553
Male	22 (64.7%)	11 (73.3%)	
Female	12 (35.3%)	4 (26.7%)	
BMI, preoperative (kg/m^2) [mean±SD]	26.3 (±6.6)	28.2 (±8.9)	0.415
Number of instrumented levels [mean±SD]	12.9 (±0.8)	13.0 (±0.9)	0.824
Preoperative			
Radiographic parameters (°) [mean±SD]			
Thoracic kyphosis (TK; T1-T12)	74.2 (±13.5)	71.9 (±10.5)	0.626
Lumbar lordosis (LL; L1-S1)	-64.5 (±11.5)	-75.6 (±14.1)	*0.010
Proximal lumbar lordosis (pLL; L1-L4)	-22.0 (±9.9)	-29.8 (±10.2)	*0.026
Distal lumbar lordosis (dLL; L4-S1)	-42.5 (±9.6)	-45.8 (±12.7)	0.358
Pelvic incidence (PI)	33.0 (±6.0)	50.2 (±3.6)	*<0.00001
Pelvic tilt (PT)	3.9 (±6.8)	11.7 (±3.4)	*0.0001
Sacral slope (SS)	29.1 (±7.5)	38.5 (±5.3)	*0.0001
Calculated parameters			
TK-PI mismatch (TK - PI; °) [mean±SD]	41.5 (±14.2)	22.0 (±10.5)	*0.0003
Normalized patient-reported outcome measures (PROMs) [mean±SD]			
SRS: Total	3.7 (±0.6)	3.3 (±0.5)	*0.027
SRS: Pain	3.9 (±0.7)	3.2 (±0.8)	*0.010
SRS: Self-Image	2.8 (±0.7)	2.8 (±1.0)	0.812
SRS: General Function	4.4 (±0.6)	3.9 (±0.8)	*0.043
SRS: Mental Health	3.7 (±0.8)	3.3 (±0.8)	0.094
SRS: Satisfaction	3.8 (±1.1)	3.6 (±0.8)	0.532
Postoperative (2-year follow-up)			
Radiographic parameters (°) [mean±SD]			
Thoracic kyphosis (TK; T1-T12)	58.1 (±14.2)	52.7 (±11.4)	0.302
Lumbar lordosis (LL; L1-S1)	-49.6 (±13.1)	-58.0 (±10.8)	0.060
Proximal lumbar lordosis (pLL; L1-L4)	-14.0 (±10.8)	-20.8 (±7.7)	0.063
Distal lumbar lordosis (dLL; L4-S1)	-35.6 (±10.5)	-37.3 (±7.9)	0.626
Pelvic tilt (PT)	5.4 (±7.5)	12.1 (±5.6)	*0.003
Sacral slope (SS)	31.9 (±8.5)	39.9 (±8.1)	*0.003
Calculated parameters			
TK-PI mismatch (TK-PI) (TK - PI; °) [mean±SD]	21.2 (±14.7)	1.4 (±10.0)	*0.0005
TK correction (postoperative TK - preoperative TK; °) [mean±SD]	-16.1 (±19.2)	-20.5 (±6.3)	0.530
Any junctional kyphosis (JK) [n,%]	17 (50.0%)	7 (46.7%)	0.830
Proximal junctional kyphosis (PJK) [n,%]	7 (20.6%)	3 (20.0%)	0.962
Distal junctional kyphosis (DJK) [n,%]	11 (32.4%)	5 (33.3%)	0.946
Normalized patient-reported outcome measures (PROMs) [mean±SD]			
SRS: Total	4.3 (±0.6)	4.3 (±0.4)	0.989
SRS: Pain	4.3 (±0.8)	4.3 (±0.8)	0.928
SRS: Self-Image	4.4 (±0.6)	4.3 (±0.4)	0.719
SRS: General Function	4.5 (±0.7)	4.8 (±0.3)	0.198
SRS: Mental Health	4.2 (±0.7)	3.9 (±0.8)	0.187
SRS: Satisfaction	4.5 (±0.8)	4.8 (±0.5)	0.306

120. Radiographic Predictors of Functional and Pain Outcomes in Scheuermann's Kyphosis: A Roc-Based Minimal Clinically Important Difference (MCID) Analysis

Matthew Geck, MD; Devender Singh, PhD; *Vik Kohli, MD*; Morgan Laviolette, DPT; Qais Zai, MD; Rory R. Mayer, MD; John Stokes, MD; Eeric Truumees, MD

Hypothesis
More stringent corrections in radiographic parameters, particularly in PI-LL mismatch and TK, would be predictive of significant improvements in patient-reported outcomes, while parameters such as LL and TPA might have weaker associations with clinical improvements.

Design
Retrospective study

Introduction
Evaluate the clinical significance of key radiographic parameters in SK correction by calculating the Minimal Clinically Important Difference (MCID) using the Receiver Operating Characteristic (ROC) curve method.

Methods
MCID was calculated using the ROC curve, with thresholds defined by the patient-reported outcomes of functional improvement (ODI) and pain relief (VAS). The Area Under the Curve (AUC) was used to assess the predictive power of each radiographic parameter.

Results
The cohort (n=45) was 52.2% male with a mean age of 19.7 yrs. PI-LL mismatch and TK were the strongest predictors of patient-reported improvements. The ROC-based MCID threshold for PI-LL mismatch was 6.0°, stricter than the commonly accepted ≤10° in the literature, with final values ranging from -7.0° to 8.0°. The AUC for PI-LL mismatch was 0.68 for ODI, indicating fair predictive value for functional improvement, while the AUC for VAS was 0.54, suggesting poor predictive value for pain relief. TK was significantly associated with pain relief, with an MCID threshold of 0.40° and an AUC of 0.69 for VAS, a fair predictor of pain improvement. However, its predictive value for functional improvement was limited, with an AUC of 0.51 for ODI. LL had ROC thresholds of 47.0° for ODI and 48.0° for VAS, with AUCs of 0.54 and 0.60, respectively, indicating poor predictive ability. TPA had limited predictive power, with thresholds of -3.0° for ODI and 9.0° for VAS, and AUCs of 0.61 and 0.54. These findings suggest that while LL and TPA are crucial for overall sagittal balance, their direct impact on patient-reported outcomes in this cohort was minimal

Conclusion
PI-LL mismatch and TK as the most clinically significant predictors of improvement in patients undergoing surgical correction for SK. Stricter corrections in PI-LL mismatch and TK were associated with better patient-reported outcomes, particularly in terms of functional improvement and pain relief, respectively. In contrast, LL and TPA, while essential for sagittal alignment, were poor predictors of meaningful clinical improvements.

121. Selection of Upper Instrumented Vertebra Level (T9 Vs T10) on Radiologic and Clinical Outcomes in the Surgical Treatment of Adult Spinal Deformity Patients over a Minimum 5 Years Follow-Up

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Hypothesis
Selecting T9 as the upper instrumented vertebra (UIV) may offer greater stability compared to T10, potentially leading to improved long-term radiographic and clinical outcomes in pts with ASD.

Design
Retrospective

Introduction
The T10 vertebra is attached to the last true rib, and the T10-T11 level is recognized as the last mobile segment in the thoracolumbar spine. For this reason, T10 has traditionally been selected as the upper instrumented vertebra (UIV) in adult spinal deformity surgery. However, when

T10 is chosen as the UIV, there is only one level of fixation above the mobile T10-T11 segment. This limited fixation may not provide sufficient support to effectively bridge the thoracolumbar spine, potentially compromising stability. We hypothesized that T9 vertebra may be a better UIV option in order to provide better stability at thoracolumbar junction. In our study, we aimed to compare the radiologic and clinical outcomes of pts in which T9 or T10 were selected as the UIV with min 5 yrs f/up.

Methods
186 pts who underwent posterior fusion from midthoracic spine down to pelvis for adult spinal deformity were reviewed. T9 Group (T9G) included 124 pts (78F, 46M) and T10 Group (T10G) included 62 pts (38F, 24M). Preoperative, postoperative and f/up pelvic and sagittal parameters including PJK angles were measured. ODI scores were used for clinical evaluation.

Results
Mean age was 71 (41-88) years and mean f/up was 68 (24-182) months in T9G. Mean age was 67 (40-75) years and mean f/up was 74 (28-144) months in T10G. Preop, early postop and f/up pelvic, coronal and sagittal parameters were similar in both groups. Radiologically, 6 pts (4.8%) showed PJK in T9G, and 14 pts (22%) in T10G. 4 pts (3%) in T9G and 8 pts (12%) in T10G had PJF and underwent revision surgery. Higher preoperative TK, PI, T4-L1 pelvic angle mismatch were found to be risk factors for PJK. Mean ODI scores at final f/up were better in T9G (23) than T10G (33).

Conclusion
We believe T9 as the UIV provides better biomechanical support and stability compared to T10 in long fusions for ASD. Pts with UIV at T9 showed significantly lower rates of PJK (4.7%) and PJF (3%) compared to pts with UIV at T10 (PJK: 22%, PJF: 12%). Clinical results of ODI scores were also better in T9 Group. These findings suggest that T9 may be a better UIV choice for ASD surgery.

122. High-Grade Pediatric Spondylolisthesis: Pelvic Retroversion Corrects Spontaneously After In-Situ Posterior Spinal Fusion

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Hypothesis
Sagittal balance can show early improvement following insitu fusion for high grade spondylolithesis

Design
Retrospective review of consecutive group of patients with High grade spondylolistheais treated with Jackson technique

Introduction
Debate exists regarding insitu fusion vs reduction and fusion in patients with high grade L5/S1 spondylolisthesis. Proponents of reduction highlight the improvement in global sagittal alignment, most obvious in patients with preoperative pelvic retroversion. The purpose of this study was to assess the radiographic sagittal alignment of patients with high grade (>50%) spondylolisthesis treated with insitu fusion using the Jackson technique.

Methods
Retrospective review of all patients treated for high grade spondylolisthesis at a single centre between 2009 and 2022 with at least two years post-operative follow up. Patient demographic data collected included age, sex, age at time of operation and weight. Radiographic data collection was undertaken on pre-operative, post-operative and two-year post-operative xrays. Radiographic parameters measured included Pelvic Incidence, Sacral Slope, Pelvic Tilt, L5 Incidence, L4 Incidence, Lumbar Sacral Angle, Meyerding grade, SDSG grade of spondylolisthesis, lordosis and number of vertebra included in the lordosis. Patients were excluded if the radiographs were unsuitable for measuring (e.g. did not include whole spine, radiation guards covering hips).

Results
Of the 57 patients treated surgically for high grade spondylolisthesis 20 underwent a Jackson procedure and had a complete xray set for the study, (14 female, 6 male, average age 13.6 range 10-16). Spontaneous alignment in a prone position was secured with a Jackson type fixation with no further attempt of correction. 8 patients improved on average by one Meyerding grade. A solid fusion was obtained in all patients. 9 patients presented with a vertical sacrum (sacral slope below 35), which remained unchanged on the first standing X-ray. Follow-up within this subgroup showed an increase in sacral slope at 2 years by an average of 14.9 (3.1-32.1). There were no post-operative complications or revisions.

Conclusion
In-situ fusion with the Jackson technique did not lead to a worsening of sagittal alignment. All patients with a sacral slope below 35 managed with an insitu fusion showed an increase in sacral slope at 2 years follow-up to greater that 35.

123. Sagittal Balance and Hrqols in Young Patients with High Grade Dysplastic Spondylolisthesis Who Underwent Modified Harm's Technique Reduction-Long Term Follow Up, Single Centre Study

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Hypothesis
Aim of study is to evaluate global sagittal balance, regional spino-pelvic alignment and (HRQOL)12-26 years after surgery for HGDS using modified Harms all posterior complete reduction technique

Design
Restrospective

Introduction
High grade spondylolisthesis is a very rare entity and it still Remains a controversial topic in spine surgery. Patients with HGS are symptomatic with back pain, radicular symptoms

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and postural deformities such as compensatory lumbar hyperlordosis for focal kyphosis.This condition can lead to severe deformity, pain, and functional impairment due to changes in spinal alignment and biomechanics•

Methods
Retrospective study of 15 patients who underwent surgery in our centre between 1998 and 2018. All patients had high-grade spondylolisthesis at L5-S1(11- grade 5, 3- grade 4, 1- grade 3•The modified Harm's reduction technique with a specific pedicle screw-based distraction manoeuvre, wide decompression, gradual reduction and maintenance of reduction with interbody fusion followed. (Parameters measured were segmental (slip percentage, Dubousset's lumbosacral angle), regional (pelvic tilt, sacral slope, L5 incidence, lumbar lordosis and thoracic kyphosis) and global alignment (spino-pelvic inclination) x-apple-ql-id://E6C10DD4-1282-442A-A057-5CAFF9838DA3/x-apple-ql-magic/84107F61-6B2B-4427-A803-65569A71042C.jpg

Results
15 patients (11- grade 5, 3- grade 4, 1- grade 3).The mean age at surgery was 13.9yrs(10-20yrs) with a mean follow up of 15years (12-26yrs)•Mean slip percentage reduced from 89% (SD 11) to 23% (SD 5) with the Meyerding grade of cases reduced to grade 1 or less. The listhesis correction was maintained at last FU- slip angle 53o preop to -11o, Dubousset lumbo sacral angle (LSA) 55o to 92o(p<0.001). sacral slope increased from 13 degrees to 35 degrees Preoperatively 73% patients had unbalanced pelvis and 13% at final FU. Only 1 patient had asymptomatic adjacent segment spondylolisthesis after 8 years FU post mono-segment L5-S1 TLIF. The median SRS 22r total score was 4.2 (p<0.001)

Conclusion
This study demonstrates the efficacy of a progressive reduction technique for managing high-grade spondylolisthesis in young patients. The procedure effectively restores global sagittal balance and achieves solid fusion, allowing patients to return to normal activities with no complications.

Parameters corrected	Pre operative value	Last FU value	P-value
Lysthesis characteristics:			
- Slip percentage/Meyerding grade	89.1±11.2/ 4.5±0.78	23.4±5.7 / 1.8±0.57	<0.001*
- Slip angle	53.67 ± 18.45	-11.4 ± 4.51	
- Dubousset LS angle	54.97 ± 22.87	92.3 ± 11.64	
Pelvic parameters:			
- Sacral slope	18.67 ± 10.23	38.2 ± 9.14	
- Pelvic tilt	40.34 ± 12.87	24.9 ± 7.6	<0.001*
- Lumbar Lordosis	64.83 ± 24.16	48.21 ± 11.7	
Global sagittal parameters:			
- SVA	48.7 ± 11.4[1]	12.3 ± 4.6	
- T1 pelvic angle (T1 spino pelvic inclincation- pelvic tilt)	27.8 ± 8.4[1]	7.2° ± 4.4°	<0.001*
- Thoracic kyphosis	6.8 ± 8.2[1]	18.4 ± 4.7	0.45

Case examples

124. Conservative Treatment Protocol for the Management of Spondylolysis in Adolescent Athletes: Excellent Rates of Return to Sport and Clinical Resolution in 176 Patients

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Hypothesis
Conservative treatment of spondylolysis with bracing, rest, and progressive physical therapy (PT) allows for high rates of return to sports (RTS) in adolescents.

Design
Retrospective review

Introduction
The optimal treatment for spondylolysis remains unclear. This study aimed to evaluate the clinical outcomes in a cohort of adolescent athletes who were treated conservatively for spondylolysis, and to determine rate of RTS and predictors of faster RTS.

Methods
This was a retrospective review of adolescents with acute spondylolysis between 2016-2024. All patients were treated conservatively with activity restriction, bracing, and eventual PT. Total bracing time and time at which PT was initiated were recorded. The primary outcome of the study was functional recovery, or RTS. Secondary outcomes included clinical resolution of pain, recurrence, and surgical intervention. Patients who failed to follow up, those not treated with bracing, or documented non-compliance with rest/brace were excluded. A multivariable linear regression analysis evaluated the association of demographic, injury characteristics, and treatment characteristics with time to RTS.

Results
176 adolescents (68% male, mean age 14.4±1.6 years) with acute spondylolysis were treated with rest, a mean bracing time of 10.9±2.3 weeks, and initiation of PT at a mean of 5.8±1.3 weeks of treatment. Soccer (15%) was the most common sport; 43% played multiple sports. Spondylolysis was bilateral in 58% and at L5 in 67%; 4% of patients had multi-level spondylolysis and 16% had spondylolisthesis (all grade 1). 97.2% RTS at a mean of 13.2±3.4 weeks. 80% of patients demonstrated clinical resolution at their first follow-up visit (~6 weeks from diagnosis), increasing to 97% at their second visit (~12 weeks from diagnosis). Multivariable analysis showed that one additional week of bracing was associated with a 0.45 week prolongment in RTS (P < 0.001). 17 (9.7%) patients had recurrence of spondylolysis at a mean 37.9 ± 26.4 weeks from diagnosis. 4 patients underwent surgical intervention (L5/S1 fusion = 3, pars screw fixation = 1) after failing conservative management.

Conclusion
Our conservative spondylolysis protocol that utilized activity restriction, bracing, and gradual PT demonstrated excellent RTS and clinical resolution.

Table 1. Descriptive Statistics of 176 Patients with Acute Spondylolysis Undergoing Conservative Bracing and Physical Therapy Protocol

Characteristic	N (%)
Age, years ± SD	14.4 ± 1.6
Sex	
Male	120 (68.2%)
Female	56 (31.8%)
Sports Played (n=283)	
Soccer	42 (14.8%)
Basketball	39 (13.8%)
Lacrosse	26 (9.2%)
Football	22 (7.8%)
Baseball	18 (6.4%)
Other	136 (48.1%)
Multi-sport athlete	75 (42.6%)
Spondylolysis Laterality	
Left	43 (24.4%)
Right	31 (17.6%)
Bilateral	102 (58.0%)
Spondylolysis Levels	
L2	1 (0.6%)
L3	7 (4.0%)
L4	43 (24.4%)
L5	117 (66.5%)
S1	1 (0.6%)
Multi-level spondylolysis	7 (4.0%)
Spondylolisthesis	28 (15.9%)
Grade 1	28/28 (100%)
Mean bracing time, weeks ± SD	10.9 ± 2.3
Mean PT initiation time, weeks ± SD	5.8 ± 1.3
Clinical resolution at 1st follow up visit (~6 weeks), %	140 (79.5%)
Clinical resolution at 2nd follow up visit (~12 weeks), %	170 (96.6%)
RTS	171/176 (97.2%)
Mean time of RTS, weeks ± SD	13.2 ± 3.4
Documented recurrence	17 (9.7%)
Surgical intervention	4 (2.3%)

SD: Standard Deviation; RTS: Return to Sport

Descriptive Statistics of 176 Patients Undergoing Spondylolysis Protocol

125. Femoral Bmd is the Superior Predictor of Screw Insertional Torque over Lumbar Bmd and Hounsfield Unit in Lumbar Fusion Surgery

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Hypothesis
Hounsfield unit (HU) value is an equivalent predictor of screw insertional torque to lumbar or femoral bone mineral density (BMD) in lumbar fusion surgery

Design
Retrospective review of prospectively collected data

Introduction
Instrumentation failure remains a significant complication in spinal surgery. Preoperative evaluation of bone health is essential to mitigate the risk of instrumentation failures. Common preoperative assessments of bone health include BMD from DEXA and HU through CT scans. HU has gained popularity, as the majority of patients undergo CT scans prior to surgery. If HU demonstrates comparable accuracy to BMD, it could emerge as a gold standard for testing. Our objective was to identify the preoperative evaluation method that most accurately reflects screw insertional torque. In this study, we examined the correlation between screw insertional torque and BMD/HU in patients undergoing lumbar fusion surgery.

Methods
Retrospective analysis of prospectively collected data from patients undergoing lumbar fusion surgery at a single institution. Preoperative evaluations included baseline demographic variables, bone turnover markers including PINP and TRAP-5b, HU, and BMD. The screw size was determined based on preoperative CT. Only 6.5 mm diameter screws were included in the study. Screw insertional torque was measured using a calibrated torque wrench. Correlations between insertional torque and preoperative variables were analyzed with Pearson's correlation coefficient.

Results
A total of 91 patients (49 males, mean age 69.7 years) were included in the analysis. Mean insertional torques were 1.89 ± 0.89 Nm for 6.5 x 40 mm screws and 2.07 ± 0.88 Nm for 6.5 x 45 mm screws, with longer screws exhibiting significantly higher torque (P= 0.041). Femoral BMD demonstrated a stronger correlation with insertional torque than lumbar BMD and HU. Other variables, such as age and ASA grade, showed weak negative correlations with torque, while BMI, serum calcium, and albumin exhibited weak positive correlations. Serum PINP and TRAP-5b showed no correlation (Table 1).

Conclusion
Femoral BMD exhibited the most robust correlation with screw insertional torque when compared to HU and lumbar BMD. While HU has gained popularity in clinical practice, our findings indicate DEXA remains the most reliable assessment for evaluating bone health prior to spinal surgery

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Table 1 Correlation between insertional torque in 6.5 x 40mm screws and patients' data

Age	**-0.345**
Sex	**-0.199**
BMI	**0.225**
ASA	**-0.222**
Ca	**0.266**
Alb	**0.209**
TRAP-5b	-0.125
PINP	0.104
BMD femur	**0.557**
T-score femur	**0.538**
BMD lumbar	**0.404**
T-score lumbar	**0.403**
HU	**0.431**

Bold letters indicate $p < 0.05$

Correlation coefficient

126. Selection of Proximal Fusion Level in Chronic Osteoporotic Vertebral Compression Fracture (OVCF) with Spinal Kyphosis: The Importance of Hounsfield Unit

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Hypothesis
we believe that the UMV and USRV might play an important role in the biomechanical stability of the spine.

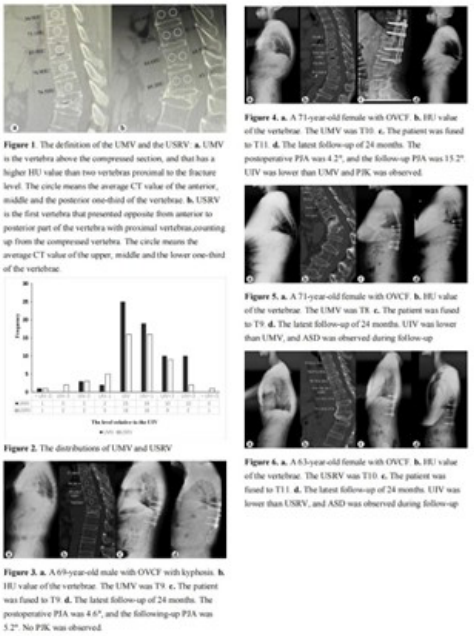
Design
Retrospective Study

Introduction
With aging, OVCF has become a significant public health issue. At least 20% of people over 50 have vertebral fractures, and in China, 21.9% of men and 67.5% of women over 80 suffer from these fractures. Chronic OVCF patients often experience poor quality of life due to long-term pain and disability, necessitating corrective surgery. However, due to advanced age and osteoporosis, these surgeries have high complication rates. The selection of the upper instrumented vertebra (UIV) is crucial, as it affects postoperative complications like PJK and ASD. We propose the upper maximal vertebra (UMV) and upper sagittal reverse vertebra (USRV) as potential indicators for selecting the UIV. Our study aims to determine if UMV or USRV can optimize fusion level selection and reduce mechanical complications.

Methods
This clinical research included 70 chronic OVCF patients (14 males and 56 females) with a mean age of 63.24 ± 7.83 years and mean follow-up of 48.13 ± 20.22 months. Whole spine CT were performed for each patient. The patients were divided into groups according to whether their UIV was below the UMV or USRV. The incidence of ASD and PJK was evaluated in each subgroup

Results
The average HU value of all patients was 80.88 ± 39.84. All sagittal parameters improved significantly after operation and at follow-up. For UMV, the UIV of 31chronic OVCF patients was located on or above the UMV, while that of 39 patients was not. There was a significant difference in the rates of ASD (p=0.003) and PJK (p=0.010) between the 2 groups. 55 patients (78.57%) were identified to have USRV. The UIV of 26 patients was located on or above the USRV while that of 29 patients was not. There was a significant difference in the rate of ASD between the two groups (p=0.010).

Conclusion
HU values should be considered in the selection of UIV. Locating UIV on UMV might decrease the incidence of PJK and ASD, and taking USRV into the fusion level might reduce the occurrence of ASD.



127. Biomechanical Evaluation of a Novel Endplate Penetrating Pedicle Screw Fixation Method Using Cadaver Spine: A Comparison with a Traditional Pedicle Screw Trajectory

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Hypothesis
The novel endplate penetrating pedicle screw fixation method for the cadaver spine is significantly stronger than the traditional pedicle screw trajectory.

Design
Basic Science

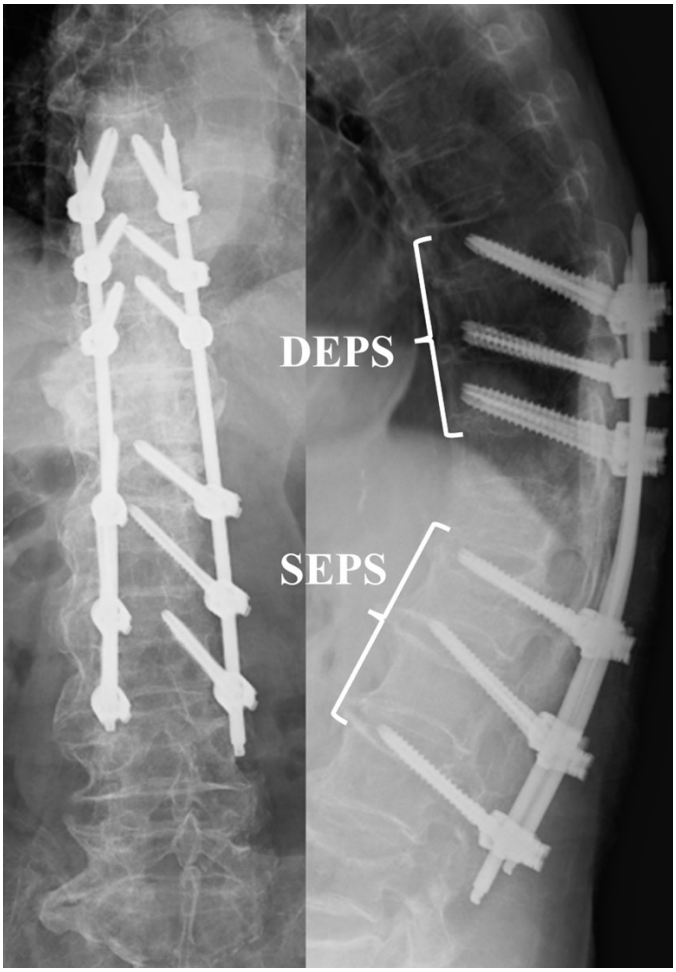
Introduction
To achieve adequate fixation strength with pedicle screws in kyphosis is challenging especially in patients with bone fragility due to vertebral fractures or DISH (diffuse idiopathic skeletal hyperostosis). We have developed a novel percuta-

neous pedicle screw (PPS) insertion technique, where screws penetrate the upper endplate of vertebra and the lower endplate of caudally adjacent vertebra to enhance the screw fixation; the single or double endplates penetrating screw (SEPS/DEPS) technique. Previously, we have reported that the fixation strength of the SEPS/DEPS trajectory (SEPST/DEPST) was 1.4-1.7 times higher than that of the TT (traditional trajectory) based on finite element method (FEM). The purpose of this study is to evaluate the fixation strength of SEPST/DEPST in comparison with TT using cadaveric spines.

Methods
Six formalin-fixed adult human cadavers (two males, four females; age at death 85.7 ± 8.8 years) were used and IT (insertion torque) and POF (pull out force) were evaluated in the following two studies. For each vertebra, the different trajectories were applied to the right and left pedicles, and the fixation strength were compared using the left-to-right ratio. Firstly, a comparison of the IT and POF were made among TT/SEPST/DEPST. Since the SEPS/DEPS trajectories differ from TT, SEPS/DEPS can be utilized in vertebrae previously inserted with TT screws, making them potentially valuable for revision surgeries. Therefore, for the second study, we evaluated the reinsertion IT and POF of DEPST (re-DEPST) screw in vertebrae where TT screws had been inserted and removed, assuming re-operation scenario.

Results
SEPST/DEPST had a 32-70% higher IT and a 45-82% higher POF than TT, and DEPST was about 1.4 times higher than SEPST. Assuming reoperation, the results show that fixation with re-DEPST provided almost the same fixation strength as initial TT insertion.

Conclusion
This study is the first to validate the fixation strength of SEPST/DEPST using cadaveric spines. The findings demonstrate that SEPST/DEPST provides high fixation strength and show potential utility in revision surgeries.



Postoperative x-ray with SEPS/DEPS method

128. The Economic and Clinical Burden of Poor Bone Health in Adult Spinal Deformity Surgery

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Hypothesis
Poor bone health leads to more revisions/complications, which increase cost burden on the healthcare system.

PODIUM PRESENTATION ABSTRACTS

Design
Retrospective analysis of a prospectively enrolled clinical trial.

Introduction
Osteoporosis is commonly comorbid with adult spinal deformity (ASD), with a reported a prevalence of 14.4-28.6%. The cyclical relationship between ASD and poor bone health poses a significant challenge to healthcare systems.

Methods
Operative ASD patients ≥18Y with complete BL and 2Y data included. Bone quality categorized per the American Association of Clinical Endocrinology for DEXA and clinical features. Cohorts: O (untreated osteopenic/osteoporotic) and NO (treated or normal). DRG reimbursements calculated using established data. QALYs calculated using ODI converted to SF-6D and employed an annual 3% discount rate to calculate surgical cost-effectiveness with linear regression extrapolating QALY data out to 5Y.

Results
Among the 1142 (21.5% O; 78.5% NO) included (62.5±14.7Y; 67%F; BMI 27.6±5.5kg/m^2; CCI 1.1±1.7), 16.6% had a formal diagnosis of osteoporosis, but 17.1% of osteoporotics and 76.1% of osteopenics were undiagnosed. 193 patients were treated 54.4% with PTH, 20.2% bisphosphonates, 19.2% Denosumab, and 4.1% Romosozumab. Surgical details: OR time 403±143mins, LOS 7.3±5.1d, EBL 1278±1177mL, Levels Fused 12±4. O had higher revision rates (9.0 v 6.7%). O was also 2x more likely to develop radiographic PJK (2.0, [1.1, 3.8], p=.029) and 3.4x as likely to require revision for PJK (3.35, 1.4, 8.1], p=.007). Similarly, O was 2.5x more likely to develop a radiographic VBF (2.5, [1.2, 5.1], p=.017) and 3.8x more likely to require revision for VBF (3.8, [1.6, 9.3], p=.003). Cost calculations located in Table 1. DRG reimbursement for index surgeries averaged $94,442.93, while revision surgeries averaged an additional $95,117.73 per case. The added cost burden for O was $2,097,334.92 for revisions alone. The cost avoidance totaled $3,675.66 per patient in the NO cohort, with an aggregate saving of $3,297,066.27. In the extrapolated dataset, NO had higher surgical cost-effectiveness at Y3 (22,202.39 v $23,777.64, p=.008), Y4 (14,994.04 v $16,057.86, p=.008), and Y5 (11,319.11 v $12,122.20, p=.008).

Conclusion
Our findings highlight the clinical and economic burden of poor bone quality in ASD surgery. Proactive management can potentially to mitigate complications, reduce revisions, and lower healthcare costs.

Table 1: Cost Calculations

Value	Equation	Populated Equation	Result
Cost Burden	(O Cohort Revision Rate) x (Mean Cost of Revision Surgery) x (O Cohort)	(9.0%) x ($95,117.73) x (245)	$2,097,334.92
Revisions Prevented	(O Cohort Revision Rate – NO Cohort Revision Rate) x (NO Cohort)	(9.0% - 6.7%) x (897)	21 Revisions Prevented
Reduction in Revision Costs	(Revisions Prevented) x (Mean Cost of Revision Surgery)	(21 Revisions Prevented) x ($95,117.73)	$1,997,472.33
PJK Cost Avoidance	(O Cohort PJK Revision Rate – NO Cohort PJK Revision Rate) x (NO Cohort) x (Mean Added Cost of Revision for PJK)	(4.5% - 1.2%) x (897) x ($21,004.24)	$621,746.51
VBF Cost Avoidance	(O Cohort VBF Revision Rate – NO Cohort VBF Revision Rate) x (NO Cohort) x (Mean Added Cost of Revision for VBF)	(3.3% - 0.6%) x (897) x ($27,988.25)	$677,847.43
Aggregate Cost Avoidance	(Reduction in Revision Costs) + (PJK Cost Avoidance) + (VBF Cost Avoidance)	($1,997,472.33) + ($621,746.51) + ($677,847.43)	$3,297,066.27

129. Weight Loss Following Treatment with Glucagon-Like Peptide-1 (GLP-1) Receptor Agonists Significantly Decreases Bone Mineral Density in the Spine as Measured by Ct-Based Hounsfield Units

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Hypothesis
Weight loss from GLP-1 agonist use may be associated with a decreased bone mineral density in the spine.

Design
Retrospective analysis of prospectively collected data

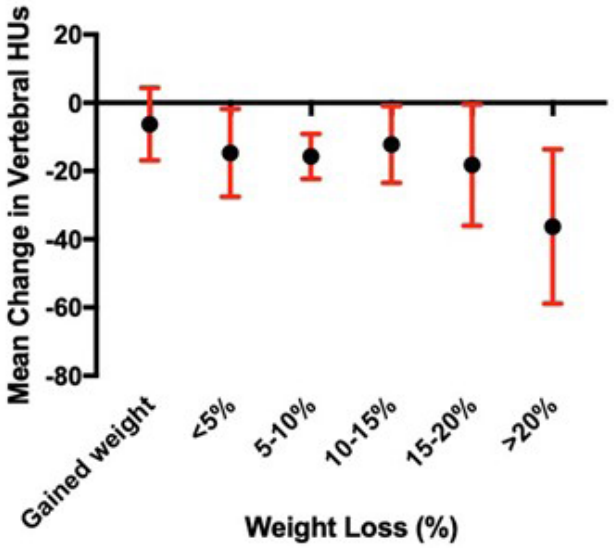
Introduction
Glucagon-like peptide-1 (GLP-1) agonists are promising therapeutics for weight loss, and have been increasingly used to optimize body mass index (BMI) prior to spine surgery. However, emerging evidence has suggested that GLP-1 agonists may reduce bone mineral density (BMD), which may result in poor outcomes postoperatively. CT-based Hounsfield units (HUs) have gained popularity as a method for measuring spinal BMD; however, no study has evaluated the effects of GLP-1-induced weight loss on spinal BMD.

Methods
Patients were retrospectively identified who had been treated with any GLP-1 agonist for >3 months. Patient body weight (BW), BMI, and HU measurements in the L1 vertebral body were measured pre- and post- GLP-1 therapy. Patients were grouped by weight loss during GLP-1 therapy. One-way ANOVA compared mean changes in spinal HUs between each group.

Results
102 patients achieved a mean BW loss of 14.5±2.5 kg over 15.9±1.2 months of GLP-1 therapy. Of these, 7 patients (6.9%) lost >20% BW (mean L1 HU loss 36.3±7.1; p=0.011), 14 (13.7%) lost 15-20% BW (mean HU loss 18.2±8.3; p=0.038), 14 (13.7%) lost 10-15% BW (mean HU loss 12.2±5.1; p=0.036), 24 (23.5%) lost 5-10% BW (mean HU loss 15.7±3.2; p<0.0001), 26 (25.5%) lost <5% BW (mean

HU loss 14.7±6.3; p=0.022), and 17 (16.7%) gained BW during GLP-1 therapy (mean HU loss 6.3±5.0; p=0.227). One-way ANOVA testing did not show a significant difference in HU loss across the cohorts (F=1.12; p=0.355). Finally, there was a significant correlation between L1 HU loss and GLP-1 therapy duration (r=-0.38; p=0.0001), but not weight loss (r=-0.18; p=0.070).

Conclusion
Despite similar pre-treatment BW and therapy durations, all weight loss cohorts experienced significant declines in vertebral HUs following GLP-1 use. This suggests that GLP-1 treatment (1.5 years) may significantly diminish spinal BMD regardless of the degree of weight loss achieved, with preferential effects on lean body mass loss.



Mean HU loss and 95% CI for each cohort in the study. Each cohort had a significant drop in L1 HUs after GLP-1 use regardless of how much weight was lost. ANOVA did not show any differences between these 6 means.

130. Paid in Bone: The Hidden Cost of Electrocautery in Spinal Fusion

Duby Okonkwo, BS; Rachel Mckee, BS; J. Court Reese, BS; Byron F. Stephens, MD; Craig R. Louer, MD; Stephanie N. Moore-Lotridge, PhD; Jonathan Schoenecker, MD, PhD

Hypothesis
Electrocautery-induced periosteum damage inhibits spinal fusion bone formation.

Design
Experimental Animal Study

Introduction
Electrocautery is commonly used in spinal fusion surgeries to achieve hemostasis during subperiosteal dissection, yet its biological impact on bone formation to obtaining fusion remains unclear. This study evaluated the effects of electrocautery-induced periosteum damage on spinal fusion, focusing on the impact on bone formation, secondary ossification, and angiogenesis.

Methods
A murine model of spinal fusion was used to compare bone formation when the periosteum was removed using electrocautery (cauterized) vs sharp dissection (non-cauterized). Bone formation and integration were assessed using micro-CT, histology, and fluorescence labeling of chondrocytes to track secondary ossification. Angiogenesis was evaluated through 3D vascular reconstruction and histological analyses.

Results
Electrocautery of the periosteum resulted in significantly reduced bone formation as measured by lower bone volume (BV) and bone volume-to-total volume (BV/TV) ratios at 6 weeks post-surgery compared to sharp dissection (Fig 1). Histology showed robust periosteum-driven bone formation and integration with sharp dissection, which was lost with electrocautery. Compared to sharp dissection, secondary ossification and angiogenesis were severely impaired following electrocautery, as evident by minimal chondrogenic activity 2 weeks post-surgery, and sparse vascular networks by 6 weeks post-surgery.

Conclusion
Electrocautery-induced periosteum damage adversely affects spinal fusion by inhibiting key regenerative processes, including bone formation, secondary ossification, and angiogenesis. These findings underscore the need for periosteum-preserving techniques in spinal fusion surgeries. Limiting electrocautery for bony exposure, when feasible, may enhance fusion outcomes. Future study can seek to understand which approach techniques can preserve periosteum and when these techniques can be applied to offer the most benefit.

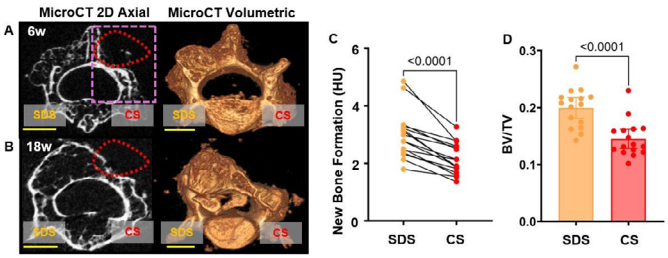


Figure 1. (A-B) Micro-CT at 6 and 18weeks shows significant bone formation on the sharp dissection side (SDS), with limited bone formation on the Cauterized side (CS). Red dash is zone of cauterization. (C-D) Pink dashed box in A is region used for quantification. The SDS shows significantly higher BV and BV/TV ratio than the CS ($p < 0.0001$; non-parametric paired Wilcoxon signed-rank test; N = 8 mice, 16 vertebral columns).

PODIUM PRESENTATION ABSTRACTS

131. In-Brace Correction in Scoliosis: Curve Type Matters More than Demographics

Omar Taha, BS; Matthew Weintraub, BS; Mehdi Elfilali, BA; Chidebelum Nnake, BS; John Tunney, BOCPO; Ritt Givens, BS; Michael G. Vitale, MD, MPH; *Benjamin D. Roye, MD*

Hypothesis
Non-modifiable patient characteristics such as curve type, Cobb angle, age, sex, and Sanders correlate with in-brace correction.

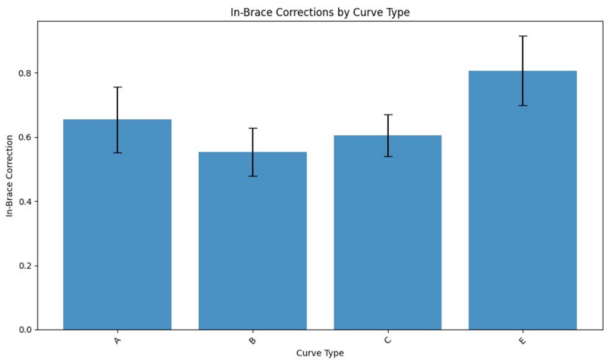
Design
Retrospective Cohort

Introduction
Idiopathic scoliosis in pediatric patients often requires bracing treatment to mitigate progression. While non-modifiable factors such as age, sex, curve pattern, and Sanders stage are often considered when initiating treatment, their impact on in-brace correction remains undefined. This study investigates the relationships between in-brace correction and non-modifiable patient specific characteristics.

Methods
We identified 246 patients with idiopathic scoliosis treated with bracing at a single institution. Demographic variables and curve patterns were obtained. Each curve was then classified by Rigo type (A1, A2, A3, B1, B2, C1, C2, E1, E2) and grouped by 'parent' type (A, B, C, E). Pre-brace and in-brace X-rays were analyzed to determine in-brace correction of the major coronal Cobb (MCC). Linear regression and ANOVA between in-brace correction and non-modifiable variables was performed.

Results
Our cohort of 209 females and 36 males had an average age of 11.4 ± 2.2 years at brace prescription. MCC was 28.2 ± 7.3° and mean in-brace correction was 64.7 ± 31.7%. Cobb angle (R = -0.42, p < 0.001) and lower curve apex (R = 0.29, p < 0.001) correlated with in-brace correction. In-brace correction varied with curve type (p = 0.022): types B and E had the largest difference (47.7 ± 20.4% vs. 77.2% ± 16.9%, p = 0.010). No significant relationship was observed between in-brace correction and age, sex, or Sanders. Multivariate regression (R = 0.503, p < 0.001) found Rigo curve type, major Cobb, and curve apex to be predictors of in-brace correction.

Conclusion
In our large cohort of braced patients, a smaller pre-brace Cobb angle and lower apex was correlated with more in-brace correction. Rigo curve type emerged as a novel, independent predictor of correction. Age, sex, and Sanders stage had no significant association. These findings underscore the critical influence of curve characteristics in shaping bracing outcomes and highlight the limited predictive utility of demographic and skeletal maturity markers. Recognizing the dominant role of curve type can help refine treatment expectations and guide personalized bracing strategies.



In-brace Correction by Rigo Curve Type

132. In-Brace Radiographs and Not Coronal Deformity Angular Ratio Independently Predict Curve Progression in Nighttime Brace Treatment for Idiopathic Scoliosis

Karina A. Zapata, PhD, PT, DPT; Daniel J. Sucato, MD, MS; Kara Davis, MS, CPO; Chan-Hee Jo, PhD; Megan E. Johnson, MD

Hypothesis
In-brace correction (IBC) and coronal deformity angular ratio (CDAR) predict curve progression in nighttime bracing.

Design
Retrospective

Introduction
The relationship between IBC and CDAR with curve progression in idiopathic scoliosis (IS) utilizing nighttime brace treatment is unknown. We determined 1) whether IBC and CDAR differ by curve location, and 2) whether IBC & CDAR predict curve progression.

Methods
284 children (56 M, 228 F) with IS ages 10-16 yrs, Risser 0-2, curves 15°-40° treated with nighttime braces with IB radiographs were reviewed until skeletal maturity or surgery. IBC was calculated by comparing curve magnitude between the standing brace prescription radiograph and supine IB radiograph. CDAR = curve magnitude / number of vertebrae in primary curve. Curve location (thoracic [T], thoracolumbar [TL], or lumbar [L]) was defined by the primary curve apex.

Results
IBC of primary curves were 103%±29% (n=282) and secondary curves were 72%±29% (n=144). TL curves had higher IBC than L and T (113% vs 94% vs 88%, p<.001). L curves had higher CDARs than TL and T (4.6 vs 4.2 vs 3.3, p<.001). IBC had a weak inverse association with curve progression (r=-0.33, p<.001) and CDAR (r=-0.27, p<.001). CDAR was associated with curve magnitude (r=0.66, p<.001). Multivariate logistic regression analysis adjusting for IBC, CDAR, biologic sex, pre-brace curve magnitude, triradiate cartilage, and Risser stage revealed that decreased IBC (OR 0.13, 95% CI 0.04-0.39) and open triradiate cartilage status (OR 2.43, 95% CI 1.30-4.68) were still associated with curve progres-

sion ≥6°. CDAR was not a risk factor. For each 1% increase in IBC there is an associated 87% decrease in the odds of curve progression ≥6°. ROC analysis revealed a threshold for IBC of 93%, which resulted in an OR of 0.13 (95% CI 0.04-0.36) for curve progression ≥6°.

Conclusion
In-brace correction is an important modifiable factor that should be maximized when using a nighttime brace for idiopathic scoliosis, since it predicts successful treatment preventing curve progression. This may be especially important for younger patients with open triradiates with significant growth remaining. Although curve location (thoracolumbar curves) allows for improved in-brace correction, CDAR is another non-modifiable factor which is not a risk factor for curve progression.

Variable	Curve Progression ≥6°		
	OR	95% CI	P-value
In-brace correction	0.13	0.04-0.39	**<0.001**
Open triradiate cartilage	0.33	1.30-4.68	**0.047**

*Also adjusted for CDAR, Risser stage, sex, and pre-brace curve magnitude.

Curve Progression

133. The Grit Factor: A Prospective Study to Predict Brace Compliance in AIS

Katerina M. Kourpas, AB; Andrew G. Kim, BS; Sulagna Sarkar, MS; Julianna Lee, BA; Sara Kiani, MD; Patrick England, MD; John M. Flynn, MD

Hypothesis
Psychosocial factors, such as "grit" or appreciation for the importance of bracing compliance, may influence bracing compliance and outcomes.

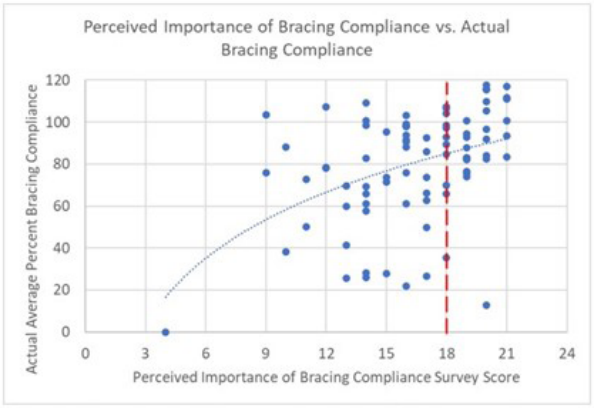
Design
Prospective

Introduction
Bracing for adolescent idiopathic scoliosis (AIS) can effectively decrease curve progression and risk for future surgery, yet a discrepancy exists between prescribed hours and actual brace wear. While recent studies have developed preliminary models to predict bracing compliance, incorporation of psychosocial factors may further build upon this work. "Grit", defined as passion and perseverance for long-term goals, is associated with success and achievement in various fields. The purpose of this study was to evaluate whether 'grit' and its subdomains can predict brace compliance.

Methods
A prospective single-center observational study was performed on a consecutive series of AIS patients who were prescribed a new, first-time brace. "Grit" was measured at a single time point via an administered survey with scales specific to assessing the following subdomains: grit, self-control, compliance perception, and student thriving. Objective brace compliance was collected from temperature-sensitive monitors. Descriptive statistics and bivariate analyses were completed using SPSS (v28.0).

Results
84 patients (82% female) were included with a mean age at bracing initiation of 12.2 years. Median bracing compliance as a percentage of prescribed wear was 84% (IQR: 69-98%). Patients who possessed higher compliance perceptions with scores of ≥18 (n=36/84) had a greater average brace compliance than those with a score <18 (n=48/84), with average compliances of 91.9% vs. 67.4%, respectively (p<0.001). Questionnaire scores relating to thoughts about brace compliance were positively correlated with improved brace wear (p=0.036). The other subdomains were not significant: there was no correlation between overall percent brace wear and scores on grit (p=0.99), self-control (p=0.34), and the student-thriving index (p=0.81).

Conclusion
A patient's own perception about the importance of bracing compliance is strongly associated with true compliance. Patients who value bracing demonstrated higher levels of overall compliance. Grit, self-control, and student thriving scores were not significantly correlated with bracing compliance. Screening tools to identify subgroups at high risk for poor bracing compliance can help guide clinical and shared decision making between the physician and patients.



Relationship Between Perceived Importance of Bracing Compliance Score and Actual Average Bracing Compliance (% of Prescribed Hours)

134. Early Brace Treatment: The New Standard for Adolescent Idiopathic Scoliosis?

Karina A. Zapata, PhD, PT, DPT; Megan E. Johnson, MD; JP Rathbun, BS; Donald Virostek, BS, LPO/CPO; Chan-Hee Jo, PhD; *Daniel J. Sucato, MD, MS*

Hypothesis
Patients treated with early brace criteria will have an increased rate of curve improvement and lower rate of curve progression than patients treated with standard brace criteria.

Design
Retrospective

PODIUM PRESENTATION ABSTRACTS

Introduction
Brace treatment in skeletally immature patients for curves <25° is increasing. However, no direct comparisons exist between bracing adolescent idiopathic scoliosis (AIS) curves <25° (early) versus observation until bracing at ≥25° (standard). The purpose of this study was to compare 1) curve improvement ≥6° and 2) progression to a surgical magnitude of 45°, between early versus standard brace treatment.

Methods
A retrospective review was performed among patients Risser 0-1 with AIS curves 15-24° at initial visit who were followed until skeletal maturity or surgery. Patients who were prescribed rigid thoracolumbar sacral orthoses (TLSO) for curves 15-24° from 2015-2019 (early brace group) were compared to a historical control observed until TLSO prescription at ≥25° from 1990-2005 (standard brace group). A sub-analysis of open triradiate cartilage status was performed.

Results
528 patients (436 F [82%], 92 M) were included. At initial visit, the early brace group had larger curves and a greater percentage with open triradiates than the standard brace group (22° vs. 19°, p < 0.001). 32% of patients in the standard brace group eventually required brace treatment at a higher curve magnitude (30° vs. 22°, p < 0.001) and a more advanced maturity (36% vs. 63% open triradiates, p < 0.001) than the early brace group. The early brace group had greater curve improvement ≥6° (19% vs. 1%, p < 0.001) with an odds ratio (OR) of 25.39 (95% CI 9.05-106.04) and less curve progression ≥6° (OR 0.29, 95% CI 0.20-0.41) but not to a surgical threshold (6% vs. 10%, p = 0.138) than the standard brace group (Table). Patients with open triradiates in the early brace group progressed to a surgical threshold significantly less than those in the standard brace group (9% [12/120] vs. 20% [25/128], p = 0.018) with an OR of 0.42 (95% CI 0.19-0.86), especially among those with thoracic curves 20-24° at initial visit (13% [7/54] vs. 43% [15/35], p = 0.001) with an OR of 0.20 (95% CI 0.07-0.54).

Conclusion
Early brace treatment of AIS curves 15-24° is superior to observation until 25° in skeletally immature children with a 25-fold increased likelihood of improving curves and reducing curve progression to a surgical magnitude by >50%.

	Early brace (n=207)	Standard brace (n=321)	p-value
Biologic Sex Female Male	 80% (n=167) 19% (n=40)	 83% (n=269) 16% (n=52)	 0.355
Initial age (yrs)	12.4±1.2 (n=207)	12.6±1.2 (n=321)	**0.047**
Initial primary curve Thoracic Lumbar/Thoracolumbar	 43% (n=89) 57% (n=118)	 51% (n=164) 48% (n=157)	 .069
Initial Risser stage 0 1	 85% (n=176) 14% (n=31)	 81% (n=261) 18% (n=60)	0.249
Initial triradiate cartilage Open Closed	 62% (n=130) 37% (n=77)	 46% (n=128) 53% (n=150)	**<0.001**
Initial menarchal status Pre Post	 76% (n=128) 23% (n=39)	 72% (n=190) 27% (n=73)	0.510
Initial BMI (kg/m^2)	18.2±2.5 (n=199)	18.9±3.8 (n=302)	**0.008**
Initial curve magnitude (°)	21.8±2.1 (n=207)	19.3±2.9 (n=321)	**< 0.001**
C-DAR	3.7±0.9 (n=207)	3.3±0.8 (n=321)	**< 0.001**
Growth (cm)	10.2±5.9 (n=199)	12.3±20.4 (n=296)	0.082
Final curve magnitude (°)	24.9±11.4 (n=207)	28.9±10.7 (n=321)	**<0.001**
Total curve progression (°)	3.1±11.2 (n=207)	9.6±10.0 (n=321)	**< 0.001**
Curve improved ≥6°	19% (n=40)	1% (n=3)	**< 0.001**
Curve stable	49% (n=103)	38% (n=122)	**0.008**
Curve progressed ≥6°	30% (n=64)	61% (n=196)	**< 0.001**
Final curve ≥30°	26% (n=54)	41% (n=132)	**<0.001**
Final curve ≥45°	6% (n=13)	9% (n=32)	0.138
Sub-analysis: Open Triradiates Final curve ≥45°	(n=120) 9% (n=12)	(n=128) 20% (n=25)	 **0.002**
Sub-analysis: Open Triradiates: Thoracic curves 20-24° Final curve ≥45°	 (n=54) 13% (n=7)	 (n=35) 43% (n=15)	 **0.001**

Early Brace vs Standard

135. Effectiveness of Daily Calcium and Vitamin D Supplementation on Preventing Curve Progression and Need for Bracing in Skeletally Immature Adolescent Idiopathic Scoliosis Females with Smaller Curves – A Randomised Double-Blinded Placebo-Controlled Trial

Adam Yiu-chung Lau, MBBS, FRCS; Kenneth Guangpu Yang, PhD, MBBS; Wayne Yuk-wai Lee, PhD; Alec Lik-hang Hung, MBBS, MS, FRCS; Jack Chun-yiu Cheng, MD, FRCS; Tsz-Ping Lam, MBBS, FRCS

Hypothesis
Calcium and vitamin D (Ca+Vit-D) supplementation in skeletally immature Adolescent Idiopathic Scoliosis females with smaller curves improve bone health and can prevent the need for bracing treatment.

Design
Randomised double-blinded placebo-controlled trial

Introduction
Low bone mass is an independent and significant risk factor for curve progression in Adolescent Idiopathic Scoliosis. Our group previously reported Ca+Vit-D supplementation could prevent curve progression ≥6° in AIS with heterogenous curve severity. Whether the need for bracing can be prevented by early bone health optimization using Ca+Vit-D supplementation in skeletally immature AIS children with smaller curves remains unknown.

Methods
199 AIS girls with mild curve (10-14years, premenarche or Year-since-Menarche (YSM) <1, Risser 0-2, Cobb 10-

20°) were randomised and given 3-year treatment of daily (500mg Calcium + 800IU VitD3 supplementation) or Placebo. The primary outcomes were (1) curve progression to SRS recommended bracing criteria and (2) improvement of bone health at three-year timepoint as measured by High Resolution Peripheral Quantitative Computed Tomography.

Results
167 subjects (83.9%) completed the three-year study with 87 in Treatment and 80 in Placebo Group. 24 in Treatment-Group (27.6%) and 28 in Placebo-Group (35%) required bracing (p=0.271), with Adjusted Cox-Hazard-Ratio aHR 0.81 (p=0.430). In subjects recruited before menarche (YSM≤-0.5year), 8 in Treatment-Group (32%) and 13 in Placebo-group (50%) required bracing (aHR 0.42, p=0.049). When compared with placebo group, Treatment group had greater bone quality improvement from baseline to 3-year in Trabecular Volumetric-BMD, Trabecular-Number and Trabecular-Separation (p<0.05).

Conclusion
This study provided strong evidence that Ca+Vit-D supplementation improved bone health during peripubertal growth. When given to AIS girls with mild curves well before menarche (onset of peak height growth), it could prevent curve progression and mitigate the need of bracing. We believe that to be effective in influencing curve progression, Ca+Vit-D supplementation should be seriously considered for mild curve detected in skeletally immature AIS through early detection. Further expanded study across different centers would be warranted.

Table 1 Percentage changes in HRpQCT bone parameters from baseline to end of 3-year treatment

	Percentage Change (%) ± SD		
	Placebo Group	Treatment Group	P*
Cortical Area (mm^2)	63.70 ±17.74	69.29 ±18.97	0.951
Trabecular Area (mm^2)	-4.35 ±20.61	-6.66 ±21.37	0.496
Total Volumetric BMD (mg/cm^3)	40.70 ±20.73	47.91 ±21.21	0.313
Cortical Volumetric BMD (mg/cm^3)	22.07 ±7.57	24.88 ±8.19	0.797
Cortical Thickness (mm)	58.52 ±23.89	65.64 ±24.63	0.998
Cortical Perimeter (mm)	5.19 ±6.86	4.68 ±7.06	0.822
Trabecular Volumetric BMD (mg/cm^3)	-9.80 ±14.25	-4.40±10.73	0.024*
Bone Volume Fraction	-4.39 ±13.44	0.23 ±10.81	0.091
Trabecular Number (/mm)	-8.51±9.24	-4.03±7.53	0.002*
Trabecular Thickness (mm)	-2.97 ±4.55	-2.79±3.71	0.624
Trabecular Separation (mm)	7.85 ±12.41	1.56 ±9.34	<0.001*
Stiffness (N/mm)	35.61 ±8.06	38.52 ±8.87	0.892
Apparent Modulus (N/mm^2)	28.75 ±13.45	32.32 ±14.61	0.902
Failure Load (N)	36.46 ±8.98	39.42 ±9.76	0.852

136. Reversing Muscle Asymmetry in Adolescent Idiopathic Scoliosis: EMG-Validated Benefits of Scoliosis-Specific Exercise

Jason Pui Yin Cheung, MD, MBBS, MS, FRCS; Kenneth M. Cheung, MD, MBBS, FRCS; *Charlene Y. Fan, PT*

Hypothesis
Scoliosis-specific exercise (SSE) can lead to targeted training of specific muscle groups.

Design
Randomized controlled trial with concealed allocation, assessor- / statistician-blinded, and intention-to-treat analysis.

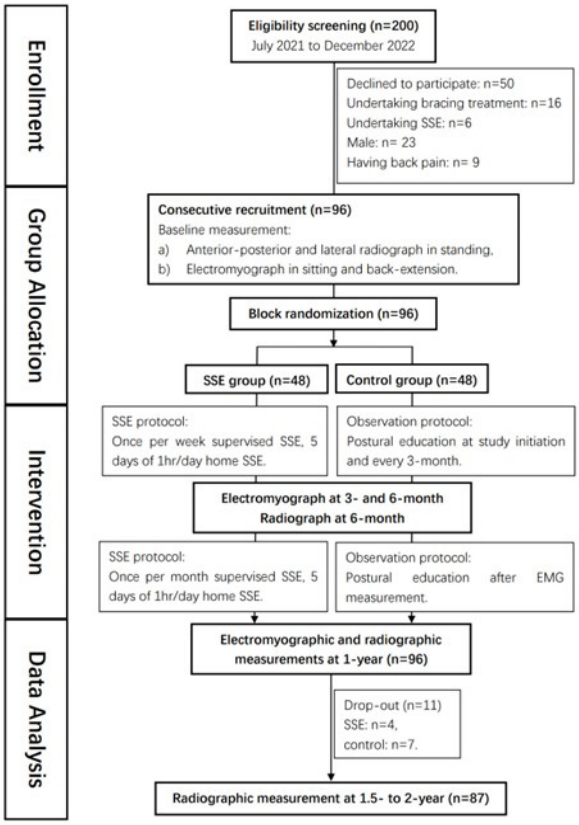
Introduction
Muscle asymmetry may contribute to curve progression in AIS. This study investigates the effect of SSE on paravertebral muscle activity and its relationship to vertebral deformation.

Methods
The SSE group received 6 months of weekly supervised sessions plus home exercises and 6 months of monthly supervised sessions with 2-year follow-up. Controls received postural education and basic core training. EMG measurements were taken at baseline, 3, 6, and 12 months, analyzing root mean square EMG ratios at upper end, apex, and lower end vertebrae during sitting and back-extension.

Results
96 AIS patients were randomized to either SSE intervention or control groups. The SSE group showed significantly improved back-extension EMG symmetry at the apex vertebra compared to controls at 6- and 12-month (p<0.01). The effect was primarily driven by increased muscle activity on the concave side. Improvements correlated with reduced Cobb angle (r=0.82), side deviation (r=0.74), and asymmetrical truncal rotation (r=0.61) at 12-month. The SSE group was granted with the lower progression rate after skeletal maturity.

Conclusion
A 12-month SSE program improves paravertebral muscle symmetry with curve progression in AIS patients. This is the first study that uses EMG to objectively document change and provide mechanistic insight into how SSE may lead to improvement in scoliosis.

PODIUM PRESENTATION ABSTRACTS



Study Flow Chart

137. Optimizing Prediction Models for Curve Progression – Is Sanders Superior to Risser Grading?

Martin Heegaard, MD; Lærke C. Ragborg, MD; Amy L. McIntosh, MD; Anne-Marie Datcu, BS; Banahene Glover, BS; Martin Gehrchen, MD, PhD; Daniel J. Sucato, MD, MS; Benny T. Dahl, MD, PhD, DMSc; Soren Ohrt-Nissen, MD, PhD; *Megan E. Johnson, MD*

Hypothesis
Using Sander stages will increase model predictability of curve progression compared to Risser stages.

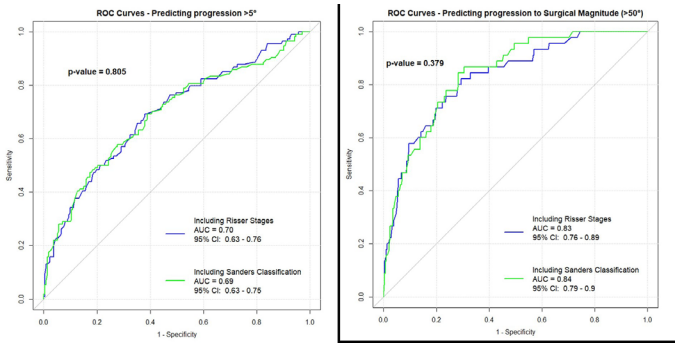
Design
Retrospective Review

Introduction
Many different skeletal maturity variables have been suggested to predict the risk of curve progression in AIS patients, including chronological age, Risser stages, premenarchal status, Sanders stages, growth velocity, in-brace correction, and flexibility. The BrAIST-Calc is a published prediction model that includes age, Cobb angle at brace initiation, sex, Risser stage, height, and weight to determine the risk of curve progression. This study aims to investigate whether Sanders rather than Risser can improve the predictability of curve progression.

Methods
Skeletally immature AIS patients with thoracic curves between 20-45° treated with full-time thoracolumbar sacral orthosis (TLSO) were retrospectively included. All patients Risser 0-3 were included regardless of compliance. Radiographic measurements, including Risser and Sanders stages, were collected at brace initiation and brace termination. A receiver operating characteristics (ROC) curve was utilized to assess the area under the curve (AUC) to determine the predictability of curve progression. The model included sex, major Cobb angle, BMI-percentile groups (healthy weight, obesity, overweight, underweight), and either Risser- or Sanders stages. Age was excluded due to collinearity. The models were compared using DeLong's test.

Results
In total, 327 patients met the inclusion criteria. At brace initiation, patients were 12.5 ± 1.4 years old with 80% being female (n=260). Major curve size was 31° (±7), whilst 35% (n=114) and 14% (n=45) progressed >5° and >50°, respectively. The AUC for progression >5° revealed no significant difference between the models including Risser stages and Sanders stages (Risser AUC: 0.70; Sanders AUC: 0.69, p=0.805). Likewise, AUC for progression >50° revealed no difference between models (Risser AUC: 0.83; Sanders AUC: 0.84, p=0.379). Using both Risser- and Sanders stages in the same progression model did not increase predictability (>5°: AUC 0.70, 95%CI 0.64-0.76; >50°: AUC 0.84, 95%CI 0.79-0.90).

Conclusion
In AIS patients with thoracic curves treated with a TLSO, using Sanders stages did not provide additional predictive value for curve progression. Both Sanders- and Risser stages, when combined with traditional predictors of progression, remain valuable for predicting curve progression.



138. Revisiting the Natural History of Moderate Adolescent Idiopathic Scoliosis in Mature Girls: What Factors Lead to Progression for Larger Curves?

Kevin M. Neal, MD; Anna J. Rambo, MD; Ramin Espandar, MD; Kylie Krombholz, MS; Mona Matthew, PhD; Eddie Geagea, MD

Hypothesis
Curves measuring 25° to 45° at skeletal maturity (SM) in females with adolescent idiopathic scoliosis (AIS) may continue

to progress. Curves in younger patients, those with longer follow up, those with greater height velocity after SM, lower Risser stage at SM, lower Sanders stage at SM, larger curve size at SM, major lumbar/thoracolumbar curves, and less time post-menarchal at SM will be more likely to progress.

Design
Retrospective cohort

Introduction
45°-50° has been proposed as a threshold above which surgery is recommended, and below which observation is advised, but the risk of progression for moderate curves 25° to 45° after SM is not well-defined. This study seeks to define this risk and assess factors that correlate with progression after SM.

Methods
We searched a Non-Operative AIS Database of >2300 patients for cases with curves 25° to 45° at radiographic SM (defined as Risser 4 and Sanders 7, or Risser 5), and follow up >24 months after SM. Progression of >5° and progression to 50° were analyzed using chi-squared tests and Mann Whitney U tests to detect differences in factors at SM that might influence progression, including age, follow up length, height velocity, Risser stage, Sanders stage, curve size, curve location, and months post-menarche.

Results
90 patients met inclusion criteria. For various starting curve sizes at SM, progression >5° was seen in 7.1% (25°), 26.7% (30°), 22.2% (35°), 42.3% (40°), and 33.3% (45°) respectively. Progression to 50° was seen in 0% (25°), 0% (30°), 11.1% (35°), 42.3% (40°), and 55.6% (45°). No significant differences were seen between those with and without progression >5° or to 50° for age at SM, length of follow up after SM, height velocity after SM, Sanders stage 7 vs 8 at SM, or curve location (thoracic vs. lumbar/thoracolumbar). Progression >5° was more likely when patients were Risser 4 at SM versus Risser 5 (p=0.04), curves were >35° at SM (p=0.04), and onset menarche was <16 months before SM (p=0.03). Progression to 50° was more likely for curves >40° at SM (p<0.00001) and when onset menarche was <15 months before SM (p=0.02).

Conclusion
Curves that measure 25° to 45° at skeletal maturity can still progress >5°. Curves that measure 35° to 45° at SM can still progress to 50°. Patients should be counseled regarding these risks so they can make informed decisions about appropriate monitoring and treatment choices.

Starting Curve Size at Maturity	>5° Progression	Progression to 50°	After Skeletal Maturity (N=90)	Average: 5° or less Progression	Average: >5° Progression	p	Average: End Curve <50°	Average: Progression to 50° or More	p
25°	7.1%	0.0%	age (yrs)	13.6	13.2	0.08	13.6	13.2	0.15
30°	26.7%	0.0%	FU length (mo)	37.2	38.5	0.79	37.6	37.4	0.94
35°	22.2%	11.1%	height velocity (cm/yr)	0.48	0.48	0.44	0.49	0.43	0.22
40°	42.3%	42.3%	Starting Risser 4	72.3%	92.0%	0.04	74.6%	89.5%	0.17
45°	33.3%	55.6%	Starting SMS 7	85.5%	95.8%	0.18	86.9%	94.4%	0.38
			Starting Curve Size (°)	34.2	37.2	0.04	33.5	40.5	<.00001
			Curve Location TL/L (%)	40.0%	32.0%	0.48	39.4%	31.6%	0.53
			Post-Menarche at Skeletal Maturity (mo)	22.8	15.9	0.03	22.6	14.5	0.02

139. What Happens if I Wait? How Fast and Frequent Will AIS Patients Have Meaningful Progression if Surgery is Delayed?

Austin Montgomery, BS; Firoz Miyanji, MD; Suken A. Shah, MD; Paul D. Sponseller, MD, MBA; Stefan Parent, MD, PhD; Peter O. Newton, MD; Burt Yaszay, MD; *Craig R. Louer, MD*

Hypothesis
We hypothesize that a proportion of patients with adolescent idiopathic scoliosis (AIS) who delay surgery will experience "meaningful progression" of their curves, which will indicate them for caudal extension of fusion levels based off objective level-selection criteria.

Design
Retrospective

Introduction
AIS patients with severe curves experience slow curve progression into adulthood. Posterior spine fusion (PSF) halts progression but requires recovery time and may limit function. For these reasons, patients with specific athletic pursuits or other concerns may inquire about the medium-term outcomes of observing a surgical curve. This study aimed to characterize the outcomes of severe AIS curves treated with observation.

Methods
A prospective, multicenter database of AIS patients treated non-operatively was queried for patients approaching skeletal maturity (Risser 4+) with curves of surgical magnitude (≥ 45°) who had ≥ 2 years of radiographic data without yet undergoing PSF. Bending radiographs were not obtained serially, therefore pre-determined criteria for "meaningful progression" was established for specific curve types that may suggest a need for more extensive surgery (Fig 1, Col 2). Patients were then categorized based off this radiographic data at 2 and 5 years (where available). Descriptive statistics were performed.

Results
55 patients (40 major thoracic, 15 major lumbar) with a mean age of 16.1 years met inclusion criteria. Average follow-up was 3.4 years, with 24/55 reaching 5-year follow-up without PSF. Mean Cobb angle was 50° at baseline and 50° at last follow-up. The major thoracic cohort consisted of 16 ALs, 6 ARs, 7 Bs, and 11 C Lenke lumbar modifiers at baseline. Four of 40 (10%) major thoracic and two of 15 major lumbar (13%) patients met "meaningful progression" criteria over the course of the study. Both lumbar EVs moved from L3 to L4.

Conclusion
Only 11% of AIS patients with curves of surgical magnitude experienced meaningful progression during medium-term follow-up. Primary thoracic curves with large lumbar curves or C Lenke modifiers are at-risk for expanded fusion indications. Thoracic curves with A/B modifiers appear stable to 2 and 5 years. Lumbar curve EVs may move caudal after 5 years but this was not seen at 2-year follow-up. This data

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can be used to counsel AIS patients who are deciding on ideal surgical timing.

Curve Type	Meaningful Progression selection criteria	Progression Criteria met? (2-years)	Progression Criteria met? (5-years)	Total Progression Criteria met? (2 or 5 years)
Major Thoracic (n=40)		*3/40 (8%)*	*2/16 (12%)*	*4/40 (10%)*
C Lenke lumbar modifier (and candidate for STF based off established criteria)	No longer meets radiographic criteria for selective thoracic fusion (STF): 1) thoracic to lumbar cobb ratio >1.2, 2) thoracic to lumbar apical vertebral translation ratio >1.2, 3) or lumbar curve exceeds 50 degrees	1/4 (25%)	1/2 (50%)	1/4 (25%)
C Lenke lumbar modifier (STF criteria not met)	Lumbar curve magnitude surpasses thoracic magnitude	2/7 (29%)	1/3 (33%)	3/7 (43%)
AL or B Lenke lumbar modifier	Progressed to Lenke C and doesn't meet above STF criteria	0/23 (0%)	0/9 (0%)	0/23 (0%)
"AR" modifier	Last Substantially Touched Vertebra (LSTV) moves distal	0/6 (0%)	0/2 (0%)	0/6 (0%)
Primary Lumbar (n=15)				
Any	End Vertebra (EV) for primary curve moves distal at least 1 level	0/15 (0%)	2/8 (25%)	2/15 (13%)
Total (n=55)		**3/55 (5%)**	**6/24 (25%)**	**6/55 (11%)**

Figure 1: Meaningful progression to 2 and 5 years

140. Preoperative Expectations in Patients with Adolescent Idiopathic Scoliosis ‡

Sara Kiani, MD; Alejandro Cazzulino, BA; Kian Niknam, BS; *Ishaan Swarup, MD*

Hypothesis
Patients and guardians will have differing expectations prior to posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS).

Design
Prospective Cohort

Introduction
AIS is associated with deformity and is commonly managed with PSF. Across several elective orthopedic procedures, positive preoperative expectations have been shown to be associated with improved patient-reported outcomes. A methodical way of measuring expectations is the first step towards developing methods to assess their effects on outcomes and satisfaction. The purpose of this study is to develop and validate a survey utilizing patient/guardian provided expectations relating to PSF in patients with AIS.

Methods
Based on existing methods and literature, 15 AIS patients indicated for PSF and their guardians were preoperatively interviewed utilizing a structured interview format. Qualitative research techniques were used to create two separate 10-item Likert scale surveys, one for patients and one for guardians. An additional 15 patients/guardians completed the survey twice, a week apart in order to validate the survey. Data was analyzed using descriptive statistics and Cohen's linear kappa was calculated for each survey item.

Results
The three most cited expectations identified by patients/guardians were return to physical/sporting activities, improvement in pain, and changes in physical appearance. These were utilized to create two draft surveys (Figure 1). In the validation phase of this study, guardians on average were more consistent in their answers than patients (κ=0.67 vs. 0.54). Patients and guardians had substantial agreement (κ=0.75) on only one question, with poor to moderate agreement (κ<0.6) throughout most of the survey.

Conclusion
Preoperative expectations surveys were generated for AIS patients undergoing PSF and their guardians. There is fair to great agreement between baseline and validation surveys; however, patient and guardian expectations are not well-aligned. The results from this study will allow surgeons to better counsel patients and their guardians to align expectations, and potentially affect outcomes and satisfaction. Future investigations will assess factors associated with preoperative expectations as well as correlate expectations with patient reported outcomes, surgical outcomes, and patient satisfaction.

Figure 1: Patient & Guardian Surveys and Validation Results

Patient Survey

Please select on scale of 1-5 your expectations following full recovery from surgery (1 = do NOT expect this at all; 5 – fully expect this). If this is not applicable to you please indicate N/A	1	2	3	4	5	N/A	κ
I would expect a straighter spine							0.6
I would expect to be pain free							0.38
I would expect to avoid medical treatments in the future related to my spine							0.43
I would expect to be able to fully participate in sporting/physical activities without pain/restrictions							0.83
I would expect to be more confident in my appearance							0.56
I would expect my posture to be overall improved							0.65
I would expect to be able sit longer without pain							0.23
I would expect to stand longer without pain							0.57
I would expect to be taller							0.4
I would expect to have a **full** recovery without any mobility or appearance issues post-surgery							0.85

Guardian Survey

Please select on scale of 1-5 your expectations following full recovery from surgery (1 = do NOT expect this at all; 5 – fully expect this). If this is not applicable to your child please indicate N/A	1	2	3	4	5	N/A	κ
I would expect my child to have a straighter spine							0.72
I would expect my child to be pain free							0.67
I would expect my child to avoid medical treatments in the future related to their spine							0.79
I would expect my child to be able to fully participate in sporting/physical activities without pain/restriction							0.82
I would expect my child to be more confident in their appearance							0.36
I would expect my child's posture to be overall improved							0.67
I would expect my child to be able sit longer without pain							0.71
I would expect my child to be able to stand longer without pain							0.59
I would expect my child to be taller							0.61
I would expect to my child have a **full** recovery without any mobility or appearance issues post-surgery							0.72

κ <0.2 Poor agreement; 0.2–0.4 Fair agreement; 0.41–0.6 Moderate agreement; 0.61–0.8 Substantial agreement; > 0.8 Great agreement; 1 Perfect agreement; 0: Agreement no better than chance

Figure 1: Patient & Guardian Surveys and Validation Results

‡ = SRS Funded Research Grant

141. Waistline Asymmetry Patterns and Clinical Impact in Patients with Adolescent Idiopathic Scoliosis

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Hypothesis
Waistline asymmetry could affect the outcome in patients with AIS.

Design
retrospective study

Introduction
Adolescent idiopathic scoliosis (AIS) often affects physical appearance, with waistline asymmetry being particularly affected. Despite its importance, studies on waistline asymmetry, especially its variation among individuals with AIS and related postoperative outcomes, are limited.This study aimed to 1) classify waistline asymmetry by scoliosis type, 2) evaluate postoperative changes, and 3) assess clinical outcomes in patients with AIS using digital photography.

Methods
We retrospectively analyzed the data of patients with AIS who underwent posterior fusion surgery and had a minimum of two years of follow-up. Waistline asymmetry was assessed using digital photography. The waist angle (WA), waist-height angle (WHA), and waistline depth (WLD) were measured pre- and postoperatively. Radiographic parameters and the revised 22-item Scoliosis Research Society Questionnaire (SRS-22r) were also evaluated. We categorized waistline patterns into two types based on the WLD ratio: Type R (WLD ratio < 0.5) and type L (WLD ratio > 0.5). The frequency of each waistline type was determined using the Lenke classification system. We defined severe waistline asymmetry (SWA) and compared its clinical outcomes with those of patients without SWA.

Results
In total, 192 patients were included in this study. The photographic parameters showed significant postoperative improvements, accompanied by radiographic improvement. Pre- and postoperative waistline parameters were significantly correlated with radiographic parameters, particularly the TL/L curves. Type R was more common in lumbar modifiers A and B, whereas type L was more common in lumbar modifier C. Preoperative SWA, which was observed in 55% of patients, reduced to 11% postoperatively. Patients who underwent postoperative SWA showed significantly higher TL/L curves and AVT-TL/L, lower L4 tilt, and lower self-image scores.

Conclusion
Postoperative residual waistline asymmetry negatively affected self-image. These data suggest that correcting the lumbar curve is crucial to improving asymmetry.

142. Does Sagittal Correction Index Correlate with Patient Reported Srs-Self-Image in Severe Spine Deformity

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Hypothesis
There is a correlation between sagittal correction and patient reported self-image outcome measures in patients with severe spine deformity

Design
Retrospective review

Introduction
Spine deformity correction aims to improve both radiographic alignment and patient perceive self-image. However, the extent to which correction index(CI) correlates with self-image remains unclear. This study examines the relationship between CI and self-image improvement in pts undergoing spine deformity surgery.

Methods
The study included pts in FOCOS spine registry with cobbs >= 100 deg. with a min 2 yr F/U. Paired t-tests were used to compare preop vs. postop SRS-22 scores and x-ray parameters. Pearson correlation analysis was used to assess the relationship between sag. correction index and SRS-22 self-image scores. Linear regression analysis was conducted to evaluate whether sag. correction independently predicted improvements in patient-reported self-image after adjusting for covariates. Alpha level at 0.05

Results
The study included 40 pts with a mean age of 15+/-3.8 years, the majority of whom were female (53.6%). Postop, there was a significant improvement in both patient-reported outcomes (SRS-22) and x-ray measures. The mean SRS score increased from 3.5+/-0.7 to 4.10+/-0.5 ($p<0.01$), reflecting a 17.1% improvement in SRS score. Radiographically, the mean coronal Cobb angle decreased from 126.3 34.6 to 64.8+/-20.1($p<0.01$), while mean sagittal angle improved from 147.0+/-39.8 to 59.4+/-19.6($p<0.01$), both demonstrating about 48% reduction in curve magnitude. The overall postop complication rate was 14.6%, with infection (7.3%), pulmonary complications (2.4%) and neuro deficits (7.3%) being the most common. Correlation analysis revealed a weak positive relationship between the SRS-22 self-image domain and both coronal CI (r =0.13) and sag. CI (r =0.25), suggesting that while radiographic correction contributes to improved patient self-image other factors may also influence pts perception of surgical outcomes.

Conclusion
The weak positive correlation between self-image and radiographic sagittal correction suggests that while spine correction contributes to better self-perceived image, other factors are likely to play an important role in patient outcomes, and further research is needed to explore these factors and their

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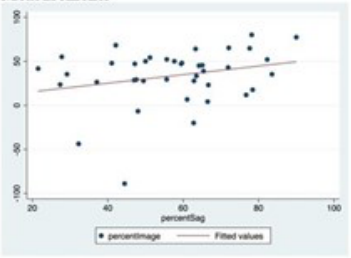
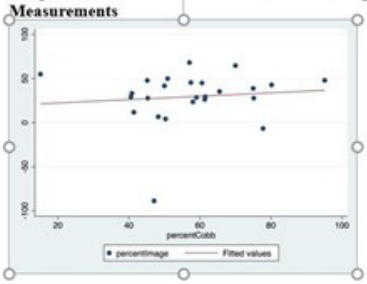
relative influence on the overall success of severe spine deformity surgery.

Graph 1: Correlation between SRS-22 Self-Image Domain and Sagittal Radiographic Measurements



Graph 2: Correlation between SRS-22 Self-Image Domain and Cobb Radiographic Measurements



Correlation Graph

143. Use of a Novel Posterior Internal Distraction Device for Single-Stage Correction of Severe AIS

Andrey Panteleyev, MD, PhD; Georgiy V. Tsopanov, MD; Maxim Sazhnev, MD, PhD; Karen A. Egiazaryan, MD, PhD

Hypothesis
A novel posterior internal distraction (PID) device providing a continuously increasing intraoperative distraction force allows for effective single-stage correction of severe adolescent idiopathic scoliosis (AIS).

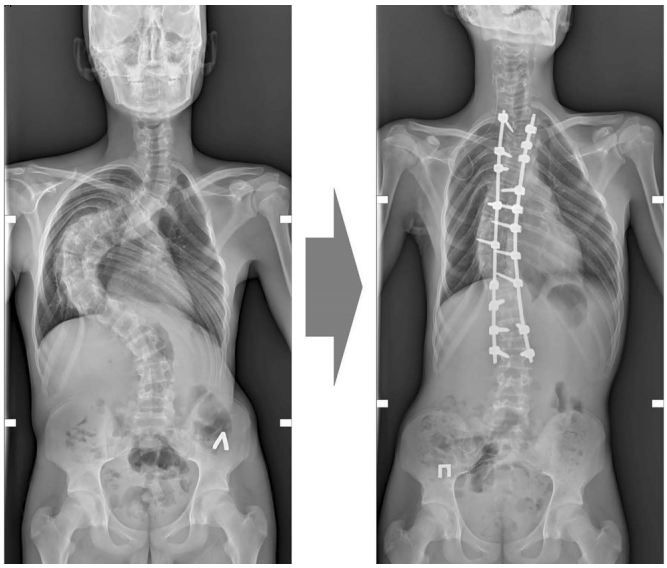
Design
Retrospective case-control study

Introduction
Traditional surgical treatment of severe rigid AIS requires either a multi-step approach involving extended preoperative halo-traction, anterior release stages and radical multi-level posterior osteotomies or vertebral column resection. PID provides robust three-dimensional corrective forces allowing for safe and effective single-stage correction.

Methods
33 AIS patients with severe rigid scoliosis ranging from 90° to 135° (avg. 99.3°) and ≥2-year follow-up were included. Two groups were formed based on treatment approach: in group I patients (n=19) underwent halo-gravity traction for at least two weeks preoperatively with standard surgical correction with intraoperative halo-traction as a second step, in group II patients (n=14) underwent single-step treatment using the novel PID device. Radiographic evaluation was conducted before halo-traction, and pre/post surgery in both groups. SRS-22 scores, major curve flexibility, number of fused segments, number of screws, operation time, estimated blood loss (EBL), total length of stay (LOS), and complication rates were also assessed.

Results
No significant differences were observed between groups in terms of demographic variables or preop angle or flexibility of major curve. Better immediate postop % correction was observed in group II (75.7 vs 71.2 %). Operative time (256.1 vs 279.7 min), EBL (530.7 vs 624.2 ml), screw density (18.4 vs 20.9), total LOS (10.8 vs 29.4 days) were also lower in group II (all $p<0.001$). There was no significant difference in SRS-22 scores. The rate of complications was higher in group I, including those associated with halo-traction. Transient neuromonitoring changes were observed in 2 patients in both groups with no postoperative neurologic deficit.

Conclusion
The novel PID device allows for effective single-stage three-dimensional correction of severe AIS and is associated with better correction, a shorter operative time, significantly lower length of stay, lower blood loss, lower pedicle screw density, lower rate of complications, and better SRS-22 scores compared to standard treatment with preoperative halo-traction.



144. Rib Resection in Spinal Fusion: Enhancing Radiographic Outcomes, Patient Satisfaction, and Clinical Benefits

Vishal Sarwahi, MD; Katherine Eigo, BS; Effat Rahman, BS; Brian Li, BS; Sayyida Hasan, BS; Keshin Visahan, BS; Chris Athanasian, BS; Victor Koltenyuk, BS; Jon-Paul P. DiMauro, MD; Yungtai Lo, PhD; Terry D. Amaral, MD

Hypothesis
Rib resection (RR) in Adolescent Idiopathic Scoliosis (AIS) patients undergoing posterior spinal fusion (PSF) will significantly reduce the rib hump and improve clinical outcomes.

Design
Retrospective Cohort Study

Introduction
Scoliosis often engenders associated rib cage deformity, leading to clinical and aesthetic implications. RR in patients with AIS undergoing PSF has been utilized to reduce the rib hump. The present study explores the impact of RR on radiographic and clinical outcomes.

Methods
400 AIS patients undergoing index PSF by one senior attending between 2018 – 2023 were included. Clinical charts and operative reports were reviewed. Cases were stratified by procedure status; those who underwent RR and those who did not (N-RR). Outcomes include rib hump (mm), operative time, 90-day complications, and length of stay (LOS). Radiographic outcomes were measured at pre and postop AP and lateral XRs. Clinical outcomes were collected utilizing SRS-22 and our institution's activity questionnaire, validated via test-retest method. Continuous variables were analyzed on Wilcoxon rank-sum tests, while categorical variables were analyzed using Chi-Square Tests.

Results
153 patients were included in the RR group, 247 were in the N-RR. Pre- and post-op cobb angle were not statistically significant in rib resected and standard patients (p= 0.56 and p=0.98, respectively). Operative time (p=0.78) and LOS (p=0.31) were not significant. PreOp rib hump was not significant between the groups (RR: 43.1mm vs. N-RR: 43.5mm, p=0.49). Final rib hump was lower in RR patients at 16.3 mm, with 60.5% rib hump correction, compared to a final rib hump of 29.8 mm (p<0.001) with a 30.4% rib hump correction (p<0.001) in N-RR. Patient reported self-image (p=0.02) and mental health (p=0.01) scores had significantly improved in RR patients. There were no differences in 90-day complication rates (p=0.19) or rate of respiratory complications (p=0.56). There were no differences observed in self-reported return to sports (p=0.26).

Conclusion
Rib Resectioned patients had approximately double the amount of rib hump correction at 60.5% correction compared to those who did not undergo rib resectioning at 30.4% correction, and no increase in rate of complications. Patients who had undergone rib resectioning had improved self-reported self-image and mental health scores with no difference in return to sports and similar activities.

145. Using Normative Proximal Junctionnal Angles to Define Proximal Junctionnal Kyphosis: Does It Make Any Difference?

Sebastien Pesenti, MD, PhD; Solène Prost, MD; Yann Philippe Charles, MD, PhD; Federico Solla, MD; Brice Ilharreborde, MD, PhD; Benjamin Blondel, MD, PhD

Hypothesis
Proximal Junctionnal Kyphosis (PJK) rate changes changes when using normative angles rather than fixed criteria

Design
Retrospective analysis of normative and AIS multicenter cohorts

Introduction
The definition of PJK according to Glattes et al. does not consider the vertebral level at which it may occur. Consequently, the diagnosis of PJK may be overstated. Our objective was to define normal junctional angles (PJA) at each vertebral level based on an analysis of a large normative cohort and to compare the rate of PJK using traditional measurement methods with those derived from normative data

Methods
We analyzed lateral radiographs of a large cohort of 780 asymptomatic volunteers aged 12 to 18 years. The measurements included T1-T12 thoracic kyphosis (TK), L1-S1 lumbar lordosis (LL), pelvic parameters, and Proximal Junctional Angles (PJA) at each vertebral level (defined as the angle between the lower endplate at a given level and the superior endplate two levels above). Normative values for PJA were established as mean ± 2SD. Additionally, using a cohort of 222 patients with adolescent idiopathic scoliosis (AIS) who underwent posterior spinal fusion (PSF) with a minimum follow-up of two years, we compared the rate of PJK according to Glattes' criteria with the rate of abnormal PJA

Results
In the volunteer cohort, the mean age was 14.6 years. The mean TK was 39.2°, and the mean LL was 54.7°. Normative values for PJA are presented in Fig 1. In the cohort of AIS patients, the mean age was 15.1 years. According to Glattes' criteria, 50 patients (23%) presented with PJK at last follow-up. When applying normative values based on the uppermost instrumented vertebra, only 22 patients (10%) exhibited abnormal PJA. The discrepancy between Glattes' criteria and normative values was more frequent at T10 (40% mismatch), T9 (25%), and T3 (20%)

Conclusion
PJK is identified as the most common mechanical complication following PSF for AIS. Our study provides normative values for Proximal Junctional Angles (PJA) according to the uppermost instrumented vertebra level. The findings suggest that PJK may be overdiagnosed, particularly in patients whose fusion begins at the lower thoracic spine

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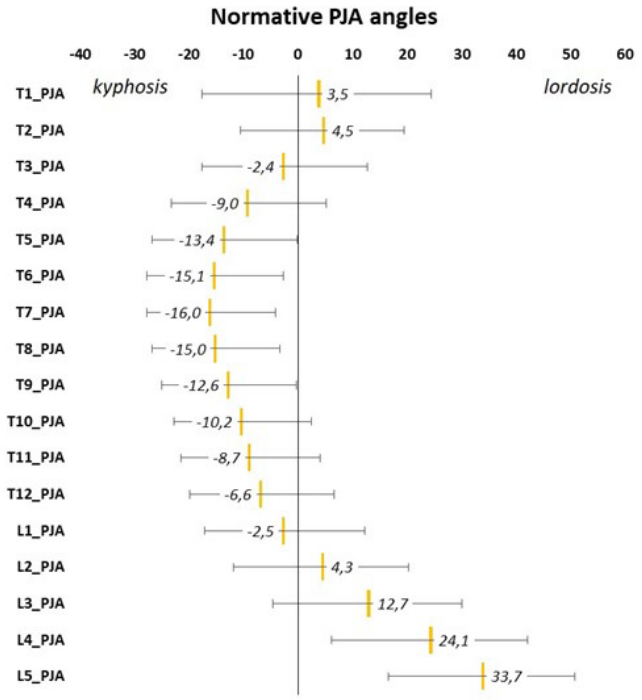


Chart of normative values for PJA ± 2SD according to vertebral level

146. The Evolution of Sagittal Alignment in Children: A Study of 300 Typically Developing Children

Anuj Gupta, MD; Satoshi Takada, MD; Petya Yorgova, MS; *Suken A. Shah, MD*

Hypothesis
L1PA has better correlation with global sagittal alignment than PI

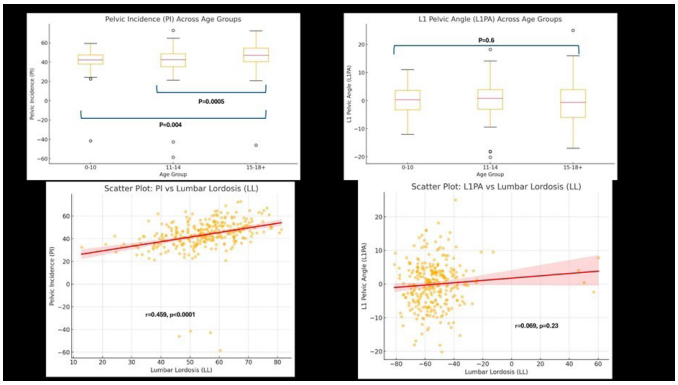
Design
Cross-sectional

Introduction
Restoring sagittal parameters is essential in pediatric & adult spinal deformity correction. Vertebral pelvic angle, especially L1(L1PA), correlates well with lumbar & thoracic spinal alignment in adults & is easily modifiable during surgery. Still, there is no data for the pediatric population. We aim to report the change of various sagittal parameters according to age & correlate this with thoracic & lumbar spinal alignment.

Methods
Patients from single institution's database were recruited. These patients (up to 18 years) visited either for suspicion of scoliosis or whole spine radiographs were done as routine screening. Patients with Cobb angle >10°, spondylolisthesis, pelvis/lower limb pathology, & significant back pain were excluded. Sagittal parameters recorded: Pelvic parameters(-PI, SS, PT), L1PA, T1PA, lumbar lordosis(LL:L1-S1, proximal LL:L1-L4, distal LL:L4-S1), & thoracic kyphosis(TK:T1-T12, upper TK:T1-T5, middle TK:T5-T9, lower TK:T9-L1). Change was assessed between age groups 2-10 years, 11-14 years, 15-18 years.

Results
300 patients(180 F) with mean age of 13±6.8 years(2-10=66, 11-14=106, 15-18=128) were included. PI(43.6°± 14.4°) & PT(6.9°± 8.3°) increased significantly with age(p=0.004 & 0.0005). On post-hoc analysis, increase was significant after 14 years of age(p=0.008 & 0.04). SS(36.5°± 12.1°) was consistent in all age groups(p=0.1). LL(54.7°± 11.4°) increased with age(p=0.005), particularly after 14 years, mainly due to proximal LL(p=0.003) & not distal LL(p=0.4). There was an increase in TK(p=0.006,0.003,& 0.9),contributed by lower TK(p=0.002). L1PA(median -0.25°, IQR 8.63°) & T1PA(median 0.55°, IQR 11.1°) did not change with age(p=0.6 & 0.7). On correlation analysis, PI was significantly correlated with LL(r=0.459, p<0.0001), especially with proximal LL(r=0.488, p<0.0001). PI had weak correlation with TK(r=0.156, p=0.006) & no correlation was found between L1PA and LL(r=0.069, p=0.23), & L1PA and TK(r=0.086, p=0.137).

Conclusion
This study reports normal values of sagittal parameters in the pediatric population. Pelvic incidence shows a significant correlation with lumbar alignment but L1PA was not found to be associated with lumbar & thoracic alignment in children. Until more data is gathered, its application for pediatric spinal deformity correction may be limited.



147. Modern AIS Surgery Using Patient Specific Rods Results in Radiographic Outcomes that Closely Match Predicted and "optimal" Sagittal Parameters

Matthew Weintraub, BS; Omar Taha, BS; Mehdi Elfilali, BA; Ritt Givens, BS; Edwin Kulubya, MD; Benjamin D. Roye, MD; *Michael G. Vitale, MD, MPH*

Hypothesis
Predicted sagittal parameters using patient specific rods (PSRs) will closely align with post-operative outcomes. However, predicted osteotomy (PCO) levels will differ from the actual levels performed during surgery.

Design
Retrospective cohort

Introduction
Surgical treatment of adolescent idiopathic scoliosis (AIS) enables 3D re-alignment, but optimizing sagittal profile remains challenging. Machine learning based PSRs aim to improve sagittal alignment. This study assesses PSR efficacy by comparing planned, achieved, and optimal post-op outcomes.

Methods
Pre-operative imaging was used to generate an operative plan and PSRs. Predicted radiographic parameters were compared to actual and "optimal" post-op outcomes with paired t-tests, accounting for multiple comparisons. Optimal post-op thoracic kyphosis (TK) and lumbar lordosis (LL) were determined with equations TK = 2 [PT + LL – PI] (Clement et al.) and LL = 0.66 [PI] + 24.2 (Sullivan et al.), respectively. Agreement between predicted and actual PCO levels was assessed with Cohen's Kappa.

Results
137 patients (93 females and 44 males) were included. The average age was 15.4 years at time of surgery, preoperative major Cobb was 53.6°, and average correction was 63.4%. When comparing pre-op plans to post-op results (Table), lumbar lordosis and L4-S1 lordosis were 6.2° ($p < 0.001$) and 3.2° ($p < 0.001$) smaller than predicted, respectively. T2-T5 kyphosis increased by 2.0° compared with plan ($p = 0.001$), while T5-T12 kyphosis was 2.0° smaller than planned ($p = 0.019$). There was 6.24° increase of PI-LL compared to predicted ($p = <0.001$). There was no difference between optimal and post-op TK ($p = 0.941$). There was an average difference of 4.8° between optimal and post-op LL ($p < 0.001$), which is less than the verified mean absolute difference of 8.3° (Sullivan et al.). Osteotomy analysis identified no agreement between predicted and actual osteotomy levels (Cohen's Kappa = -0.12).

Conclusion
Post-op radiographic outcomes with PSRs closely match pre-op plans and optimal measures. Sagittal alignment remains the area with the largest variability, though differences between plan and execution were generally small and likely not clinically significant. Osteotomy prediction, however, remains the area with the greatest inconsistency, with no agreement between the predicted and actual levels.

Variable	Plan (mean)	Post-op (mean)	Mean Difference	p-value	Benjamini-Hochberg adjusted p-value
CL	1.66	-5.22	-6.89	<0.001	<0.001
T2-T5 Kyphosis	12.33	14.28	1.95	0.001	0.001
T5-T12 Kyphosis	30.69	28.75	-1.95	0.015	0.021
L1-L4 Lordosis	23.8	22.54	-1.26	0.163	0.204
L4-S1 Lordosis	36.38	33.23	-3.15	<0.001	<0.001
LL	59.03	52.84	-6.19	<0.001	<0.001
PI	50.56	50.61	0.05	0.740	0.740
PI-LL	-8.46	-2.22	6.24	<0.001	<0.001
SVA	2.77	14.87	12.1	0.003	0.005
cSVA	17.28	18.28	1.0	0.489	0.544

Planned and Post-Op Outcomes

148. Which Factors Contribute to the Loss of Planned Kyphosis when Using Pre-Contoured Rods in Adolescent Idiopathic Scoliosis (AIS)?

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Hypothesis
The loss of kyphosis postoperatively due to flattening of the rod intraoperatively is dependent on both the rigidity of the curve and the magnitude of hypokyphosis.

Design
Single-center retrospective cohort study

Introduction
Pre-contoured rods are used to correct the sagittal plane in AIS. The sagittal profile planned for the rods is determined based on preoperative sagittal parameters and how much correction is needed. However, rods can flatten during placement leading to less thoracic kyphosis (TK) postoperatively than planned. The purpose of this study was to determine whether curve flexibility on bending films or degree of preoperative hypokyphosis had a greater effect on rod flattening and postoperative kyphosis loss.

Methods
AIS patients ≤ 25 years old undergoing spinal deformity surgery using pre-contoured rods were included. A 6.0 cobalt chrome rod was used on the concave side and a 6.0 titanium rod on the convex side. Posterior column osteotomies at the apex were performed in all patients. Coronal and sagittal alignment parameters including bending films were obtained from EOS images. Patients were divided into two groups: preoperative TK within 20˚ of normal (20-40˚; G1) or > 20˚ from normal (G2). In a sub-analysis, patients with > 50% correction on bending films (flexible group-FG) were separated from those with < 50% correction (rigid group-RG). Analysis included independent t-tests and $\chi 2$ tests.

Results
81 patients were included (G1=65, G2=16). Coronal parameters were not significantly different between groups. Patients in G1 had mean TK of 35˚ preoperatively, 36˚ in the planned rod contour, and 35˚ postoperatively. Patients in G2 had 2˚ preoperatively, 36˚ in the planned rod contour, and 26˚ postoperatively. The difference in kyphosis between the planned rod contour and the postoperative rod was -1.2˚ in G1 and -10˚ in G2 ($p = .007$). Patients in G2 had higher mean PI-LL ($p=<.001$) and LL ($p=<.001$) preoperatively and higher PI-LL ($p=.017$) postoperatively than G1. There was no significant difference between the pre-contoured TK and the postoperative kyphosis when comparing FG and RG ($p = .502$).

Conclusion
Patients who have more than 20˚ deviation between the preoperative kyphosis and pre-contoured kyphosis have more flattening of the rod intraoperatively and may bene-

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fit from additional pre-contoured kyphosis to achieve the desired sagittal plane profile.

Coronal and Sagittal Parameter Comparisons Between Patients with Preoperative TK within 20° of Normal (G1) and >20° from Normal (G2)									
	Preoperative Parameters			Preoperative Plan Parameters			Postoperative Parameters		
	G1 n=65	G2 n=16	p	G1	G2	p	G1	G2	p
Age	15 ± 3.4	16 ± 3.3	.223						
BMI	22 ± 5	21 ± 3.6	.765						
LL	-59 ± 13	-40 ± 16	<.001	-58.2 ± 18	-54 ± 12	.324	-52 ± 12	-41 ± 27	.118
PI-LL	-7.3 ± 15	10 ± 13	<.001	-8.3 ± 10	-3.3 ± 10	.076	-2 ± 12	6.9 ± 17	.017
TK	35 ± 18	2 ± 14	<.001	36 ± 9	36 ± 3.8	.731	35 ± 11	26 ± 9.5	.004
Sanders	5.29 ± 2	5.14 ± 1.95	.854						
Risser	2.9 ± 2	2.8 ± 2.5	.894						
	Postoperative – Preoperative Plan			Preoperative Plan - Preoperative					
LL	-44 ± 14	-38 ± 19	.146						
PI-LL	.97 ± 9	13 ± 7	<.001						
TK	-1.2 ± 11	-10 ± 8.2	.007	1.00 ± 15	33 ± 11	<.001			
Coronal and Sagittal Parameter Comparisons Between Patients with >50% Correction on Bending Films (FG) and those with <50% Correction (RG)									
	RG n=35	FG n=24	p						
Age	15.2 ± 3.4	15.5 ± 4	.710						
BMI	20.7 ± 3.6	20.4 ± 2.7	.752						
Sanders	4.9 ± 2	6 ± 1.7	.406						
Risser	2.7 ± 2.2	3.5 ± 1.8	.315						
	Postoperative - Preoperative Plan								
TK	-2 ± 11	-4 ± 10	.502						

149. Achieving "ideal" Sagittal Alignment Does Not Influence Hrqol Outcomes 5 Years Following Psf for Lenke 1 AIS

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Hypothesis
Achieving patient-specific regional sagittal alignment parameters will improve HRQoL outcomes following PSF for AIS

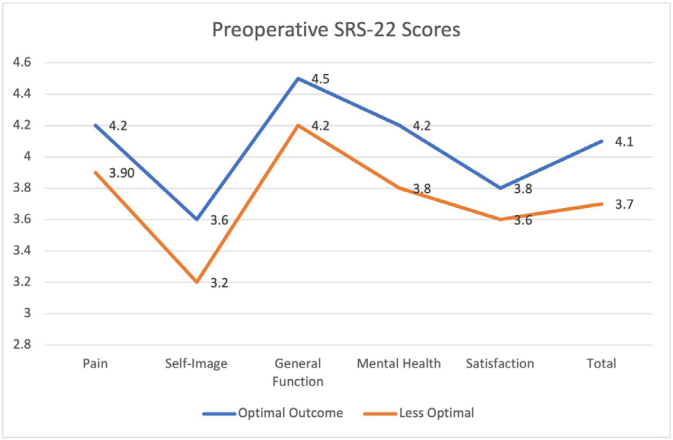
Design
A retrospective cohort study of a multicenter AIS database

Introduction
Previous studies have emphasized the importance of sagittal alignment for long-term outcomes following posterior spinal fusion (PSF) for adolescent idiopathic scoliosis (AIS). Although various equations have been introduced to predict ideal regional alignment, no study has investigated the influence of achieving these regional parameters on health-related quality of life (HRQoL) outcomes following PSF for AIS

Methods
Patients undergoing PSF for Lenke 1 AIS with 5-year follow-up was performed. Data collection focused on sagittal alignment parameters for lumbar lordosis (LL), TK (T2-12), and sagittal vertical alignment (SVA) and patient-reported outcomes scores (SRS-22) at preoperative and 5-year follow-up. "Ideal" TK was calculated using pelvic incidence (PI). PI-LL mismatch was used to characterize ideal lumbar alignment. Patients were subdivided based on whether ideal regional alignment was achieved at 5 years follow-up (predicted TK ±5°). SRS-22 total scores were subdivided into quintiles with the lowest 40% of patients (≤4.3) defining less optimal outcome.

Results
192 patients met inclusion criteria (mean 14.5±2.1 years, 88.5% female). The mean "ideal" TK was calculated at 37.6±5.7° with a mean measured preoperative TK of 27.0±11.8°. Following surgery, there was a significant increase in TK(P<0.001) with 62 patients (32.3%) achieving ideal TK. Achieving ideal TK demonstrated no impact on SRS-22 domain scores. Additionally, there was no association between achieving ideal regional alingment and the development of less optimal outcome (33.9% vs 42.3%; P=0.16). Less optimal outcome was not associated with achieving ideal thoracic or lumbar alignment (5-year PI:LL mismatch-LOO:-7.7 vs -9.7; P=0.24) but was correlated with preoperative SRS-22 scores (Figure 1, P<0.001) for all domains except Satisfaction)

Conclusion
In a cohort of patients undergoing PSF for Lenke 1 AIS, the pursuit of ideal region-specific alignment parameters does not influence HRQoL 5 years following surgery. A more modern approach to sagittal plane assessment in AIS, searching beyond regional measures of sagittal curvature magnitude to better understand the sagittal plane distribution and shape is needed.



SRS 22 Scores

150. Sarcopenic Obesity: An Underrated Phenomenon Impacting Adult Spinal Deformity Intervention Outcomes

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Hypothesis
Sarcopenic obesity may impact ASD surgery outcomes and better characterize the health of important surrounding structural tissue that is key to alignment.

Design
retrospective cohort review of a prospectively enrolled database

Introduction
The amount and quality of tissue do not always positively correlate as is the case with sarcopenic obesity. As the population of elderly people with ASD continues to increase, sarcopenia and obesity continue to soar in prevalence, although sarcopenia is underacknowledged.

Methods
Operative ASD patients with complete baseline (BL) and two-year (2Y) baseline, radiographic, and health related quality of life (HRQL) data were included. Sarcopenia was defined based on the validated European Working Group of Sarcopenia in Older People (EWGOSOP2). Obesity was classified via traditional BMI categories. The cohort with sarcopenic obesity (SO) was compared to a cohort of patients without.

Results
529 patients met inclusion criteria. Altogether, 206(38.9%) of patients demonstrated aspects of SO. The SO cohort was older with a significantly greater number of comorbidities and higher frailty score(all;p<.05). At BL, SO demonstrated significantly lower baseline lower extremity motor scores(p=.004). Radiographically, SO patients had greater PT, greater PI-LL, less LL, greater VPA at T1, T4, T9, L1 and L4, and greater GAP scores (all; p<0.05). In terms of complications, SO patients demonstrated considerably higher rates of cardiac complications (83.3% v. 16.7%, p=0.025) and surgical infection (66.7% v. 33.3%, p=0.025).The SO cohort also sustained a greater rates of pseudoarthrosis (64.3% v. 35.7%, p=0.049) and failure with reoperation (p=0.027), higher rates instrumentation failure (p=0.045). The use of PJK prophylaxis amongst those with SO showed lower rates of screw breakage (p=0.039) and mechanical complications (p=0.004) as opposed to SO patients who did not receive prophylaxis. SO was a positive predictor of instrumentation failure (OR 1.7, p=0.047) while obesity or sarcopenia were not significant predictors alone. SO patients also achieved age-adjusted match goals at a lower rate (p<.001). Clinically, this manifested as greater back and leg NSR pain scores at every time point up to two years.

Conclusion
Sarcopenic obesity appears to significantly hamper outcomes after ASD, and awareness of the patient's muscle quality could guide operative decision-making.

151. Cell Saver in Adult Spinal Deformity Surgery: Helping or Hurting?

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Hypothesis
Cell Saver (CS) in adult spinal deformity (ASD) surgery reduces intraoperative transfusions and increases postoperative hematocrit but leads to increased complications.

Design
Retrospective cohort study

Introduction
While CS is meant to give patients back their own blood products, the quality of said blood products has been called into question. In patients undergoing ASD surgery, we evaluated the impact CS on:1) intraoperative transfusions, 2) postoperative hematocrit, and 3) complications.

Methods
A retrospective cohort study was performed for patients undergoing ASD surgery from 2009-23. Inclusion criteria were:≥5-level fusion, sagittal/coronal deformity, and ≥2-year follow-up. The primary exposure was use of CS. Primary outcomes were: 1) intraoperative transfusions, 2) postoperative hematocrit, and 3) overall complications. Secondary outcomes were intraoperative hypotension, defined as total minutes mean arterial pressure (MAP) was <65mmHg, length of stay (LOS), and discharge status. Bivariate and multivariable analysis controlling for age, sex, body mass index and operative time were performed.

Results
Of 288 patients undergoing ASD surgery with a mean age of 63±18 years, 209 (73%) used CS. Mean CS given back was 428±404 ml. CS use was associated with a longer operative time (442±149 vs. 382±150 minutes, p=0.003) and higher blood loss (1490 vs. 765 ml, p<0.001).The CS group paradoxically had higher intraoperative transfusion rates (68% vs. 32%, p<0.001) and blood product usage (3±4 vs. 1±2 units, p<0.001). Postoperative hematocrit was not different between groups (30±4 vs 30±5, p=0.936). On multivariable regression, CS was independently associated with increased transfusions (OR=2.94, 95%CI: 1.56-5.53, p<0.01) and medical complications (OR=2.72, 95%CI:1.01-7.00, p=0.038). Regarding secondary outcomes, multivariable regression analysis showed that Cell Saver was associated with longer intraoperative hypotension (β=16.8, 95%CI:3.8-29.7, p=0.011) and higher odds of having MAP<65mmHg for ≥90 minutes (OR=3.3, 95%CI:1.1-9.7, p=0.032)

Conclusion
While controlling for operative time, Cell Saver use in ASD surgery was independently associated with increased intraoperative transfusions, medical complications, and prolonged hypotension without an improvement in postoperative hematocrit levels. Though giving patients back their own blood products appears beneficial, these data question the safety of Cell Saver in ASD surgery.

152. Examining the Burden of Complications on Long-Term Satisfaction in Adult Spinal Deformity (ASD)

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Hypothesis
After ASD correction, the number and severity of complications are not correlated with two-year satisfaction.

Design
Multicenter, prospective cohort

Introduction
Understanding how complication burden affects satisfaction is key to improving ASD surgery outcomes. This study examined whether severity and number of complications predict long-term patient satisfaction.

Methods
Data from a multicenter ASD cohort with ≥2 years of follow-up and at least one complication were analyzed. Patients were categorized as high complication burden (≥2 major complications or one reoperation) or low burden (≤2 minor complications). They were also stratified by whether any complication had an ISSG-AO Complication Intervention Score (CIS) ≥2 (high) or not (low). Satisfaction was defined as an SRS-22 subscore ≥4 at two years. Demographics, spinopelvic parameters, and ASD-SR index were recorded. Relationships between complication burden, ISSG-AO CIS, and satisfaction were evaluated using univariate and multivariate analyses, adjusting for covariates.

Results
Of 616 patients, 333 met inclusion criteria (high burden: 206; low burden: 127). The mean age was 61.5 ± 12.9 years; 78.7% were female (Table 1). High and low-burden groups differed significantly in ASD-SR index (p=0.03), Δ T2-T12 Cobb Angle (p=0.003), baseline C7-S1 SVA (p=0.02), 2-year C7-S1 SVA (p=0.01), 2-year C2PA (p=0.03), baseline T4PA (p=0.04), baseline T4L1PA (p=0.004), and high satisfaction (p=0.006). On multivariate regression low complication burden was significantly associated with high satisfaction at two years (OR 1.70 [95% CI 1.10–2.92], p=0.049). Stratified by ISSG-AO CIS, 518 patients met inclusion criteria (high: 236, low: 282). There was significant overlap between patients with high or low complication burden and high or low ISSG-AO CIS. Similar trends as above were found, with low ISSG-AO CIS significantly associated with high satisfaction (OR 1.29 [95% CI 1.08–1.54], p=0.006).

Conclusion
High complication burden and ISSG-AO CIS are associated with lower satisfaction two years post-ASD correction. Although greater surgical invasiveness may underlie this association, it was not significant in multivariate analysis. This highlights a link between increased surgical invasiveness and higher complication burden resulting in reduced satisfaction after ASD surgery.

Table 1.

Variable	Overall (n=333)	High Burden (n=206)	Low Burden (n=127)	p-value
Age	61.54 ± 12.85	62.41 ± 11.3	60.12 ± 14.96	0.14
Gender				0.66
Male	71 (21.3%)	46 (22.3%)	25 (19.7%)	
Female	262 (78.7%)	160 (77.7%)	102 (80.3%)	
Smoker	19 (5.7%)	11 (5.3%)	8 (6.3%)	0.92
Alcohol/Drug Abuse	6 (1.8%)	5 (2.4%)	1 (0.8%)	0.50
Charlson Comorbidity Index	2.15 ± 1.86	2.23 ± 1.88	2.02 ± 1.82	0.30
Body Mass Index	28.81 ± 6.06	29.09 ± 6.04	28.35 ± 6.1	0.29
Osteoporosis at Baseline	55 (16.5%)	38 (18.4%)	17 (13.4%)	0.29
Depression at Baseline	91 (27.3%)	58 (28.2%)	33 (26.0%)	0.76
American Society of Anesthesiologists Classification Risk				0.63
Low	168 (50.5%)	101 (49.0%)	67 (52.8%)	
High	158 (47.4%)	100 (48.5%)	58 (45.7%)	
Adult Spinal Deformity-Surgical and Radiographical Index	83.9 ± 36.6	87.3 ± 36.7	78.2 ± 36.9	**0.03**
ISSG-AO Complication Intervention Score 2 or 3 for at Least One Complication				**<0.001**
Low	133	17	116	
High	199	188	11	
High Satisfaction	209 (62.8%)	117 (56.8%)	92 (72.4%)	**0.006**

153. Surgical Treatment for Adult Spine Deformity Improves Quality of Life and Promis Health Domains to Normal Population Values at Minimum 2-Year Postoperative

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Hypothesis
Adult spine deformity (ASD) patients report pain and poor physical and social function that can improve to normal values following surgery.

Design
Prospective, multi-center, observational study.

Introduction
ASD is associated with severe disability. Surgery for ASD can improve health related quality of life (HRQOL). The patient reported outcome measurement information system (PROMIS) is the NIH recommended tool to assess patient reported outcomes. Benefits of using PROMIS include ability to reference domain scores to normal patient values. No

data exists evaluating ≥2-year ASD surgical outcomes using PROMIS.

Methods
ASD patients > 18 years of age were enrolled into a prospective, multi-center, observational study. Patients were administered legacy HRQOLs (SRS-22r, ODI, NRS back and leg pain, VR-12) and computerized adaptive test versions of PROMIS health domains for Pain Interference (PI), Physical Function (PF), Satisfaction with Social Roles (SR) and Participation in Discretionary Social Activities (DSA) at preop and ≥ 2-year postop. Pre and postop HRQOL scores were compared, distributions of patients achieving minimal clinically important difference (MCID) for legacy HRQOL and PROMIS domains was evaluated, preop and ≥ 2-year postop PROMIS score distributions were referenced to normative population values.

Results
144 of 190 patients enrolled were evaluated (mean preop age 62.6 years, scoliosis=34.2°, SVA=74.2mm, PI-LL=16.7°). Surgical treatment improved spine alignment (mean 2.3 year follow up scoliosis=14.7°, SVA=34.5 mm, and PI-LL=4.5°; p<0.0001). All legacy HRQOL and PROMIS scores improved from preop to ≥ 2-year postop (p<0.005; figure 1). At last follow-up, >50% of patients reached MCID for all legacy and PROMIS health domains (figure 1). Referencing PROMIS scores to normative values demonstrated 50-85%% of patients preop reported moderate-severe deficits in all PROMIS domains, at ≥2 years postop 52-88% of patients reported normal to mild deficits in all PROMIS domain. Social function domains demonstrated the greatest postop PROMS gains.

Conclusion
This is the first study evaluating ≥2-year ASD surgical outcomes using PROMIS. ASD patients demonstrated postop improvements in all legacy and PROMIS health domains with the majority of ASD patients reaching normal population values.

Total Patients (n=144)	Preoperative: Mean (SD)	Postoperative: Mean (SD)	P value
Age, years	62.6 (13.3)	NA	NA
Body mass index	27	NA	NA
Gender, % female	48.8	NA	NA
History of prior spine fusion, %	47.2	NA	NA
Scoliosis maximum value, degrees	34.2 (21.4)	14.7 (12.9)	<0.001
C7-S1 sagittal vertical axis, mm	75.4 (66.2)	34.5 (47.3)	<0.001
Pelvic incidence-lumbar lordosis, degrees	16.7 (22.2)	4.5 (12.7)	<0.001
PROMIS Pain Interference, T-score, % population	T-score= 63.9 (7.5) % Population within normal limits= 9.8, mild deficits=10.5, moderate deficits= 62.2, severe deficits= 17.5	T-score= 54.1 (10.8) % Population within normal limits=48.6, mild deficits=19.4, moderate deficits=26.4, severe deficits=5.6	<0.0001
PROMIS Physical Function, T-score, % population	34.2 (6.8) % Population within normal limits=4.9%, mild deficits=10.5%, moderate deficits=58.7%, severe disability=25.9%	41.6 (8.8) % Population within normal limits=31.9%, mild deficits=20.1%, moderate deficits=41.7%, severe deficits= 6.3%	<0.0001
PROMIS Satisfaction with Participation in Discretionary Social Activities, T-score, % population	41.2 (7.8) % Population very high=0.7; high =1.4; average=51.7; low=44.1; very low=2.1	51.9 (10.5) % Population very high=0; high=21.0; average=67.1; low=10.5; very low=1.4	<0.0001
PROMIS Satisfaction with Participation in Social Roles, T-score, % population	40.1 (7.6) % Population within normal limits=25.2; mild deficits= 25.2; moderate deficits=42.7; severe deficits=7.0	49.9 (11.0) % Population within normal limits=58.7; mild deficits=23.8; moderate deficits=16.1; severe deficits=1.4	<0.0001
Back pain, numeric pain scale	7.1 (2.2)	3.6 (3.0)	<0.0001
Leg pain, numeric pain scale	4.3 (3.3)	2.6 (2.8)	<0.0001
SRS-22r Activity domain, value	2.9 (0.7)	3.6 (0.9)	<0.0001
SRS-22r Pain domain, value	2.3 (0.8)	3.5 (1.0)	<0.0001
SRS-22r Self-image domain, value	2.4 (0.7)	3.6 (0.9)	<0.0001
Oswestry disability index, value	44.7 (15.6)	26.2 (16.6)	<0.0001

154. The Variable Impact of Frailty on Adult Spine Deformity Patients Based on Contemporary Definitions: Are We Speaking the Same Language?

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Hypothesis
To investigate predictive ability of frailty indices on postop outcomes in adult spine deformity (ASD)

Design
Retrospective cohort

Introduction
Numerous frailty classifications exist. These likely have varying postoperative implications.

Methods
Thoracolumbar fusions-to-pelvis were included. ASD diagnosed as: SVA > 5cm, PI-LL>10, or PT>20. Four frailty indices were compared Miller et al index (ASD-FI), Passias et al index (mASD-FI), FRAIL scale & 5-Factor frailty index (mFI-5). Patients were stratified into non-frail (NF), frail (F), and

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severely frail (SF). ANOVA and regression analyses assessed associations between indices and outcomes, factoring differences in disability and deformity severity.

Results
864 patients included (Age 61.3 years, BMI 28.1 kg/m^2). F/SF status generally correlated with increasing SICU time and length of hospital stay, with no differences between indices. F/SF status in all but mFI-5 was significantly predictive for SICU admission, with FRAIL scale demonstrating the highest odds (OR 1.33, 1.14 – 1.57, p<0.001). Within 90 days, the ASD-FI had the strongest predictive ability for any complications (OR 1.19, 1.05-1.35, p=0.006), including major complications (OR 1.47, 1.21-1.77, p<0.001) and reoperations (OR 1.24, 1.04-1.54, p=0.046). By 2 years, the mASD-FI demonstrated 1.5x the predictive odds than any other index for mechanical complications (OR 1.47, 1.27 – 1.70, p<0.001) and reoperations (OR 1.44, 1.22 – 1.69, p<0.001). Only FRAIL scale and mFI-5 correlated F/SF status with not achieving the minimum clinically important difference in ODI & SRS-22, with FRAIL scale predicting this 1.3x stronger than mFI5 (OR 1.31, 1.09-1.58, p=0.005). SF status was generally associated with the highest complication rates, translating to higher cost/QALY at two years. This was seen most strongly with mASD-FI, which predicted F/SF patients having the highest additional costs per QALY ($571,099 p<0.001). Overall, ASD-FI correlated strongest with 90-day complications, mASD-FI with QALY outcomes, mFI5 with mechanical complications, and FRAIL scale with SICU admission.

Conclusion
Variable frailty indices translate to variable risk stratification and outcomes. Streamlining these indices will enhance the outcome prediction aspect of surgical planning.

	Miller et al ASD-FI			Passias et al mASD-FI			5-Factor mFI			FRAIL Scale		
Not Frail (NF)	346			388			412			322		
Frail (F)	356			332			311			423		
Severely Frail (SF)	162			144			141			119		
	NF	F	SF	NF	F	SF	NF	F	SF	R	PF	F
Age, yrs	57.0	64.4	63.7	58.3	63.6	64.0	56.6	64.9	67.3	58.2	62.4	65.8
BMI, kg/m^2	25.8	28.8	31.4	25.1	29.6	32.7	26.2	29.3	30.8	26.4	28.6	30.9
CCI	1.09	2.08	3.39	1.23	2.10	3.40	0.90	2.29	4.12	1.41	1.98	3.12
ODI	31.0	49.7	61.3	35.5	49.2	57.3	38.9	47.4	53.7	36.1	45.9	61.1
SRS-22	3.26	2.64	2.14	3.10	2.64	2.32	2.94	2.71	2.55	3.08	2.74	2.21
Radiographic Metrics												
PI-LL, °	9.7	20.0	24.5	11.5	20.5	22.1	11.5	20.2	24.1	10.8	18.5	26.3
PT, °	22.1	26.2	26.6	22.9	26.3	25.7	23.0	25.9	26.8	22.5	25.5	27.7
T1PA, °	18.9	25.4	28.2	19.8	25.9	26.7	20.3	25.4	27.6	19.5	24.6	29.0
SVA,	40.0	73.1	100.7	42.9	78.5	92.7	46.4	76.4	95.0	43.1	71.7	101.0

155. Preoperative Cervical Degeneration Predisposes Adult Spinal Deformity Patients to Poor Postoperative Cervical Sagittal Alignment After Thoracolumbar Deformity Correction

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Hypothesis
Adult spinal deformity (ASD) pts with preoperative cervical degeneration are at risk of worsening cervical sagittal alignment following thoracolumbar deformity correction.

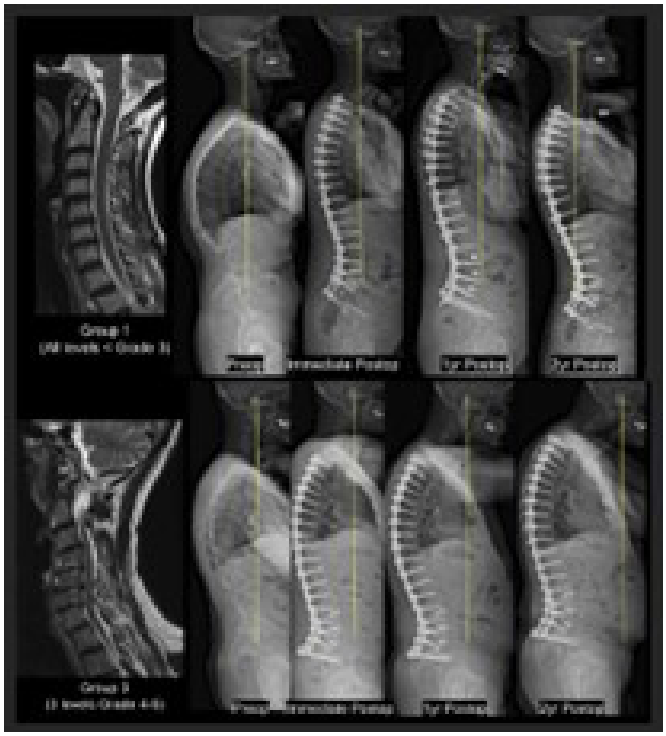
Design
Retrospective Cohort

Introduction
Prior studies have shown that thoracolumbar (TL) deformity correction in Adolescent Idiopathic Scoliosis can lead to compensatory cervical changes, often restoring lordosis. However, the impact of cervical degeneration in ASD remains unclear. This study examines how preoperative cervical degeneration affects alignment after TL deformity correction in ASD.

Methods
181 ASD pts s/p deformity correction from the cervicothoracic (C7–T4 UIV) to the lumbosacral spine (L1–S1/Ilium LIV) with ≥2-year follow-up were included. Preop cervical MRI was used to grade disc degeneration per the Wang et al. classification and form 3 groups: G1 minimal degeneration, G2 1–2 severely degenerated (grade ≥4) discs, and G3 ≥3 grade ≥4. Cervical alignment was assessed preop and immed.(IPO), 1-year(1PO), and 2-years(2PO) postop. Optimal cervical sagittal alignment(CSA) was defined as within 20° of T1 slope(T1S) -T1S-CSA difference <20°.

Results
The 3 groups had no difference in preop CSA, T1S, cSVA or postop TL alignment- C7SVA, TK, T4-L1PA, or PI-LL. IPO G2&3 had worse CSA than G1 (0.3°&-7° vs -11.2°,p<0.02), with no difference in T1S(24.6°,25.6°,27.6°,p>0.13). The CSA difference persisted and worsened up to 2PO, where G1 T1S-CSA was <10° as compared to G2 & 3 which was 17° and 22°(p<0.0001). G1 T1S-CSA improved from preop to 2PO, with an average -7° CSA and 4.7° T1S-CSA decrease(p=0.0002). G2 kept the same preop CSA, but with cSVA +8.9mm and T1S-CSA by +3.8°(p<0.04). G3 CSA on average changed +6.4° and cSVA +9.1mm(p<0.05). After multivariable regression, the odds of achieving T1S-CL<20° were 81% less in G2(OR=0.19) and 91% less in G3(OR=0.087,p<0.0001,AUC=0.88). On multivariable linear regression, each cervical disc ≥4 grade was associated with 1.4° increase in T1S-CSA(β=1.4,R^{2}0.75,p<0.0001).

Conclusion
ASD pts with minimal cervical degeneration can expect reciprocal improvements in CSA after TL deformity correction up to 2 years. Pts with preop cervical degeneration will either maintain or have worsening CSA and T1S-CSA postop. All ASD pts should have preop cervical MRIs to evaluate for degeneration.



Comparison between G1 & 3 from Preop to 2PO

156. Predicting Proximal Junctional Kyphosis in Patients Undergoing Adult Spinal Deformity Surgery: A Multifactorial Artificial Intelligence Based Approach

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Hypothesis
Synthesizing imaging data and traditional patient data can enhance prediction tools for proximal junctional kyphosis/failure (PJK/F)

Design
Retrospective review of multi-surgeon, single-institution prospective and consecutively collected patient data.

Introduction
PJK/F is a poorly understood, multifactorial condition. Artificial intelligence (AI), which has been unexplored, possesses the potential to synthesize different modalities of data to comprehensively predict PJK/F.

Methods
498 patients who underwent adult spinal deformity surgery with 5 or more fusion levels between 2015 and 2022 were retrospectively reviewed, with 95 perioperative variables included. Preoperative and initial postoperative radiographs were also collected. A twofold AI model with a multi-layer perceptron (MLP) network arm and a convolutional neural network (CNN) arm was developed to predict PJK/F. Continuous/categorical data was analyzed using the MLP network arm. Imaging data was analyzed using the CNN arm. Both arms were then synthesized to make a comprehensive PJK/F prediction. Such models were developed for the preoperative period and initial postoperative period and compared to two models from prior studies – a continuous/categorical data-only AI model and an imaging-only CNN model. Model performances were evaluated using accuracy, sensitivity, specificity, and area under the receiver operating curve (AUROC) score. Comparative statistical analysis ($p<0.05$) was also performed.

Results
25 (5.0%) patients developed PJK/F. Age, osteoporosis, UIV, LIV, symptoms at the UIV, and initial postoperative radiographic metrics, such as posterior cranial vertical line (PCVL) to sacrum, PCVL to acetabulum, PCVL to medial malleolus, PCVL to thoracic apex, PCVL to UIV tulip, sagittal vertical axis (SVA), and proximal junctional angle (PJA), were found to differ significantly. Evaluation of preoperative models showed AUROC scores of 0.46 (continuous/categorical data-only), 0.59 (imaging-only), and 0.73 (twofold AI). Evaluation of initial postoperative models showed AUROC scores of 0.64 (continuous/categorical data-only), 0.82 (imaging-only), and 0.85 (twofold AI).

Conclusion
The twofold AI model, synthesizing numerical data and imaging, resulted in an excellent AUROC of 0.73 and 0.85 in predicting PJK/F in the preoperative and initial postoperative period, outperforming previous predictive tools.

Table 1. Summary of model performances

	Model Type	Accuracy	Sensitivity	Specificity	AUC
Preoperative	Continuous/Categorical Data Only	**0.947**	0	**1.0**	0.465
	Imaging Data Only	0.460	0.800	0.436	0.594
	Twofold AI Model	0.600	**1.0**	0.583	**0.734**
Postoperative Initial	Continuous/Categorical Data Only	0.687	0.538	0.695	0.635
	Imaging Data Only	0.673	**1.0**	0.660	0.818
	Twofold AI Model	**0.833**	0.857	**0.832**	**0.845**

157. The Relationship of CT Hounsfield Units at UIV+1 and UIV+2 Relative to Uiv Predicts Proximal Junctional Kyphosis in Patients with Long Spinal Constructs

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Hypothesis
CTHU at UIV+1 and UIV+2 are critical risk factors for developing PJK in ASD patients undergoing deformity correction with long constructs to the pelvis.

Design
Retrospective cohort

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Introduction
Prior literature has evaluated the relationship between CT Hounsfield units (CTHU) and postoperative complications in deformity surgery. Low CTHU at the Upper Instrumented Vertebra (UIV) and UIV+1 has been shown to increase the likelihood of PJK, pseudarthrosis, and pedicle screw loosening. For this study, we aimed to study the relationship of CTHU at the UIV, UIV+1, UIV+2 in adult spinal deformity (ASD) patients with postoperative complications.

Methods
191 ASD patients with a UIV at L2 or cephalad and pelvic fixation were identified with minimum 2-year follow up. Patients with UIV distal to L2, prior anterior fusion at UIV, or UIV at C2 were excluded. CTHU were measured at the UIV, UIV+1, and UIV+2 of each patient. Statistical analysis was performed with significance set to p<0.05.

Results
40 pts (20.9%) developed radiographic PJK, of which 19 went on to have revision surgery. PJK was more common at lower thoracic or thoracolumbar UIVs, as compared to upper thoracic and cervical(p=0.0048). After multivariable logistic regression, CTHU below 160 at the UIV+1 and UIV+2 was found to be a significant predictor of PJK(OR=8.10, p=0.0002 and OR=4.60, p=0.106, respectively). Cox proportional hazards regression analysis also identified CTHU at UIV+1 and UIV+2 as significant predictors of PJK(HR=6.52, p=0.0002 & HR=3.59, p=0.0131, respectively). Kaplan-Meier survival analysis demonstrates that pts with CTHU≥160 at UIV+1 and UIV+2 demonstrated significantly greater PJK free survival. Lastly, a sub-analysis found that pts with CTHU at UIV+1≥UIV, were less likely to develop PJK(p=0.0035). Even for pts with CTHU at the UIV below 160, if the CTHU at UIV+1 increased, these patients were significantly less likely to develop PJK.

Conclusion
Patients with CTHU at UIV+1 and UIV+2 ≥ UIV were significantly less likely to develop PJK, even among those with CTHU <160 at the UIV. These findings highlight the critical role of regional bone health in mitigating PJK risk.

	Parameter Estimate	p-value	Hazard Ratio (95% CI)
Age	0.038	0.0845	1.04 (1.00 – 1.08)
Female Gender	-0.111	0.7528	0.90 (0.45 – 1.78)
UIV Designation (*Reference = Thoracolumbar*)			
Cervical (C2-C7)	0.995	0.1930	2.71 (0.61 – 12.10)
Upper Thoracic (T1-T5)	-0.411	0.3715	0.66 (0.27 – 1.63)
Lower Thoracic (T6-T10)	-0.018	0.9652	0.98 (0.43 – 2.23)
CTHU at the UIV	0.006	0.1017	1.01 (1.00 – 1.01)
CTHU at the UIV + 1	**1.875**	**0.0002**	**6.52 (2.45 – 17.33)**

Abbreviations: *PJK* – proximal junctional kyphosis; *UIV* – upper instrumented vertebrae; *CTHU* - computed tomography Hounsfield units

Table 1b. Cox proportional hazards regression to determine the influence of CTHU at UIV + 2 on developing PJK within the postoperative period (p=0.0006)

	Parameter Estimate	p-value	Hazard Ratio (95% CI)
Age	**0.044**	**0.0399**	**1.52 (1.00 – 1.06)**
Female Gender	-0.252	0.4825	0.78 (0.39 – 1.57)
UIV Designation (*Reference = Thoracolumbar*)			
Cervical (C2-C7)	0.933	0.2219	2.53 (0.57 – 11.37)
Upper Thoracic (T1-T5)	-0.188	0.7249	0.83 (0.29 – 2.36)
Lower Thoracic (T6-T10)	-0.116	0.7327	0.89 (0.39 – 2.03)
CTHU at the UIV	0.002	0.6023	1.00 (1.00 – 1.01)
CTHU at the UIV + 2	**1.278**	**0.0131**	**3.59 (1.31 – 9.84)**

Abbreviations: *PJK* – proximal junctional kyphosis; *UIV* – upper instrumented vertebrae; *CTHU* - computed tomography Hounsfield units

Cox proportional hazards regression to determine the influence of CTHU at UIV +1 and +2 on developing PJK within the postoperative period (p<0.0001)

158. Thoracic Spine Degeneration Impacts Reciprocal Changes and Proximal Junctional Kyphosis (PJK) Following Correction of Adult Spinal Deformity (ASD)

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Hypothesis
ASD patients with uppermost instrumented vertebral (UIV) proximal zone degeneration will exhibit increased rates of radiographic PJK.

Design
Retrospective analysis of prospectively collected data.

Introduction
Degeneration in the thoracic spine, especially immediately proximal to the UIV, represents a critical point of vulnerability in ASD surgery. Understanding its impact on radiographic outcomes could guide surgical planning.

Methods
Primary ASD patients who underwent correction surgery with a UIV between T9-L1 and an LIV at S1/ilium were included. Thoracic spine (T1-L1) degeneration was assessed radiographically using Kellgren-Lawrence (KL) grading. Global thoracic spine degeneration was defined as >1 degenerated arcs (>2 levels with KL grade 3+ in T1-T5, T5-T9, or T9-L1). Proximal zone degeneration was defined as KL grade 3+ in the two levels above the UIV. Patients without any degenerated levels in the thoracic spine served as controls. Demographics, spinopelvic alignment, and junctional changes were compared pre- and post-op.

Results
In total, 151 degenerated and 72 control patients were included. Preop, degenerated patients had higher mean age (65.7 vs 62.6 yrs), higher TK (36.1 vs 27.6°), lower PI-LL (15.9 vs 24.1°), and higher LL (38.6 vs 32.2°) (p<0.05). Six-week postop, they had lower reciprocal kyphotic changes in the unfused thoracic spine (1.6 vs 5.8°, p=0.02). Two-year postop, they had a more kyphotic PJA (17.5 vs 14.4°, p=0.04) and higher PJK rates (38 vs 24%, p=0.04). Proximal zone sub-analysis revealed that two-year PJA (-18.9 vs -16.2 vs -14.4°) and PJK rates (43 vs 32 vs 24%) incrementally decreased from proximal zone degeneration to distal zone degeneration to control patients (p<0.05). Multivariate logistic regression revealed that presence of proximal zone degeneration predicted two-year PJK (OR=2.1, p=0.04); however,

addition of PJK prophylaxis into this model attenuated this relationship (OR=1.8, p=0.14).

Conclusion
Thoracic spine degeneration was associated with smaller reciprocal kyphotic changes in the unfused spine but larger two-year proximal junctional angle. Proximal zone degeneration was further associated with higher junctional failure rates. Meticulous selection of the UIV proximal zone in thoracolumbar deformity surgery may improve surgical outcomes.

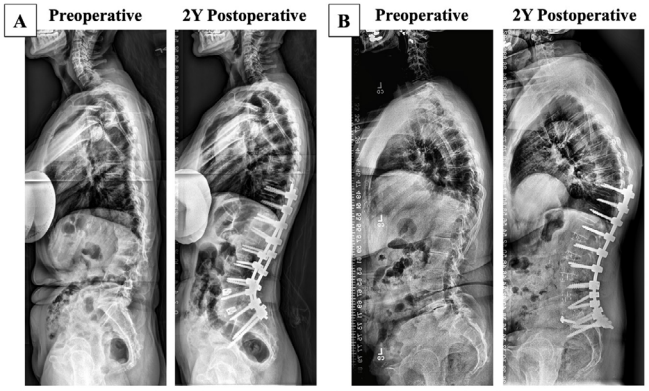

Figure 1. Preoperative and 2-year postoperative standing lateral radiographs demonstrating (A) no landing zone degeneration and (B) landing zone degeneration with subsequent development of proximal junctional failure.

159. Underreporting Bias of Proximal Junctional Kyphosis and Failure in Adult Spine Deformity Surgery: A Multicenter Radiological Review Using Multiple Diagnostic Criteria

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Hypothesis
Proximal junctional kyphosis/failure (PJK/PJF) are underreported in the prospective adult spine deformity (ASD) surgery study when reported by the subjective diagnosis made by clinicians.

Design
A prospective, multicenter, longitudinal cohort study conducted by AO Spine

Introduction
PJK/PJF are often underreported due to variable clinical significance and radiological subtlety. This study reviewed radiologic data from an international multicenter study of ASD to determine PJK/PJF rates based on different diagnostic criteria and compare them with clinicians' reports.

Methods
The study enrolled patients aged ≥60 years undergoing primary fusion surgery of ≥5 levels for spinal deformity. PJK/PJF was reported in adverse events case report form (CRF), denominated as "junctional pathology" or "compression fracture" by 2 years post-op. Radiologic diagnosis was made by the following 3 criteria: (1)Glattes' PJK: (a)∂Proximal junctional angle (PJA)(pre-op vs. 2y post-op) >10° and (b)PJA at 2y post-op >10°, (2)ASLS-1 PJF: (a)∂PJA >20°, (b)UIV and/or UIV+1 fracture with >20% height loss, (c)screw dislodgement, and (d)spondylolisthesis at UIV+1/UIV >3 mm, (3) Consensus-based PJF: review by four experts focusing on bone, construct or junctional failure.

Results
PJK reported in CRF was found in only 9.0%, but the detailed radiologic review of 166 cases identified Glattes' PJK in 51.5%, whereas ASLS-1 PJF was diagnosed in 45.7% and consensus-based PJF was reported in 52.7%, indicating significant underreporting. The kappa values against ASLS-1 PJF were 0.47 (95%CI: 0.34-0.61) for Glattes' PJK, showing moderate agreement, and 0.81 (95%CI: 0.72-0.90) for consensus-based PJF, indicating almost perfect agreement, but CRF based report showed minimal agreement with a kappa of 0.19 (95%CI: 0.09-0.29). ASLS-1 PJF reported in CRF had lower EQ-5D (0.6 vs 0.7, p=0.006) and higher ODI (39.6 vs 28.9, p=0.04) than underreported cases, showing more symptomatic disability. Cases performed in Asia had higher odds of underreporting than in North America (OR: 8.61, 95%CI: 1.01-73.7, p=0.049).

Conclusion
PJK was underreported in clinicians' reports compared to the radiologic assessment of PJK/PJF based on geometric definitions. Underreporting tended to occur when the disability was relatively small, and geographic differences were observed.

160. Transition Rods with or Without Junctional Tethering in the Prevention of Proximal Junctional Kyphosis in Adult Spinal Deformities Surgery

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Hypothesis
To **evaluate** the effectiveness of transition rods with or without junctional tethering in the prevention of proximal junctional kyphosis

Design
Retrospective

Introduction
Proximal junctional kyphosis (PJK) is one of the most problematic complications in the field of spinal deformities surgery. Aim of the study is to evaluate the effectiveness of transition rods with or without junctional tethering to prevent this complication in adult patients

Methods
97 consecutive patients were included in the study. All patients had been treated by "long" posterior instrumented

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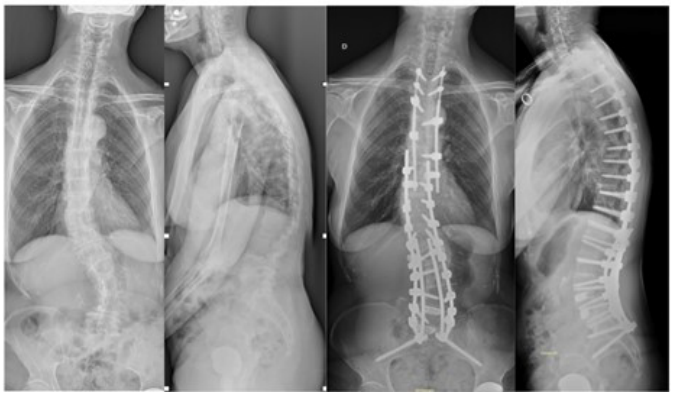
fusion (screws only construct, with or without anterior lumbar support), extended from the proximal thoracic segment (T1-T5) to the pelvis, for an adult spinal deformity in the coronal or sagittal plane. Exclusion criteria were: oncological or infective spinal diseases, neurologic diseases (like Parkinson). Patients were divided in 3 groups. In 38 cases (R Group) regular 5.5 mm rods were used in the upper part of the instrumentation. In 32 cases (TR Group) transition rods (3.5 mm, titanium or cobalt crome) were used in the proximal thoracic segments (1 or 2 levels), in 27 cases (TRJ) transition rods were associated with junctional tethering (UIV + 2). The 3 groups were comparable in terms of age (69.8 vs 67.2 vs 68.5 years), prevalence of female sex (81.5 vs 84.3 vs 77.8%), underlying pathology (adult idiopathic scoliosis 24 vs 15 vs 12 cases, failed back surgery 11 vs 12 vs 11 cases, global kyphosis 3 vs 5 vs 4 cases)

Results
At a mean follow up of 31 months (range 24 to 40), PJK occurred in 18 cases in R Group (47.4%), in 3 cases in TR group (9.4%), in 2 cases in TRJ group (7.4%). In R Group, PJK always occurred in first 3 months after surgery; in TR/TRJ Groups PJK occurred in 3 cases in first 3 months, in 2 cases later. Neurological impairment was present in 3 cases in R Group, in no case in TR/TRJ Groups. Revision surgery was performed in 11 cases in R Group, in 1 case in TR Group. Clinical results, evaluated with VAS and Oswestry questionnaires, were similar in TR and TRJ groups, statistically worst in R Group ($p<0.05$)

Conclusion
The use of transition rods has been shown to be effective in adult spinal deformities surgery, with a statistically significant reduction of PJK if compared to 5.5 mm rods. The association with junctional tethering has not shown significant advantages in the PJK prevention



161. A Novel Surgical Technique to Prevent Proximal Junctional Kyphosis in Adult Spinal Deformity: The Combined Use of Sublaminar Tethering and Shorter UIV Screws

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Hypothesis
Sublaminar tethering of the upper-instrumented vertebra (UIV)+1 combined with a 1 cm shorter screw at UIV reduces the risk of proximal junctional kyphosis (PJK) in adult spinal deformity (ASD) surgery.

Design
Prospectively collected, retrospectively analyzed cohort study

Introduction
While previous studies have described the effects of teriparatide, sublaminar tethering, and spinal process tethering, there is still no widely accepted strategy for reducing PJK risk. This study evaluates the effectiveness of combining sublaminar tethering with shorter UIV screws in minimizing PJK incidence.

Methods
161 patients who underwent spinal fusion from the sacrum to the lower thoracic spine for ASD and were followed more than two years were included. PJK was defined as the angle between the lower margin of the upper fixed vertebra and the head of two vertebrae. Proximal junctional failure was defined as PJK required revision surgery. Patients were categorized into three groups: conventional pedicle screw (PS), PS with sublaminar tethering at UIV+1 (T-PS), and shorter PS with sublaminar tethering at UIV+1 (T-SPS). Demographic data, surgical factors, and pre- and postoperative radiographic parameters were analyzed. Statistical significance was set at $P<0.05$.

Results
PJK occurred in 78 patients (48.9%), with 35 (43.2%) in the PS group, 7 (26.9%) in the T-PS group, and 36 (16.7%) in the T-SPS group. PJK was significantly lower in the T-PS group compared to the PS group ($p=0.01$). PJF occurred in 6 patients (8.6%) in the PS group, 2 (7.4%) in the T+PS group, and 1 (2.8%) in the T+SPS group, with no significant difference between the groups ($p=0.38$). Age ($p=0.18$), BMI ($p=0.23$), bone mineral density ($p=0.07$), operative time ($p=0.89$), fusion level ($p=0.38$), and pre- and postoperative sagittal parameters were not significantly different among the three groups.

Conclusion
Sublaminar tethering is effective in reducing PJK incidence in ASD. Furthermore, the use of a 1 cm shorter screw at UIV provides additional protection against PJK by allowing a more gradual transition at the fixation site and minimizing vertebral body damage during pedicle screw insertion. This combined approach offers a promising strategy for improving long-term surgical outcomes in ASD patients.

162. Machine Learning-Derived Alignment Targets for ASD: Multi-Center Validation of Age-Adjusted PI-LL Goals

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Hypothesis
Machine learning applied on spinal alignment among asymptomatic volunteers offers personalized targets for pelvic incidence minus lumbar lordosis (PI-LL) in ASD correction

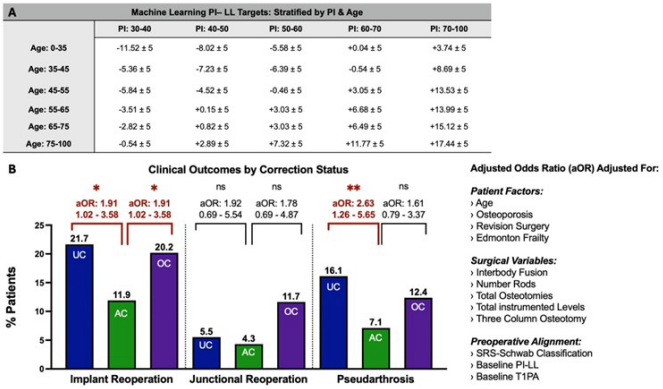
Design
Retrospective w/ external validation in a multicenter cohort.

Introduction
Evidence underscores aligning lumbar spinal shape w/ pelvic morphology and age. Emerging age-adjusted targets risk under-correction. This study validates surgical PI-LL targets using spinopelvic shape analysis in asymptomatic volunteers

Methods
PI-LL targets were developed using 468 asymptomatic multi-national, multi-ethnic adults(80% training, 20% validation) via the eXtreme Gradient Boosting algorithm, incorporating PI, age, & sex. Fig A illustrates age- & PI-stratified targets. Validation included 664 ASD pts w/ min 2yr, classified as under(UC), adequate(AC), or over(OC) corrected based on targets ±5°(Fig A). Outcomes were implant-related reoperation; pseudarthrosis & proximal junctional revision& PROMs. Outcomes analyzed using multivariable regression adjusted for significant univariate variables. Data shown as (UC vs AC vs OC)

Results
Greater PI-LL mismatch is normative in older patients & those with higher PI (Fig A). In the ASD cohort (n=664), 235 (35.4%) were UC, 210 (31.6%) AC, & 219 (33.0%) OC. UC patients were younger (60.5 vs 61.6 vs 63.3), had more males (41.7% vs 26.2% vs 27.8%), fewer instrumented levels (10.3 vs 11.5 vs 11.9), & greater sagittal malalignment (T1PA: 27.9 vs 22.5 vs 21.8). UC had highest reoperation (21.7% vs 11.9% vs 20.2%) & pseudos (16.1% vs 7.2% vs 12.4%), while OC had highest junctional revisions (5.5% vs 4.3% vs 11.7%). UC (OR=2.31,CI: 1.38–3.93) & OC (OR=1.87,CI: 1.09–3.25) had higher reoperation odds vs AC. OC had greater junctional revision odds (OR=2.93,CI: 1.37–6.81) vs AC. Pseudo was higher in UC (OR=2.49,CI: 1.33–4.83). Multivariable models showed AC had lowest reoperation odds (AUC=0.87, P<0.0001) vs UC (aOR=1.91, CI: 1.02–3.58) & OC (aOR-=1.91,CI: 1.02–3.58). Pseudo rates were higher in UC vs AC (aOR=2.63,CI: 1.26–5.65, AUC=0.73, P<0.0001). No sig. differences in junctional reoperation were found after adjustment. Interestingly, correction did not impact PROMs

Conclusion
Overall, PJK pts were overcorrected, pseudarthrosis pts undercorrected, emphasizing that individualized alignment targets considering both age and pelvic morphology affects surgical outcomes.



163. The Association Between Lumbosacral Transitional Vertebrae and Distal Adjacent Segment Degeneration Following L4/5 Instrumented Fusion

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Hypothesis
Castellvi type 2 can provide structural stability and prevent adjacent segment degeneration (ASD) following L4/5 instrumented fusion.

Design
Retrospective cohort study.

Introduction
L5/S1 is a distinctive anatomical region. The decision not to fuse the L5/S1 segment along with upper levels can sometimes be challenging, as degenerative changes frequently occur at this level. Lumbosacral transitional vertebrae (LSTV) are common anomaly at the lumbosacral junction and are classified using the Castellvi classification. This study investigated whether Castellvi type 2, characterized by pseudoarticulation of the transverse process with the sacrum, could provide structural stability and thus prevent ASD following L4/5 instrumented fusion.

Methods
In this retrospective cohort study, patients who underwent L4/5 instrumented fusion with minimum two-year follow-up were included. Castellvi types were assessed, and patients were subgrouped as follows: Castellvi type 0, 1A, and 1B as one group; type 2A as another; type 2B as a third; and types 3A, 3B, and 4 as the final group. Demographic, alignment, and ASD-related parameters were analyzed.

PODIUM PRESENTATION ABSTRACTS

Results
This study included 591 patients with LSTV prevalence of 37.7%. Compared to Castellvi type 0, 1A, and 1B group (n=418) and type 2A group (n=75), Castellvi type 2B group (n=68) exhibited significantly less decrease in distal (L5/S1) mean disc height (4.2% vs 10.5%), less progression in Weiner grades (0.19 vs 0.41), and fewer radiographic ASD (5.9% vs 14.8%) at final follow-up. Castellvi type 3A, 3B, and 4 group (n=30) showed almost no changes in disc height or Weiner grades at final follow-up.

Conclusion
Castellvi types 2B and higher were associated with significantly reduced distal (L5/S1) degenerative changes following L4/5 instrumented fusion compared to Castellvi types 0, 1, and 2A. It suggests that bilateral pseudoarticulation provides added stability at L5/S1, potentially reducing the need for combined fusion with L4/5 at this level. This study invites further investigation for L5 stop in extended lumbar or thoracolumbar fusion based on LSTV types.

Table 3. Subgroup analysis of radiographic and surgical adjacent segment degenerations across four groupings based on Castellvi classification: group 1 (Types 0, 1A, 1B), group 2 (Type 2A), group 3 (Type 2B), and group 4 (Types 3A, 3B, and 4)

Grouped Castellvi Types	0,1A,1B (n=418)	2A (n=75)	2B (n=68)	3A,3B,4 (n=30)
Radiographic ASD, proximal	126 (30.1%)	22 (29.3%)	21 (30.9%)	12 (40.0%)
Surgical ASD, proximal	54 (12.9%)	9 (12.0%)	9 (13.2%)	5 (16.7%)
Time to proximal ASD surgery (mo)	80.0 (±65.2)	70.2 (±50.6)	81.8 (±37.5)	49.2 (±48.9)
Radiographic ASD, distal*	68 **(16.3%)** [cd]	10 (13.3%)	4 **(5.9%)** *	0 **(0%)** *
Surgical ASD, distal	25 (6.0%)	6 (8.0%)	3 (4.4%)	0 (0%)
Time to distal ASD surgery (mo)	52.4 (±43.1)	97.5 (±76.6)	78.0 (±63.6)	NA

Superscript annotations (a, b, c, and d) next to each variable indicate significant differences from group 1 (Castellvi types 0, 1A, 1B), group 2 (Castellvi type 2A), group 3 (Castellvi type 2B), and group 4 (Castellvi types 3A, 3B, 4), respectively. ASD, adjacent segment degeneration; mo, month

164. Comparing Motion of Discs Adjacent to One- and Two-Level Soft-Landing Techniques Proximal to Lumbar Deformity Constructs: A Cadaveric Biomechanical Study

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Hypothesis
Soft-landing constructs will limit motion adjacent to long lumbar fusion.

Design
A human cadaveric biomechanical study.

Introduction
Proximal junctional kyphosis (PJK) is a common consequence of long segment spinal fusion. progression of PJK may be affected by hypermobility of the free levels adjacent to long fusion. This study compares the ability of single-level and multi-level proximal soft-landing techniques, to provide gradual transition of motion adjacent to the upper instrumented vertebra (UIV) of a long lumbar fusion.

Methods
The difference in motion between the upper instrumented disc (UID) and the adjacent level (UID+1) of seven human cadaveric spine segments (T5-Pelvis) was evaluated using a using a six degrees-of-freedom range of motion (ROM) simulator (±7.5Nm) in flexion/extension (FE), lateral bending (LB), and axial rotation (AR). Four soft-landing techniques were evaluated: Transverse Process Hooks (TP), Untensioned Polyethylene-Terephthalate Cord (U-PET), Tensioned Polyethylene-Terephthalate Cord (T-PET), and a dynamic stabilization device (DSD). Soft-landing constructs were placed across one (T9-T10) and two (T8-T10) levels. All specimens were fused from T10-Pelvis with posterior fixation.

Results
The ROM increase from UID to UID+1 is almost consistently higher in two-level soft-landing constructs with the exception of DSD (one-level: +3.66°; two-level: +3.52°) in LB. One-level U-PET had the smallest ROM increase, in FE (+0.79°) and AR (+2.18°). LB ROM increase was similar for U-PET one-level (+1.76°) and two-level (+1.79°). In LB, TP had the smallest ROM increase of one level (+1.44°) and two-level (+1.66°) constructs. Of all one-level soft-landing constructs, DSD had the greatest ROM increase, in all bending planes (FE: +1.87°; LB: +3.66°; AR: +3.91°). Of all two-level soft-landing constructs, DSD had the greatest ROM increase in FE (+3.29°) and LB (+3.52°); while 2-level T-PET had the greatest ROM increase in AR (+4.58°).

Conclusion
Adjacent to fusion, two-level soft-landing constructs may be more likely to induce greater ROM at the free adjacent discs, as compared to one-level soft-landing constructs. Further clinical analysis is needed to determine if there this translates to a greater risk of PJK adjacent to the fusion.

165. Utility of Initial Clinic Imaging Following Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

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Hypothesis
The hypothesis of this study is that routine radiographic imaging during the first postoperative clinic visit following posterior spinal fusion (PSF) in adolescent idiopathic scoliosis (AIS) patients does not significantly impact decisions to return to the operating room.

Design
This retrospective cohort study included primary AIS patients aged 11–19 who underwent PSF at a single institution, with a minimum follow-up period of two years. Patients were categorized into two groups: those with in-person

clinic follow-up who received routine imaging and those with initial telehealth follow-up without imaging.

Introduction
The aim was to compare rates of unplanned returns to the operating room (UPROR) within 90 days of surgery between patients who received routine imaging at their first postoperative clinic visit and those who had telemedicine follow-ups without imaging.

Methods
Patient demographics and clinical characteristics were summarized using descriptive statistics and stratified by visit type (in-person vs. telehealth). Continuous variables were analyzed with t-tests or Wilcoxon rank-sum tests, and categorical variables with Fisher's exact or chi-squared tests.

Results
The study cohort included 696 patients, 9% of whom had telehealth visits without imaging. All patients in the in-person group received imaging at their initial clinic visit. The cohort predominantly consisted of females (82%) and patients with thoracic curves (75%), with a median preoperative Cobb angle of 57° and a median curve correction of 66%. The 90-day UPROR was low, occurring in only 1 patient in the in-person group (0.16%; 95% CI: 0.03–0.89%). There were no UPROR in the telemedicine group.

Conclusion
The results indicate that routine imaging during the first postoperative clinic visit rarely influences reoperation decisions for AIS patients after PSF. These findings suggest that routine early postoperative imaging has limited utility and that its elimination could reduce radiation exposure and healthcare costs without compromising patient outcomes.

Characteristic	Overall (N=696)	Patients with imaging (N=633)	Patients without imaging (N=63)	p[1]
Curve Location				0.003
Thoracic	523 (75%)	479 (76%)	44 (70%)	
Thoracolumbar	162 (23%)	148 (23%)	14 (22%)	
Lumbar	11 (2%)	6 (1%)	5 (8%)	
Pre-operative Cobb	57 (52, 64)	58 (52, 65)	55 (51, 61)	0.4
No. of levels fused	9 (8, 11)	9 (8, 11)	9 (8, 11)	0.7
Post-operative Cobb	20 (15, 25)	20 (15, 25)	20 (16, 27)	0.3
Curve correction (%)	66 (57, 73)	66 (57, 73)	64 (58, 69)	0.2
90-day UPROR	1 (0.14%)	1 (0.16%)	0 (0%)	>0.9
90-day UPROR due to imaging	0 (0%)	0 (0%)	0 (0%)	-

[1]p-value estimated from t-test, Wilcoxon rank sum test, chi-squared test, or Fisher's exact test

Table 1. Clinical, surgical, and postoperative characteristics of cohort, stratified by imaging.

166. Novel Ultrasound Algorithm Reduces Unnecessary Radiography in School Scoliosis Screening by 56% – A Prospective and Validation Study in 508 Adolescent Girls

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Hypothesis
Ultrasound curve angle (UCA) have higher accuracy than Spinous process angle (SPA) in determining referral status for orthopaedic consultation in skeletally immature Adolescent idiopathic scoliosis (AIS) girls.

Design
Prospective diagnostic accuracy study.

Introduction
AIS is a three-dimensional spinal deformity. Hong Kong has a scoliosis screening program since 1995, referring more than 3000 cases for radiographical confirmation of scoliosis annually. Ultrasonography emerged as a potential radiation free alternative for scoliosis screening. A previous study showed that adding SPA measurement with ultrasonography to the current screening workflow could reduce the number of unnecessary referrals for radiography by more than 50%. The UCA was developed as a novel algorithm to measure ultrasound-based Cobb angle, designed to be more robust in cases with spinal rotation compared with SPA.

Methods
Girls aged 10-14 years old recommended for x-ray in the scoliosis-screening program were recruited from 2018 to 2020. Another consecutive cohort of AIS girls were recruited for validation between 2020 to 2023. Ultrasound scanning and EOS x-rays were performed according to a standardized validated procedure. Referral for orthopaedic consultation was indicated and hence Referral Status was considered positive when EOS-Cobb angle ≥20°.

Results
In the primary cohort of 414 participants, logistic regression model with UCA achieved a sensitivity of 0.94 and specificity of 0.59 to predict positive Referral Status. The SPA model achieved a sensitivity of 0.91 and specificity of 0.31. In the validation cohort of 94 participants, logistic regression model with UCA achieved a sensitivity of 0.94 and specificity of 0.59. Model with SPA resulted in a sensitivity of 0.95 and specificity of 0.19. Combining both cohorts, 6 (1.2%) cases were screened false negative (Table 1).

Conclusion
Incorporation of ultrasonography into the scoliosis screening program could potentially reduce unnecessary radiography by 56-59% in skeletally immature female AIS patients. Ultrasonography shows promising potential in scoliosis screening. implementation studies could be considered for incorporation of USG into the scoliosis screening workflow.

PODIUM PRESENTATION ABSTRACTS

Validation Cohort	EOS Referral Status			
SPA-based Referral Status	Yes	No	Total	
Yes	22	57	79	PPV: 0.26 (0.18-0.33)
No	1	14	15	NPV: 0.93 (0.67-1.00)
Total	23	71	94	
	Sensitivity: 0.95 (0.77-1.00)	Specificity: 0.19 (0.12-0.30)		

Validation Cohort	EOS Referral Status			
UCA-based Referral Status	Yes	No	Total	
Yes	22	31	53	PPV: 0.41 (0.29-0.54)
No	1	40	41	NPV: 0.97 (0.86-1.00)
Total	23	71	94	
	Sensitivity: 0.95 (0.77-1.00)	Specificity: 0.56 (0.44-0.67)		

Comparing Logistic Regression Models on SPA and UCA Based Methods in the Validation Cohort

167. Magnetic Resonance Imaging Generated Synthetic Computed Tomography in Pediatric Spine Patients

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Hypothesis
We hypothesize clinical congruence between CT and synthetic CT evaluation of the pediatric spine.

Design
Retrospective Cohort Study

Introduction
Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are common imaging studies used to evaluate pediatric spine patients. Novel MRI-generated synthetic CT (sCT) images have demonstrated near equivalence in accuracy compared to traditional CT (tCT) in cadaveric studies. To date, there are no reports of the use of sCT in evaluating pediatric spinal pathologies. This study aimed to evaluate the clinical utility of sCT in managing pediatric and adolescent patients with various spinal conditions.

Methods
Retrospective chart review of pediatric spine patients at a quaternary care hospital from October 2023 - September 2024. Inclusion criteria included any patients receiving a sCT for spinal evaluation. Patient demographics and imaging results were collected. For any patient having a tCT within 3 months of the sCT (n=10), osseous anatomical measurements on the coronal, sagittal, and axial sequences were compared. Official radiology reads were also compared between sCT and tCT.

Results
25 patients underwent sCT of the spine (2 cervical and 23 lumbar). Indications included: rule out congenital cervical anomalies in congenital muscular torticollis (2 patients); spondylolysis (13); spondylolisthesis (2); scoliosis/back pain (4); chronic back pain (4); back pain with transitional lumbosacral anatomy (4). 176 measurements of osseous anatomy were performed. 62.5% of the measurements were within 0.5 mm of each other, 95.5% were within 1 mm, and 4.5% differed by 1 mm or more.

Conclusion
MRI generated sCT is a radiation-free alternative imaging modality for the evaluation of the osseous spine in children. MRI generated sCT provides 3-dimensional imaging of the child's bony anatomy, largely within 1 mm compared to a tCT. We believe MRI generated sCT has significant clinical utility in the pediatric and adolescent population, allowing the diagnosis of both bony and soft tissue pathologies without exposing patients to radiation and utilizing a single imaging study.

Case	Vertebra	R pedicle width	L pedicle width	R pedicle height	L pedicle height	Vertebral width	Vertebral length	Vertebral height	Spinal canal width	Spinous process length
2	L3	0.8	0.4	0.3	0.2	0.3	0.4	0.3	0.4	0.4
3	L4	0.8	1.2	0.1	0.1	0.7	0.1	1	0.3	0.1
6	L5	0.6	0.8	0.4	0.2	0.8	0.1	0.3	0.6	0.2
10	L4	0.3	0.4	0.3	0.3	0.4	0.2	0.4	0.9	0.2
12	L5	-	0.6	-	0.6	0.3	0.3	0.3	0.3	0
16	L5	0.3	0.6	0.2	0.6	0.6	0.8	0.4	0.4	0.3
18	L2	0.9	0.8	1.3	0.6	0.7	0	1.1	0	0.5
20	L3	0.1	0.4	0.5	0.5	0.7	0.4	0.8	0.5	0.2
21	L4	0.4	0.4	0.6	0.1	0.6	0.1	0.4	0.4	0.1
22	L5	0.9	0.3	0.5	0.8	0.7	0.7	0.8	0.8	0.6

Comparison of vertebral measurements between synthetic CT (sCT) and traditional CT (tCT) (magnitude of difference, mm).

168. Incidence and Risk Factors of Postoperative Motor Deficits After Spine Deformity Surgery: Results of the SDIM Study

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Hypothesis
The need for three-column osteotomies and greater corrections in coronal and sagittal planes are associated with a higher incidence of postoperative motor deficits

Design
Retrospective analysis of an international, multicenter, prospectively collected patient cohort

Introduction
Understanding and preventing new-onset postoperative mo-

tor deficits (NOPMD) is a critical concern in spinal deformity surgery. Despite advancements in surgical techniques and intraoperative neuromonitoring (IONM), these complications still arise, resulting in significant morbidity. This study aims to explore the association between pre- and intra-operative variables and the development of NOPMD in patients undergoing surgery for spine deformity

Methods
The SDIM study prospectively enrolled patients aged 10-80 years from 20 international centers undergoing spine deformity correction surgery for a major Cobb >80° or any surgery involving an osteotomy at a non-cord level. We retrospectively compared baseline, intraoperative, and postoperative characteristics, including demographics, radiological features, and lower extremity motor scores (LEMS), between patients with and without NOPMD

Results
Of the 555 patients who met the inclusion criteria, 55 (10.1%) experienced NOPMD, defined as a decrease of at least 1 point in the ASIA LEMS from baseline. These deficits affected: hip flexors (n=38), knee extensors (n=35), ankle dorsiflexors (n=17), ankle plantar flexors (n=14), and great toe extensors (n=28). IONM alerts were observed in only 21 (38.2%) patients with NOPMD. Univariable analysis revealed that the key factors associated with NOPMD included: older age, higher BMI, presence of baseline motor deficits, revision surgery, posterior decompression, use of interbody devices, and the occurrence of IONM alerts during surgery ($p<0.05$). Interestingly, patients with NOPMD exhibited lower baseline coronal Cobb angles, smaller postoperative changes in both coronal and sagittal Cobb angles, and fewer posterior column osteotomies compared to those without NOPMD ($p<0.05$)

Conclusion
New onset postoperative motor deficits occurred in 10.1% of patients undergoing spine deformity correction surgery. Older age, higher BMI, baseline motor deficit, revision surgery, posterior decompression, use of interbody devices and presenting IONM alert during surgery were identified as key contributing factors.

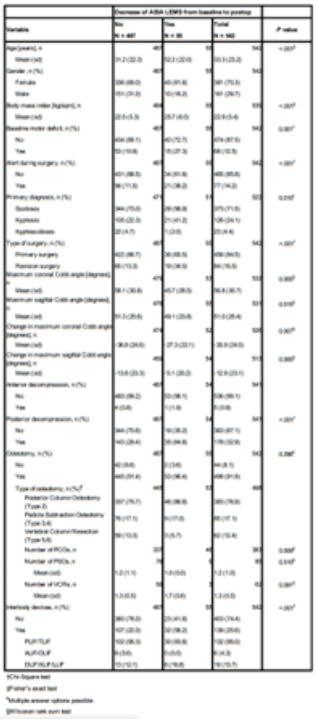

Table 1: Patients with and without NOPMD

169. False Negative Intraoperative Neuromonitoring Alerts During Pediatric Spinal Deformity Surgery: The Dreaded Outcome

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Hypothesis
To investigate false negative intraoperative multimodal neuromonitoring (IONM), and outcomes, in pediatric spinal deformity surgery.

Design
Retrospective Case Series

Introduction
IONM reduces the risk of postoperative spinal cord dysfunction in pediatric spinal deformity surgery by enabling intraoperative corrective actions. However, false negative IONM results, where postoperative neurologic decline occurs without intraoperative alerts, are dreaded, poorly understood outcomes.

Methods
An institutional IONM database was reviewed (11/1992 to 4/2024) to identify all consecutive patients (0–18 yrs) who underwent pediatric spine deformity surgery at one of our three tertiary-care hospitals. Inclusion criteria were false negative cases.

Results
Out of 5317 consecutive surgeries, 16 (0.32%) false negative cases were identified. Mean age was 14 years (11-16). Most common diagnoses were spondylosis/spondylolisthesis

PODIUM PRESENTATION ABSTRACTS

(n=6) and idiopathic (n=5). Surgeries were 14 posterior spinal fusions and 2 anterior/posterior fusions. IONM modalities included somatosensory evoked potentials only (SSEPs) (n=5), SSEPs and descending neurogenic-evoked potentials (DNEPs) (n=10), and SSEPs and transcranial motor-evoked potentials (TCeMEPs) (n=1). Five patients had preoperative neurologic abnormalities, including BLE weakness (n=3), weakness/paresthesia (n=1), and paresthesia (n=1). Among patients with preoperative neurologic abnormalities, 4 had sustained neurologic deficits at final exam (80%), compared to 9 patients among those with normal preoperative neurologic exam (82%). At final evaluation, 3 had complete recovery, 5 had partial recovery, 5 had no recovery, and 3 were unknown. Worst case scenario in FN cases only 19% (3 of 16) had complete recovery. In spinal cord level surgeries (n=9), 11% had complete recovery; 89% used SSEP/DNEP, and 11% used SSEP/TCeMEPs. At the nerve root level (n=6), 17% had full recovery.

Conclusion
This study reports the largest series of false negative IONM cases (n=16) in pediatric spinal deformity surgery; a 0.32% rate out of 5317 consecutive surgeries. The single false negative case with use of SSEP/TCeMEP, and the only 17-19% complete recovery rate supports the use of multimodal combination over SSEP/DNEP.

Table 1. Outcomes of False Negative IONM Alerts

170. Can the Recovery of Root-Level Intraoperative Neuromonitoring Data Result in a Lower Risk for Postoperative Lower Extremity Weakness in Spine Deformity Surgery?

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Hypothesis
The resolution of root-level intraoperative neuromonitoring (IONM) data alerts portends an improved rate of avoiding postoperative motor weakness

Design
Retrospective study of 1,065 adult and pediatric spinal deformity pts

Introduction
IONM is commonly used in spinal deformity surgery to reduce the risk for neurologic injury. Spinal cord data loss has been associated with postoperative deficits in prior literature; however, the clinical implications of root-level data improvement after intervention is less well understood.

Methods
1,065 pts who underwent spinal deformity surgery from 2015 to 2023 were reviewed. All patients underwent multimodal IONM, including bipolar recording of motor evoked potentials (MEP), somatosensory evoked potentials (SSEP), and electromyography (EMG). Root level data was reviewed with the senior member of the neuromonitoring team. Timing of IONM loss, interventions, and baseline/postoperative day 1 (POD1) lower extremity motor scores were analyzed.

Results
Overall, root-level IONM loss was 3.8% (41/1065). In those 41 patients, compared to their preop motor exam, 48.8% (20/41) of patients had a POD1 deficit and 50% (10/20) of those patients had severe weakness (motor strength grade 3 or less out of 5) in the corresponding muscle group after surgery. All 41 patients had MEP changes, while 26.8% (N=11) had SSEP changes and 17.5% (N=7) had abnormal spontaneous EMG. Most root alerts occurred after rod (N=11) or screw (N=7) placement, or after decompression/laminectomy(N=6). Interventions were performed in all 41 patients with root data loss, and most required further decompression (N=28). After intervention, IONM data improved in 70.7% of patients (Full improvement: N=15; Partial improvement: N=14). For those with full and partial IONM recovery, severe weakness was 6.7% (1/15) and 21.4% (3/14), respectively. In comparison, for those without any improvement by closure, 58.3% (7/12) had severe POD1 weakness (P=0.009).

Conclusion
In spinal deformity surgery, root-level data loss followed by intraoperative interventions lead to data improvement in 71% of patients. Those with full and partial recovery of IONM are significantly associated with a lower risk for severe (motor strength grade 3 or less) lower extremity weakness with an absolute risk reduction of 51.7% and 37%, respectively.

Timing of IONM Root Loss, N=41	#	%
After Rod	11	26.8%
After Screws	7	17.1%
Decompression/Laminectomy	6	14.6%
During 3CO	5	12.2%
TLIF	4	9.8%
Decompression/PCO	3	7.3%
Positional	3	7.3%
Kickstand	2	4.9%
Interventions	**#**	**%**
Further Decompression	28	68.3%
Screw Revision	5	12.2%
Positional	3	7.3%
Less Correction	2	4.9%
Increased MAP Alone	2	4.9%
Normal WUT	1	2.4%

171. Liposomal Bupivacaine Results in a Six-Fold Reduction of Inpatient Opioid Use Following Posterior Spinal Fusion (PSF) in Adolescent Idiopathic Scoliosis (AIS) Surgery

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Hypothesis
Liposomal bupivacaine can effectively eliminate the need for post-operative PCA and significantly reduce opioid usage, without negatively impacting postoperative pain scores, following PSF surgery in patients with AIS.

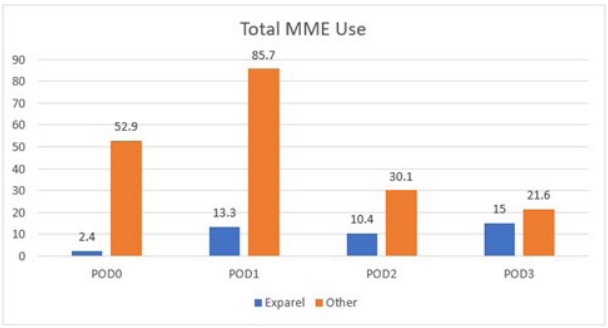
Design
Single-center, retrospective study of children with AIS undergoing PSF over a 5-year period at a single institution

Introduction
Historically our institution has used intra-operative intrathecal (IT) morphine, or IV methadone paired with postoperative patient-controlled analgesia (PCA) for perioperative AIS analgesia. To align with evidence-based practices that aim to optimize patient outcomes and minimize opioid-related harm, we recently transitioned to intraoperative intravenous methadone with liposomal bupivacaine (LB) intra-muscular infiltration.

Methods
Patients were subdivided according to their peri-operative pain pathway into 3 cohorts: intrathecal (IT)morphine, methadone, or liposomal bupivacaine (LB). Patients with non-AIS, undergoing revision surgery, or a chronic pain condition were excluded. Patients with IT morphine and methadone received a postoperative hydromorphone PCA whereas LB patients did not. Inpatient opioid usage was recorded using morphine equivalents (MME).

Results
A total of 69 patients were identified (mean 14.7±1.7 years, 85.5% female). Patients were subdivided as: 41 IT morphine, 16 methadone, 12 LB,. Patients were fused a mean of 10.3 levels with a mean surgical time of 263 minutes (±67), with a mean LOS of 2.9±0.8 days. The mean opioid use for the inpatient stay was 162.4 MME (2.76±1.8 MME/kg). Patients receiving LB had significantly lower total opioid use when compared to the methadone and IT morphine groups (28.6±18.6 vs 190.5±100.8; P<0.001), which remained after correction for patient weight (0.5±0.3 MME/kg vs 3.2±1.6 MME/kg; P<0.001). Total opioid usage was significantly lower in the LB cohort at POD0 and POD1. There was no difference in total MME use between the IT morphine (IT) and methadone (M) cohorts (IT: 191.8±107.7 vs M:187.3±83.4). There was no difference in daily mean pain score between cohorts.

Conclusion
Opioid stewardship is a vital component in postoperative pain management following PSF for AIS. Incorporating LB while avoiding postoperative PCA use resulted in a six-fold reduction of inpatient opioid usage while eliciting similar daily pain scores.



Total opioid usage was significantly lower in the LB cohort at POD0 and POD1.

172. Low Utility of Pre-Operative Cardiology Referrals Using a Cutoff of Cobb >70 Degrees for Patients with Adolescent Idiopathic Scoliosis

Alyssa Barre, MD; Andrew Kirk, MD; Ryan D Muchow, MD; Vishwas R. Talwalkar, MD; Aamir Kadri, MD; Vincent Prusick, MD

Hypothesis
Referral of AIS patients undergoing PSF to cardiology for preoperative clearance using a Cobb angle cutoff of >70° has low clinical utility.

Design
Retrospective

Introduction
Larger scoliotic curves raise cardiopulmonary concerns. Literature indicates higher incidences of congenital cardiac malformations, valvular anomalies, and pulmonary hypertension in patients with idiopathic scoliosis. Often, larger curves are referred to cardiology for pre-operative assessment and clearance. This study aimed to evaluate the utility of pre-op-

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erative cardiology referrals for patients with Cobb angles >70°.

Methods
Patients undergoing PSF for AIS from 2017-2024 were reviewed. Cobb angles, symptoms, auscultation, EKG, and TTE findings were documented, along with cardiology interventions or follow-up needs.

Results
Among 134 patients who underwent PSF for AIS, 31 had Cobb angles >70° and were referred to cardiology for preoperative clearance, along with 12 patients with Cobb <70° but who had symptoms, EKG findings, or murmur. Of those with Cobb >70°, three (10%) had significant findings warranting additional intervention or follow-up. One patient had a significant murmur identified at their preoperative anesthesia appointment, and another had cardiac symptoms and an abnormal EKG, leaving only one (3.2%) who had no symptoms, no murmur, and a normal EKG. Five patients (three with Cobb >70° and two with Cobb <70°) had findings warranting intervention or follow-up. Four of these five patients (80%) had either cardiac symptoms, a murmur, or an abnormal EKG at their preoperative anesthesia appointment. Ten patients (19%) with Cobb >70° had cardiac symptoms (dyspnea, palpitations, chest pain) compared to three patients (3%) with Cobb <70° (p=0.0017). No patients had surgery delayed by cardiology referral or findings. No patients had adverse cardiac events related to their surgery.

Conclusion
In patients with AIS with no cardiorespiratory symptoms, murmur, or EKG abnormalities, TTE yielded abnormal findings in 3.2%, comparable to reported norms of 3.7% in the general adolescent population. Using a Cobb angle cutoff of >70° for preoperative cardiology referral did not identify any additional cardiac pathology beyond expected norms. However, patients with Cobb angle >70° were more likely to report cardiac symptoms (palpitations, dyspnea on exertion, chest pain).

173. Impact of Postoperative Dexamethasone on Inflammation and Opioid Consumption Following Psf for AIS: A Prospective Study

Nicholas D. Fletcher, MD; Hilary Harris, BS; Tracy Ruska, NP

Hypothesis
Postoperative dexamethasone would decrease both inflammation and opioid consumption following PSF for AIS.

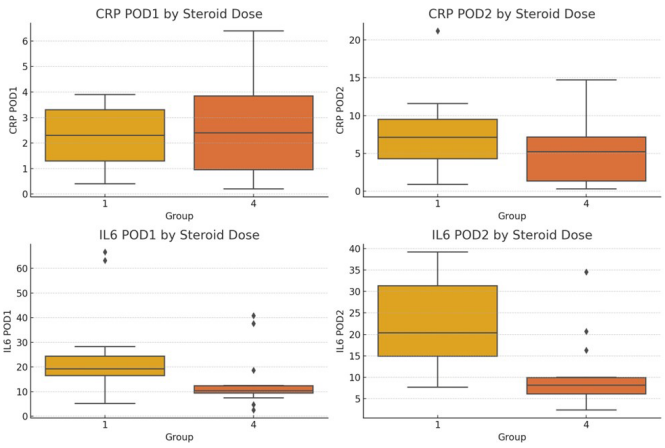
Design
Prospective sequential cohort study of patients treated with and without postoperative dexamethasone.

Introduction
Perioperative dexamethasone has been associated with a decrease in opioid consumption in retrospective studies following PSF for AIS however no prior studies have evaluated the biochemical response to postoperative steroids to help clarify the mechanism of action.

Methods
A prospective cohort of AIS patients was analyzed. All patients received an intraoperative dexamethasone dose (0.15 mg/kg) and were divided into two groups: those receiving 0 (NS) or 3 postoperative doses (WS) administered every 8 hours. Serum interleukin-6 (IL-6) and C-reactive protein (CRP) levels were measured on postoperative days (POD) 1 and 2. Opioid consumption was calculated as morphine milligram equivalents (MME). Surgery duration was stratified as long (>4 hours) or short (≤4 hours) to assess differential effects.

Results
15 patients were treated with postoperative steroids, and 15 without postoperative steroids. The groups were similar in age, BMI, curve magnitude, and surgical characteristics. IL-6 levels were lower in the WS group on POD1 (13.9 ± 10.9 WS vs. 23.9 ± 18.2 NS, p=0.01) and POD2 (10.5 ± 8.1 WS vs. 21.2 ± 9.9 NS, p=0.001). Longer surgeries were associated with higher IL-6 levels in both groups, but WS showed a greater reduction in IL-6 levels compared to the NS in long surgeries (POD2: 12.3 ± 8.7 WS vs. 25.1 ± 10.5 NS, p=0.002). The difference in IL-6 levels was not seen in shorter surgeries. CRP levels did not differ between groups on either POD1 or POD2. Opioid consumption was 23% lower in the WS group on POD1 (18 ± 8 WS vs. 24 ± 5 NS, p=0.06) and 25% lower overall (33 ± 12 WS vs. 44 ± 13 NS, p=0.02). No significant difference was observed on POD2. Multivariable regression confirmed that steroid use independently reduced IL-6 levels on POD2 and total opioid consumption. Length of stay was similar between groups, and no complications occurred.

Conclusion
Perioperative dexamethasone was associated with reductions in IL-6 levels and opioid consumption, particularly in longer surgeries. This effect on inflammation was primarily driven by IL-6, a dynamic serum marker, rather than CRP. Postoperative steroids reduced opioid consumption by approximately 25%.



CRP and IL6

174. Economic Benefits of Rapid Recovery Pathway Protocol Utilizing Intrathecal Morphine

Vishal Sarwahi, MD; Katherine Eigo, BS; Effat Rahman, BS; Cole Dutton, BS; Nora Donahue, BS; Sayyida Hasan, BS; Keshin Visahan, BS; Benita Liao, MD; Yungtai Lo, PhD; Jon-Paul P. DiMauro, MD; *Terry D. Amaral, MD*

Hypothesis
Rapid Recovery Pathway (RRP) protocol utilizing intrathecal morphine (ITM) has important cost-saving outcomes, while reducing pain and opioid consumption.

Design
Retrospective cohort study

Introduction
At our institution, our RRP protocol, introduced in 2018, utilizes ITM (ITM-RRP) which has allowed for the elimination of PCA, decreasing opioid consumption while providing adequate pain control. It has also reduced length of stay and narcotic refills. We sought to investigate cost outcomes of ITM-RRP in this large sample.

Methods
Patients with AIS undergoing primary instrumentation and fusion by three senior attendings between 2014-2023 were included. Patients who were operated on prior to the ITM-RRP protocol (2014-2017) were in the PCA group (n=250). Patients operated on after 2018 were in the ITM-RRP group (n=400). Patient outcomes measured include operative time, anesthesia time, estimated blood loss (EBL), maximum pain score at activity (POD 0 – 2), time to OOB, LOS, rate of transfusions, 90-day complications, narcotic refills, and morphine consumption at various timepoints. Cost outcomes measured included intraoperative anesthesia cost, postoperative anesthesia cost, ICU stay cost, total length of stay cost, operating room cost, and total cost. Wilcoxon rank-sum, Kruskal-Wallis, and Chi-Squared tests were used in data analysis to determine statistical significance.

Results
Operative time ($p<0.001$), anesthesia time ($p=0.03$), EBL ($p<0.001$), LOS ($p<0.001$), time to OOB ($p<0.001$), and morphine consumption ($p<0.05$) were significantly lower in the ITM-RRP group. Maximum VAS scores at activity were lower for the ITM-RRP group. Intraoperative ($p<0.001$) and postoperative medication costs ($p<0.001$), operating room costs ($p<0.001$), and total hospital stay costs ($p<0.001$) were significantly lower for ITM-RRP. There was no difference in ICU stay cost ($p=0.36$). Total cost was lower in ITM-RRP by approximately 17%, due to shorter hospital stay and lower anesthesia costs.

Conclusion
ITM-RRP decreases total cost with savings of about 9,000-10,000.00 USD per case. For an institution performing 100+ cases a year, this can result in significant cost savings. In addition, it also decreases the number of opioids prescribed and consumed while having better pain scores, earlier mobilization, and earlier discharge. The superior costs benefits are a result of a shorter length of stay and reduction in anesthesia medications.

175. the Importance of Postoperative Thoracic Kyphosis as a Predictor of Pain Improvement in Adolescent Idiopathic Scoliosis: A Multicenter Study.

Alejandro Gomez-Rice, MD, PhD; Susana Núñez Pereira, MD; Sleiman Haddad, MD, PhD, FRCS; Riccardo Raganato, MD; Francisco Javier S. Perez-Grueso, MD; Frank S. Kleinstueck, MD; Ibrahim Obeid, MD; Ahmet Alanay, MD; Ferran Pellisé, MD, PhD; Javier Pizones, MD, PhD; European Spine Study Group

Hypothesis
Some postoperative radiographic parameters (RP) may predict pain improvement after surgery in Adolescent Idiopathic Scoliosis (AIS) patients with significant preoperative pain.

Design
Retrospective multicenter observational study

Introduction
The relationship between pain and AIS and the factors involved in its postoperative improvement remain unknown. Our objective was to evaluate whether any RP could help predict a clinically significant improvement in pain after surgery in these patients.

Methods
A total of 378 AIS patients who underwent surgery were identified. The study included those with significant preoperative pain (SRS-22 pain score ≤ 4).To assess pain improvement beyond the immediate postoperative period, we analyzed the pain delta using the SRS-22 pain domain one year after surgery. Patients were divided into 2 groups: those who achieved a clinically meaningful improvement (MCID > 0.6) and those who did not. A multivariate logistic regression identified independent predictors.

Results
Of the 88 patients included (mean age 14.7 ± 1.8 years; 77 females), 64 achieved MCID, while 24 did not. Both groups were comparable in baseline demographics, surgical factors, and preoperative RP. However, postoperative thoracic kyphosis (TK) values differed: those who achieved MCID had a T2-T5 kyphosis of 12.7 ± 7.6, compared to 17.2 ± 7.9 in those who did not ($p = 0.030$). Similarly, T2-T12 kyphosis was 38.7 ± 10.8 in the MCID group and 30 ± 8.8 in the non-MCID group ($p = 0.001$). In the final model (see table), lower preoperative SRS-22 pain scores, lower postoperative T2-T5 kyphosis, and higher postoperative T2-T12 kyphosis were predictors of achieving MCID one year after surgery. A 5° increase in postoperative T2-T5 kyphosis reduced the likelihood of achieving MCID by 70%, while a 10° increase in postoperative T2-T12 kyphosis increased the likelihood by 3.4 times. The model was statistically significant ($p = 0.000$) and correctly predicted 94.3% of the outcomes.

Conclusion
In AIS patients with significant pain, greater preoperative

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pain, lower postoperative T2-T5 kyphosis, and higher postoperative T2-T12 kyphosis were independent predictors of clinically meaningful improvement after surgery. These findings suggest that TK flattening and its associated reciprocal changes (increased kyphosis in unfused proximal segments) should be avoided for optimal outcomes.

Logistic Regression

Variables	B	OR	Wald	*P Value*	95% CI
Postoperative T2-T5 Kyphosis	-0.22	0.799	7.453	0.006	0.680-0.939
Postoperative T2-T12 Kyphosis	0.122	1.129	4.434	0.035	1.008-1.177
Preoperative SRS-Pain	-5.405	0.005	8.473	0.007	0.000- 0.177

OR: Odds Ratio. CI: Confidence interval

176. Adolescent Idiopathic Scoliosis Patients Undergoing Minimally Invasive Surgery Have Superior Pain Control to Traditional Posterior Spinal Fusion

Vishal Sarwahi, MD; Katherine Eigo, BS; Effat Rahman, BS; Brian Li, BS; Victor Koltenyuk, BS; Yungtai Lo, PhD; Terry D. Amaral, MD

Hypothesis
Patients who undergo MIS will have superior pain control than those who undergo a traditional approach.

Design
Retrospective study

Introduction
Adolescent idiopathic scoliosis (AIS) patients are typically supplied with narcotics for postoperative pain control. It is imperative to reduce opioid consumption in the adolescent patient population to reduce the risk of addiction. Minimally invasive surgery (MIS) has been shown to demonstrate significant benefits compared to posterior spinal fusion (PSF) in terms of pain control. The purpose of this study was to evaluate the MIS technique on postoperative recovery, particularly postoperative pain, when compared to the traditional PSF method in one tertiary medical institution.

Methods
AIS patients undergoing spinal surgery from 2011 – 2023 were reviewed retrospectively. Radiographic, surgical, and clinical data was collected for both MIS and PSF patients. In addition, narcotic consumption, pain score, time to catheter removal, and length of stay (LOS) were recorded. Kruskal-Wallis test was used for continuous variables, while Chi-squared test was used for categorical variables.

Results
317 patients were reviewed (MIS: 45; PSF: 272). Preoperative major Cobb angles were similar between the two groups ($p = 0.25$). MIS patients had significantly lower morphine consumption compared to PSF patients ($p<0.001$) as well as lower maximum pain scores at activity ($p = 0.039$) and length of stay (3 days vs. 5 days $p<0.001$). Patients were matched based on levels fused, amongst patients with <12 levels fused, MIS patients had significantly lower total morphine consumption ($p = 0.007$), significantly shorter time to catheter removal ($p = 0.023$), but similar pain scores at activity ($p = 0.874$). In patients with ≥ 12 levels fused, MIS patients had significantly lower total morphine consumption ($p < 0.001$) and lower maximum pain scores at activity ($p = 0.007$) but similar time to catheter removal ($p = 0.428$).

Conclusion
This is the first study to objectively analyze pain measures between MIS and PSF patients. Patients seem to benefit from MIS through decreases in length of stay, narcotic consumption, and postoperative pain scores. Pain control in spine surgery should continue to be investigated to avoid use of narcotics in the young population as much as possible.

177. Is Medullar Canal Invasion as a Predictor for Posterior Ligamentous Complex Injury in Thoracolumbar Burst Fractures?

Murat Korkmaz, MD; Taha furkan Yağcı, MD; Yekta Furkan Altin, MD; Turgut Akgul, MD

Hypothesis
There is a direct relationship between the amount of medullary canal invasion after trauma and PLC injury.This cut-off value will be a guide in cases where MRI cannot be performed or in cases where urgent surgical intervention is required.

Design
Clinical trial

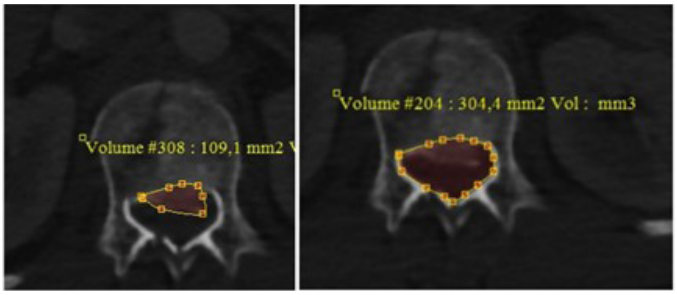
Introduction
Posterior ligamentous complex(PLC) acts a major role in spinal stability and injury of this structure leads to spinal instability. In this study,correlation of medullar canal invasion and PLC injury were evaluated.

Methods
A total of 58 patients with thoracolumbar fractures were retrospectively evaluated between January 2013 and December 2022.Exclusion criteria include flexion distraction and fracture dislocation injuries and pathological fractures.Computed tomography(CT) was performed to asses the medullar canal invasion and magnetic resonance imaging(MRI) was performed to assess the PLC injury.The compromise of the spinal canal defined as the ratio of the amount of the canal compromise to total spinal canal diameter at the cross-sectional area of injured level.Loss of vertebral body height(LOVBH),local kyphosis(LK),vertebral body translation,interlaminar distance(ILD), supraspinous distance(SSD),and interspinous distance(ISD) were also evaluated radiographically.

Results
42 patients were included in the study.There were 25 males(59.5 %) and 17 females(40.5 %),and the average age was 38.2(15.3) years.The mean follow-up time was 19.9(21.9) months.Preoperative STIR-weighted MRI showed that 17 patients had PLC injury.Based on the comparison of the radiographic parameters according to presence of the PLC injury,a significant difference was found between

the two groups only in canal compromise (p<0.001).The results of ROC curve analysis indicate that medullar canal compromise rate greater than %27.99 is a predictive factor for posterior ligamentous injury.[area under the curve (AUC) 0.838; 95% CI 0.714-0.961; p<0.001; 82.4% sensitivity; 80% specifity].

Conclusion
The results of our study indicate that LOVBH,LK,vertebral body translation,ILD,ISD, and SSD were not associated with the presence of a PLC injury,while medullar canal compromise percentage greater than 28% was associated with PLC injury.Our data demonstrate that canal compromise rate measured with CT at the cross-sectional area of injured level is a reliable indicator for PLC injury.



Measurement of medullary canal compromise rate

178. Dynamic Spinal Cord Mapping: A Study of Accuracy, Sensitivity, and Specificity in Localizing Spinal Cord Injury Using an Animal Model

Adam Mansour, MD; Mutaleeb Shobode, MBBS; Kirsten Tulchin-Francis, PhD; Daryn Strub, BA; Anirejuoritse Bafor, MBBS; Darek Stanfield, D.C., CNIM; Reid C. Chambers, DO; *Allen Kadado, MD*

Hypothesis
Dynamic spinal cord mapping (DSCM) can accurately detect and localize spinal cord injury (SCI) with high sensitivity, accuracy, and specificity, improving intraoperative monitoring in spinal deformity surgery.

Design
Prospective controlled animal study using a porcine model.

Introduction
Spinal deformity surgeries present a significant risk of spinal cord injury (SCI), necessitating precise intraoperative neuromonitoring (IONM). While TcMEPs and SSEPs reliably detect signal loss, they lack the resolution to localize specific area of SCI. The technique described as dynamic spinal cord mapping (DSCM), utilizing descending neurogenic evoked potentials (DNEPs), aims to fill this gap by offering specificity and accuracy in pinpointing SCI. This study evaluates the sensitivity, specificity, and feasibility of DSCM in a pig model of thoracic SCI.

Methods
A total of 10 pigs underwent single-level thoracic SCI induction (T5-T9) using a 100g weight to compress the spinal cord. Compression continued until signal loss was detected on TcMEPs/SSEPs, confirmed by amplitude and latency changes. Following SCI, DSCM was performed by recording DNEPs at each thoracic level using an epidural catheter. Notably, conduction was recorded proximally and distally. A blinded neurophysiologist interpreted the DNEP data to localize the specific site injury. Sensitivity, specificity, and accuracy of DSCM were calculated by comparing DNEP findings to the known SCI level.

Results
The results demonstrated that DSCM performed exceptionally well across all evaluated metrics. Sensitivity was 100%, indicating that signal changes were consistently detected in all cases of spinal cord injury (SCI). Accuracy also achieved 100%, with the neurophysiologist correctly localizing the precise level of injury in every instance. Specificity was 70% for exact level identification without detecting changes at other levels, improving to 90% when cases localized within one level of the injury were included.

Conclusion
Dynamic spinal cord mapping is a promising intraoperative tool for precise localization of SCI. These findings confirm DSCM's effectiveness in reliably detecting and localizing SCI while minimizing false positives from adjacent levels. The results of this study support its integration into clinical practice to improve safety and outcomes in complex spine deformity surgeries.

179. "Transient Spinal Neuropraxia in Pediatric Patients" (T-SNIPP): Analysis of an Institutional Experience Four Decades After the Introduction of Sciwora

Diwas Gautam, BS; Douglas L. Brockmeyer, MD; *Rajiv Iyer, MD*; Vijay Ravindra, MD; Kyril Cole, BS; Katie Russell, MD

Hypothesis
To investigate the incidence and clinical characteristics of pediatric patients with true imaging-negative traumatic cervical spinal cord injuries (SCIs).

Design
Retrospective review

Introduction
The concept of "spinal cord injury without radiographic abnormality" (SCIWORA) was introduced in the 1980s. Unfortunately, the nomenclature creates confusion in the modern MRI-based era when applied to pediatric traumatic spinal injuries.

Methods
A prospective pediatric Level 1 trauma center database at Primary Children's Hospital was queried to identify patients with cervical spine injuries tagged with "SCIWORA" or "transient spinal cord injury." Demographic and clinical data were analyzed retrospectively after applying the following inclusion/exclusion criteria: patient age ≤16 years, evidence of transient neuropraxia on neurological examination, cervical spine MRI available for review, Glasgow Coma Scale (GCS)

score ≥8, no intracranial pressure monitoring during hospitalization, and no evidence of SCI on MRI.

Results

Of the 226 patients who met the initial search criteria, 21 met the final inclusion criteria. Eighteen patients were male (85.7%), and the mean age was 13.66±2.48 years. The median GCS score was 15 (IQR 13–15). Neurologic deficits noted on presentation included sensory, motor, and rectal tone loss in 19 (90.5%), 19 (90.5%), and 1 (4.8%) patients, respectively. The most common mechanism of injury was American football (10 patients, 47.6%), followed by wrestling (4, 19.0%) and motor vehicle collisions (2, 9.5%). The mean hospital stay was 1.81±0.98 days (range 1–5), with 3 (14.3%) patients admitted to the pediatric intensive care unit for 1.33±0.58 days on average. All 21 patients were initially managed with a rigid cervical orthosis worn for 1–42 days (mean 4.57±5.42). Neurological symptoms completely resolved by discharge in 16 (76.2%) patients. No patient required surgery or prolonged collar usage.

Conclusion

In this cohort, patients with MRI-negative neuropraxic cervical SCI were predominantly adolescent male athletes who recovered from their injuries within a few days without surgery or prolonged use of cervical collars. The authors assert that the term “transient spinal neuropraxia in pediatric patients” (T-SNIPP) is more appropriate to describe these injuries in the modern, MRI-based era of pediatric trauma care.

201. Incidence, Risk Factors and Long-Term Consequence of Neurological Complications After Surgery for Degenerative Cervical Myelopathy

Michael G. Fehlings, MD, PhD, FRCS(C)

Hypothesis
This study aims to investigate the occurrence and predictors of neurological complications using a large trial data.

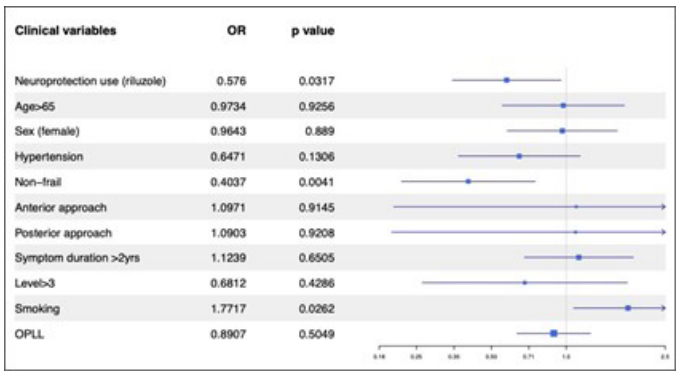
Design
Prospective analysis of the CSM-PROTECT (Cervical Spondylotic Myelopathy - PROTECT) Prospective trial

Introduction
Degenerative cervical myelopathy (DCM) is the most common cause of nontraumatic spinal cord dysfunction among adults. Surgery improves outcomes and enhances quality of life, but carries inherent risks, including postoperative neurological complications. The incidence and risk factors associated with neurological worsening however remains unclear.

Methods
Adult patients diagnosed with mild DCM were enrolled in the prospective CSM-PROTECT trial between 2012 and 2017. The primary outcome was postoperative neurological deterioration and symptom worsening, defined as the occurrence of postoperative C5 palsy, nerve root injury, worsening myelopathic symptoms, or the development of new numbness, neck, and shoulder pain. Patients were dichotomously categorized into groups with and without neurological complications. Functional and neurological outcomes were evaluated at one-year post-surgery and compared between groups using univariate and multivariate logistic regression analysis.

Results
Among the 290 patients enrolled in the CSM-PROTECT trial (mean age 57.95 years, 44.5% females, mean baseline mJOA =11.91), 117 patients (40.34%) experienced postoperative neurological complications following surgery. Non-frail (39.3% vs 23.1%, p=0.004), non-smokers (64.7% vs 52.1%, =0.032) and riluzole therapy recipients (54.9% vs 39.3%, p=0.009) were less likely to deteriorate. The majority of patients who developed postoperative numbness, root injury, and pain fully recovered without residual symptoms at one year (60%, 38.10%, 47.17%, respectively). Long term outcomes did not significantly differ between patients with and without neurological deterioration. After adjusting for covariates, significant predictors for neurological deterioration included the use of neuroprotective agent (OR: 0.58, CI 0.330-0.907, p=0.03), non-frailty (OR: 0.40, CI 0.210-0.733, p=0.004), and smoking (OR: 1.77, CI 1.033-2.851, p=0.026).

Conclusion
Neuroprotective-agent use (i.e riluzole), non-frailty and non-smoking are associated with reduced postoperative deterioration risk. Addressing these modifiable risk factors preoperatively may optimize DCM surgical outcomes.



Predictors

204. Predicting Necessity of Operation for Adolescent Idiopathic Scoliosis After Brace Application

Chang Ju Hwang, MD, PhD; Sehan Park, MD; Dong-Ho Lee, MD, PhD; Jae Hwan Cho, MD, PhD

Hypothesis
Prediction the possibility of operation after brace application would aid in clinical decision.

Design
Retrospective cohort study

Introduction
Bracing is recommended for adolescent idiopathic scoliosis (AIS) during the growth phase when the Cobb angle exceeds 25°, aiming to prevent curve progression. Known risk factors for brace failure include greater Cobb angle at presentation, lower Risser stage, younger age, and low correction rates. The integration of these factors to predict the need for surgery after bracing has not been studied. This study aimed to develop a predictive model to assess the likelihood of surgery in AIS patients treated with a brace.

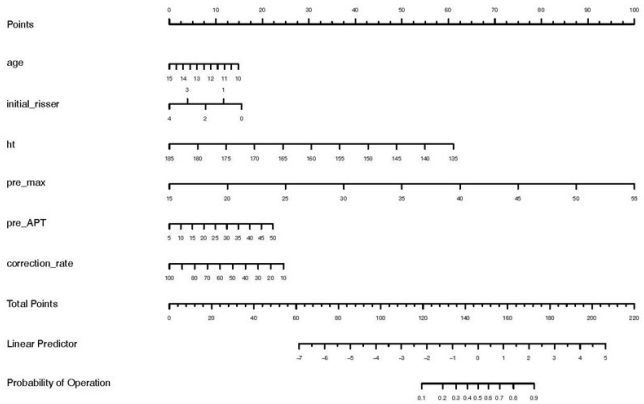
Methods
A total of 205 AIS patients treated with bracing were included. Patients were classified into the brace-success group if surgery was not required by growth completion and the brace-failure group if surgery was indicated during follow-up. Logistic regression identified factors associated with brace failure. Patients were split into a training set (70%) and a validation set (30%). A predictive nomogram was developed using significant factors from the regression analysis. The nomogram's performance was assessed with calibration plots, the Hosmer-Lemeshow test, and receiver operating characteristic (ROC) curve analysis.

Results
Of the 205 patients, 44 (21.4%) required surgery and were classified as brace-failure, while 161 (78.5%) were classified as brace-success. Significant factors for brace failure included age (p=0.003), height (p=0.005), Risser grade (p=0.018), largest Cobb angle at presentation (p<0.001), apical vertebral translation (p<0.001), and correction rate (p=0.046). A

E-POINT PRESENTATION ABSTRACTS

nomogram was created using these factors. The Hosmer-Lemeshow test indicated good fit (p=0.261 for training and p=0.153 for validation). The area under the ROC curve was 0.914 for the training set and 0.812 for the validation set, showing excellent predictive performance. Calibration plots and ROC curves confirmed the nomogram's accuracy.

Conclusion
A predictive nomogram was developed to estimate the likelihood of surgery in AIS patients treated with bracing. Key predictors included age, height, Risser grade, largest Cobb angle, apical vertebral translation, and correction rate. The nomogram demonstrated excellent predictive performance, with high AUC values and good calibration. It can help clinicians identify high-risk patients and guide personalized treatment decisions.



Nomogram

205. Is Lumbar Lordosis an Adaptative Segment Between Pelvic Incidence and Thoracic Kyphosis? A New Approach of Sagittal Alignment Based on 764 Subjects

Sebastien Pesenti, MD, PhD; Solène Prost, MD; Yann Philippe Charles, MD, PhD; Benjamin Blondel, MD, PhD

Hypothesis
Lumbar Lordosis is an adaptative segment driven by both PI and TK

Design
Retrospective normative study

Introduction
Literature reported that spinal sagittal curvatures are defined by the magnitude of pelvic incidence. Therefore, this chain of correlation implies that magnitude of PI will define the amount of LL, which will subsequently define the amount of TK. However, thoracic spine is a rigid segment; therefore, it is likely that LL adapts to TK rather than the other way around.

Methods
We analyzed the radiographs of 764 asymptomatic adults (18-50 yo). Different sagittal parameters were measured and compared, including PI, L1S1 LL and T1T12 TK. Secondarily, stratification by PI groups (<45°, 45-60°, >60°) and TK groups (<35°, 35-55°, >55°) was obtained. Distribution of subjects according to PI and TK was analyzed using Chi-2 test, correlations between parameters were evaluated using Pearson tests and means were compared ANOVA tests.

Results
On the whole series, mean age was 36yo, TK was 43°, LL 56° and PI 51°. Significant correlations were found between LL and PI (r=0.525, p<0.001) and between LL and TK (r=0.35, p<0.001), but not between TK and PI (p=0.078). After stratification by PI, significant differences between groups were found for LL and PT (p<0.001) but not for age (p=0.2) or TK (p=0.078). Among the 247 subjects with a low PI (<45°), only 25% of them had a low TK (<35°). On the other hand, among the 172 subjects with high PI (>60°), only 21% had a high TK (>55°). Repartition of TK groups was not different among PI groups (p=0.228). In each PI group, ANOVA tests revealed a significant increase in LL values (p<0.001) among TK groups, without changes in PT (p>0.05). This correlation between the increase of LL and TK in each group was significant (p<0.001).

Conclusion
The traditional upward chain of correlation stating that low PI=low LL=Low TK or high PI=high LL=high TK is probably not a correct way to assess sagittal alignment. For TK, this representation is correct for 60% of subjects with an intermediate PI (45-60°), but for only 25% of subjects with a low PI (<45°) and 21% of subjects with a high PI (>60°). While PI and TK are not directly correlated, a different way of sagittal alignment evaluation should consider both PI and TK as predetermined for each subject and LL as the only adaptative segment between these two constant parameters.

206. Is Fusion to the Stable Sagittal Vertebra Necessary to Avoid Distal Junctional Kyphosis in Thoracic Adolescent Idiopathic Scoliosis?

Lærke C. Ragborg, MD; Martin Heegaard, MD; Thomas B. Andersen, MD, PhD, DMSc; Martin Gehrchen, MD, PhD; Benny T. Dahl, MD, PhD, DMSc; *Soren Ohrt-Nissen, MD, PhD*

Hypothesis
Fusion proximal to the stable sagittal vertebra (SSV) in adolescent idiopathic scoliosis (AIS) patients undergoing selective thoracic fusion does not increase the incidence of distal junctional kyphosis (DJK).

Design
Single-center, retrospective consecutive cohort study

Introduction
Selection of fusion levels in the surgical treatment of AIS is complex, as motion preservation and sufficient construct length to avoid DJK often are contradictory. The SSV has been proposed as a key sagittal parameter to consider when

choosing fusion levels. Studies have suggested an elevated risk of DJK in cases where the fusion is ending proximal to the SSV. With limited literature on the topic, further evidence is needed to determine whether including the SSV in the fusion provides significant benefits.

Methods
We retrospectively reviewed a consecutive cohort of surgically treated AIS patients with Lenke 1-2 curves with A and B modifiers between 2011 and 2022 with a minimum of 2 years of follow-up. The SSV was defined as the vertebra bisected by the posterior sacral vertical line on long-standing sagittal radiographs. All patients underwent posterior pedicle screw instrumentation and the decision of fusion level was at the surgeons' discretion. Distal junctional kyphosis was defined as ≥10° angulation between the lower instrumented vertebra (LIV) and the vertebra below the LIV (LIV+1). Patients were stratified into; Fusion proximal of SSV (Prox-SSV) and fusion including SSV (Incl-SSV). Multivariable backward regression was performed to identify predictors for DJK.

Results
A total of 196 patients were included, with 80 in the Prox-SSV group. The overall DJK rate was 4% (7/196), occurring in 6% (5/80) in the Prox-SSV group and 2% (2/116) in the Incl-SSV group, respec-tively (p=0.125). Fusion proximal of SSV did not significantly increase DJK risk (Univariate OR 7.98, 95% CI 0.87–66.6; excluded in multivariable regression). Using SSV for LIV selection would extend the fusion by one level in 64%, two in 25%, and three in 11% of patients.

Conclusion
The overall risk of DJK is small in thoracic curves and fusion proximal to the SSV did not significantly increase the risk of DJK. Standardized use of SSV as LIV would result in a substantial extension of the fusion area with questionable benefits to the patients.

207. What is the Optimal Last Instrumented Vertebra in Selective Thoracic Fusion for Patients with Adolescent Idiopathic Scoliosis?: T12 Vs L1†

Chang Ju Hwang, MD, PhD; Sehan Park, MD; Hyuk-joon Sohn, MD

Hypothesis
In selective thoracic fusion(STF) for adolescent idiopathic scoliosis (AIS), extending the fusion to L1 rather than T12 may incorporate a greater portion of the lumbar curve, thereby facilitating a more pronounced spontaneous correction of the unfused lumbar segments.

Design
A retrospective review was conducted on AIS patients (Lenke 1B, 1C, 3B, or 3C) who underwent STF with the last instrumented vertebra (LIV) at either T12 or L1 between February 2012 and December 2021. All patients had a minimum follow-up period of two years. Based on the LIV level, they were allocated to either the T12 group or the L1 group.

Introduction
In STF, the primary concern is often inadequate spontaneous lumbar curve correction (SLCC), which leads to residual deformity rather than the more widely discussed issues of coronal decompensation or adding-on. Since T12 and L1 are commonly selected as the lowest instrumented vertebrae (LIV), this study aims to determine whether extending the fusion to L1 can enhance SLCC and thereby mitigate residual deformities.

Methods
Radiographic evaluations included Cobb angle, percent correction, coronal balance, LIV disc angle, lumbar apical vertebra translation, distal junctional angle, and sagittal balance. Patient-reported outcomes were assessed using the Scoliosis Research Society (SRS) questionnaires. Comparisons were made between the LIV-T12 and LIV-L1 groups preoperatively and at a minimum follow-up of two years.

Results
A total of 85 patients (LIV-T12: 15, LIV-L1: 70) were included in this study. Baseline demographic characteristics (age, height, weight, and follow-up period) were similar in both groups (p > 0.05). The mean main thoracic curve correction was significantly greater in the LIV-L1 group (80.8% vs. 74.4%, p < 0.05). The LIV-L1 group also exhibited approximately 10% greater SLCC. All patients in both groups achieved satisfactory coronal balance postoperatively, and the incidence of adding-on or distal junctional kyphosis was minimal.

Conclusion
Using L1 as the LIV resulted in superior main thoracic curve correction and greater spontaneous correction of the lumbar curve. Therefore, L1 appears to be a more favorable choice for LIV in STF for AIS without increasing the risk of serious coronal decompensation or adding-on.

	LIV		
	T12	L1	p
Post MT	14.2±5.5	10.2±5.6	0.021
Post TL-L	18.3±7.3	13.0±7.1	0.011
MT correction	74.3±9.8	80.8±9.8	0.023
TL-L correction	55.6±16.7	64.3±19.2	0.110
LIV-CSVL	12.5±6.1	14.1±7.1	0.452
LAV-CSVL	20.7±5.7	15.7±6.3	0.006
LAV translation correction	-7.7±32.9	-12.7±49.5	0.710
C7-CSVL	-7.1±8.7	-5.9±11.0	0.688
Coronal imbalance	6.7%(1/15)	7.1%(5/70)	1.000
Adding on	0%(0/15)	0%(0/70)	1.000
Distal Junctional angle	1.32±2.2	2.11±3.0	0.353
DJK	0%(0/15)	1.4%(1/70)	1.000
Pre SRS-22	53.3±4.9	52.8±4.6	0.807
Post SRS-22	49.5±4.1	49.1±4.5	0.833

MT : Main Thoracic, TL-L : Thoracolumbar and Lumbar, LIV : Last Instrumented Vertebra, CSVL : Central Sacral Vertical Line, LAV : Lumbar Apical Vertebra, DJK : Distal Junctional Kyphosis

†Louis A. Goldstein Best Clinical Research E-Point Presentation

E-POINT PRESENTATION ABSTRACTS

208. Comparing Surgeons to an AI-Algorithm to Identify Non-Idiopathic Scoliosis

Kellen Mulford, PhD; *Hans K. Nugraha, MD*; Julia Todderud, BA; Todd A Milbrandt, MD, MS; Melvin D. Helgeson, MD; A. Noelle Larson, MD

Hypothesis
A deep learning-based image classifier will be as successful as experienced surgeons in differentiating idiopathic, congenital and neurogenic causes from 2-view spine x-rays.

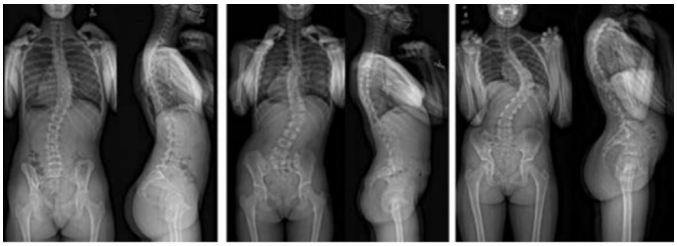
Design
Training, validation, and model testing based on a retrospective dataset

Introduction
We sought to develop a classifier for preop spine x-rays capable of differentiating between scoliosis etiologies including idiopathic, congenital, or neurogenic scoliosis due to syrinx, tethered cord, or Chiari malformation. As treatment may differ due to the underlying etiology, tools that can reliably & efficiently differentiate x-ray input and help physicians weigh the need for screening MRI.

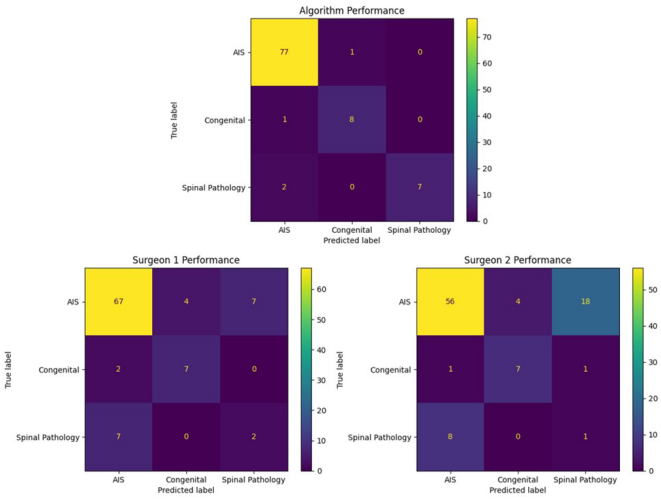
Methods
1036 pediatric patients at a single institution with confirmed scoliosis diagnosis and paired AP & lateral images from the same visit were included. Patients were manually classified based on their etiology from EMR review and MRI. Categories included idiopathic, congenital, and scoliosis related to cord pathology. Images were then randomized & assigned in 80:10:10 split for training, validation, and testing. A deep learning classifier using the EfficientNet B4 architecture was trained on paired x-rays. Accuracy & positive predictive value as defined by precision, recall, and F1 score were calculated to assess final performance metrics.

Results
The trained classifier performed very well at identifying the correct etiologies, with F1-Score (harmonic mean of precision & recall) of 0.97. Model precision in identifying AIS was 0.99, 0.89 for congenital, and 0.78 for cord pathology groups. Errors were mostly misidentified as AIS by the model, while AIS was mostly misidentified as cord pathology. Compared to 2 senior spine surgeons, the algorithm has the highest overall precision (0.96), recall (0.96), and F1 (0.96), while the two surgeons had lower accuracies (precision 0.80, recall 0.79, F1 0.79, & precision 0.76, recall 0.67, F1 0.71, respectively).

Conclusion
A deep learning convolutional neural network classifier has been trained to a high degree of accuracy to distinguish between 3 classes of etiologies for scoliosis on spine radiographs of pediatric patients. This has potential for improving diagnoses and need for referral for axial imaging. Our study found the AI model had superior diagnostic performance compared to surgeons.



	Overall				AIS				Congenital				Spinal Pathology			
	N	Precision	Recall	Accuracy	N	Precision	Recall	F1-Score	N	Precision	Recall	F1-Score	N	Precision	Recall	F1-Score
Algorithm	96	0.96	0.96	0.96	78	0.96	0.99	0.97	9	0.89	0.89	0.89	9	1.00	0.78	0.88
Surgeon 1	96	0.80	0.79	0.79	78	0.88	0.86	0.87	9	0.64	0.78	0.70	9	0.22	0.22	0.22
Surgeon 2	96	0.76	0.67	0.71	78	0.86	0.72	0.78	9	0.64	0.78	0.70	9	0.05	0.11	0.07



209. Successful Nighttime Brace Treatment Modulates Growth in Children with Idiopathic Scoliosis

Karina A. Zapata, PhD, PT, DPT; Joshua B. Utay, EdD, CPO; KayLynn Beard, BS; Chan-Hee Jo, PhD; Daniel J. Sucato, MD, MS; *Megan E. Johnson, MD*

Hypothesis
Curves that improve with brace treatment have better symmetric vertebral growth while progressive curves have worsened asymmetric vertebral growth.

Design
Retrospective review

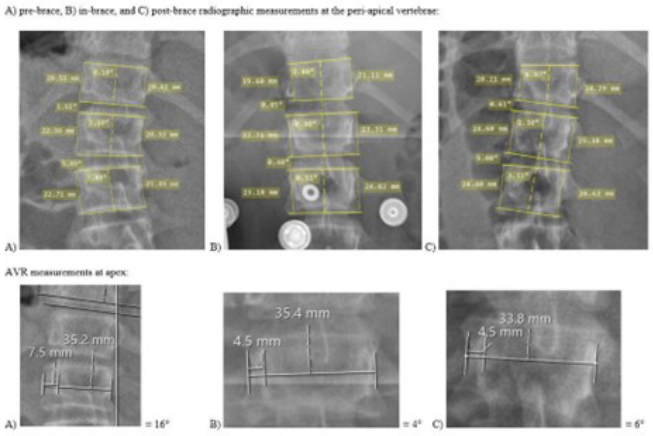
Introduction
Some patients with idiopathic scoliosis have improved curves during brace treatment. One hypothesis for this observation is vertebral body growth modulation. This study determined whether nighttime Providence bracing leads to vertebral body growth modulation in curves that improve ≥6° during treatment.

Methods
Patients at Risser 0 who completed nighttime brace treatment for idiopathic scoliosis with 2-yr follow-up were reviewed. Improved and progressive groups were matched by age, sex, curve location/magnitude (23°±2°), triradiate cartilage, brace adherence (8±2 hrs/night), and growth. Measurements were made pre-, in-, and post-brace. Vertebral body heights, vertebral wedging angles, and disc wedging

angles were measured at concave (cc) and convex (cv) sides of the 3 peri-apical vertebrae. Axial vertebral rotation (AVR) was measured using Raimondi's method at the apex.

Results
68 patients were included (45 improved, 23 progressive). Curves that got better during brace treatment improved by an average of 10°±4°. Pre-brace to in-brace, vertebral body heights increased more on the cc vs cv side (p<.001). Vertebral and disc wedging angles were better pre-brace to in-brace (p<.001). Pre-brace to post-brace, vertebral body heights increased more on the cc vs cv side (3.2 vs 2.5 mm, p=.001), vertebral wedging angles decreased (2.0° to 0.8°, p<.001), disc wedging angles decreased (3.6° to 1.5°, p<.001), and AVR improved (10.1° to 8.5°, p=.047). Curves that progressed during treatment did so by an average of 13°±8°. Pre-brace to post-brace, vertebral body heights increased more on the cv vs cc sides (3.4 vs 2.6 mm, p=.028), vertebral wedging angles increased (2.7° to 4.0°, p=.009), disc wedging did not change, and AVR worsened (9.8° to 13.3°, p=.007).

Conclusion
The mechanism for curve improvement in skeletally immature patients treated with a nighttime Providence brace may be due to vertebral body growth modulation as evidenced by better symmetric vertebral body growth post-brace compared to pre-brace. Patients with curve improvement also had significantly decreased axial vertebral rotation after bracing.



Peri-apical Vertebrae and AVR measurements

210. The Role of Scoliosis Specific Exercises in the Non-Operative Treatment of Adolescent Idiopathic Scoliosis: A Prospective Matched Cohort Study † ‡

Megan E. Johnson, MD; Ying Li, MD; Grant D. Hogue, MD; Maia Regan, BA; Jason B. Anari, MD; Jennifer J. Winell, MD; Kevin M. Neal, MD; Keith Baldwin, MD, MPH, MSPT

Hypothesis
Scoliosis specific exercises do not alter the natural history of curve progression in AIS.

Design
Prospective matched cohort

Introduction
The role of bracing and observation in the treatment of AIS is well documented. The role of physical therapy for decreasing the size of the curve or preventing progression remains controversial. Schroth therapy is the most commonly prescribed form of scoliosis specific exercise (SSE). A recent meta-analysis failed to show a clinically significant effect of SSE on curve magnitudes. Many studies on SSE fail to account for skeletal maturity and curve size, which are known predictors of curve progression. Our goal was to use a prospective multicenter database to match patients who received SSE with those who did not and assess curve progression while controlling for initial curve magnitude and skeletal maturity.

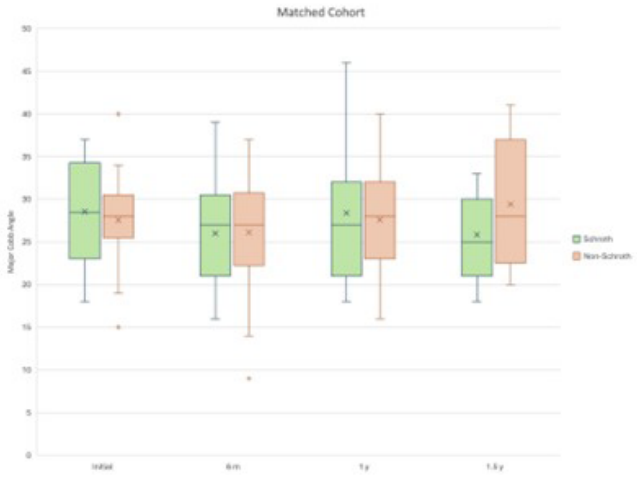
Methods
We utilized a multicenter database from several tertiary referral institutions to collect data on patients treated non-operatively for AIS. We identified 18 patients who were treated with SSE and matched them 1:1 with patients who did not by initial curve size as measured by the Cobb method and skeletal maturity as measured by the Sanders method. Patients were prospectively followed every 6 months until they required surgery or reached Sanders stage 7B. We compared patients at 6-month intervals to detect differences between patients who received SSE and those who did not. A difference in ≥ 5 degrees was considered clinically significant.

Results
There were no significant differences in age, skeletal maturity, or initial curve sizes detected between groups indicating that the groups were well-matched. We found no significant differences between groups at 6 months, 1 year, or 1.5 years in terms of curve size (all p>0.05). Only 28% of patients initially prescribed SSE were practicing those exercises at 1 year. Average brace wear was 14.2 hours for the SSE group (n=13) and 13.8 hours for the non-Schroth group (n=13). Brace wear was not significantly different between the two groups (p >0.05).

Conclusion
Although SSE are frequently prescribed for AIS, their role remains unclear. Our study failed to demonstrate any differences for SSE in altering the natural history of progression or improving compliance with bracing modalities. The majority of patients in our study no longer practice SSE at one year.

†Louis A. Goldstein Best Clinical Research E-Point Presentation ‡SRS Funded Research Grant

E-POINT PRESENTATION ABSTRACTS



211. Increasing Trends of Pediatric Thoracic and Lumbar Spine Fractures in the United States from 2004 to 2023: A 20-Year National Injury Review Depicting Shifts in Mechanisms of Injury

Patrick Nian, BA; Ithika Senthilnathan, BS; Isabella G. Marsh, BS; Christopher Williams, BS; *Jessica H. Heyer, MD*

Hypothesis
The incidence of pediatric thoracic and lumbar fractures has increased over the past 20 years.

Design
A retrospective query of nationally representative ED presentations in the National Electronic Injury Surveillance System (NEISS) database from 2004 to 2023

Introduction
Fractures of the thoracic and lumbar spine are uncommon pediatric injuries, but carry significant morbidity and mortality risk. There remains a paucity of meaningful epidemiological data with specific attention to the pediatric spine, which is not only unique to the adult spine, but also undergoes important changes throughout phases of skeletal maturation. This study aimed to characterize overall and sex- and age-specific trends, mechanisms of injury, and incidence risks of all-cause pediatric thoracic and lumbar fractures.

Methods
The NEISS was queried for patients aged 0-18 years old (children: <14; adolescent 14-18) who presented with all-cause thoracic and lumbar fractures between 2004 and 2023, yielding an estimated 28,814 thoracic fractures and 31,357 lumbar fractures. Incidence rates were calculated using provided national estimates and per US population. Linear regression characterized overall and demographic-specific trends. Incidence rate ratios (IRRs) compared demographic groups in regards to overall fracture incidence.

Results
The average annual incidence rate over the 20-year study span was 19±6 pediatric thoracic and 20±5 pediatric lumbar fractures per 1 million person-years. There were overall increasing trends in pediatric thoracic and lumbar fractures by 58 and 38 fractures per year, respectively, most notably among males. Falls from height and motorsports were the most common mechanisms of injury for pediatric thoracic and lumbar fractures. Motor vehicle accidents were minimal. The overall rate of thoracic and lumbar fractures was higher in males vs females (IRR: thoracic: 1.82, lumbar: 1.63) and in adolescents vs children (IRR: thoracic: 3.67, lumbar: 6.69).

Conclusion
An increasing propensity towards risky recreational activities that disproportionately affect adolescent males is likely responsible for increasing trends of pediatric thoracic and lumbar fractures. Our findings call for increased public policy in the form of mandatory protective equipment, formal safety training, and age requirements applied to a broad category of recreation.

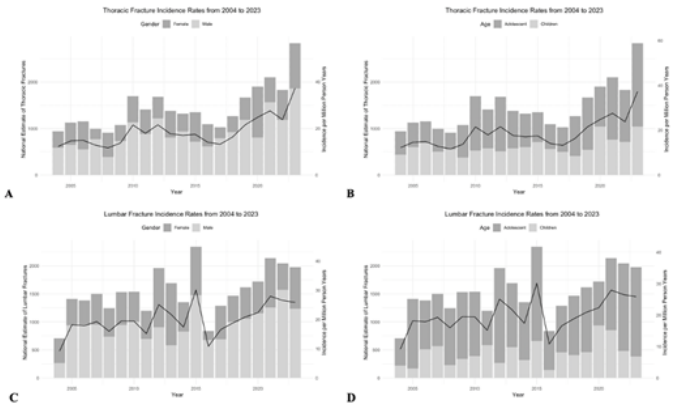


Figure 1. Pediatric Thoracic (A-B) and Lumbar Fracture (C-D) Fracture Incidence Rates in the United States from 2004 to 2023 by (A,C) Sex and (B,D) Age Groups

213. Do We Practice What We Preach? Has the Evidence Impacted Trends in Surgical Management of Early Onset Scoliosis in "tweeners"?

Nathan V. Houlihan, MD; Jaime A. Gomez, MD; *Ying Li, MD*; Pediatric Spine Study Group

Hypothesis
Rates of growth-friendly (GF) surgery have decreased and rates of single posterior spinal fusion (PSF) have increased in "tweeners" with early onset scoliosis (EOS).

Design
Multicenter retrospective review

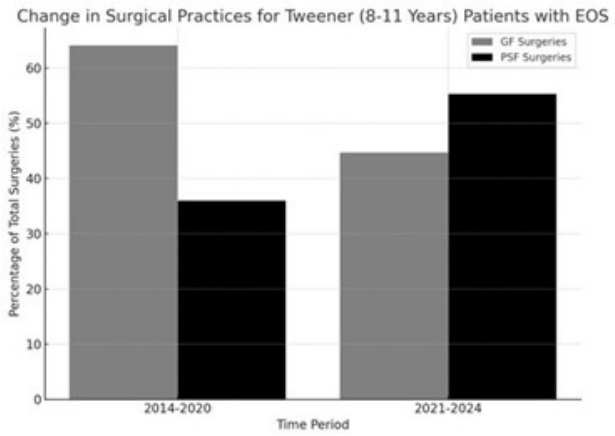
Introduction
GF surgical techniques, such as traditional growing rods (TGR) and magnetically controlled growing rods (MCGR), have been widely used to treat EOS in skeletally immature patients. The high complication rate associated with GF techniques and unclear impact of increased thoracic spine length on pulmonary function in older EOS patients have resulted in heightened interest in the optimal treatment method in the "tweener" population (ages 8-11 years). Several studies have shown decreased curve correction, a higher complication rate, a higher rate of unplanned returns to

the operating room, and worse health-related quality of life outcomes in tweeners undergoing GF surgery vs single PSF. The purpose of this study was to evaluate whether there has been a shift from GF surgeries to PSF in this age group following recent evidence suggesting poorer outcomes with GF techniques.

Methods
EOS patients treated with GF (TGR, MCGR) or single PSF between 2014-2024 were identified from a multicenter database. In accordance with a published consensus definition of "tweener," females aged 8-10 years and males aged 9-11 years at the time of their index surgery were included. The frequency of GF and PSF surgeries were compared across two time periods (2014-2020, 2021-2024). Fisher's exact test was used to assess statistical significance.

Results
From 2014-2020, 595 surgeries were performed, of which 381 (64.0%) were GF surgeries and 214 (36.0%) were PSF. In 2021-2024, 208 surgeries were performed, with 93 (44.7%) being GF surgeries and 115 (55.3%) PSF (Figure). A significant decrease in the proportion of GF procedures was observed between these two periods (p<0.001). There was a significant reduction in GF procedures for congenital, neuromuscular, and idiopathic scoliosis (p<0.001) but no difference was found in syndromic scoliosis (p=0.41).

Conclusion
There has been a notable shift away from TGR and MCGR and an increase in single PSF in "tweener" patients with EOS since 2021. This trend may reflect growing concerns over complications associated with GF techniques and recent evidence showing superior long-term outcomes with PSF.



Figure

214. Incremental Impact of Cervical Deformity and Lower Extremity Arthritis on Patient-Reported Outcome Measures (Proms) in Patients with Thoracolumbar Sagittal Plane Deformity

Michael Farias, BS; Manjot Singh, BS; Joseph Nassar, BS; Richard Hostin, MD; Munish C. Gupta, MD; Eric O. Klineberg, MD; Kojo D. Hamilton, MD, FAANS; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Han Jo Kim, MD; Robert K. Eastlack, MD; Jay D. Turner, MD; Justin S. Smith, MD, PhD; Jeffrey L. Gum, MD; Khaled M. Kebaish, MD; Lawrence G. Lenke, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Frank J. Schwab, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Bassel G. Diebo, MD; *Alan H. Daniels, MD*; International Spine Study Group

Hypothesis
Cervical deformity and lower extremity osteoarthritis (OA) incrementally worsen baseline and postoperative outcomes in patients with thoracolumbar deformity.

Design
Retrospective analysis of prospectively collected data.

Introduction
Thoracolumbar deformity commonly coexists with cervical spine deformity and lower extremity OA, thus potentially compounding functional disability. This study investigates the additive burden of these conditions on PROMs at 2 years postoperatively.

Methods
Primary thoracolumbar deformity patients with preoperative severe sagittal plane deformity (SRS-Schwab > ++) undergoing correction surgery were included. Demographics, spinopelvic alignment, and PROMs were described. Concomitant cervical deformity (C2–C7 lordosis ≤ −10° or C2–C7 SVA ≥ 40 mm), hip OA (Kellgren–Lawrence [KL] grade ≥ 3 in one or both hips), and knee OA (KL grade ≥ 3 in one or both knees) were identified. Hierarchical regression and mixed-effects models were performed to evaluate the roles of these conditions on PROMs.

Results
Among 245 patients, mean age was 61.3 yrs and 64% were female. At baseline, 24% had cervical deformity, 48% had hip OA, and 41% had knee OA. Hierarchical regression revealed that hip OA increased ODI by 6.5pts (p=0.01), cervical deformity increased ODI by 2.2pts (p=0.41). Knee OA was not significantly associated with ODI (p=0.79). Similar trends were observed for the ODI walking, SRS-22 Total, SRS-22 Activity, and PROMIS Physical Activity scores. Mixed-effects analyses revealed improvements in ODI, SRS-22 Activity, VR-12 PCS, and PROMIS Physical Activity from baseline to 2-yr postop (p<0.001). Hip OA continued to have the strongest negative impact postop, increasing ODI walking (0.4) and decreasing SRS-22 Activity (0.3), VR-12 PCS (3.4), and PROMIS Physical Activity (2.1) (p<0.05). Cervical deformity had a modest worsening impact on PCS (3.1; p=0.04) and a non-significant worsening impact on other PROMs.

E-POINT PRESENTATION ABSTRACTS

Conclusion
Cervical deformity and hip OA were shown to compound baseline disability in patients with thoracolumbar deformity, while knee OA did not affect PROMs. Surgical correction yielded robust improvements in all PROMs at 2-year follow-up, although hip OA continued to have a persistent negative effect on functional outcomes.

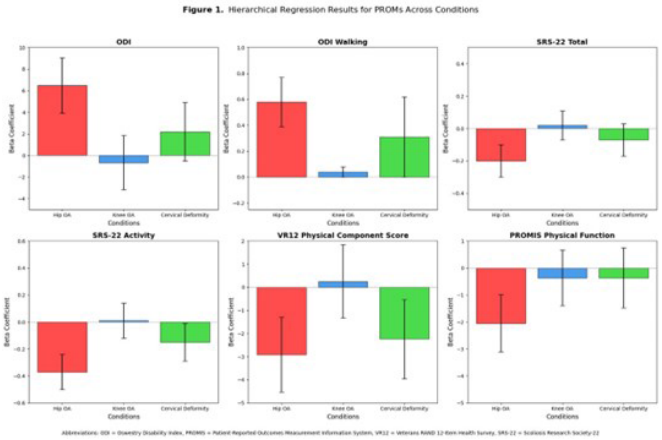


Figure 1. Hierarchical Regression Results for PROMs Across Conditions

215. Early Onset Scoliosis Questionnaire (EOSQ-24) Variation Amongst Parents/caregivers

Alastair Sterns, BS; Jordan Robinson, MS; Tishya Wren, PhD; Tiffany N. Phan, BA; Michael J. Heffernan, MD; Tyler Tetreault, MD; Brandon A. Ramo, MD; Pediatric Spine Study Group; *Lindsay M. Andras, MD*

Hypothesis
Significant variability will be encountered in parents'/caregivers' responses to the EOSQ-24 completed at the same timepoint.

Design
Multi-Site, Cross-Sectional

Introduction
The EOSQ-24 is a validated questionnaire to measure health-related quality of life for patients with early-onset scoliosis (EOS) and is used to evaluate the impact of this condition on the patient and their family. This study examines if variability exists between caregivers' responses to the EOSQ-24.

Methods
Included were EOS patients with two caregivers, each of whom was administered the EOSQ-24 and asked to respond independently. If one caregiver was unavailable during the patient's visit, the questionnaire was requested electronically. If the caregivers completed the study more than 4 weeks apart, it was excluded. Differences between caregiver responses were examined.

Results
Two caregivers of 88 patients both completed the EOSQ-24. 74 respondents identified as mother, 70 as father, and 32 as other/undisclosed. The mean difference between caregivers for standardized total EOSQ scores was 7.4 points (range 0-38.6) on a 100-point scale. 27.3% (24/88) of caregivers had a difference of >10 points. Fathers gave slightly higher scores than mothers, and the difference was significant (mean 75.1 vs. 72.6, p=0.03). The subdomain with the highest mean difference was Daily Living with a difference of 14.9. The subdomain with the lowest mean difference was Pain/Discomfort with a difference of 9.8 (Table 1). At the time the survey was administered, patients were being treated as follows: 20 patients (22.7%) with magnetically controlled growing rods (MCGR), 20 patients (22.7%) with bracing, 14 patients (15.9%) with fusion, 11 patients (12.5%) with elongation derotation flexion (EDF) casting, 3 (3.4%) patients with traditional growing rods (TGR), 1 (1.1%) patient with tethering, and 19 patients (21.6%) with monitoring/observation alone. Patients had similar median EOSQ-24 scores regardless of treatment type (p=0.38).

Conclusion
While the EOSQ-24 provides important insight into the impact of this condition and its treatment on quality of life, there is often variability between parent/caregiver respondents. In fact, nearly a third of caregiver pairs reported a difference in score of >10 points. The difference between caregivers completing surveys warrants greater consideration when interpreting EOSQ-24 results.

Subdomain	Mean Raw Score (SD)	Mean Difference [range]
General health	73.2 (16.0)	10.8 [0, 50]
Pain/ Discomfort	73.4 (21.2)	9.8 [0, 37.5]
Pulmonary Function	84.1 (19.7)	10.8 [0, 75]
Transfer	77.9 (25.7)	10.9 [0, 50]
Physical Function	72.3 (30.4)	12.4 [0, 75]
Daily Living	59.8 (34.3)	14.9 [0, 75]
Fatigue/ Energy Level	71.0 (24.3)	14.1 [0, 75]
Emotion	73.1 (23.8)	10.5 [0, 62.5]
Parental Impact	72.8 (21.5)	10.8 [0, 70]
Financial Impact	78.2 (22.6)	12.5 [0, 100]
Satisfaction	69.7 (24.2)	12.4 [0, 75]
Total Score	74.1 (18.72)	7.4 [0, 38.6]

Table 1: EOSQ-24 subdomain analysis between caregivers

216. Treating Scoliosis Early May Mitigate Proximal Junctional Kyphosis, Avoid a More Complex Surgery, and Possible Progression to Biplanar Deformity

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Hypothesis
Earlier management of surgically indicated scoliosis will yield lower sagittal deformity, less invasive procedures and fewer complications.

Design
Retrospective analysis of prospectively collected data.

Introduction
Data to inform patients about the benefits of addressing scoliosis surgically in earlier decades of life is limited in the literature.

Methods
Primary scoliosis pts with a main coronal curve above 45° who underwent correction surgery were included. Pts were grouped by age (45-65, >65 yo). Demographics, surgical parameters, spinopelvic alignment, complications and PROMs were compared on univariate and multivariate analyses. Subgroup analyses compared op pts aged 45-65 to their nonop counterparts.

Results
In total, 325 pts (216 op [141 45-65 and 75 >65yo] and 109 45-65yo nonop) were included. Older op pts had higher CCI (2.1 vs 1.2) and osteoporosis rates (39 vs 12%) ($p<0.01$). Preop, they had higher SVA (73.6 vs 35.7mm), PI-LL (18.7 vs 10.7°); lower L4-S1 lordosis (37.8 vs 42.2°) ($p<0.05$); and similar scoliosis type and magnitude (60 vs 63°), and PROMs ($p>0.05$). Older op pts had higher ISSG invasiveness score (109 vs 98.0), more levels fused (14.4 vs 12.9), iliac fixation rates (92 vs 71%), and longer ICU stays (2.2 vs 1.8days) ($p<0.05$). 2Y postop, they had higher TK (47.1 vs 41.9°) and worse SRS pain (3.9 vs 3.5) ($p<0.05$). Multivariate analyses revealed that older patients had 2.9- and 2.3-times higher odds of developing PJK and PJF ($p<0.01$), all comparisons to young op pts. In subgroup analyses, young nonop pts had lower BMI (25.5 vs 26.3kg/m^2), frailty (2.0 vs 3.0), CCI (0.8 vs 1.4) ($p<0.05$), and similar osteoporosis rates (13 vs 12%) ($p>0.05$). They had similar curve types and magnitude (60 vs 63°) ($p>0.05$); lower SVA (20.5 vs 35.7mm), PI-LL mismatch (6.1 vs 10.7°), and TL (15.7 vs 19.4°) ($p<0.05$). They also had better SRS activity (3.7 vs 3.0), appearance (3.1 vs 2.4), mental (3.6 vs 3.4), satisfaction (3.1 vs 2.7), total (3.4 vs 2.8), and ODI (25.1 vs 41.8) scores.

Conclusion
When indicated, early surgical correction of adult scoliosis may prevent sagittal deformity progression, reduce surgical invasiveness, and mitigate the risk of PJK/PJF. While making this decision is complex, this data can support surgical counselling, facilitating informed and shared decision-making about the optimal timing for surgical correction of adult scoliosis.

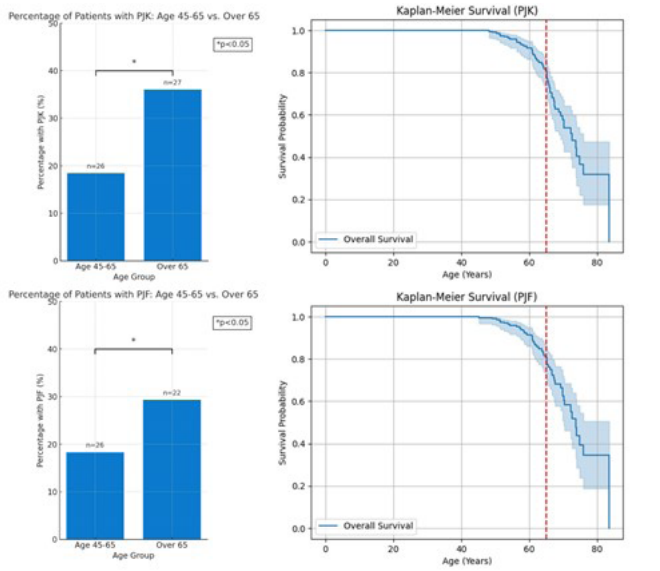

Figure: Bar Diagrams and Kaplan-Meier Survival Curves for Normative-Defined Proximal Junctional Kyphosis (PJK) (Top) and Lafage-Defined Proximal Junctional Failure (PJF) (Bottom).

217. Surgical Treatment of Adult Spinal Deformity Patients with Less Disability at Baseline Still Results in Improved Quality of Life with Lower Postoperative Complications

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Hypothesis
ASD pts treated early prior to onset of disabling factors see significant improvement in PROMs.

Design
Prospective, multicenter cohort of ASD pts

Introduction
With time, ASD pts become progressively more disabled, creating a ceiling effect on outcome improvement.

Methods
Pts were dichotomized to less disability (LD) and greater disability (GD) cohorts based on BL ODI scores (LD≤40, GD>40). Demographic and operative characteristics were compared to assess differences in treatment and outcomes. PROMs consisted of the NRS-Back/Leg, SRS-22r, PROMIS, VR12, and ODI and were compared at baseline (BL), 1yr, 2yr. Revision pts were excluded to limit influence of prior surgery on reported outcomes.

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Results
133 pts were included (LD=79, GD=54). LD were younger (53.2 vs 63.6,p<0.01), less frail (1.5 vs 3.5,p<0.01), took less pain meds(59.5 vs 87.0, p<0.01), and presented w/ better PROMs at BL(p<0.05). GD presented w/ greater sagittal malalignment w/ greater C2PA(p=0.01), T4PA(p=0.001), SVA(p=0.002), and PI-LL(p=0.003), but comparable coronal parameters, in line with concepts in the literature as degenerative changes induced by increase age exacerbates sagittal imbalance among ASD pts, leading to greater pt disability. Postop, GD pts experienced greater complications, specifically spine (57.4% vs 32.9%,p=0.01), neurological (27.8% vs 7.6%,p=0.002), and readmissions(31.5% vs 10.1%, p=0.0020). Mixed effects modeling found LD and GD improved significantly between BL, 1yr, and 2yr w/ LD pts presenting w/ better postop PROMs. However, ΔPROMs to 1yr and 2yr were comparable aside from GB experiencing greater ΔODI, ΔSRS function, and ΔV12 mental health(p<0.05). While both groups were comparable in believing their deformity was better at 2yr postop, more LD pts stated that they would repeat the surgery (93.7% vs 77.8%, p=0.01).

Conclusion
ASD pts with less BL disability experience a less complicated postop course with significant improvement in outcomes despite high PROMs at BL. Most ΔPROM was comparable aside from GD pts experiencing greater improvement in function and mental health, demonstrating a ceiling effect on the magnitude of pt improvement. Thus, surgical intervention for ASD pts with lesser disability still continues to enhance quality of life with overall lower complications and should be considered when appropriate.

218. Why Are Some Adult Spinal Deformity (ASD) Patients Walking Worse After Surgery?

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Hypothesis
ASD patients(pts) are walking worse due to pain or neurological complications

Design
Retrospective review of a prospective multicenter ASD database

Introduction
Following ASD surgery, there is a subset of patients that do not improve in walking times. Reasons as to why have not been elucidated.

Methods
Pts completed timed up and go 6 meter walk time(WT) in seconds at baseline ,1 and 2yrs postop. Pts were categorized as having postop WTs improved(shorter time), same(no time difference), or worse(longer time). Pts that improved were compared to those that were worse for demographics, walking time, physical exam findings, sagittal and coronal radiographic parameters, surgical data, patient reported outcome metrics (PROMs).

Results
426 pts(mean age 60.1±15.6yrs, 72.3% female) included with min 1yr follow-up. 191 of those had 2yr follow-up. Preop mean WT(range): 10.7s±5.5(3-46s). 1yr WTs were: 219(51.4%) improved, 44(10.3%) same, 163(38.3%) worse. The 2yr WTs were 102(53.4%) improve, 23(12.0%) same, 66(34.6%) worse. For pt that worsened at 1yr, significant differences compared to those that improved are presented in the table. No significant differences(p>0.05) between the groups for age, gender, BMI, Charlson comorbidity index, subjective/objective leg numbness/weakness, pain/osteoporosis med use, prehab, or deformity curve type and sagittal modifier, surgical approach, use of osteotomy, decompression, number levels instrumented/fused, pelvic fixation, interbody use, or ICU admission. Worse pts had significantly(p<0.05) less improvement(change to preop) in most of the PROMs. No significant differences for(p>0.05) pts' feeling spine was better after surgery, pts' would have same surgery again, objective leg weakness, knee and hip osteoarthritis grade, total hip arthroplasty, knee surgery, pain med use, bursitis, PSIS pain, back/leg pain. Of the 191 with 2yr follow up, 64(33.5%) were worse at 1yrand of those, 16(25%) improved at 2 years. 109(57.1%) were improved at 1yr but of those, 17(1.6%) declined to worse at 2yrs.

Conclusion
WTs improved in only about half of the pts at 1 and 2yrs. Worsened pts had better baseline objective/subjective function, higher rates of surgical revision, rates of upper thoracic UIV, subjective leg weakness, and severe complications. Both groups had similar rates of satisfaction and would have the surgery again.

Variable	Worse (n=163)	Improve (n=219)	P value
Baseline			
Walking time mean	8.5±3.9	12.7±6.1s	<0.0001
Prior thoracolumbar surgery	34.4%	46.6%	0.016
PROMIS physical function	36.3±7.6	34.9±7.8	0.013
PROMIS Social Role	41.9±8.8	39.9±8.2	0.022
Surgical			
Revision rate	22.7%	16.7%	0.042
Implant revisions	69.6%	30.4%	0.008
T1-5 UIV	51.5%	49.0%	0.03
T9-12 UIV	37.9%	41.2%	
1 year postop			
Walking time change to preop	+3.1±3.5s	-4.1±4.4s	<0.0001
Subjective leg weakness	34.4%	22.8%	0.026
Severe complications	30.1%	19.6%	0.018
SRS-Schwab PT modifier			
Grade 1	52.6%	37.7%	0.011
Grade 2	34.2%	40.6%	
Grade 3	13.2%	21.7%	

219. Tissue Expanders in Complex Pediatric Spine Deformity

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Hypothesis
Tissue expanders are an effective adjunct in managing treatment of complex spine deformities associated with compromised soft tissue.

Design
Retrospective Chart Review

Introduction
Tissue expanders (TE) have been used to manage complex soft tissue problems in various non-musculoskeletal conditions. This study aims to describe the use of tissue expansion as an adjunct for management of tenuous soft tissue envelopes in children with complex spine deformities.

Methods
Single institution, retrospective review of patients (minimum 2-year follow-up) who had tissue expansion for management of spinal deformity between 1997-2021. Patients were included if tissue expanders were placed prior to a spinal fusion. Demographics, clinical and radiographic data were reviewed. Complications were classified using the Clavien-Dindo system (Grade 3 defined as requiring unplanned return to the operating room [UPROR]) and recorded as being related to the TE or the management of the spine deformity.)

Results
20 patients were included. 15/20 patients had a diagnosis of myelomeningocele (MM) and 7/20 patients (all who had MM) had an open wound at the time of TE placement. 5 of the 7 patients (71%) with an open wound and 5 of 13 patients (38%) without an open wound experienced a Grade 3 complication (p=0.16). All 10 patients with a grade 3 complications had an UPROR related to the spinal procedure (one also had an UPROR related to the TE). Patients who had an open wound at the time of TE insertion experienced more UPROR (avg. 3.71 / patient) than those without an open wound (avg. of 0.93 / patient, p=0.081).

Conclusion
Tissue expanders can be a useful adjunct in the management of complex spine deformities associated with poor soft tissue envelopes. Patients should be counseled of the high probability of UPROR, particularly those with open wounds.

Variable/Level		Overall	Open Wound	No Wound
		N (20)	N (7)	N (13)
Age at Tissue Expansion		12.2 (6.2-20.6)	11.7 (6.2-20.6)	12.5 (9.1-16.7)
Diagnosis	Spina Bifida	15	7	8
	†Other	5	0	5
Ambulatory Status	Non-Ambulatory	13	5	8
	Ambulatory	7	2	5
Prior Spinal Surgeries	Growth Sparing (Instr.)	5	0	5
	Spina Bifida Management	14	7	7
	Both	1	0	1
*Clavien-Dindo Sinke Classification	No Complication	4	0	4
	1	5	1	4
	2	1	1	0
	3	10	5	5
	4	0	0	0
	5	0	0	0
Grade 3 complications related to:	Tissue Expansion	0	0	0
	Spine Surgery	9	4	5
	Spine & Tissue Expansion	1	1	0
Average UPROR Post Tissue Expansion		1.9 (1-8)	3.7 (1-8)	0.9 (1-7)

†Other: Congenital Scoliosis (1), Sarcoma (1), Escobar Syndrome (1), Neurofibromatosis (1), and Early Onset Syndromic Scoliosis (1).
*Patients were graded by most severe complication

220. Halo-Home: Guideline for Home Based Halo Gravity Traction in Children with Severe Spine Deformities

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Hypothesis
In-Home halo gravity traction for patients with severe spinal deformities is effective and safe for children.

Design
Prospective cohort study.

Introduction
Surgical management of severe spinal deformities remains complex. In the majority of centers, inpatient halo-gravity traction (HGT) is implemented until surgery. It has been suggested that treating these children at home can be just as effective in correcting the deformity as inpatient care, with comparable complication rates. Furthermore, in-home treatment provides additional social and family advantages and reduces overall costs.

Methods
Forty four patients with kyphoscoliosis undergoing outpatient preoperative HGT were analyzed. Traction time (weeks), traction weight (kg), radiographic curve correction and complications were evaluated. All children were monitored according to the in-home HGT control guideline. Its principles involve parents' education and continued communication ensured at all times.

Results
Four HGT outpatient children were excluded because they did not meet the criteria for in-home HGT, they received care at the Hospital Foundation. Forty patients were analyzed. Mean age was 12 years. The mean initial coronal deformation was 105°. Mean traction time was 14 weeks. Traction weight was 46% of body weight in a wheelchair and at bed. There were 8 complications. Pin loosening was observed in 1 patient, 1 patient had a pin infection, 2 patients mentioned that it caused them significant discomfort. There

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were 5 halo replacements in 4 patients. All patients finished their HGT treatment at home.

Conclusion
Childrens who meet the clinical criteria for in-homeHGT should be offered this option, due to its potential for family and hospital cost reduction and the preservation of patients' social and educational integration. Our results show that preoperative in-home HGT is a safe option. The hospital management guideline is an important tool to monitor the children.

221. Do Adult Spinal Deformity (ASD) Patients with High Pelvic Incidence (Pi) Require Fusion to the Upper Thoracic Spine?

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Hypothesis
ASD patients with high pelvic incidence (PI) are more likely to suffer from proximal junctional kyphosis (PJK) and failure (PJF) if the upper instrumented vertebrae (UIV) extends to the lower thoracic (LT) region, compared to the upper thoracic (UT) region.

Design
Retrospective Review of prospectively collected database of ASD

Introduction
Patients with high PI often have larger thoracic kyphosis and require larger sagittal corrections, making them prone to PJK. This study investigates whether patients with high PI should undergo fusions to the upper or lower thoracic spine to avoid this common complication.

Methods
ASD patients with PI greater than 65° and instrumentation to the pelvis were included. Patients were divided into groups based on their UIV (UT: T6 or above vs LT: T7 to T12). The groups were compared by demographics, radiographic parameters, HRQLs, and rate of PJK/F at baseline and 2-years using t-tests and chi2 tests. Patients with revision surgeries with UIV extension were excluded from alignment analyses.

Results
253 total patients were included with 35.6% UT and 64.4% LT fusions. At baseline, UT patients had more thoracic kyphosis, higher T1-L1 Pelvic Angle (TLPA), and C2 Pelvic Angle (C2PA) than LT fusions (all p<0.01). UT patients had a lower PJK angle at baseline (p=0.006) and had a smaller change in PJK angle between baseline and 2-years post-op (p=0.03). Patients with UT UIVs had larger corrections in SVA (-91.6 ± 69mm vs 38.8 ± 57mm, p<0.001), T1 Pelvic Angle (-14.6 ±11° vs -6.1 ± 11°, p<0.001), TLPA (-10.5 ±6.8° vs -1.6± 6°, p<0.001), and C2PA (-12.6 ±11° vs -5.8 ± 10°, p=0.004) compared to those with lower thoracic UIV. Rates of PJK/F did not differ between cohorts at any timepoint up to 2 years post-operation. There were no significant differences in baseline, 2-year, or change in T10 Pelvic Angle between UT and LT patients, showing UT patients did not achieve greater correction. No significant differences in demographics or HRQLs were observed.

Conclusion
These results demonstrate that high PI patients do not need to be fused to the upper thoracic region as a rule. Surgeons should make decisions on UIV to optimize corrections while utilizing techniques to mitigate proximal junctional kyphosis and failure.

		Upper Thoracic UIV (n=56)	Lower Thoracic UIV (n=125)	p-value
PJK/PJF	PJK developed within 2 Years	42 (46.7%)	73 (44.8%)	0.8
	PJF developed within 2 Years	19 (21.1%)	25 (15.3%)	0.2
Baseline	Pelvic Incidence (deg)	72.9 ± 6.8	72.6 ± 6.1	0.8
	Pelvic Tilt (deg)	34.7 ± 10.2	33.7 ± 9.2	0.5
	PI-LL (deg)	31.5 ± 22.1	31.7 ± 19.3	0.95
	T2-T12 Thoracic Kyphosis (deg)	**-41.8 ± 22.1**	**-33.8 ± 17.8**	**0.007**
	SVA (C7-S1 (deg)	116.5 ± 79	100.7 ± 61.1	0.2
	L1 Pelvic Angle (deg)	23.4 ± 9.8	24 ± 9.3	0.7
	T1 Pelvic Angle (deg)	37 ± 12	34.4 ± 12.2	0.2
	T4 Pelvic Angle (deg)	33.4 ± 11.7	31.3 ± 12.6	0.3
	T10 Pelvic Angle (deg)	26.3 ± 11.9	26 ± 11.1	0.9
	T1-L1 Pelvic Angle (deg)	**14.8 ± 8.2**	**10.7 ± 7.7**	**0.002**
	C2 Pelvic Angle (deg)	**40.4 ± 12.3**	**35.5 ± 10.4**	**0.01**
	PJK angle (deg)	**-11.9 ± 20.1**	**2.4 ± 17.8**	**0.002**
2-year	Pelvic Incidence (deg)	72.3 ± 6.9	72.3 ± 6.3	0.8
	Pelvic Tilt (deg)	29.7 ± 7.1	29.7 ± 7	0.9
	PI-LL (deg)	10.4 ± 8.3	11.8 ± 11.8	0.6
	T2-T12 Thoracic Kyphosis (deg)	**-59.1 ± 16.8**	**-48.8 ± 19.5**	**0.01**
	SVA (C7-S1 (deg)	**28.3 ± 54.8**	**55.2 ± 42.9**	**0.008**
	L1 Pelvic Angle (deg)	18.1 ± 6.1	19 ± 6.5	0.5
	T1 Pelvic Angle (deg)	24 ± 7.6	26.9 ± 8.3	0.09
	T4 Pelvic Angle (deg)	**19.6 ± 6.3**	**23.3 ± 7.8**	**0.029**
	T10 Pelvic Angle (deg)	16.6 ± 6.3	17.3 ± 7.2	0.7
	T1-L1 Pelvic Angle (deg)	**4.9 ± 8.1**	**7.9 ± 5.5**	**0.006**
	C2 Pelvic Angle (deg)	29.2 ± 8.2	30.2 ± 8.6	0.6
	PJK angle (deg)	-18.6 ± 12	-15.7 ± 12.7	0.3
Change in 2-year and Baseline	Pelvic Incidence (deg)	-0.6 ± 2.1	-0.5 ± 1.9	0.7
	Pelvic Tilt (deg)	-4.3 ± 7.4	-2.9 ± 8.7	0.058
	PI-LL (deg)	-21.6 ± 19	-18.1 ± 17.4	0.4
	T2-T12 Thoracic Kyphosis (deg)	-15.8 ± 19.2	-17.1 ± 13.8	0.6
	SVA (C7-S1 (deg)	**-91.6 ± 68.9**	**-38.8 ± 56.9**	**<0.001**
	L1 Pelvic Angle (deg)	-4.8 ± 7.2	-4.5 ± 7.5	0.9
	T1 Pelvic Angle (deg)	**-14.6 ± 11.1**	**-6.1 ± 11**	**<0.001**
	T4 Pelvic Angle (deg)	**-14.9 ± 10.5**	**-6.5 ± 10.8**	**<0.001**
	T10 Pelvic Angle (deg)	-10.4 ± 9.8	-7.9 ± 9.6	0.2
	T1-L1 Pelvic Angle (deg)	**-10.5 ± 6.8**	**-1.6 ± 5.9**	**<0.001**
	C2 Pelvic Angle (deg)	**-12.6 ± 10.8**	**-5.8 ± 9.5**	**0.004**
	PJK angle (deg)	**-4.1 ± 19.6**	**-19 ± 19.3**	**0.01**

222. Elevated Postoperative T1 Slope (T1S) Is Reflective of Poor Surgical Correction of Cervical Deformity (CD)

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Hypothesis
T1 slope is modifiable depending on the surgical strategy and an increased T1 slope is associated with poor corrections of cervical deformity (CD)

Design
Retrospective multi-center cohort analysis

Introduction
High T1S is a marker of underlying thoracolumbar deformity. T1S has been proposed as a parameter to determine the cervical lordosis necessary in CD corrections. A high preoperative T1 slope is a risk factor for poor postoperative alignment. Few studies have focused on outcomes from changes in T1 slope after CD surgery.

Methods
CD patients were classified as increased or decreased T1S following surgical correction. Preoperative and postoperative radiographic parameters, including in-construct angles (C2-T4 sagittal angle, C2-T10 sagittal angle), were analyzed with surgical data such as the use of 3COs, approach and fusion levels. A sub-analysis of patients with low, medium and high preoperative T1S (<24, 24-39, >40) was performed. Health-related quality of life was assessed using the NDI, mJOA, and EQ-5D. Chi-square and ANOVA analyses were used with a significance set at p<0.05.

Results
Of the 106 patients included, 27(25.5%) experienced reduced T1S, while 79(74.5%) had increased T1S at one year postoperatively. Patients with reduced T1S had greater baseline deformity (cSVA, C2 slope, CTPA, in-construct angles, all p<0.05), longer fusions (p=0.001), more 3CO utilization (p=0.005), greater postoperative corrections by in-construct angles (change in C2T4 SA and C2T10 SA, p<0.001) and better postoperative alignment by C2-T10 SA (p<0.05). Patients who had longer fusions with all posterior approach and LIV below T2 had the largest decrease in T1S. In the subanalysis, as the T1S increased, there was worse baseline and postoperative cervical alignment by cSVA, C2Slope, CTPA (all p<0.001) and thoracolumbar alignment by C2PA (p<0.05). High T1S patients had less improvement in NDI than low and mid T1S (-4.99 vs -13.9 and -13.8, p<0.05).

Conclusion
T1 slope is an important parameter in cervical deformity correction. Improvement in T1S correlated with larger corrections and better postoperative alignment. Worsening T1S resulted from insufficient corrections. Patients with high baseline T1S had worse baseline and postoperative cervical and thoracolumbar alignment and less improvement in NDI, demonstrating the clinical impact of the parameter.

Table 1. Main Cohort

Measurement Units	Reduced T1S (n=27)	Increased T1S (n=79)	P-Value
Cervical Parameters			
Preoperative cSVA (mm)	48.71 ± 19.22	34.40 ± 18.43	<0.001
1-Year cSVA (mm)	46.05 ± 15.47	38.39 ± 17.60	0.054
Δ cSVA (mm)	-14.15 ± 14.53	-2.57 ± 17.57	0.035
Preoperative C2 Slope (°)	45.77 ± 26.56	34.60 ± 18.85	0.017
1-Year C2 Slope (°)	29.73 ± 13.72	27.21 ± 12.99	0.491
Δ C2 Slope (°)	-16.04 ± 23.26	-7.39 ± 17.71	0.042
Preoperative C2-T10 Pelvic Angle (°)	14.95 ± 6.50	11.48 ± 5.04	<0.001
1-Year C2-T10 Pelvic Angle (°)	13.75 ± 5.99	13.27 ± 5.77	0.722
Δ C2-T10 Pelvic Angle (°)	-0.77 ± 3.82	1.65 ± 3.54	<0.001
Preoperative T1 Slope(°)	47.69 ± 15.55	24.85 ± 13.49	<0.001
1-Year T1 Slope (°)	37.05 ± 14.99	37.02 ± 14.82	0.994
Δ T1 Slope (°)	-10.64 ± 8.36	12.17 ± 8.35	<0.001
In-Construct Angles			
Preoperative C2–T4 Sagittal Angle	20.14 ± 14.82	4.66 ± 12.08	<0.001
1-Year C2–T4 Sagittal Angle	6.19 ± 9.89	1.55 ± 9.43	0.038
Δ1-Year C2–T4 Sagittal Angle	-13.29 ± 13.70	-2.98 ± 11.15	<0.001
Preoperative C2–T10 Sagittal Angle	33.74 ± 15.42	21.15 ± 12.02	<0.001
1-Year C2–T10 Sagittal Angle	27.85 ± 11.50	22.97 ± 10.20	0.047
Δ1-Year C2–T10 Sagittal Angle	-5.64 ± 10.92	1.14 ± 7.36	0.001
Surgical Characteristics			
Number of Levels fused	4.81 ± 6.48	1.75 ± 2.99	0.001
3CO	9(32.1%)	8(9.8%)	0.005

Table 2. Tertile groups

Measurements	Low T1S	Mid T1S	High T1S	P-Value
Preoperative cSVA (mm)	23.02 ± 13.01	41.32 ± 18.37	56.93 ± 11.39	<0.001
1-Year cSVA (mm)	27.52 ± 16.08	44.62 ± 14.90	51.38 ± 13.16	<0.001
Δ cSVA (mm)	1.67 ± 13.64	-5.63 ± 21.24	-16.18 ± 14.42	<0.001
Preoperative C2 Slope (°)	27.77 ± 14.10	36.94 ± 18.42	53.34 ± 22.19	<0.001
1-Year C2 Slope (°)	21.03 ± 10.14	29.44 ± 14.08	34.13 ± 12.14	<0.001
Δ C2 Slope (°)	-5.89 ± 14.03	-5.61 ± 18.90	-20.18 ± 23.44	0.001
Δ NDI Score	-13.92 ± 19.34	-13.77 ± 16.87	4.99 ± 12.95	0.033

223. Height, Not Weight, is an Independent Predictor of Proximal Junctional Kyphosis After Adult Spinal Deformity Surgery

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Hypothesis
Height and Weight and their interaction have an effect on risk of PJK.

Design
Prospective Multicenter Study

Introduction
While body mass index (BMI) has traditionally been used to assess the impact of body composition on surgical outcomes, the individual effects of height and weight have not been studied in relation to proximal junctional kyphosis (PJK). This study aims to address this gap by evaluating height

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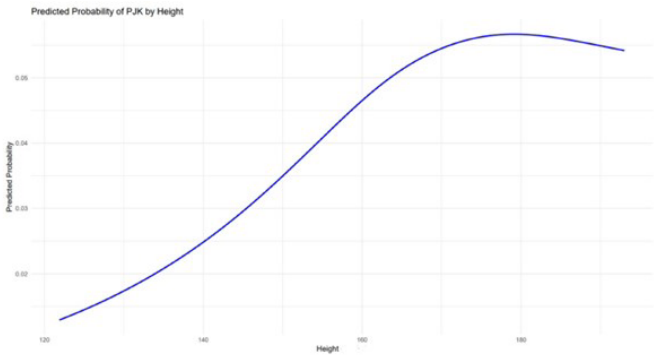
and weight both independently and interactively to explore whether certain combinations increase the risk of PJK.

Methods
A prospective multicenter adult spine deformity (ASD) database was utilized to analyze the impact of height and weight on the risk of developing PJK. Baseline demographics, radiographic measurements and perioperative variables were compared between patients who developed PJK and those who didn't. Using a generalized additive model with a logistic link function, we modeled height and weight as smooth terms to capture potential non-linear effects on PJK risk.

Results
931 patients were identified (median age 65 years, IQR: 58–71), 76% were female. PJK developed in 133 patients (14.2%). Baseline characteristics including frailty, comorbidities, and radiographic measures, did not differ significantly between the PJK and non-PJK groups. Multivariate analysis was adjusted for age, weight, UIV, levels fused, preoperative Schwab modifiers (GA and PI-LL), and postoperative PI-LL and T1PA. Height was identified as a significant predictor of PJK ($p = 0.028$). In contrast, weight was not an independent predictor when considered alongside height, and there was no significant interaction between height and weight. Predicted probabilities plotted against height revealed that the risk of PJK peaked at a height of approximately 179 cm before plateauing.

Conclusion
Height significantly influences the risk of developing PJK after ASD surgery, with taller patients facing a potentially higher risk. Weight did not independently predict PJK in our model. These findings underscore the importance of considering height as a critical factor in surgical planning. Although weight did not emerge as a significant predictor, further research could explore other dimensions of body composition or weight distribution.



224. Comparison of QoI Priorities Between Caregivers & Children with Complex Scoliosis: A CPCHILD Analysis

Carlos Monroig-Rivera, MD; David C. Thornberg, BS; Daniel J. Sucato, MD, MS; Karl E. Rathjen, MD; *Amy L. McIntosh, MD*; Brandon A. Ramo, MD

Hypothesis
Patients and Caregivers prioritize different QoL items; differences will persist between diagnoses and ambulatory statuses.

Design
Retrospective

Introduction
Literature is scarce regarding whether concordance exists between the perspectives of children with neuromuscular, syndromic, and skeletal dysplasia (NSSD) affected by scoliosis and their caregivers regarding HQoL. The CPCHILD questionnaire offers a tool for assessing unique QoL concerns in this population. Our objective is to analyze Section 7 of the CPCHILD to identify areas of agreement/disagreement between caregivers and NSSD patients regarding QoL priorities.

Methods
A single-center retrospective review of prospectively, consecutively enrolled NSSD patients who underwent fusion (2016-2022). Section 7 asked respondents to prioritize 36 QoL items. Responses by children/caregiver were ranked in order of priority and grouped into concordant agreement (high/low priority) and discordant agreement (high to caregiver or children). The cohort was also analyzed by diagnosis and ambulatory status.

Results
164 CPCHILDs were analyzed. Overall health, happiness, eating/drinking or being fed, comfort while sitting, and bathing/washing were items both caregivers/children agreed were high priorities. Conversely, items such as transferring, comfort while dressing/undressing, being able to play independently, grooming, putting on/taking off upper clothing, lower clothing, footwear, and standing for exercise were rated as low priority. NM patients prioritized their physical comfort & social engagement while their caregivers prioritized their emotional well-being & communication. Syndromic patients prioritized their comfort & immediate needs, while caregivers prioritized child safety & social engagement. Skeletal dysplasia patients prioritized their functional independence, while caregivers prioritized their social engagement. Ambulatory children emphasized mobility-related activities, while non-ambulatory children emphasized comfort.

Conclusion
NSSD children and their caregiver sporadically agree on QoL priorities. Understanding these areas of concordance/discordance may help providers address and assess the outcomes of scoliosis surgery. Our findings recognize that the impact of surgery extends beyond improving spinal alignment. Factors such as emotional well-being, social engagement, and

functional independence may influence perceptions of QoL after surgery.

Rank Group	Diagnosis		
	Neuromuscular	Syndromic	Skeletal Dysplasia
Concordant Agreement, High Priority	Happiness Overall health Able to be understood by you [caregiver]	Bathing/washing Happiness Overall health Emotional state or behavior	Comfort while sleeping Minimizing doctor visits and hospitalization Overall health Emotional state or behavior Comfort while lying down Getting in/out of a motor vehicle
Concordant Agreement, Low Priority	Putting on/wearing footwear Standing for exercise/transfers Able to play alone Moving about outdoors Minimizing number of medications	Putting on/taking off upper clothing Hair care/grooming Transferring into/out of a wheelchair/chair Putting on/taking off lower clothing Sitting in a wheelchair/chair Putting on/wearing footwear Able to play alone	Able to play alone Eating/drinking or being fed
Discordant Agreement, High Priority for Caregiver	Comfort while sitting Able to understand you [caregiver] Comfort while lying down Emotional state or behavior	Eating/drinking or being fed Able to be understood by you [caregiver] Able to understand you [caregiver] Comfort while lying down	Visiting public places Able to attend school/child care Standing for exercise/transfers Able to participate in recreational activities
Discordant Agreement, High Priority for Children	Comfort during toileting activities Able to play with others Able to communicate with others	Able to participate in recreational activities Getting in/out of a motor vehicle Comfort while dressing/undressing Comfort during transfers or position changes Moving about outdoors Minimizing number of medications Comfort during toileting activities	Toileting activities/hygiene Moving about indoors Moving about outdoors Minimizing number of medications

226. Marfan Syndrome Patients Undergoing Scoliosis Surgery Have Lower Lumbar HU Values than AIS Patients

Kosei Nagata, MD; Hiroyuki Nakarai, MD; Hideki Nakamoto, MD, PhD; So Kato, MD, PhD; Yuki Taniguchi, MD, PhD

Hypothesis
Spine surgeons increasingly use Hounsfield unit (HU) on lumbar spine CT as a measure of bone mineral density (BMD). The Hounsfield Unit (HU) of Marfan syndrome (MFS) patients undergoing scoliosis surgery is lower than that of adolescent idiopathic scoliosis (AIS) patients.

Design
Retrospective study.

Introduction
Since the report of Schreiber and his colleagues in 2011, Hounsfield Units (HU) within a Region of interest (ROI) on CT scans as a proxy for bone mineral density (BMD) is widely used in adults. In children or adolescents, the limited ROI is used excluding venous sinus or active hematopoetic marrow of the posterior vertebral body. This method of measuring lumbar spine HU values was generalized in children and adolescents, and the measured HU value was correlated to the Dual Energy X-ray absorptiometry data. However, the BMD in MFS patients has not yet been fully investigated.

Methods
We investigated 202 adolescent idiopathic scoliosis (AIS) patients and 33 MFS patients who underwent surgery at the University of Tokyo Hospital from 2006 to 2023. Preoperative CT for navigation was performed in all patients for scoliosis surgery at our institution. We performed 2:1 matching using propensity score by Age/Sex/body mass index (BMI)/main curve Cobb angle. The HU was measured on axial image in L1, L3, and L5 vertebrae at the center of the vertebral body. The used axial slice was parallel to the pelvis and each vertebrae tilt angle was also measured. Interobserver reproducibility of HU value was calculated by means of intraclass correlation coefficient (ICC).

Results
Sixty two patients with AIS (mean BMI 16.6) and 31 patients with MFS (mean BMI 16.1) were matched (age 10-19 yo). Average HU value was higher in the AIS group than the MFS group (217.1±33.7 vs 168.4 ±49.2, P<0.001). Patients with HU values less than 177, suggesting osteoporosis, were 9.7% in the AIS group and 61.3% in the MFS group, respectively (p<0.001). There was no difference in tilt angle at each vertebra between the two groups for L1 (11.1° vs. 13.7°, P=0.13) and L3 (7.4° vs. 7.9°, P=0.71), but for L5 (4.3° vs. 7.5°, P=0.005). ICC (2,1) for HU value was above 0.86, 0.92, and 0.81 at L1, L3, and L5, respectively.

Conclusion
Our data indicated that BMD screening of MFS patients with scoliosis could be reasonable.

227. Night-Time Vs. Full-Time Bracing in Thoracic AIS – Are There Differences in Curve Progression when Matching for Time-In-Brace?

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Hypothesis
The night-time brace (NTB) is superior to the full-time thoracolumbar sacral orthosis (FTB), when matched for time-in-brace.

Design
Dual-centre restrospective comparative study

Introduction
The FTB treatment for thoracic adolescent idiopathic scoliosis (AIS) is well-established but compliance remains a challenge. The NTB with a higher in-brace correction presents a viable treatment option. Whether patients with low compliance in FTB would benefit from switching to an NTB is unknown. This study aimed to compare the efficacy of FTB and NTB in patients with similar brace wear time.

Methods
We included skeletally immature AIS patients with thoracic curves of 20-45°, treated with either FTB or NTB. Patients with compliance ranging between 6-10 hours per day, Risser stage 0-3, and less than one-year post-menarche were included. Radiographic measurements were collected at brace initiation and termination. A mixed effects model was used to determine significant predictors of curve progression >5°.

Results
A total of 80 FTB patients and 106 NTB patients were included in the final analysis. At baseline, the FTB patients were younger (12.4y vs. 13.1y, p<0.001) and had smaller curves (31±6° vs. 37±6°, p=<0.001). The FTB patients showed significantly lower rates of curve progression >5° (44% vs. 63%, p=0.008) as well as progression to >50° (18%

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vs. 41%, p<0.001). The in-brace correction percentage was 59% (±18) in the NTB group and 37% (±18) in the FTB group (p<0.001). In the mixed effects model, we found decreased odds of progression >5° for treatment with FTB (OR 0.30, 95%CI 0.13-0.72), Risser stage 3 (OR 0.23, 95%CI 0.06-0.86), and age (OR 0.67, 95%CI 0.48-0.94). The NTB, male gender, and initial major curve size were associated with increased odds of progression (NTB: OR 3.33, 95%CI 1.39-8.03; Male: OR 5.49, 95%CI 1.62-18.68; Initial curve: OR 1.07, 95%CI 1.01-1.13).

Conclusion
The FTB demonstrated lower progression rates than the NTB in thoracic AIS patients with similar brace wear times.

228. Card14-Mediated MYC Interaction Promotes Osteoclastogenesis and Bone Density Reduction in Adolescent Idiopathic Scoliosis*

Hao Luo, MD, PhD; Zhenhai Zhou, MD, PhD; Junlong Zhong, MD; Jiachao Xiong, MD, PhD; Sijian Lin, MD; *Kai Cao, MD*, PhD

Hypothesis
Elevated CARD14 expression promotes osteoclastogenesis, which results in aberrant osteoclast differentiation and function as well as reduces bone mineral density(BMD) in AIS.

Design
Control, parallel, repetitive design

Introduction
Adolescent idiopathic scoliosis (AIS) is linked to reduced bone mineral density, which contributes to adverse health outcomes. This study aims to elucidate the role of the CARD14 gene in osteoclast differentiation and bone metabolism in AIS patients.

Methods
Twenty-nine AIS patients (ages 10-18) and 24 age-matched controls were enrolled in this study. Peripheral blood mononuclear cells (PBMCs) were isolated for RNA sequencing, revealing elevated CARD14 expression in AIS. Osteoclast differentiation was induced in vitro from PBMCs and assessed using TRAP staining. We also constructed adenoviral vectors for CARD14 overexpression and transduced bone marrow-derived macrophages (BMMs) from C57/B6 mice to evaluate its effects on osteoclastogenesis. Conditional CARD14 knockout mice (LysM-Cre; Card14flox/flox) were generated to assess CARD14's role in osteoclast activity and bone metabolism through micro-CT scans and histological analysis. Serum markers were also measured in these mice to further understand the impact of CARD14 on bone metabolism.

Results
AIS patients exhibited significantly lower BMD and higher osteoclast counts compared to controls. In vitro assays demonstrated that CARD14 overexpression in BMMs enhanced osteoclast differentiation and resorption, indicated by increased TRAP-positive cells and resorption pits. Conversely, CARD14 knockout mice showed reduced osteoclast activity and increased bone density, highlighting a protective role. CARD14 was found directly binds to MYC and regulates osteoclast formation in a MYC-dependent manner, while also activating the NF-κB and MAPK signaling pathways, which are crucial in osteoclast differentiation.

Conclusion
Aberrant osteoclast differentiation and function correlate with reduced BMD in AIS. Elevated CARD14 expression promotes osteoclastogenesis and bone resorption. Targeting CARD14 may present a therapeutic avenue to address bone loss in AIS patients.

229. Preserving Distal Mobile Segments Prevents Rod Breakage in Adult Spinal Deformity Surgery

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Hypothesis
Avoiding fusion to the pelvis and preserving distal mobile segments to compensate may reduce the risk of rod breakage (RB) in Adult Spinal Deformity (ASD) patients.

Design
Retrospective multicenter observational study

Introduction
RB is a known complication following ASD fusion surgery, though its incidence remains significant. Previous studies have linked RB to factors such as pelvic fixation, malalignment, and age. However, the real impact of pelvic fixation as an independent risk factor for RB remains unclear.

Methods
This study included ASD patients aged 50-75 who underwent fusion of more than six levels, with a lower instrumented vertebra (LIV) at or below L4, and a minimum 2-year follow-up. Patients were divided into two groups: those who experienced rod breakage (RB) and those who did not. Univariate and multivariate regression analyses were conducted to identify demographic, surgical, and radiographic factors influencing RB, with particular focus on LIV as an independent variable.

Results
A total of 642 patients met the inclusion criteria. The cohort was 84% female, with a mean age of 64 years, BMI of 26.3, and ASD Frailty Index (ASD-FI) of 0.44. The LIV distribution was as follows: L4 (52), L5 (44), S1 (48), Iliac (498). RB occurred in 17.3% (113 patients). Univariate analysis revealed no significant differences in age, BMI, ASD-FI, or coronal deformity between the RB and non-RB groups (p>0.05). However, RB patients exhibited worse preoperative global alignment (RSA), pelvic version (RPV), higher estimated blood loss (EBL), more levels fused, greater use of osteotomies, higher 1-year coronal Cobb angle, and lower implant density.

*John H. Moe Best Basic Research E-Point Presentation

Notably, interbody fusion was associated with a reduced risk of RB. Multivariate analysis identified two independent risk factors for RB (p<0.005): implant density (OR 0.98; CI 95% 0.97-0.99) and LIV (OR 0.74; CI 95% 0.02-0.312), with LIV being the strongest predictor. Among the 96 patients with LIV at L4 and L5, only 2 (2.1%) experienced RB, compared to 111 of the 546 patients with LIV at S1 or Iliac (20.3%).

Conclusion

In ASD surgery, setting the LIV at L4 or L5 was associated with significantly lower rates of rod breakage compared to pelvic fixation, independent of other demographic, surgical, and radiographic variables. This suggests that preserving distal mobile segments, whenever possible, may be a protective strategy against rod failure.

Table 1. Univariate analysis with demographic, surgical and radiographic variables associated with rod breakage (RB) at 2 years.

Variables	RB 17.3% (113)	No-RB 67.8% (528)	P
Gender	Female 80.5%	Female 85.4%	0.189
Age (yrs)	64 (59;69)	65 (58;70)	0.427
BMI (kg/m2)	26.1 (23.3;30.5)	25.6 (22.7;29)	0.099
ASD-PI	0.42 (0.33;0.51)	0.44 (0.36;0.51)	0.444
Major Cobb (°)	42 (26.4;58.5)	37.8 (21.9;57.3)	0.185
RPV(°)	-14.4 (-20.8;-8.5)	-12.7 (-18.3;-8.4)	**0.031***
RSA(°)	25.9 (16.1;35.2)	21.4 (14.2;31.4)	**0.030***
GAP	11 (7.7;12.2)	10 (8;12)	0.066
Osteotomy	Yes 20.5% RB	No 13.7% RB	**0.024***
IB-Fusion	Yes 14.6% RB	No 23.1% RB	**0.007***
Surg Time (min)	270 (219;366)	255 (180;460)	0.437
EBL (ml)	1802 (1200;2800)	1350 (700;2025)	**0.000***
Num Levels	11 (9;15)	10 (8;11)	**0.001***
Implant Density	1.8 (1.6;2)	1.93 (1.7;2)	**0.015***
Major Cobb 1yr(°)	23.3 (17.1;35.1)	21 (14.6;29.8)	**0.023***
RPV 1yr(°)	-10.98 ± 7.2	-10.2 ± 6.6	0.415
RSA 1yr (°)	16.4 ± 10.5	15.5 ± 9.5	0.434
GAP 1yr	6 (4;9)	6 (3;9)	0.835

BMI: body mass index; RPV: relative pelvic version; RSA: relative sagittal alignment; GAP: GAP score; IB fusion: interbody fusion; Surg Time: surgical time; EBL: estimated blood loss; RB: rod breakage.
* Significant.
Normal variables are expressed as mean +- standard deviation.
Non-normal variables are expressed as median (interquartile range).

230. Adult Scoliosis Prevalence Redefined: New Evidence from a Population-Based Sample of 37,710 Subjects Challenges Historical Data

Jeremy T. Ng , MBBS; Dong Chen, MS, BS; Guan-Ming Kuang, MD, PhD; *Kenneth M. Cheung, MD, MBBS, FRCS*

Hypothesis

The prevalence of adult scoliosis in a general population is significantly lower than previously reported studies, with distinct age and gender-related distribution patterns.

Design

Prospective cross-sectional study

Introduction

The reported prevalence rates of adult scoliosis vary widely (2-68%) in literature, primarily derived from studies focused on older females seeking medical attention. Such selection bias and lack of comprehensive population data limit understanding of true prevalence. This study addresses this gap through an extensive analysis of a general population sample.

Methods

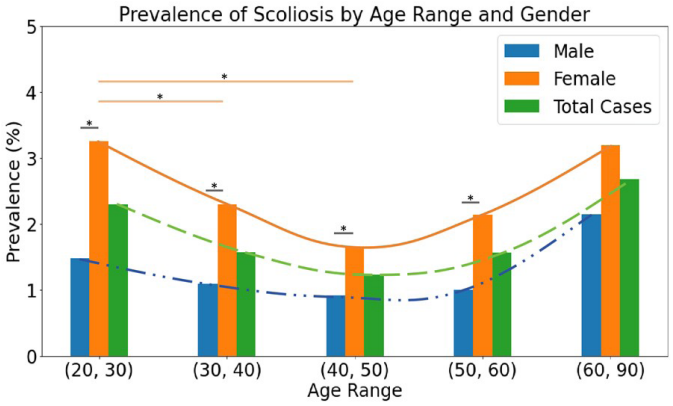
The study prospectively enrolled 38,023 subjects aged 20 or above undergoing routine health check-ups between June and November 2021. Initial reviews of standard chest radiographs showing spine levels C1 to upper L2 were conducted by radiologists. Suspected scoliosis cases underwent a secondary review by two independent technicians who measured Cobb angles. Demographic data, including age and gender, were analyzed in relation to scoliosis prevalence and severity.

Results

After excluding cases with prior spinal surgery or poor image quality, 37,710 subjects (16,295 female, 21,415 male; age range 20 to 90 years, mean age 35.12 ± 9.77 years) were included. The study identified 677 subjects with scoliosis, yielding an overall prevalence of 1.80%. Females demonstrated a significantly higher prevalence than males (2.56% vs 1.21%, P<0.05). The mean Cobb angle was 15.7°, indicating mostly mild deformities. Age distribution analysis showed a bimodal pattern, with prevalence peaks in younger and older groups and lower rates in middle age. The severity of scoliotic curves showed no significant correlation with age and gender. These findings contrast with previous studies which report much higher prevalence, due to their focus on populations comprising 84-90% females, predominantly aged 50-70 years, and presenting for bone density testing (Kebaish et al., 2011; Xu et al., 2013; Urrutia et al., 2014; Liu et al., 2016).

Conclusion

Our study of 37,710 subjects reveals adult scoliosis prevalence of 1.8%, significantly lower than previous estimates. We found a bimodal age distribution and higher female prevalence, though curve severity showed no demographic correlation. These findings aid in understanding adult scoliosis and guiding targeted interventions.



The Prevalence of Scoliosis by Age Group and Gender

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231. Surgically Relevant Anatomy of Loeys-Dietz Vertebrae

Myung-Jin Cha, BS; William G. Elnemer, BS; Paul D. Sponseller, MD, MBA; *Zaid Elsabbagh, BS*

Hypothesis
Pedicles and lamina of Loeys-Dietz syndrome (LDS) patients differ from those of idiopathic scoliosis (IS) patients.

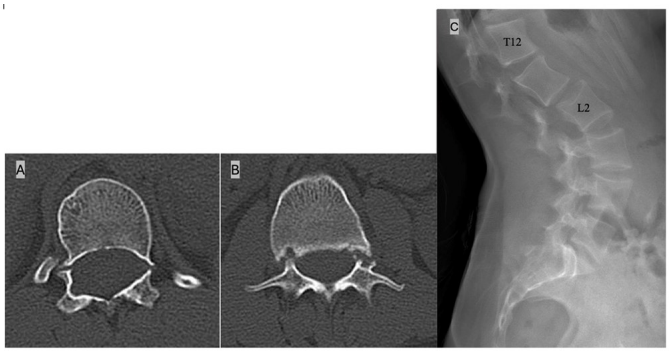
Design
Retrospective cohort study

Introduction
Understanding pedicle and laminar anatomy is crucial for securing spinal instrumentation's fixation and ultimately preventing complications such as pseudoarthrosis. This study explores the spinal morphology in the LDS vertebrae and compares it to IS vertebrae.

Methods
The morphology of 492 vertebrae from T1 to L5 was measured in 19 LDS patients, using MRI, CT, and X-rays. The morphology of 140 vertebrae from T1 to L5 was measured in IS patients, using MRI, CT, and X-rays. These values were then compared to each other via paired Student's t-test.

Results
On average, pedicle widths in LDS vertebrae were significantly thinner than pedicles in non-connective tissue disorder vertebrae ($p<0.001$). Four LDS patients (10%) had dysplastic/discontinuous ("broken") pedicles (Fig. 1). Type D pedicles (< 2mm wide) were found in 59% of LDS vs only 9% of IS ($p<0.001$).In LDS, type D pedicles were found in 58% of atypical locations (outside the concave apex). Pedicle width did not correlate with either the vertebral level or distance from the curve apex. Pedicles became progressively thinner than idiopathic scoliotic pedicles at more caudal levels of the spine. The average thickness of the LDS lamina was significantly thinner by 1.5 mm, on average than that of idiopathic scoliosis ($p<0.001$). The presence of dural ectasia did not show an association with thinning of laminae or pedicles. Pedicle measurements estimated by radiograph were larger than by CT scans 67% of the time and by MRI scans 17% of the time.

Conclusion
LDS spines were associated with thinning of anchor sites, with the thinnest pedicles most often found in the L1 and T6 vertebrae. There can also be unexpected findings of "broken" pedicles. LDS laminae were much thinner than in idiopathic scoliosis. Radiographs often overestimate the width. Therefore, this study supports obtaining preoperative MRI or CT when operating on LDS spine patients with pedicle screws and laminar hooks. MRI may provide a larger value for pedicle width than CT.



A 16-year-old female with LDS with bilateral discontinuous/fractured pedicles at T12 (A), L2 (B) seen on axial CT, sagittal plain radiograph of Patient's spine

232. A Propensity Matched Analysis of the Impact of Sternal Fractures on Outcomes in Concurrent Thoracic Spine Fractures: The Fourth Column of the Spine

Austin H. Carroll, MD; *Alejandro Quinonez, BS*; Alejandro Perez-Albela, BS; Daniel Griffin, MD; Christoper Bellaire, MD; Ruijie Yin, PhD; Addisu Mesfin, MD

Hypothesis
Patients with concomitant sternal and thoracic spine fractures will have increased rates of spinal cord injury (SCI), need for surgical intervention, and medical complications compared to patients without sternal fractures.

Design
1:1 propensity matched national database study

Introduction
The thoracic cage, consisting of the ribs and sternum, serves as a structural and protective unit for the upper body. It provides stability to the thoracic spine through its osteo-ligamentous connections, which mitigate rotational forces and support spinal alignment. This unique anatomy suggests that fractures involving the thoracic spine and sternum typically occur as a result of significant trauma. These combined injuries often signify spinal instability, contributing to increased rates of SCI,need for surgical intervention, and medical complications. Despite their clinical relevance, the medical and surgical outcomes of combined sternal and thoracic spinal fractures remain poorly understood.

Methods
Patients presenting with acute sternal and thoracic spine fractures in the same admission were identified using the PearlDiver database. Patients with sternal and vertebral fractures were propensity-matched in a 1:1 ratio to a control group by age and Elixhauser Comorbidity Index (ECI). Medical complications, rate of SCI, and rates of surgical intervention were assessed at 90 days.

Results
A total of 9,026 patients were identified in this study with 4,513 patients presenting with sternal and thoracic spine fractures and 4,513 patients in the control group. Sternal and vertebral fracture co-injury was associated with higher rates of SCI compared to the control group (P < 0.0001) as well the need for spinal decompression/fusion (OR = 4.38 [2.88-6.68], p < 0.0001) and thoracic surgery (OR = 3.01 [2.26-4.00], p <0.0001). These patients were also statistically significantly more likely to develop hemodynamic, respiratory, cardiac, and renal complications within 90-days of injury compared to the control group.

Conclusion
The sternum and rib cage provide additional rigidity and support to the thoracic spine. This propensity matched study of a large national patient sample demonstrates that patients with thoracic spine fractures who also sustain sternal fractures are more likely to have concomitant SCI, require surgical intervention, and develop medical complications.

Table 1. Demographics

	SFx + TFx	Control	P
Female (%)	2178 (48.3)	2590 (57.4)	<0.0001
ECI (SD)	3.72 (3.22)	3.71 (3.2)	0.8824
Spinal cord Injury (%)	173 (3.83)	33 (0.73)	<0.0001

ECI = Elixhauser Comorbidity Index

Table 2. 90-day Medical Complications

	SFx + TFx n=4513		Control n=4513		OR	95% CI	P
PE	117	2.59%	80	1.77%	1.47	1.10-1.97	0.0081
DVT	202	4.48%	106	2.35%	1.95	1.53-2.47	<0.0001
Pneumonia	556	12.32%	288	6.38%	2.06	1.78-2.39	<0.0001
UTI	517	11.46%	386	8.55%	1.38	1.20-1.59	<0.0001
AKI	237	5.25%	156	3.46%	1.55	1.26-1.90	<0.0001
Transfusion	156	3.46%	77	1.71%	2.06	1.57-2.72	<0.0001
Anemia	55	1.22%	29	0.64%	1.91	1.221-2.99	0.0051
MI	34	0.75%	23	0.51%	1.48	0.87-2.52	0.1464
Stroke	77	1.71%	43	0.95%	1.80	1.24-2.63	0.0021
Resp. Failure	804	17.82%	275	6.09%	3.34	2.89-3.86	<0.0001
CHF	273	6.05%	242	5.36%	1.14	0.95-1.36	0.1597
Arrhythmia	851	18.86%	551	12.21%	1.67	1.49-1.88	<0.0001
Cardiac Arrest	28	0.62%	13	0.29%	2.16	1.12-4.18	0.0219

Table 3. Surgical Interventions within 90 Days

	SFx + TFx n=4513		Control n=4513		OR	95% CI	P
Thoracic Surgery	116	2.57%	27	0.60%	4.38	2.88-6.68	<0.0001
Spinal Fusion/Decompression	187	4.14%	64	1.42%	3.01	2.26-4.00	<0.0001
Cardiac Surgery	<10		<10				

Tables

233. Early Results of Prospective Study of a Non-Operative Multicenter Cohort of Adolescent Idiopathic Scoliosis Patients: Natural History with Non-Operative Care ‡

Grant D. Hogue, MD; Keith Baldwin, MD, MPH, MSPT; Maia Regan, BA; Megan E. Johnson, MD; Kevin M. Neal, MD; Jason B. Anari, MD; Ying Li, MD

Hypothesis
The rate of progression of spinal deformity and progression to surgery will be low.

Design
Prospective Cohort

Introduction
Although, a great deal of study focus is on surgical technique and safety, over 90% of patients with AIS can be successfully treated non-operatively. Our study group seeks to further define this group in a multicenter fashion with focus on risk factors for progression to surgical range.

Methods
We performed a prospective multicenter study of non-operative patients. Only patients with a diagnosis of AIS and curves >10 and <45° with Sanders bone age (SBA) at the first visit and a PA radiograph were included. We identified 198 patients with at least 6 months and 116 who completed at least one-year of prospective follow-up for analysis. We assessed for deformity progression and risk factors for curve progression.

Results
At 6 months, 16.2% of patients experienced progression of their Cobb angle by more than 5°, 13.6% had their Cobb angle decrease 5°or more, and 70.2% remained within ±5° of their original measurement. At 1 year, 27.2% had an increased Cobb relative to the original, 17.1 % had a smaller Cobb than the original, and 55.6% remained unchanged. Risk of progression was similar for predominantly TL/L versus thoracic curves (6-month p=0.456; 1 year p=0.658). Progression was observed at similar rates for bracing versus observation patients (6-month p=0.460; 1 year=0.890). Risser 0 patients were 2.6 times more likely to progress >5° at 6 months (p=0.013) but were no more likely to progress compared to Risser >0 at 1 year (p=0.336). Initial Cobb angle was correlated with change in Cobb at 6 months (p=0.013) and 1 year (p=0.047). SBA 1 patients were more likely to have curve decreases >5° at 6 months and 1 year compared to >SBA1 who were more likely to have their curve stay the same or get larger (Figure 1; p=0.02). Two children progressed to surgical range by 6 months, and 2 more progressed to surgical range by one year (2%).

Conclusion
Though more than 25% of patients experience progression of their curve over the course of 1 year, only around 2% experience progression to surgical range in this time frame. Although early progression can be predicted by skeletal immaturity at 1 year, the rates of progression become similar to

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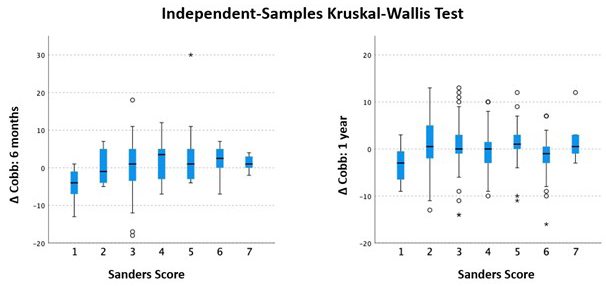
more mature patients after following for one year, and larger curves are more likely to progress.



234. To Wear or Not to Wear: Are Our Patients Adhering to Bracing Recommendations? A Prospective Cohort Study ‡

Keith Baldwin, MD, MPH, MSPT; Maia Regan, BA; Grant D. Hogue, MD; Megan E. Johnson, MD; Kevin M. Neal, MD; Jason B. Anari, MD; *Ying Li, MD*

Hypothesis
Prescribed brace time will be higher than actual bracing time by heat sensor measurement.

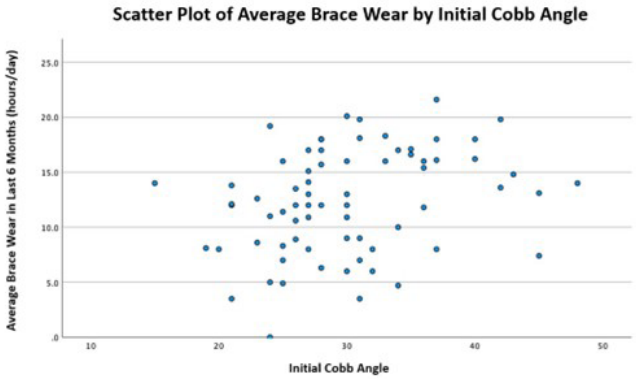
Design
Prospective cohort study

Introduction
Bracing is the mainstay of treatment for growing adolescents affected by idiopathic scoliosis with curves between 25° and 45°. Previous randomized trials have indicated that duration of bracing is an important factor in preventing curve progression.

Methods
Our multicenter group prospectively collected heat sensor data placed in a brace to assess for compliance with bracing recommendations. These patients were followed prospectively and had x-rays performed at regular intervals. We aimed to assess brace recommendations versus actual wear time and if any demographic or curve factors affected this relationship.

Results
We identified 104 patients with minimum 6-month follow-up brace heat sensor data for analysis. 94.3% were prescribed full time (>12h) bracing. All patients were within bracing range and were diagnosed with adolescent idiopathic scoliosis. The average brace prescription was for 16.2 hours/day (+/-3.2; Range: 8-23 hours) and the wear time as indicated by heat sensor was 12.4 hours (+/-4.8). This constituted 3.7 less hours worn than prescribed (2.4-4.3; p=0.001). On average, males wore the brace less than females (10.6 hours/day vs 12.9 hours/day; p=0.044) despite having on average 1 hour longer brace prescription (17 vs 16 hours). Age was not correlated with brace wear (p=0.238) nor was location of major curve, though thoracolumbar/lumbar (T/L) curves had decreased brace wear versus target compared to thoracic (4.6 less hours in T/L versus 2.6 less in thoracic). Curve magnitude was positively associated with total brace wear average over 6 months (R=0.295, p=0.012) but was not associated with compliance versus target brace wear.

Conclusion
Brace adherence averages 3.7 hours less than prescribed or 76.5% of the original prescribed time. Boys are significantly less compliant than girls despite being prescribed more hours. Patients with larger curves were prescribed longer brace wear but did not have better adherence versus target. T/L curves had less compliance compared to target compared to thoracic curves. This information can be used to counsel patients during bracing treatment.



235. Is a Double Tether Construct Better than a Single Tether Construct from a Biomechanical Point of View?

Jil Frank; Per D. Trobisch, MD; Miguel Pishnamaz, MD; Ulf K. Hofmann, MD; Frank Hildebrand, MD; Maximilian Praster, PhD

Hypothesis
A double tether construct reduces the prevailing tether tension forces in the tether cords.

Design
Biomechanical study by using a multi-body simulation approach

Introduction
Vertebral body tethering (VBT) has become an increasingly popular surgical technique for scoliosis correction in recent years. However, complications - particularly high tether breakage rates - have led surgeons to adapt their technique by utilizing double tether constructs (DTC). The in-vivo biomechanical consequences of these DTCs remain largely unknown. Therefore, the aim of our study was to analyze the total prevailing tether forces and the distribution of forces between the cords in a DTC.

Methods
Therefore, we conducted a biomechanical study using a multi-body simulation (MBS). MBS enables analysis of various physiological movements while accounting for the anatomical muscles and ligaments´ properties. In the single tether construct (STC), the tether has a pre-tension of 300

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N, while in DTC, the anterior has a pre-tension of 100 N and the posterior 200 N. We modeled the spine tethered between T7 and L3 and simulated a 25° lateral bend to the untethered side. This allowed us to analyze total tether forces and their distribution between the two tethers.

Results
The tether force in the single tethered condition (STC) peaked at 741 N during a 25° lateral bend. In contrast, for the double tethered condition (DTC), the calculated forces were 541 N anteriorly and 619 N posteriorly, summing to a total of 1,160 N. This higher total tether force in DTC explains the increased spinal compression forces observed. Specifically, there was a 30% increase in spinal compression forces in DTC compared to STC, with 3,044 N observed in DTC versus 2,313 N in STC during the 25° lateral bend. (Fig. 1).

Conclusion
DTC reduces the load on each individual tether, potentially reducing the risk of tether failure. However, it also results in up to a 30% increase in spinal compression forces compared to STC. This increased compression could affect spinal health over time. Therefore, while the DTC may offer benefits in reducing individual tether forces, clinicians should carefully consider the associated increase in spinal compression forces when deciding whether to use it.

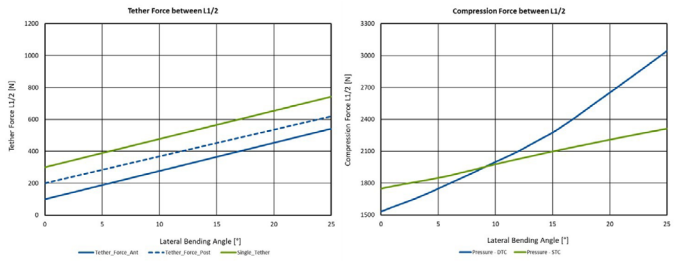

Fig. 1: Representation of the tether and intervertebral compression force between L1/2 for an 25° lateral bending task to the untethered side

236. Seated Vs. Standing Spine Kinematics

Jessica Lewis, PT, DPT; Mallory Rowan, MS; Matthew Parrett, MS; Reid C. Chambers, DO; *Kirsten Tulchin-Francis, PhD*

Hypothesis
Seated spinal kinematics significantly differ from standing emphasizing the need for normative seated data

Design
Comparative study

Introduction
3D motion analysis of spinal motion in children with adolescent idiopathic or neuromuscular scoliosis has advanced our understanding of surgical fusion-level implications. However, there remains a significant knowledge gap regarding PSF in non-ambulatory children, as their spinal kinematics have been largely unexplored. Examining seated spinal kinematics in this group could guide surgical planning and functional assessments, highlighting post-operative movement restrictions and their impact on daily activities.

Methods
22 control subjects' spinal motion was analyzed using the Wilks spine protocol in standing and a modified seated version. Movements assessed included flexion, extension, lateral bending, and rotation for the pelvis, lumbar, thoracic, and total spine. Kinematic differences between seated and standing positions were evaluated across sagittal, frontal, and transverse planes using the Wilcoxon signed-rank test.

Results
Sagittal flexion movements showed significant differences between standing and seated positions, with increased seated thoracic flexion (18.3° and 12.7° for bend and tuck) and reduced lumbar and pelvic motion (17.0° and 15.8°, 21.5° and 19.5°, respectively). Seated extension reduced sagittal pelvic motion by 15.3°. Lateral bending and rotation differed, with transverse thoracic movement decreasing by 5.7°. Rotation varied in all planes, with seated sagittal plane lumbar flexion increasing by 6.9° and pelvic flexion decreasing by 4.5°. Total spine and pelvic motion in the frontal plane decreased by 16.5° and 1.9°, respectively, while lumbar movement increased by 2.0°. In the transverse plane, rotation differences were significant across all spinal regions.

Conclusion
Seated spinal kinematics differ from standing, with the effect diminishing progressively up the spine. These findings highlight the need for positional context and normative seated control data to better assess post-surgical changes in non-ambulatory populations. Future research should focus on how these motion patterns impact ADLs and inform surgical planning.

Table 1: Movement Differences, Standing vs Seated Protocol

	Forward Flex Bend	Forward Flex Tuck	Extension	Lateral Bend	Rotation
Sagittal Plane					
Total Spine	0.291	0.833	0.586	**0.003 (+4.3)**	0.062
Thoracic Spine	**<0.001 (+18.3)**	**<0.001 (+12.7)**	0.070	0.053	0.152
Lumbar Spine	**<0.001 (-17.0)**	**<0.001 (-15.8)**	0.469	0.484	**0.009 (+6.9)**
Pelvis	**<0.001 (-21.5)**	**<0.001 (-19.5)**	**0.007 (-15.3)**	0.179	**0.004 (-4.5)**
Frontal Plane					
Total Spine	0.381	0.846	0.118	0.077	**<0.001 (-16.5)**
Thoracic Spine	0.931	0.229	0.277	0.081	0.051
Lumbar Spine	0.080	0.639	0.518	**0.002 (-0.6)**	**0.001 (+2.0)**
Pelvis	0.745	0.299	0.177	**0.002 (-3.9)**	**0.004 (-1.9)**
Transverse Plane					
Total Spine	0.871	0.845	0.836	**0.001 (-3.7)**	**<0.001 (-8.9)**
Thoracic Spine	0.487	0.626	0.518	**0.010 (-5.7)**	**0.026 (+5.0)**
Lumbar Spine	0.194	0.649	0.897	**<0.001 (-4.7)**	**0.037 (-2.5)**
Pelvis	0.626	0.408	0.185	**0.003 (-1.8)**	**<0.001 (-31.4)**

*p values (motion gained or lost in seated position)
Shaded: in plane motion

Table 1: Movement Differences, Standing vs Seated Protocol

237. "Puny" Little Screw? The Importance of S1 Screws on Outcomes in Pelvic Fixation for Neuromuscular Scoliosis

Hannah Hoopes, MD; Lydia Klinkerman, BS; Tega Diejomaoh, BS; Amit Jain, MD, MBA; Brandon A. Ramo, MD; *Daniel J. Sucato, MD*, MS; Amer F. Samdani, MD; Harms Study Group; Jaysson T. Brooks, MD

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Hypothesis
S1 screws are inconsequential and have no effect on postoperative outcomes in long fusion constructs in NMS patients.

Design
Multicenter Retrospective Review

Introduction
Children with neuromuscular scoliosis (NMS) often require long fusion constructs with extension to the pelvis. While it is widely accepted that posterior spinal fusions (PSFs) in NMS require pelvic fixation, (usually with iliac screws [IS] or sacral alar iliac [SAI] screws), there is equipoise on the role that S1 screws play in the stability of the construct and the evolution of postoperative outcomes. The purpose of this study is to compare the effect of adding or excluding S1 screws from T2 to the pelvis fusion constructs using modern pelvic fixation instrumentation.

Methods
A prospect multi-center database was reviewed of NMS patients with fusion to the pelvis yielding 369 patients. The cohorts were evaluated based on the presence of S1 screws complementing bilateral IS or SAI screws.

Results
The mean cohort age was 14 +/- 2.7 years old. Two-years postoperatively, there was no significant difference in major curve angles between cohorts. Patients with S1 screws did have a significantly lower pelvic obliquity (7.9° ± 8°) compared to the no S1 screw cohort PO (10.4° ± 9°), however this difference was clinically insignificant. At 2 years of follow-up, the no S1 screw cohort did have significantly more medical and instrument related complications as compared to the S1 screw cohort (Table). The instrument complications due to dislodgement of the lateral connector between the IS and the midline rods. A sub-group analysis was performed comparing pelvic fixation constructs that included bilateral SAI screws with and without S1 screws; no difference in postoperative complications were found. Finally at 2 years of follow-up, there was no difference in patient reported outcome measures (as measured by the HUI and CPCHILD instruments) between the S1 and no S1 screw cohorts.

Conclusion
There is no clinically significant difference in pelvic obliquity, major curve correction, PROs, or complications in patients who had S1 screws added to their pelvic fixation construct vs those that did not.

Variable	N	S1 Group	N	No S1 Group	p-value
GMFCS Level					
1-3	-	16 (11.5%)	-	6 (3%)	N/A
4	-	38 (27%)	-	33 (14%)	
5	-	77 (55%)	-	183 (79%)	
PreOp Major Curve Angle	139	86° ± 22°	230	83° ± 24°	0.103
PreOp Pelvic Obliquity	123	29° ± 15°	204	28° ± 15°	0.409
Length of Surgery (min)	137	363 ± 146	224	448 ± 149	<0.0001
EBL (cc)	139	1507 ± 1126	229	1278 ± 15973	0.04
Pelvic Screw Constructs					
Bilateral Iliac Screws	22	17.3%	104	46.8%	<0.0001
Bilateral SAI Screws	102	80.3%	117	52.7%	
IS and SAI Screws	3	2.4%	1	0.45%	
2YR PostOp Major Curve Angle	139	29° ± 16°	230	31° ± 17°	0.135
2YR PostOp Pelvic Obliquity	126	7.9° ± 8°	214	10.4° ± 9°	0.007
Complications					
Infections	12	8.6%	13	5.6%	0.26
Pseudoarthrosis	0	0%	1	0.4%	1
Medical	2	1.4%	21	9.1%	0.003
Instrument Related	6	4.3%	23	10%	0.04
Reoperation	2	1.4%	6	2.6%	0.71
PreOp Health Utility Index (HUI) Score	106	-0.06 ± 0.3	160	-0.13	0.009
2YR PostOp HUI Score	104	-0.03 ± 0.2	153	-0.11	0.006
PreOp CPCHILD Positioning, Transferring, Mobility Domain	99	35.7 ± 17	186	33 ± 17	0.147
2YR PostOp CPCHILD Positioning, Transferring, Mobility Domain	89	44 ± 19	174	41.7 ± 17	0.52
PreOp CPCHILD Total Score	104	50.2 ± 15	190	49.7 ± 15	0.73
2YR PostOp CPCHILD Total Score	95	57 ± 17	175	57.1 ± 13	0.88

Table 1

238. Robotic-Assisted and Computer-Assisted Navigation in PSF for AIS and JIS Increase Total Radiation Exposure for the Patient but Reduce Intraoperative Fluoroscopy Time Compared to Freehand Technique†

Isabella G. Marsh, BS; Ithika Senthilnathan, BS; Patrick Nian, BA; John A. Carrino, MD, MPH; John S. Blanco, MD; Roger F. Widmann, MD; *Jessica H. Heyer, MD*

Hypothesis
Freehand (FH) posterior spinal fusion (PSF) will have a higher intraoperative radiation exposure (fluoroscopy dosage and time) but lower total radiation exposure (including preoperative computed tomography [CT]) than computer-assisted navigation (NAV) or robotic-assisted navigation (RAN) PSF.

Design
Retrospective review from 9/2021 to 12/2024.

Introduction
NAV and RAN have been increasingly adopted for the placement of pedicle screws in PSF for patients with idiopathic scoliosis (IS). Both require either intraoperative three-dimen-

†Louis A. Goldstein Best Clinical Research E-Point Presentation

sional image acquisition or preoperative CT scans. Safety concerns exist with regards to radiation exposure for both the patient and the surgeon, who experience higher cancer rates than the general population. The objective of this study was to compare the mean fluoroscopy time and dosage as well as the total radiation dosage for RAN, NAV, and FH PSF in patients with IS.

Methods
135 patients who underwent PSF (41 FH, 12 NAV, and 82 RAN) were included. The mean fluoroscopy time in seconds, fluoroscopy radiation dose in milliGray (mGy), and total radiation dose (including preoperative CT and intraoperative fluoroscopy) in mGy were compared by one-way analysis of covariance, controlling for preoperative curve, BMI, and number of levels fused, followed by pairwise comparisons. Significance was set at an alpha of 0.05.

Results
NAV had a significantly lower fluoroscopy time compared to RAN and FH [31.8±8.0 versus 49.7±13.8 ($p = 0.028$) and 66.5±25.6 seconds ($p < 0.001$)]. NAV also had a lower mean fluoroscopy dosage than FH [3.5±1.7 versus 7.6±4.5 mGy ($p = 0.030$)]. When accounting for preoperative CT radiation dose, however, the FH cohort had a significantly lower mean total radiation dose than NAV and RAN [7.6±4.5 versus 21.9±3.3 ($p < 0.001$) and 26.6 ± 9.6 mGy ($p < 0.001$)]. There was no difference between NAV and RAN ($p = 0.486$).

Conclusion
In this series of PSF for IS, NAV was associated with a 2-fold decrease in intraoperative radiation, but a higher total radiation dosage compared to FH, representing a potentially lower radiation exposure to the surgeon but higher exposure to the patient. As NAV and RAN become increasingly adopted, it is important to be aware of the cumulative radiation exposure to surgeons, patients, and the operating room staff and to take proper precautions when feasible.

239. Perioperative Recovery Kinetics and Narcotic Use Following CMIS Surgery for Adult Spinal Deformity Correction of 6 or More Levels

Neel Anand, MD; Gurmit Singh, MD; Nikita Iyer, MS; Anita Anand, BS; Nicole Nishime, MS; Navid Reshadinezhad, MS; Shashank Coorapati, MS; Babak Khandehroo, MD; Cheri Phillips, PA-C

Hypothesis
Utilizing cMIS for ASD helps in early mobility and use of less narcotic pain medications post-surgery.

Design
Retrospective study

Introduction
Circumferential minimal invasive surgery (cMIS) for adult spinal deformity (ASD) avoids extensive muscle dissections and osteotomies to achieve optimal alignment. Therefore, it is conceivable that patients would ambulate early after surgery and would need fewer narcotic medications. It is important to objectively quantify these parameters to better understand cMIS outcomes.

Methods
We analyzed retrospectively a prospectively maintained registry of patients undergoing 6+ levels thoracolumbar 2 staged cMIS for ASD from Jan 2011 to Dec 2023. Total number of steps ambulated in postop period and the morphine milligram equivalent (MME) of narcotics administered were calculated in postoperative period and up to 3months after surgery.

Results
A total of 133patients were identified. No patient went to the ICU.126 patients (95%) were able to stand sometime between the 2 stages of cMIS. On postop day 1 {(POD 1), days denoted after second stage} 71patients (53.3%) were able to stand upright, and 22 patients (16%) walked at least 25 feet. By POD 4,131 patients (98.5%) had walked at least 25 feet, 103 (77%) walked 50 feet and 66 patients (50%) walked 100 feet or more. The patients needing narcotics decreased from 124(93%) (average MME 89.7) on POD 1 to 36patients (27%) on POD 7(average 47.3MME). At 2 week follow up, 57patients (43%) were completely off narcotic medications and the rest 76 patients had narcotics use decreased to 13.6 MME on average. At the 3 month follow up 94 patients (71%) were completely off narcotics, and the rest of 39 patients (29%) had a decreased use to an average of 4.8 MME (95% decrease from POD 1). Out of 62pts who were taking narcotics preoperatively, At 3 months postop 40pts(65%) were off all narcotics.

Conclusion
Utilizing cMIS for ASD probably helps in early mobility and use of significantly less narcotic pain medications post-surgery. These advantages of cMIS could minimize complications associated with hospital stay and could improve functional outcomes in the early postoperative phase. This possibly makes cMIS a more favorable option for elderly population and patients with comorbidities. Further studies directly comparing data from open surgical techniques may be warranted to delineate the differences with cMIS.

Tables

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240. Sociodemographic Factors Are Associated with Larger Curve Magnitudes at Presentation in Patients with Neuromuscular Scoliosis and Cerebral Palsy

Daniel J. Miller, MD; Luis Torres-Gonzalez, BS; Rhonda Cady, PhD; Zelphia Brown, MPH; Maykala Williams, MPH; Christopher Seaver, BS; Sara Morgan, PhD

Hypothesis
There are no relationships between clinical/radiographic outcomes and demographic characteristics.

Design
Retrospective cohort

Introduction
Socio-demographic factors such as race/ethnicity, spoken language, and insurance type have been associated with disparities across healthcare. Identifying health disparities for children with neuromuscular scoliosis (NMS) who require specialty spine care can inform strategies to promote equity in care for these children. The aim of this study was to identify disparities in care for patients with NMS associated with non-ambulatory cerebral palsy (CP) treated at a single quaternary pediatric hospital.

Methods
A retrospective review was conducted examining children with non-ambulatory CP and NMS who received spinal deformity surgery between 01/2012-12/2022. Relationships between demographic factors (Area Deprivation Index, race/ethnicity, language spoken, insurance type, distance from hospital) and clinical factors (Cobb angle at presentation and time from surgical recommendation to surgery) were assessed using multiple linear regression models.

Results
On average, eligible patients (n=328) had initial major coronal curves of 45±23 degrees and lived 104±149 miles from the hospital. Most (70%) were white, 13% were Black, 6% were Hispanic or Latino, and the remaining participants were Asian, Native American, or Alaska Native. Most patients spoke English (89%). Just under half (45%) had both government and commercial insurance; 24% had government insurance only. Black compared to white race (p=.03), government compared to commercial insurance (p=.02), and farther distance from hospital (p<.001) were associated with larger curve magnitudes at presentation after adjustment for covariates. Additionally, non-English language (p=.002) was associated with longer time from surgical recommendation to surgery after adjustment for covariates (Table 1).

Conclusion
Health disparities identified in these analyses included (1) larger curve magnitudes at presentation for children who are Black, have government insurance, or live farther from the hospital and (2) longer time between surgery recommendation to actual surgery for those who did not primarily speak English. These findings can be used to train personnel and prioritize resources towards reducing disparities.

	Cobb angle at Presentation, degrees		Length of time to surgery, months	
	Estimate (SE)	p-value	Estimate (SE)	p-value
Race				
White	Reference	Reference	Reference	Reference
Black or AA	8.87 (4.13)	**.033***	0.61 (1.3)	.638
Hispanic or Latino	6.92 (5.85)	.238	-2.61 (1.85)	.158
Other	9.27 (5.14)	.072	-0.11 (1.62)	.948
Primary language				
English	Reference	Reference	Reference	Reference
Non-English	2.58 (4.95)	.602	4.85 (1.56)	**.002***
Insurance				
Commercial	Reference	Reference	Reference	Reference
Commercial/Government	6.67 (3.53)	.059	1.66 (1.11)	.136
Government	8.95 (3.96)	**.024***	0.70 (1.25)	.573
Self-pay	4.08 (4.78)	.395	2.14 (1.51)	.156
Distance	3.40 (8.75)	**<.001***	-0.004 (0.003)	.188
Area Deprivation Index	1.15 (4.95)	.998	0.01 (0.02)	.718

**denotes statistical significance at alpha < .05*

Table 1. Multiple linear regression results showing relationships between factors.

241. Changes in Intraoperative Neurophysiological Monitoring Are Seen in 9% of Spinal Deformity Surgery Cases Performed for Neuromuscular Scoliosis

Mo Chen, PhD; Sara Morgan, PhD; Aaron Patterson, BS; Salma Noor, BS; Zack Thompson, BS; Eduardo C. Beauchamp, MD; Walter H. Truong, MD, FRCS(C), FAOA; Tenner Guillaume, MD; Joseph H. Perra, MD; Alyssa Kimber, BS; Timothy Feyma, MD; *Daniel J. Miller, MD*

Hypothesis
Neuromonitoring events for neuromuscular scoliosis surgery are similar to rates seen in other etiologies of pediatric spinal deformity.

Design
Retrospective cohort

Introduction
IONM is a tool that can improve safety during spinal surgery. Patients with neuromuscular scoliosis have inherent neural axis or primary muscle pathology that may present challenges to neuromonitoring. A clear understanding of IONM event rates, patterns and outcomes for patients with neuromuscular scoliosis would assist surgeons in counselling patients and families. The aim of this study was to report the monitorability of patients with neuromuscular scoliosis and the rate of IONM events during pediatric neuromuscular scoliosis spine deformity correction surgery over a 10-year period.

Methods
This chart review was conducted at a single pediatric quaternary care center. Eligible surgery cases were consecutive patients with neuromuscular scoliosis under 21 years of age who underwent spine deformity surgery where IONM was attempted. Patients who opted-out of research activities were excluded. Surgical, radiographic, and IONM data from pediatric spine deformity correction procedures between 2012-2022 in patients with neuromuscular scoliosis were abstracted into a database. Eligible cases were reviewed

to determine cases with monitorable IONM data as well as cases with IONM changes. Descriptive statistics were calculated for IONM monitorability and events. If no SSEPs and no TcMEPs were observed from any extremity, the case was determined as non-monitorable.

Results
Of the 443 eligible cases, 404 (91%) were monitorable from either upper or lower extremities and 363 (82%) were monitorable from the lower extremities. Of monitorable cases, 37 (9%) cases had a true IONM event. Presumed causes for these events are described in Table 1. One case (0.2% true positive case rate) had clinically-identifiable post-surgical neurological complications.

Conclusion
This study provides an estimate of monitorability, IONM event rates, and clinically identifiable neurological injury for children with neuromuscular scoliosis. These rates were similar to those reported in studies of other populations of children with idiopathic or congenital spine deformity. Our data suggest that neuromonitoring in this population is feasible.

Presumed cause	Cases with events	
	n	%
Extremity positioning	10	27
Hypotension	9	24
Spinal traction with deformity correction	7	19
Direct neural contact	3	8
Vascular compression	1	3
Unclear	7	19

Table 1. Presumed etiology of neuromonitoring changes

243. Are Multilevel Three-Column Osteotomies Safe to Perform?

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Hypothesis
Multilevel three-column osteotomies (3CO) can be performed but with significant risk.

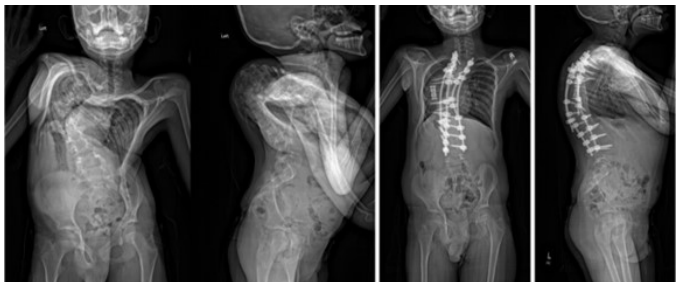
Design
Retrospective case series from a single institution

Introduction
3CO carry some of the greatest risk in deformity surgery, but occasionally they are required and, even less commonly, several 3COs may be necessary. We sought to investigate outcomes and safety of multilevel 3COs

Methods
We reviewed a series of patients having undergone more than one 3CO in our center, collecting demographic, radiographic, surgical details and complications. All patients with 3COs from 2008 to 2022 with 2-year follow-up and preoperative imaging were included.

Results
17 patients underwent multilevel 3COs of whom 3 had pre-existing VEPTR constructs. The primary deformity was predominantly sagittal plane (3 with focal kyphosis/dislocations; 5 with kyphosis and 6 with kyphoscoliosis). The means age at surgery was 10.3±5.6 years with a mean follow-up of 43±26 months. The median number of 3COs was 2 with a mean pre-op maximal curve of 100±40° (40-160°) and a mean deformity angular ratio (DAR) of 24±9. The mean pre-op coronal Cobb angle was 70±40° which corrected to 34±20° and was 38±24° at last follow-up ($p<0.05$). Mean pre-op sagittal vertical angle (SVA) was 19±45mm which improved to 7±35mm post-op. 6 patients (35%) were treated with halo gravity traction prior to the spine fusion. The mean OR time was 487±119min with an EBL of 686±679mL for the fusion. 7 procedures were staged with a mean OR time of 435±113min and EBL of 1170±1512mL during the second stage. 5/17 patients (29%) had intraoperative neuromonitoring (IONM) changes during surgery; 1 upper extremity and 4 tcMEP changes with 2 associated new neurological changes post-op. Both patients improved over time; one returned to their baseline function and one was still improving. 8 (47%) patients required further surgery (4 wound/infection related, 3 instrumentation/curvature, and 1 delayed neurological decline). 2 patients had halo vests for stabilization post-op.

Conclusion
Multi-level 3CO can be performed but are associated with a significant risk of neuromonitoring changes and reoperations (50%). Surgeons should anticipate these associated risks when considering multilevel 3COs.



244. Collagen X Biomarker (Cxm) is Predictive of Growth Cessation in Idiopathic Scoliosis *

Michelle C. Welborn, MD; Asal Roudbari, BS; Reza Zandehshahvar, PhD; Pascal Van Hentenryck, PhD; Amer F. Samdani, MD; Robert H. Cho, MD; Joseph D. Stone, MD; Selina C. Poon, MD; Vishwas R. Talwalkar, MD; Michal Szczodry, MD; Purnendu Gupta, MD; James O. Sanders, MD; Susan Sienko, PhD

Hypothesis
We theorized that the combination of CXM and radiographic or clinical measures may allow for accurate prediction of cessation of growth

*John H. Moe Best Basic Research E-Point Presentation

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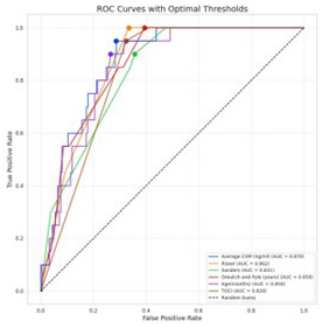
Design
IRB approved multicenter prospective diagnostic study using STROBE guidelines

Introduction
Assessment of cessation of growth is critical for determining surgical and nonsurgical treatment of idiopathic scoliosis (IS). Skeletal maturity has long been used to facilitate these decisions, however when used alone to determine cessation of bracing 25% of Risser score 5 (RS) pts progressed and 20% of Sanders Maturity Stage 7(SMS) pts progressed. Type X collagen (COLX) is produced in the growing physis during endochondral ossification. CXM is a breakdown product of COLX, as COLX is a measure of physeal activity, decreases in CXM have the potential to be a measure of cessation of growth

Methods
Pts were recruited between 2018-2024. Q6mo anthropometrics and spine PA biplanar slot scanner images including the hand were assessed for major curve magnitude and skeletal maturity. CXM levels were obtained via dried blood spots on 3 consecutive days Q1-2months and assayed using a proprietary enzyme-linked immunosorbent assay. Receiver operating characteristic (ROC) analysis was conducted to evaluate predictors of growth cessation, defined as Ht-V<1cm/yr. Predictors included age and Cobb at presentation, HtV, bone age, SMS, RS, and CXM were examined for specificity and sensitivity

Results
253 enrolled pts, 42(35 female, 7 male) completed the minimum 2yr fu and met at least one criteria for cessation of growth, w/ 205 visits after theoretical growth cessation. Among the predictors, CXM demonstrated the most balanced overall performance with sensitivity of 95%, specificity of 71%, and AUC of 87%. While Risser had perfect sensitivity (100%), it resulted in lower specificity (66%). Notably, growth cessation occurred in 20% of visits with RS4 and an additional 35% of visits with RS5. SMS had a comparable performance to RS with 55% of growth cessation happening at SMS7A and an additional 30% at 7B

Conclusion
Assessment of the cessation of growth remains challenging. Current metrics for cessation of bracing are inadequate w/ 20-25% of pts experiencing curve progression and upwards of 75-100% of pts may have remaining growth when RS, SMS, TOCI, CA or BA are used alone. The combination of biologic(CXM), clinical and radiographic parameters may have the potential to more accurately determine cessation of growth



ROC Analysis of cessation of growth

Features	Optimal Threshold	Sensitivity	Specificity	Accuracy
Average CXM (ng/ml)	< 8.7	0.95	0.71	0.74
Risser	> 4	1.00	0.66	0.71
Sanders	> 6	0.90	0.64	0.67
Greulich and Pyle (years)	> 14.0	1.00	0.60	0.64
Age (months)	> 163.3	0.90	0.73	0.75
TOCI	> 8.00	0.95	0.68	0.70

245. Scoliosis Progression After Lung Transplantation in Pediatric Patients

Takayoshi Shimizu, MD, PhD; Bungo Otsuki, MD, PhD; Takashi Sono, MD

Hypothesis
Lung volume asymmetry after lung transplantation may contribute to scoliosis progression in pediatric patients.

Design
Retrospective review of prospectively collected data from a single academic institution.

Introduction
Scoliosis progression has been reported in various pediatric cardiothoracic conditions. However, no study has specifically examined the incidence and progression of scoliosis following lung transplantation. This study investigates the prevalence of post-transplant scoliosis and its potential relationship with lung volume asymmetry.

Methods
A total of 285 patients were analyzed, comprising 43 pediatric patients (≤17 years) and 242 adults (>18 years). Baseline demographics, Cobb angle measurements before and after transplantation, and lung volume data at one year post-transplant were collected for pediatric patients. The prevalence of scoliosis was compared between pediatric and adult patients, and the impact of lung volume asymmetry (right lung volume minus left lung volume) on scoliosis progression was assessed.

Results
The mean age was 10.3 years for pediatric patients (n=43) and 44.9 years for adults (n=242). Scoliosis was significantly more prevalent in pediatric patients, with 30.2% exhibiting a Cobb angle >10° and 13.9% exceeding 20°, compared to 11.5% and 1.6% in adults, respectively. Pediatric patients with Cobb angles >20° demonstrated significant lung volume asymmetry one year post-transplant. Lung volume disparities were associated with an increased risk of scoliosis progression, particularly in cases of unilateral lung collapse.

Conclusion
Pediatric lung transplant recipients exhibit a significantly higher incidence of scoliosis compared to adults. Post-trans-

plant lung volume asymmetry, particularly in cases of unilateral lung collapse, may contribute to scoliosis progression. Routine spinal assessments are crucial for pediatric lung transplant patients to monitor scoliosis progression, mitigate severe curvature development, and promote long-term musculoskeletal health.

246. Sagittal Alignment Differences Between Normal Subjects and Adolescent Idiopathic Scoliosis Using Vertebral Pelvic Angles

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Hypothesis
L1 and T4 pelvic angles (L1PA, T4PA) were described in adults. Thoracolumbar alignment differs in AIS and growth-related pelvic anteversion might influence vertebral pelvic angles.

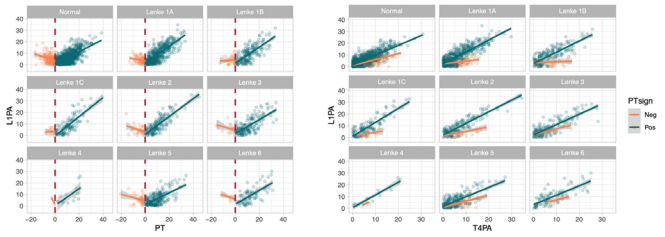
Design
Retrospective analysis of normative and AIS multi center registries.

Introduction
Sagittal alignment and the position of L1 can be abnormal in AIS. Growth influences alignment and anteverted pelvic patterns (Roussouly 3A) exist in adolescents and young adults. The objective was to assess relationships between L1PA, T4PA, pelvic tilt (PT), pelvic incidence (PI) in healthy individuals and AIS.

Methods
Radiographs of 1781 surgical AIS and 1115 healthy subjects, median age 15 (10-30) years, were analyzed. Variables included L1PA, T4PA, PT, PI, segmental lordosis or kyphosis T10-L1, L1-L4, and Roussouly types. PT was categorized retroverted (+) or anteverted (-). Statistical analyses included linear regression and Spearman correlation, stratified by Lenke type and PT sign. The age-effect was tested.

Results
Compared to normal, T10-L1 kyphosis was lower by 6.4°, 5.9°, 5.4° and L1-L4 lordosis was larger by 4.1°, 3.8°, 4.2° in Lenke 1, 2 and 3 curves respectively ($p<0.001$). L1PA and T4PA kept constant with age. Correlations between PI and L1PA were 0.64 (normal), 0.54 (Lenke 5) to 0.72 (Lenke 3). Correlation between PI and T4PA were 0.23 (normal) and <0.5 (AIS). PT and L1PA correlations varied according to pelvic version: normal 0.55 (PT+) and -0.37 (PT-), AIS 0.52 (Lenke 5) to 0.78 (Lenke 2) for PT+, -0.57 (Lenke 6) to 0.04 (Lenke 1B) for PT-. For T4PA correlations were: normal 0.60 (PT+) and -0.34 (PT-), AIS 0.52 (Lenke 5) to 0.78 (Lenke 2) for PT+, -0.57 (Lenke 6) to -0.04 (Lenke 1B) for PT-. Roussouly type 3A were equally present in normal subjects and AIS (15.8%). Correlations between L1PA and T4PA depended on pelvic version: normal 0.69 (PT+) and 0.55 (PT-), AIS 0.58 (Lenke 5) to 0.80 (Lenke 2) for PT+, 0.07 (Lenke 1B) to 0.66 (Lenke 6) for PT-.

Conclusion
L1PA and T4PA correlate in healthy adolescents and young adults with PT+. The prevalence of Roussouly 3A and T10-L1, L1-L4 variations emphasize the importance of precise evaluation in thoracic scoliosis. The T4-L1 axis represents a valuable alignment target, while segmental analysis at the thoracolumbar junction and age-specific considerations regarding pelvic version need to be considered to refine surgical planning.



L1PA correlation according to PT sign

247. Waterproof Versus Non-Waterproof Mehta Casting for Infantile Idiopathic Scoliosis

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Hypothesis
Waterproof (WP) Mehta casting is as efficacious as non-waterproof (NWP) casting to treat infantile idiopathic scoliosis (IIS) and has improved health-related quality of life (HRQoL).

Design
A retrospective comparison of data collected prospectively in a multicenter international spine registry.

Introduction
IIS is often treated with early Mehta casting, but studies have shown a negative impact on HRQoL. A WP cast option may be as efficacious with improved HRQoL. The purpose of this study is to compare WP and NWP Mehta casting in patients with IIS.

Methods
IIS patients treated with a WP or NWP Mehta cast and 2 years of follow-up were included. Radiographic and clinical data were extracted at four time points: pre-casting (PreC), 6 and 12 months after casting began, and within 6 months after last cast removal (PostC). HRQoL was measured using the Early Onset Scoliosis Questionnaire (EOSQ) tool.

Results
A total of 506 patients (38 WP, 468 NWP) had similar age at index casting ($p=0.581$). The WP group had higher mean

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PreC Cobb angle (54° vs 47°, p=0.012), longer time in cast (24.8 vs 16.8 months, p=0.028) and greater number of casts (8 vs 6, p=0.015). Curve reduction and correction index between each time point were similar between groups (p>0.1), with an ANOVA analysis demonstrating no difference in mean Cobb angle between the groups over time (p=0.420), with similar Cobb angles at PostC (43° WP vs 35° NWP, p=0.199). Surgical conversion rate was similar (16% WP vs 18% NWP, p=0.771), with a non-significant 18.8-month longer median delay from index casting to surgery in the WP group (71.0 vs 52.2 months, p=0.441) and with similar surgical intervention type (growth-friendly constructs, tethering, and posterior spinal fusion, p=0.925). In-cast EOSQ scores and departures from age-adjusted norms for each domain were similar between groups (n=16 WP, 215 NWP, p>0.1).

Conclusion
WP and NWP Mehta casts have similar radiographic efficacy, surgical conversion rate and type, and in-cast EOSQ scores. The WP group had significantly longer cast duration and a greater number of casts; given the retrospective nature of this registry study, it is unknown whether this is due to cast type or surgeon preference. Although WP casts did not improve in-cast HRQoL scores as expected, surgeons can use WP casting material without concern for sacrificing treatment efficacy. Further study is needed to confirm the absence of a positive effect on HRQoL scores.

248. Pre-Bracing Health-Related Quality of Life Predicts Brace-Related Psychological Stress in Adolescents with Idiopathic Scoliosis

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Hypothesis
Preoperative psychological factors are associated with brace-related stress in patients with adolescent idiopathic scoliosis (AIS).

Design
Retrospective study

Introduction
Bracing is a critical intervention for managing AIS. However, prolonged brace wear can induce significant psychological stress, impacting patient compliance and treatment outcomes. Patient responses to bracing vary, and the factors predicting heightened stress remain unclear, complicating the stratification of patients at risk for psychological distress. This study aims to identify pre-bracing factors associated with brace-related stress in AIS patients.

Methods
This retrospective study included AIS patients aged 10-15 years with a Cobb angle of 20-40 degrees. Demographic and radiographic data were collected alongside AIS-specific health-related quality of life (HRQOL) measures, including the Scoliosis Research Society-22r (SRS-22r) and the Scoliosis Japanese Questionnaire-27 (SJ-27). Brace-related psychological stress was evaluated using the Bad Sobernheim Stress Questionnaire-Brace (BSSQ-brace) at one month, six months, and one year post-bracing initiation. A linear mixed-effects model was utilized to identify pre-bracing factors correlated with higher stress scores.

Results
A total of 163 patients (11 males, 6.7%) were included. Moderate to severe stress was reported by 31.3% of participants at one month, 28.8% at six months, and 27.3% at one year. Multivariable analysis revealed that the SJ-27 total score (β = −0.14, SE = 0.04, p < 0.001) significantly predicted higher brace-related stress. Conversely, bracing duration and initial Cobb angles were not significant predictors. Further analysis of SJ-27 items indicated that increased self-consciousness about appearance was a primary contributor to stress.

Conclusion
Pre-bracing AIS-specific HRQOL is a critical determinant of subsequent brace-related psychological stress. These findings underscore the importance of early psychological screening to improve brace compliance and treatment outcomes. The SJ-27 questionnaire may serve as an effective tool for identifying high-risk patients, facilitating proactive psychological support and enhancing adherence to brace treatment.

Variable	Estimate	SE	t value	p-value
Time	0.00	0.04	-0.04	0.97
Age	-0.22	0.38	-0.56	0.58
Male	2.70	1.50	1.80	0.07
Risser sign	0.03	0.25	0.12	0.91
Monitored bracing time at 1 month	**0.14**	**0.07**	**2.08**	**0.040***
Major Cobb angle	0.04	0.10	0.39	0.70
In-brace correction rate: 30.8-42.3%	-0.74	0.86	-0.86	0.39
In-brace correction rate: 42.8-85.2%	0.93	0.87	1.07	0.29
SRS-22r total	-0.44	1.48	-0.30	0.77
SJ-27 total	**-0.14**	**0.04**	**-3.78**	**<0.001***

TRC, triradiate cartilage; SRS-22r, scoliosis research society-22 revised; SJ-27, scoliosis Japanese Questionnaire-27; BSSQ-brace, SJ-27, Bad Sobernheim Stress Questionnaire-Brace (Japanese version)

Major curve indicates the maximum coronal Cobb angle across all spinal segment.

Table. A linear mixed-effects model for post-bracing BSSQ-score

249. History of Scoliosis Bracing Does Not Impact Mental Health Outcomes Following Definitive Surgery for Adolescent Idiopathic Scoliosis

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Hypothesis
A history of scoliosis bracing does not negatively impact long-term mental health and health-related quality of life (HRQoL) outcomes in patients who progress to surgery.

Design
Multicenter retrospective cohort from an international spine registry

Introduction
Scoliosis treatments, including bracing and surgery, impact adolescents' physical and psychological well-being. The psy-

chological effect of progression to surgery despite bracing is unclear. This study evaluates whether bracing failure negatively affects mental health and HRQoL compared to surgery without prior bracing.

Methods
AIS patients who underwent posterior spinal fusion with a minimum two-year follow-up were analyzed. Inclusion criteria included primary fusion, available bracing history, and mental health outcomes via the SRS-22 questionnaire. Exclusion criteria included non-idiopathic scoliosis and prior scoliosis surgery. Statistical analyses included Wilcoxon rank-sum and Fisher's exact tests.

Results
Of 632 patients, 238 had prior bracing, and 394 had no documented bracing history. The braced group was younger at diagnosis (10.7 ± 2.4 vs. 12.4 ± 2.4 years; p<0.001) but not at surgery. Preoperatively, the braced group had higher self-image (3.41 ± 0.69 vs. 3.25 ± 0.72; p=0.003) and total SRS scores (3.85 ± 0.52 vs. 3.75 ± 0.54; p=0.024). Postoperatively, no significant differences were observed. At two-year follow-up, the braced group had higher scores (although less than the minimum detectable measurement difference) in pain (4.41 ± 0.61 vs. 4.29 ± 0.68; p=0.019), self-image (4.41 ± 0.58 vs. 4.27 ± 0.67; p=0.010), general function (4.50 ± 0.45 vs. 4.40 ± 0.54; p=0.019), satisfaction (4.64 ± 0.56 vs. 4.47 ± 0.75; p=0.016), and total (4.36 ± 0.46 vs. 4.25 ± 0.52, p=0.019). Mental health scores were not different.

Conclusion
This study suggests that bracing progression to surgery does not appear to negatively impact HRQoL outcomes after surgery. However, the relatively low proportion of patients who were braced in this cohort may represent a limitation of the results. Despite this, these results suggest that AIS patients demonstrate resilience, with no evidence of long-term adverse effects on mental health or HRQoL due to bracing failure.

		Brace Cohort		
		Braced (n=238)	Not Braced (n=394)	P-value
Preoperative				
	Pain	3.99 ± 0.74	3.88 ± 0.79	0.086
	Self-Image	3.41 ± 0.69	3.25 ± 0.72	**0.003****
	General Function	4.18 ± 0.54	4.10 ± 0.65	0.242
	Mental Health	3.89 ± 0.76	3.83 ± 0.81	0.389
	Satisfaction	3.68 ± 1.00	3.71 ± 0.95	0.84
	Total	3.85 ± 0.52	3.75 ± 0.54	**0.024***
Postoperative				
	Pain	3.60 ± 0.89	3.63 ± 0.84	0.799
	Self-Image	4.04 ± 0.57	4.28 ± 0.67	0.215
	General Function	3.45 ± 0.58	3.10 ± 0.67	0.198
	Mental Health	4.02 ± 0.64	3.88 ± 0.63	0.468
	Satisfaction	4.01 ± 0.90	4.44 ± 0.73	0.142
	Total	3.80 ± 0.49	3.84 ± 0.51	0.735
Two-Year Follow-up				
	Pain	4.41 ± 0.61	4.29 ± 0.68	**0.019***
	Self-Image	4.41 ± 0.58	4.27 ± 0.67	**0.010***
	General Function	4.50 ± 0.45	4.40 ± 0.54	**0.019***
	Mental Health	3.99 ± 0.75	4.01 ± 0.78	0.646
	Satisfaction	4.64 ± 0.56	4.47 ± 0.75	**0.016***
	Total	4.36 ± 0.46	4.25 ± 0.52	**0.019***
Pre-operative to Two-Year Difference in Scores				
	Pain	0.42 ± 0.06	0.41 ± 0.05	0.898
	Self-Image	1 ± 0.06	1.02 ± 0.05	0.798
	General Function	0.32 ± 0.05	0.3 ± 0.04	0.755
	Mental Health	0.1 ± 0.07	0.18 ± 0.06	0.386
	Satisfaction	0.96 ± 0.07	0.76 ± 0.06	**0.031***
	Total	0.51 ± 0.05	0.5 ±0.04	0.876

Significant differences between variables indicated as follows: <.05*, <.01**, <.001***

SRS Scores Stratified by History of Bracing and Timepoint

250. Pulmonary Function During Growth Friendly Treatment of Early Onset Scoliosis: Importance of Apical Translation

Scott Yang, MD; Natalie Maharaj, BS; Apeksha Gupta, MS, MPH; Michael Trask, BS; Anna Faino, MSc; Sean Pirkle, MD; Kelson Adcock, BS; Jennifer M. Bauer, MD, MS; Burt Yaszay, MD; Gregory Redding, MD

Hypothesis
Changes in radiographic measures do not correlate with pulmonary function changes during early onset scoliosis treatment.

Design
Retrospective Case Series

Introduction
Serial pulmonary function tests (PFTs) and their relationship to spinal deformity during growth friendly (GF) treatment of early onset scoliosis (EOS) are not widely reported, with sparse data correlating changes in serial PFTs to changes in scoliosis severity during GF treatment. This study evaluates if changes in pulmonary function correlate to changes in radiographic measures of scoliosis during distraction-based GF treatment of EOS.

Methods
All patients undergoing GF surgical treatment for EOS with matched serial PFTs and radiographs were included in this single center retrospective study. The primary pulmonary function measure was forced vital capacity % predicted (FVC%). Radiographic measures included Cobb angle, T1-T12 height, thoracic kyphosis (TK), and thoracic apical vertebral translation distance (AVT). Spearman correlation

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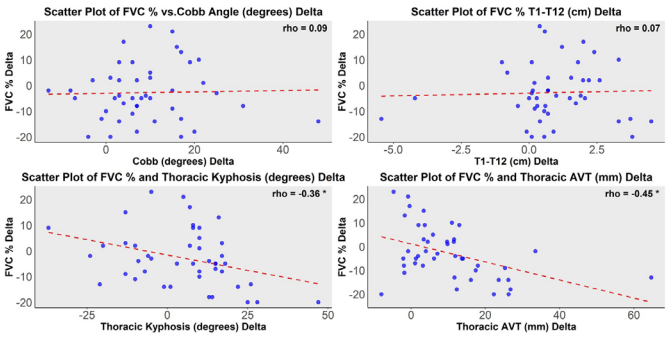
analysis was utilized to observe the association between the difference in radiographic and PFT measures at two serial time points during GF treatment.

Results
44 patients with EOS were included, with all patients undergoing distraction-based instrumentation. Mean age at first PFT was 9.6 years, with mean 4.4 years between serial PFT evaluations. Mean Cobb Angle, T1-T12, length, TK angle, and AVT distance were 55.3°, 18.2 cm, 53.3°, and 41.5 mm respectively at the time of the first PFT during GF treatment. FVC% declined during GF treatment in 36.4%, improved in 20.5%, and remained unchanged in 43.2%. Changes in Cobb angle and T1-T12 length did not correlate to changes in FVC% (rho = 0.08, rho = 0.07 respectively). Changes in TK and AVT had a significant moderate negative correlation to changes in FVC% (Rho=-0.36, p = 0.017 and Rho=-0.45, p=0.002 respectively).

Conclusion
Scoliosis curve behavior and pulmonary function continue to co-evolve during GF treatment of EOS. Coronal cobb or thoracic height measurements are not useful predictors of how pulmonary function will respond during GF treatment of EOS. Changes in thoracic AVT was the strongest radiographic parameter correlating to changes in pulmonary function in EOS during GF treatment. A renewed interest in controlling the apex in GF spine surgery may have an important role in preserving pulmonary function during GF treatment in EOS.



251. Rate of Conversion to Fusion Following Cervical Laminectomy Versus Laminoplasty: A Retrospective Analysis of 4,406 Patients

Andy M. Liu, BS; Adeesya Gausper, BS; Suhas Etigunta, BS; Alexander Tuchman, MD; Christopher Mikhail, MD; David L. Skaggs, MD, MMM; *Vivien Chan, MD, MS, FRCS(C)*

Hypothesis
Laminectomy and laminoplasty will have no difference in rates of post-operative cervical fusion.

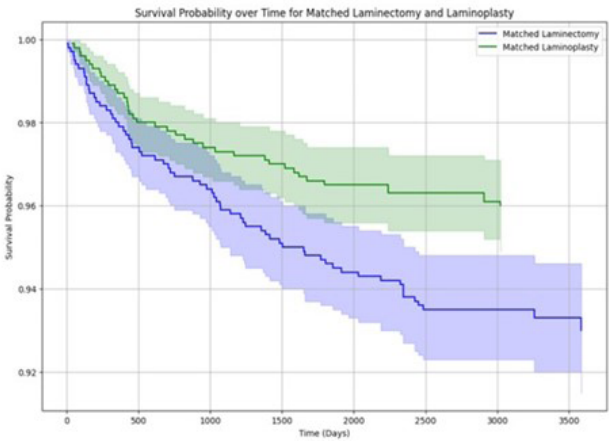
Design
Retrospective cohort study

Introduction
The theoretical benefit of a laminoplasty is to preserve motion while reducing risk of postoperative kyphosis associated with cervical laminectomies. However, there is limited data comparing outcomes between cervical laminectomy without fusion and cervical laminoplasty. The purpose of this study was to compare the rate of conversion to cervical fusion between patients that received cervical laminectomy and cervical laminoplasty for degenerative cervical disease.

Methods
The PearlDiver database for years 2010 to 2021 was queried for patients who received either a posterior cervical laminectomy or a cervical laminoplasty for a diagnosis of degenerative cervical disease. Multivariable regression analysis was performed to identify variables associated with conversion to fusion. A matched analysis was performed using the significant variables. Rates of conversion to cervical fusion were determined for each cohort for 2-years, 5-years, and 10-years after surgery. The rates were compared using Chi-square test. Survival analysis was performed.

Results
A total of 4,406 patients (Laminectomy: 2,258; Laminoplasty: 2,148) were included in this study. In the multivariable logistic regression analysis, age and obesity were significant variables. In the matched analysis, the rate of conversion to fusion for laminectomy at 2-years, 5-years, and 10-years were 3.2%, 5.0%, and 5.7%, respectively. The rate of conversion to fusion for laminoplasty at 2-years, 5-years, and 10-years were 2.2%, 3.2%, and 3.5%, respectively. There was no significant difference between the two groups at 2-years after surgery. Cervical laminectomy patients had a higher rate of conversion to fusion than cervical laminoplasty at 5-years and 10-years after surgery.

Conclusion
In patients with degenerative cervical disease, cervical laminectomy had a significantly higher rate of conversion to cervical fusion than cervical laminoplasty at 5-years and 10-years post-surgery. This is the largest study comparing laminectomy to laminoplasty to date.



Survival probability of post-operative cervical fusion for matched laminectomy and laminoplasty cohorts.

252. Optimizing Robotic-Assisted Spine Surgery: The Effect of Standardized Institutional Guidelines

Suhas Etigunta, BS; Anirudh Gowd, MD; Adeesya Gausper, BS; Nora Galoustian, BA; Andy M. Liu, BS; Vivien Chan, MD, MS, FRCS(C); Sonal Sodha, MD; Tiffany G. Perry, MD; David L. Skaggs, MD, MMM; Terrence Kim, MD

Hypothesis
Standardized institutional guidelines can identify and minimize robot-related complications in spine surgery.

Design
Retrospective Cohort Study

Introduction
Robotic-assisted spine surgery is known for improving the accuracy and optimizing trajectory of pedicle screw placement, yet complications remain a significant concern. Prior studies suggest that breaches and ensuing complications related to robotic surgery may be from poor reference frame calibration or a lack of standardized practices. This study evaluates whether the introduction of standardized institutional guidelines for robotic-assisted spine surgery reduces complications associated with robotic screw placement.

Methods
This retrospective cohort included 554 patients who underwent robotic assisted spine surgery at a single institution. 264 robotic-assisted spine surgeries were performed before the implementation of institutional guidelines to ensure safety with robotic placement of pedicle screws, and 290 surgeries after their adoption. The surgical team was provided detailed guidelines for reference frame placement, intraoperative alignment checks, screw positioning verification, and postoperative imaging using two robotic systems. Patient demographics, preoperative diagnoses, surgical characteristics, and complications were collected.

Results
There was no statistical difference in patient demographics between the pre-protocol and post-protocol groups. In the pre-protocol cohort, 6 (2.2%) patients experienced robot-related complications, including nerve injuries, durotomies, and misplaced screws, with half of these cases attributed to reference frame errors. Following guideline implementation, no (0%) robot-related complications occurred in the 290 post-protocol surgeries, involving 2,030 robotic screws. Notably, there were no instances of pedicle breach with neurostimulation or on post-operative imaging.

Conclusion
Standardized robotic surgery guidelines effectively minimized robot-related screw complications in a combined cohort of 554 patients. This study underscores the importance of protocol standardization, alongside technological advancements, in optimizing patient safety and improving outcomes. These findings suggest that well-designed institutional protocols may significantly reduce robotic surgery complications and can be a valuable model for other institutions.

Step	Guidelines
1	Adhere to manufacturer recommendation to limitations in working distance from reference frame and/or bone mount.
2	Attending reviews all screw planning trajectories.
3	Attending present for fluoro-to-CT calibration/matching.
4	Anatomic confirmation of accuracy of robotic navigation tools.
5	High-speed drill/burr to create pilot hole, stopping at approximately 5 mm deep for thoracic spine and 10 mm deep for lumbar spine
6	Ball probe check, where able, prior to screw insertion.
7	Use of neuromonitoring stimulation of thoracic screws.
8	Postoperative check imaging prior to exiting OR (e.g., X-ray, fluoro, O-arm).
9	Robotic Reference Frame Accuracy: - Mazor X: Black end effector divot check. - ExcelsiusGPS: Surveillance pin.
10	Robotic Navigation Accuracy: - Mazor X (thoracic spine): Use of patient-based reference frame not robot-mounted reference frame. - Mazor X (lumbar spine): Robot-mounted reference frame allowed. - ExcelsiusGPS: Aggressive foot pedal resettling; avoid offset warnings.

Spine Robotic Guidelines

253. A Retrospective Analysis of Patients Deemed Ineligible for Surgery in a Multidisciplinary Complex Spine Conference

Patricia Lipson, BS; Rafael Garcia de Oliveira, MD; Takeshi Fujii, MD, PhD; Jean-Christophe A. Leveque, MD; Venu M. Nemani, MD, PhD; Philip K. Louie, MD; Rajiv K. Sethi, MD, PhD

Hypothesis
here may be a subset of patients who do not meet surgical criteria implemented by the multidisciplinary conference yet may benefit from surgery.

Design
Retrospective observational study.

Introduction
A multidisciplinary preoperative conference for adult spinal deformity (ASD) patients offers a case-by-case evaluation of surgical eligibility. However, the outcomes for patients deemed ineligible for surgery remain unclear. This study aims to assess patient experiences and outcomes following a recommendation against surgery and to evaluate the proportion of patients who later pursued surgery elsewhere, along with their rates of complications, reoperations, and readmissions.

Methods
This retrospective analysis examined patients advised against surgery during a multidisciplinary ASD conference. A phone-based survey assessed patient satisfaction, alternative treatment effectiveness, and rates of outside surgeries, along with associated complications, reoperations, and readmissions.

Results
A total of 101 patients who were presented at a multi-

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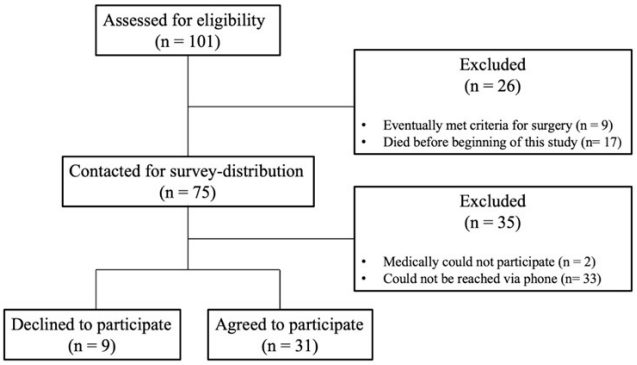
disciplinary conference from 2015-2024 were evaluated and recommended against surgery; 9 patients eventually met criteria for surgery and underwent surgery with this study's group while 17 patients died before the beginning of this study. Therefore, 75 patients were contacted for survey-distribution. . Additionally, 2 patients could medically not participate, and 33 patients could not be reached via phone. A total of 40 patients participated in this study with 9 declining to answer questions and 31 agreeing to answer all questions. Of the 31 patients, 71% were satisfied with our recommendation not to undergo surgery, 38.7% sought a second opinion, and of those who sought a second opinion 4 eventually underwent surgery at an outside hospital. The majority of participants rated their quality of life as "acceptable" and used physical therapy and pain medications as nonoperative treatments for pain.

Conclusion
Approximately 38.7% of patients sought a second opinion after being recommended against surgery at a multidisciplinary conference. Of those who sought a second opinion, 41.7% were recommended surgery, and 33% eventually underwent surgery with minimal complications. This highlights that there may be a subset of patients who do not meet surgical criteria implemented by the multidisciplinary conference yet may benefit from surgery.



254. What's Next After Gwas Studies in Ais? Insight from Clinical and Preclinical Study with a New Validated Mouse Scoliosis Model on the Metabolic Role of Lbx1 on Curve Progression *

Wayne Yuk-wai Lee, PhD; Zhe Zhang, PhD, MBBS; *Adam Yiu-chung Lau, MBBS, FRCS*; Daniel Kam-wah Mok, PhD; Zezhang Zhu, PhD; Huanxiong Chen, PhD, MBBS; Gen Tang, MSc; Kenneth Guangpu Yang, PhD, MBBS; Tsz-Ping Lam, MBBS, FRCS; Yong Qiu, PhD; Jack Chun-yiu Cheng, MD, FRCS

Hypothesis
We hypothesized that LBX1 could affect curve progression in a mouse model of scoliosis via modulating metabolic pathways in paraspinal muscles.

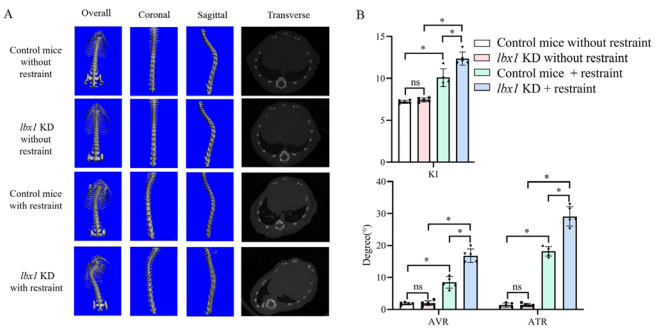
Design
Cross-sectional and animal study.

Introduction
Ladybird homeobox 1 (LBX1) is a widely investigated susceptibility gene in AIS, but its role on curve progression remains elusive. We previously reported LBX1 could influence muscle carbohydrate metabolism. Using a new mouse model of scoliosis with reproducible three-dimensional structural curve, this study aims to investigate whether LBX1 could affect curve progression and targeting its modulated metabolic pathway could mitigate the curve progression.

Methods
Part 1: Apical concave and convex deep paraspinal muscle biopsies (PSM) were collected from 28 AIS patients undergoing posterior spinal-fusion surgery. Metabolomics was used to identify potential metabolic pathways influenced by LBX1. Part II: 4-week-old female C57BL/6 background lbx1 floxed mice with or without lbx1 knockdown in one side of PSM by adeno-associated virus were used to induce spinal deformity by 3D-printed asymmetric hypo-kyphosing thoracic restraint. The mice were then randomly subjected to spermidine treatment (target derived from Part I study) or vehicle control. Weekly X-ray spinal radiography, CT, histological examination after 6 weeks of intervention were performed to evaluate outcomes.

Results
Part I: Higher LBX1 levels were found in apical convex PSM, Cobb angle was negatively correlated with concave/convex LBX1 ratio, and polyamine pathway was found to be disrupted by LBX1 in metabolomic analysis. Part II: Mice with lbx1 knockdown in their concave PSM exhibited higher susceptibility to restraint induced three-dimensional spinal deformity, which could be significantly alleviated by spermidine treatment.

Conclusion
This new mechanically induced scoliosis-like mouse model on female mice undergoing rapid skeletal growth can serve as a consistent and reproducible research tool for studying relevant factors affecting curve progression. Using this new model, this proof-of-concept preclinical study provides novel evidence on the role of LBX1 on curve progression via polyamine pathway and possibility of targeted therapy. Further clinical investigation is warranted to verify its translational potential.



Lbx1 knockdown exacerbates spinal deformity in scoliosis mouse model

*John H. Moe Best Basic Research E-Point Presentation

255. Spinopelvic Parameters Measured from the Sacral Endplate Resulted in Greater Radiographic Improvement After Reconstruction in Deformity Patients with Transitional Lumbosacral Anatomy

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Hypothesis
Using the midpoint of the sacrum will result in predictable improvement in spinopelvic parameters after surgery

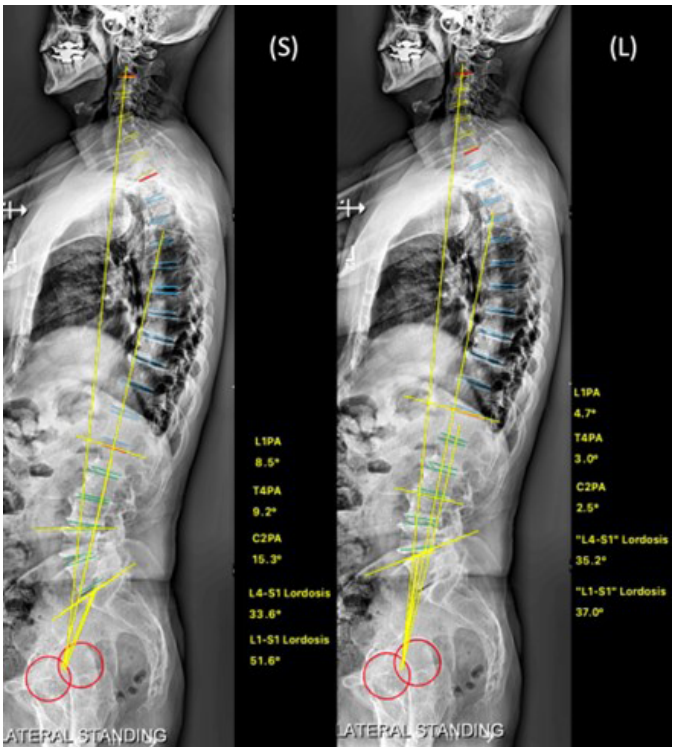
Design
Retrospective analysis of prospectively collected data

Introduction
Lumbosacral transitional anatomy (LSTA) occurs in 10-20% of patients with adult spinal deformity (ASD) and selection of the last motion segment (LMS) has significant implications for surgical planning. The purpose of this study was to describe the distribution of spinopelvic parameters using two distinct LMS before and after reconstruction.

Methods
A multicenter prospective ASD database with a min 2yr follow-up was used to identify LSTA patients. Demographic, perioperative, and radiographic data were collected before and after surgery. Two groups were created from the same set of patients to measure sagittal alignment based on: 1. The midpoint of the sacral endplate (SE); 2. the midpoint of the superior endplate of the cephalad vertebra (LE) (Fig 1). Chi-squared and Student's t-tests were calculated for categorical and continuous variables, respectively.

Results
1536 patients were available for analysis. The incidence of LSTA in ASD was 11.1% (N=171). 82 had fusion to the pelvis and complete data with mean age 62 (+/- 12 years). Preop there were differences in most sagittal parameters, with SE references resulting in greater mean PI (56°(+/-11.5) vs. 28° (+/-11), P<.001), L4-S1 lordosis (33° vs. 23°, P=0.26), L1PA (12° vs. 6°, P<.001), T4PA (20° vs. 15°, P<.001), and C2PA (26° vs. 20°, P<.001) compared to LE. The majority of LE measurements (95%) were Roussouly (R) type 1 or 2 spines, while only 25% of SE cases were (P<0.001). The difference between measured and ideal preoperative L1PA was greater when using LE as the reference (10.8° vs. 4.8°, P<.001). Postoperatively, patients were a mean 2.4° (+/- 7.7) from target L1PA when using SE, and 8.4° (+/- 7.0) with LE. 42 patients (51.2%) were close to their target L1PA goal (within 50%) following reconstruction using SE, while only 22 (26.8%) with LE were.

Conclusion
Using SE as the LMS appears to have improved sagittal alignment compared to LE. Further studies are needed to explore the clinical implication of using different endplates for spinopelvic parameters in this patient population.



256. Better Curve Correction and Growth Maintenance with Multi-Segment Growth Guidance Rod in Juvenile Scoliosis: A Preliminary Two-Year Study

Kai Li, MD; Sheng Zhao, MD; Xuhong Xue, MD, PhD

Hypothesis
The Multi-Segment Growth Guidance Rod (MSGGR) provides superior correction and growth maintenance compared to traditional growing rod (GR) and spinal fusion techniques in older juvenile scoliosis patients.

Design
Prospective study

Introduction
Distraction-based devices are popular for scoliosis treatment but have limitations in controlling the apex of curvature and providing satisfactory correction, especially in older juvenile scoliosis patients. A growth-friendly implant with better correction capabilities is needed.

Methods
The MSGGR system consists of multiple segments of 5.5-mm stainless steel rods, allowing independent lengthening of segments between the caudal/cephalad screws and the apical screws. Data were prospectively collected from five patients (4 females, 1 male; mean age 10.3 years) who underwent MSGGR surgeries. Clinical and radiographic outcomes, including curve correction and spinal height measurements (T1-T12 and T1-S1), were analyzed and compared

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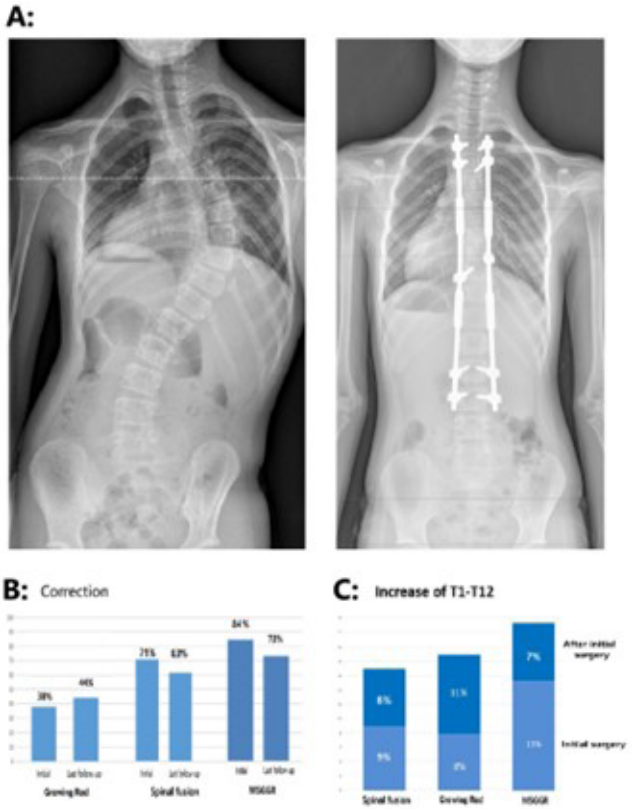
to reported results of GR and spinal fusion in similar patient populations.

Results
The mean Cobb angle improved from 66°±18° preoperatively to 11°±7° immediately postoperatively, with an initial correction rate of 84%±7%. At 24-month follow-up, the Cobb angle was 18°±5°, maintaining a correction rate of 73%±2%. The Nash-Moe index decreased from 2.2±0.4 preoperatively to 1.0±0 postoperatively. T1-T12 height increased from 19.8±2.2 cm to 22.6±1.5 cm immediately after surgery, and further to 24.1±1.6 cm at 24 months. T1-S1 height increased from 32.0±2.8 cm to 36.3±2.3 cm postoperatively, and to 38.8±2.0 cm at 24 months. Instrumented segments grew by 7%±4% at 24 months. Complications included one case of infection requiring implant removal and one rod breakage without revision. Compared to GR and spinal fusion outcomes reported in the literature, MSGGR patients demonstrated superior correction and height gain.

Conclusion
The MSGGR technique offers greater curve correction and spinal height increase than traditional growing rod and spinal fusion techniques in older juvenile scoliosis patients. It is a promising growth-friendly approach that provides better apical control and growth potential for scoliosis patients.



A: Image of patient. B: MSGGR Correction Outperforms Growing Rod & Spinal Fusions. C: MSGGR Patients' T1-T12 Height Increase in 2 Years Exceeds Growing Rod & Fusion Patients' in 5 Years

257. Biomechanical Analysis in Hip Joints According to Sagittal Pelvic Tilt on Non-Ambulatory Patients with Neuromuscular Scoliosis Using Finite Element Modeling

Donghee Ye, MD; Jaewon Shin, MD, PhD

Hypothesis
We hypothesize that changes in sagittal pelvic tilt (SA-PT) influence hip joint stress distribution in non-ambulatory neuromuscular scoliosis (NM-S) patients, with a reduction in SA-PT increasing acetabular stress and predisposing patients to hip pain and subluxation.

Design
This is a biomechanical computational study using the finite element method (FEM) to evaluate the mechanical effects of varying SA-PT angles on hip joint stress. While informed by prior clinical findings, this study is independent of patient-derived clinical data.

Introduction
Patients with NM-S frequently develop hip subluxation and pain due to pelvic obliquity. While coronal pelvic tilt (CO-PT) has been the primary focus of correction, recent clinical evidence suggests that changes in sagittal pelvic tilt (SA-PT) may also contribute to postoperative hip instability. This study employs FEM modeling to analyze the biomechanical relationship between SA-PT and hip joint stress distribution.

Methods
A 3D finite element model of the pelvis and femur was developed using CT-derived anatomical data. Five models with SA-PT angles of -30°, -15°, 0°, 15°, and 30° were constructed, simulating a seated posture with a 400 N vertical load applied to the sacrum. Peak von Mises stress (PVMS) and stress distribution across the acetabular cartilage were analyzed to assess the effects of SA-PT on hip biomechanics.

Results
As SA-PT decreased, acetabular stress increased: PVMS was highest at -30° SA-PT (22.44 MPa) and lowest at 30° SA-PT (9.41 MPa). Additionally, stress shifted from a central distribution at higher SA-PT angles to a more peripheral concentration at lower angles, suggesting a mechanical predisposition to subluxation. These findings align with prior clinical observations of increased postoperative hip pain and instability in NM-S patients following SA-PT reduction.

Conclusion
Finite element analysis demonstrates that decreasing SA-PT increases acetabular stress and alters stress distribution, potentially contributing to hip pain and subluxation. These findings highlight the biomechanical importance of sagittal balance adjustments in surgical planning for NM-S patients.

258. Clinical and Biomechanical Analysis of Postoperative Rod Fracture in Spinal Deformity

Junyu Li, MD; Yihao Liu, MD; Runan Pan; Zhuoran Sun, MD; Yongqiang Wang, MD; Yan Zeng, MD; Weishi Li, MD; *Miao Yu, MD*

Hypothesis
In spinal deformity surgery, the average curvature of the fixation rod is related to the rod fracture risk. Larger curvature means higher risk. Also, pre - bending of the rod affects residual stress and fatigue life, with greater pre - bending increasing fracture risk.

Design
Finite Element Analysis, Clinical Research

Introduction
Postoperative mechanical complications, especially rod fractures, are a current hot topic in spinal deformity surgery. Changes in biomechanical structure after surgery increase the risk of rod fractures, causing significant patient distress. We combined clinical data with finite element analysis to evaluate stress changes in fixation rods post-surgery, aiming to identify risk factors for rod fractures.

Methods
We enrolled 17 patients who had rod fractures after spinal deformity surgery with 5.5mm titanium fixed rod.According to the causes of spinal deformity, they were divided into four groups.We measured and compared the postoperative radiographic results,especially the average curvature of the fixed rod.In finite element analysis,we choose Ti-6Al-4V as the modelling material to establish a model, and pre-bend it with different curvatures to analyze the residual stress corresponding to the curvature, and investigate the effect of fatigue life of spinal implanted rods with different pre-bending rates resulting in different residual stresses.

Results
In the degenerative,idiopathic,tuberculosis and OVCF group,it was found that there were significant differences in curvature between non-rod fracture group and rod fracture group(2.17±0.76 vs 3.40±1.86,P=0.017;2.21±0.63 vs 4.05±0.86,P<0.001;1.57±0.61 vs 4.53±1.47,P<0.001;1.65±0.52 vs 4.32±1.24,P<0.001).In biomechanics,the corresponding curvature after pre-bending increases gradually with the increase of torque applied at both ends of the rods.Their maximum residual stresses are located in the upper path of the center axial section.When the pre-curvature of the spinal implant rod is large, there will be obvious stress concentration in the middle part,which ultimately leads to a decrease in its fatigue life and an increase in its fracture risk.

Conclusion
After spinal deformity surgery, a greater fixation rod curvature means higher fracture risk due to large orthopedic range. Rod pre - bending increases residual stress, which reduces the rod's fatigue life and raises fracture risk.

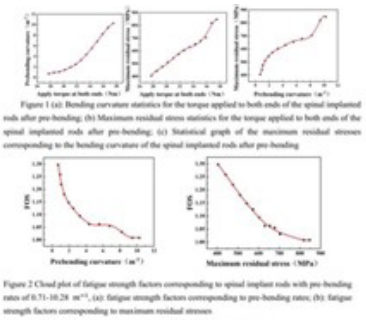


Figure 1 (a): Bending curvature statistics for the torque applied to both ends of the spinal implanted rods after pre-bending; (b) Maximum residual stress statistics for the torque applied to both ends of the spinal implanted rods after pre-bending; (c) Statistical graph of the maximum residual stresses corresponding to the bending curvature of the spinal implanted rods after pre-bending

Figure 2 Cloud plot of fatigue strength factors corresponding to spinal implant rods with pre-bending rates of 0.71-10.28 m^{-1}; (a): fatigue strength factors corresponding to pre-bending rates; (b): fatigue strength factors corresponding to maximum residual stresses

Figure 3 A 59-year-old man was diagnosed with tuberculous kyphosis and fixed with a 5.5 mm titanium rod after surgical osteotomy.(a)Post-operation:Cobb angle 34.9°,SVA 35.7mm,CL 12.0°,LL 83.2°,TK 85.5°,PI 29.2°,PT 9.6°,SS 19.6°, average curvature of titanium rod 6.2195m^{-1};(b) After 19 months of follow-up, the fixation rod was found to be broken.

259. The Influence of Klippel-Feil Syndrome on Coronal Plane Deformity and Surgical Outcomes in Congenital Cervicothoracic Scoliosis: A Comparative Analysis

Sai-hu Mao, PhD; Zezhang Zhu, PhD; Yong Qiu, PhD

Hypothesis
CTS patients with KFS exhibit more severe coronal deformities and higher revision surgery rates compared to those without KFS.

Design
A Single-Center Retrospective Study

Introduction
This study aimed to assess the differences in coronal morphology and surgical outcomes between congenital cervicothoracic scoliosis (CTS) patients with and without Klippel–Feil syndrome (KFS).

Methods
A total of 69 CTS patients were retrospectively included in this study. They were divided into KFS and non-KFS groups. Primary deformity parameters, as well as secondary coronal compensatory parameters were measured preoperatively, postoperatively, and at the last follow-up. Radiographic parameters, coronal subtypes, fixation length, blood loss, surgical duration, and complications were compared between the two groups.

Results
The KFS group consisted of 41 patients, while the non-KFS group had 28 patients. In the KFS group, 21 patients had cervical fusion involving three or more segments, and 30 patients were classified as Samartzis type III (multiple contiguous congenital fusions). Before surgery, the KFS group exhibited a smaller CCC but greater head tilt, head shift, trunk tilt, and DCC compared to the non-KFS group (all P<0.05).

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In the KFS group (61.0%), the proportion of patients with significant trunk tilt or compensatory thoracic curves (Type B or Type C) was notably higher than in the non-KFS group (10.7%, P<0.001). Although there were significant improvements in all deformity parameters after surgery (all P<0.05), the head shift, trunk tilt, and DCC in the KFS group experienced a notable worsening and were significantly greater than those in the non-KFS group at the last follow-up (all P<0.05). Despite having longer initial fixation segments (P=0.003), five patients in the KFS group required revision surgery due to progressive trunk tilt and DCC, compared to only one patient in the non-KFS group. No significant differences were observed between the groups regarding blood loss, surgical duration, or neurological complications.

Conclusion
CTS patients with KFS were prone to develop secondary trunk tilt or DCC in the coronal plane. Such deformities may not be effectively corrected by initial short-segment surgery and may continue to progress with growth and potentially require revision surgery.

260. Biomechanical Analysis of Spinal Cord Injury During Scoliosis Correction Surgery

Junyu Li, MD; Runan Pan; Yongqiang Wang, MD; Yan Zeng, MD; Weishi Li, MD; *Miao Yu, MD*

Hypothesis
spinal cord injury during scoliosis correction surgery is associated with biomechanical changes in the spinal cord, and that finite element analysis (FEA) can predict stress distribution and potential injury areas in the spinal cord during surgery.

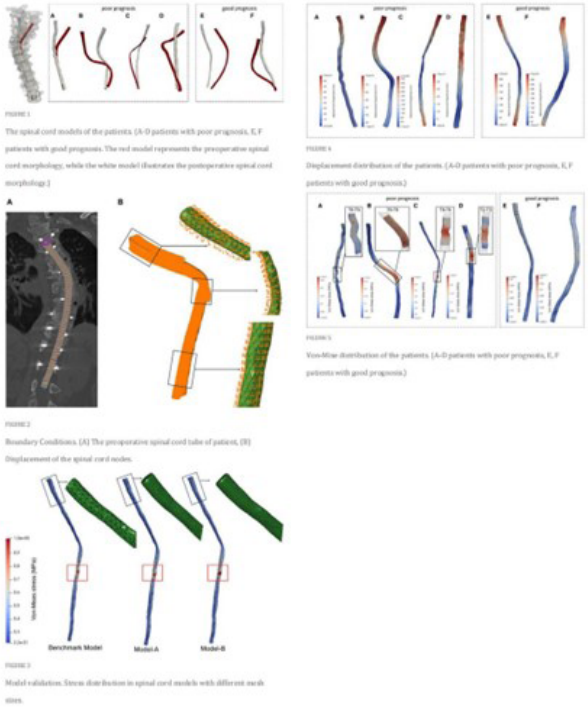
Design
patient-specific FEA approach

Introduction
Surgical correction is a common treatment for severe scoliosis.Due to the significant spinal deformation that occurs with this condition, spinalcord injuries during corrective surgery can occur, sometimes leading to paralysis.

Methods
Such events are associated with biomechanical changes in the spinalcord during surgery, however, their underlying mechanisms are not well understood. Six patient-specific cases of scoliosis either with or without spinal complications were examined. Finite element analyses (FEA) were performed to assess the dynamic changes and stress distribution of spinal cords after surgical correction. The FEA method is a numerical technique that simplifies problemsolving by replacing complex problem solving with simplified numerical computations.

Results
In four patients with poor prognosis, there was a concentration of stress in the spinal cord. The predicted spinal cord injury areas in this study were consistent with the clinical manifestations of the patients. In two patients with good prognosis, the stress distribution in the spinal cord models was uniform, and they showed no abnormal clinical manifestations postoperatively.

Conclusion
This study identified a potential biomechanical mechanism of spinal cord injury caused by surgical correction of scoliosis. Numerical prediction of postoperative spinal cord stress distribution might improve surgical planning and avoid complications.



262. 3D Radiological and Clinical Prognostic Factors for Failure and Improvement of Bracing for Adolescent Idiopathic Scoliosis (AIS): A Comparative Analysis

Nikos Karavidas, MSc, PT; Yavuz Yakut, PhD

Hypothesis
Our objective was to analyze radiological and clinical prognostic factors for Cobb angle difference more than 5o in progressive (PRO) and improved (IMP) groups of patients and detect potential associations.

Design
Comparative Experimental Study

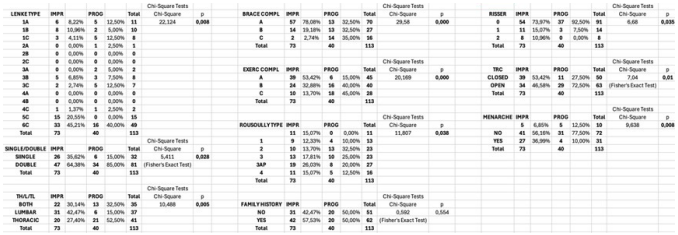
Introduction
The rate of success and failure for bracing in AIS patients varies in the literature and some factors have been highlighted as positive or negative to the treatment outcome. To date, no study compared the characteristics of failures and improvements from the same initial sample.

Methods
113 patients (73 IMP and 40 PRO) with progression or improvement from our prospective database, were select-

ed for analysis. Our inclusion criteria were brace treatment and scoliosis specific exercises (SSE) with Cobb angle >25o, Risser sign 0-2. We evaluated initial Cobb angles (Cobb-I), in-brace correction (IBC) and final Cobb angles (Cobb-F) for thoracic (TH) and lumbar (LU) curves. The factors that we analyzed were Lenke type, apex location, compliance, supervised sessions/year, Pelvic Incidence (PI), Pelvic Tilt (PT), Sacral Slope (SS), Roussouly type, thoracic kyphosis (TK), lumbar lordosis (LL), family history, Risser sign, Triradiate Cartilage (TRC) ossification, Body Mass Index (BMI) and Angle Trunk Rotation (ATR). Chi-square, Fisher's exact and Mann-Whitney U tests were used for statistical analysis.

Results
IBC (41% IMP – 22.9% PRO, p<0.01), Cobb-FI TH(25.7o IMP – 50.1o PRO, p<0.01), Cobb-F LU (21.9o IMP – 49.26o PRO, p<0.01), Brace compliance (78.1% high for IMP - 32.5% high for PRO, p<0.01), SSE compliance (53.4% high for IMP - 15% high for PRO, p<0.01), curve type (single 35.6%, double 64.4% IMP – single 15%, double 85% PRO, p=0.02), Lenke types (1C 4.1%, 3C 2.7%, 5C 20.6% IMP - 1C 12.5%, 3C 12.5%, 5C 0% PRO, p=0.01), Roussouly types (p=0.038), Risser (p=0.03), TRC (open 46.5% IMP – open 72.5% PRO, p=0.01), menarche (no 56.2% IMP – 77.5% PRO), BMI (17.7 IMP – 19.2 PRO,p=0.04) and sessions/year (26.1 IMP – 15.4 PRO) were significantly different between groups. Cobb-IN TH, PI, PT, SS and family history were not significantly different between groups.

Conclusion
Higher IBC and compliance with brace and SSE, later growth stage, single curves and lower BMI were associated with better outcomes. All these prognostic factors should be carefully monitored for improving prognosis.



Statistics of prognostic factors

263. Unsatisfactory Results in Parkinson's Patients Undergoing Spinal Surgery: Is Parkinson's Disease Severity the Major Culprit?

Hannah A. Levy, MD; Matt H. Lindsey, MD; Tyler Allen, MD; Andrew Pumford, BA; Brian Kelley, BS; Abdelrahman Hamouda, BS; Ahmad Nassr, MD; Brian Karamian, MD; Arjun S. Sebastian, MD; Brett A. Freedman, MD

Hypothesis
Greater Parkinson's disease (PD) severity is associated with impaired radiographic and clinical outcomes after spinal fusion.

Design
Retrospective cohort analysis

Introduction
PD represents a progressive neuromuscular disorder associated with postural instability and spinal deformities. Historically, spinal fusion in PD is fraught with high rates of hardware failure, pseudoarthrosis, and reoperation. However, it remains unclear if the risk for adverse outcomes after spinal fusion in PD is disproportionately associated with the patient's degree of functional decline and advancement of PD.

Methods
All adult PD patients who underwent spinal fusion for deformity, degenerative, and traumatic indications at an academic center between 2017-2022 were retrospectively identified. PD severity was assessed according to the validated Hoehn and Yahr (H&Y) scale. PD specific metrics were extracted. Outcomes included length of stay (LOS), infection, medical complications, discharge destination, pain, reoperations, mortality, and fusion status and junctional complications from the one-year postoperative CT. Univariate and regression analysis compared outcomes based on binarized H&Y score (1-3 vs 4-5) and other PD severity metrics.

Results
A total of 163 PD patients were identified (80 H&Y 1-3, 83 H&Y 4-5). There were no significant differences in patient demographics, medical comorbidities, bone and muscle quality, operative indication, and construct related factors between H&Y groups. Greater H&Y score independently predicted increased LOS (6 vs 4 days, p<0.001) and postoperative mortality rate (30.1% vs 7.5%, p=0.001) and within the TL subgroup stenosis below the lower instrumented vertebrae (30.0% vs 3.7%, p=0.019), distal junctional complications (50.0% vs 18.5%, p=0.018), and decreased short-term pain relief (-1.5 vs-3.5, p=0.030). Within the thoracolumbar subgroup, essential tremor was associated with increased distal junctional complications (46.0% vs 13.8%, p=0.008), stenosis below the lower instrumented vertebrae (22.0% vs 3.5%, p=0.047), and decreased fusion rates (63.9% vs 90.9%, p=0.049).

Conclusion
In PD patients undergoing spine surgery, postoperative complications were found to associate with PD severity and characteristics. Calculation of the H&Y score and assessment of overall disease control may be helpful for risk stratification during preoperative evaluation of PD patients.

264. Radiographic and Functional Outcomes for Sagittal Alignment in Growing Rod Graduates: Are We Able to Rebuild Them?

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Hypothesis
Definitive fusion has no impact on sagittal alignment and functional outcomes

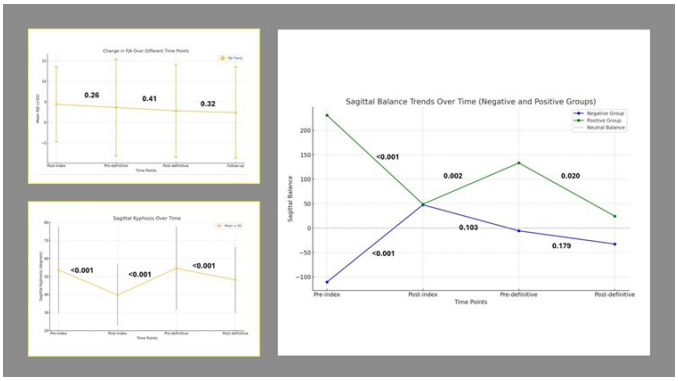
Design
Retrospective cohort

Introduction
The role of sagittal alignment has been extensively studied in adults and has now extended to pediatric populations. The inability to restore the sagittal parameters has a direct impact on functional outcomes. Sagittal alignment in early-onset scoliosis (EOS) managed with growth-friendly implants is modifiable, but what about after definitive fusion?

Methods
A prospective database was queried, and patients managed with dual TGR or MCGR & anchors at the spine were included. The variables were collected at pre-index (before growth rod implantation), post-index, pre-definitive, post-definitive (final fusion), & latest FU.

Results
420 patients(257 F) with a mean age 8.1 years & 13.2 years at index & definitive time points, respectively were included. The most common etiologies: neuromuscular(135), idiopathic(127), syndromic(119). 234 patients were with TGR & 186 MCGR. There was a significant change in Cobb angle and T1-S1 length at all time points($p<0.0001$). TGR had better maintenance of curvature (loss of 8° vs 12°,$p=0.016$) & increase in length(36.8mm vs 11.7mm, $p=0.001$) during lengthening. There was significant change($p<0.001$) in kyphosis, MCGR ended with lower value at post-definitive time point(47.7° vs 52.4°, $p=0.02$). Sagittal balance tends to move towards neutral after index & definitive surgery. Patients with positive balance shifted to more positive(+84.4mm, $p=0.002$), & with negative balance, to more negative(-53.3mm, $p=0.10$) during lengthening; restored to near neutral after final fusion and mean follow-up of 2.9 yrs. PJA decreased overall from post-index to follow-up($p=0.003$). The EOSQ-24 scoring was not in normative range at pre-definitive & follow-up. It showed no change from pre-definitive to follow-up in all 3 domains except for transfer (76.6% vs 71.6%, $p=0.013$) and fatigue/energy level(75.2% vs 69.3%, 0.0008) sub-domains, where deterioration was observed. 28%(119/420) had unplanned return to OR, the most common reason was rod fracture(53), followed by anchor pull-out(43).

Conclusion
Sagittal balance & PJA were not significantly different from GR alignment after definitive fusion surgery. Kyphosis is reduced & MCGR patients have lower final kyphosis. EOSQ-24 scores are not in the normative range in this group of patients and were not impacted by definitive surgery.



265. Hip Coverage and PI Changes Following Correction for Adult Spinal Deformity: Are They Associated with Mechanical Failure?

Zhen Liu, PhD; Jie Li, MD; Dongyue Li; Yanjie Xu, MD; Zezhang Zhu, PhD; Yong Qiu, PhD; *Jun Qiao, PhD*

Hypothesis
Hip joint coverage may indicate the compensatory capacity of the hip joint in ASD patients.

Design
retrospective

Introduction
To investigate the relationship between changes in hip joint coverage and pelvic incidence (PI), as well as the correlation between postoperative changes in hip joint coverage and mechanical complications (MC), in adult spinal deformity (ASD) patients following sacral alar-iliac (S2AI) screw fixation.

Methods
A retrospective analysis was conducted on 110 cases (220 hip joints) of ASD patients who underwent long spinal fusion with S2AI fixation in our single-center from January 2016 to January 2020. Based on changes in postoperative hip joint coverage, patients were divided into group C (pre-to-post hip coverage changes in the top quartile or above) and group NC (pre-to-post hip coverage changes in the bottom quartile or below).

Results
The average postoperative change in hip joint coverage among the 110 patients was 2.9% ± 2.8%, with 60 patients (54.5%) experiencing changes greater than 2%. Patients in group C showed higher change in hip joint coverage than those in group NC . The differences in preoperative LL , SVA , and PI between C and NC groups had no statistical significance. However, patients in group C had smaller preoperative hip joint coverage, and greater postoperative decrease in PI (ΔPI:5.03°±5.8°vs.0.3°±4.0°,P=0.001). At the final follow-up, the incidence of PJK was significantly lower in the C group compared to the NC group. Compared to group C, patients in group NC had a higher ΔSVA during follow-up and exhibited a greater trend toward sagittal imbalance progression. Additionally, the ΔPJA (8.0°±8.7°vs. 2.9°±°6.0,P=0.016) and PJA at 2-year-follow-up were significantly higher in the

NC group (12.1°±9.1°vs. 7.6°±6.7,P=0.038). Correlation analysis showed a negative correlation between the immediate postoperative change in hip joint coverage and the follow-up ΔSVA (R=-0.880,P<0.001), follow-up ΔPJA (R=-0.849, P < 0.001), and follow-up PJA (R=-0.751, P<0.001).

Conclusion
Hip joint coverage may indicate the compensatory capacity of the hip joint in ASD patients. Those with lower preoperative hip joint coverage and sufficient postoperative capacity for hip joint coverage changes tend to have a higher hip compensatory capacity. Consequently, these patients may exhibit a reduced risk of postoperative MC following S2AI fixation.

266. Emerging Growing Modulation Techniques in Adolescent Idiopathic Scoliosis Treatment: A Meta-Analysis Evaluating Outcomes and Safety of Anterior Vertebral Body Tethering and Apifix.

Eduardo Hevia Sierra, MD; Jesus Burgos Flores, PhD; Vicente García Gonzalez, MD; Gonzalo Mariscal, MD, PhD; Carlos Barrios, MD, PhD

Hypothesis
It was hypothesized that the evaluation of Anterior Vertebral Body Tethering (AVBT) and ApiFix as treatment options for Adolescent Idiopathic Scoliosis (AIS) will reveal varying degrees of effectiveness in curve correction and implant stability

Design
Meta-analysis.

Introduction
Novel vertebral modulation techniques such as AVBT and ApiFix are gaining popularity. However, they yield controversial results that require thorough evaluation. The aim of this study was to systematically evaluate and analyze the effectiveness and implant failures of AVBT and ApiFix as treatment options for AIS.

Methods
A meta-analysis using the PICOS framework was conducted. Studies that enrolled adolescents with idiopathic scoliosis treated with AVBT or ApiFix were included. Quality was evaluated using the MINORS criteria and GRADE system. Data were analyzed in R and R studio, using mean changes and event rates, with heterogeneity assessed through the Q test and I^2 statistic.

Results
A total of 27 studies (n=1263) in AVBT and 5 studies (n=167) in ApiFix were included. Regarding AVBT, at 1 year, the main thoracic curve showed a correction from 46.81°±9.01° to 20.55°±9.37° (53.3% reduction), and at 2 years from 42.95°±9.10° to 22.65°±10.47° (47.6% reduction). The thoracolumbar curve showed a correction at 1 year from 42.04°±10.82° to 20.19°±10.96° (53.8% reduction), and at 2 years from 40.18°±9.78° to 20.42°±10.09° (48% reduction). The thoracic kyphosis showed minimal changes at both 1-year and 2-year follow-ups 0.60° (95% CI; -0.88° to 2.09°) and 0.81° (95% CI; -3.38° to 4.99°), respectively. The overall tether breakage rate was 25% (95% CI; 17%-33%), with the highest rate at 3 years (48%), and the reoperation rate was 7% (95% CI; 4%-10%). Concerning ApiFix, at 2-3 years follow-up, the main thoracic curve showed a correction from 45.07°±6.58° to 22.74°±6.02° (47.2% reduction). The pooled mean change for kyphosis was -10.04° (95% CI; -35.52° to 15.44°). The analysis of the reoperation rate was 25% (95% CI; 9%-42%).

Conclusion
The modulation techniques achieved insufficient deformity reduction. During follow-up, it was not possible to verify any vertebral body growth modulation. Absence of correction the sagittal plane and rotation was found. Furthermore, the presented modulation techniques resulted in a high number of complications.

267. Dynamic Interspinous Radiology as a Predictor for Early-Onset Adjacent Segment Degeneration After Multilevel Lumbar Interbody Fusion (L2-Ilium).

Yong-Chan Kim, MD, PhD; Sung-Min Kim, MD, PhD; Inseok Son, MD; *XiongJie Li, MD*

Hypothesis
We hypothesized that increased preoperative dynamic interspinous radiography (DIR) is associated with a higher risk of early adjacent segment degeneration (ASD) following multilevel lumbar interbody fusion (L2-iliac) for degenerative spinal disease.

Design
Retrospective Study

Introduction
In our study, we aimed to evaluate dynamic interspinous radiology (DIR) as a predictor of early-onset adjacent segment degeneration (ASD) following multilevel lumbar interbody fusion (L2-ilium).

Methods
From 2018 to 2022, 52 patients who underwent L2-ilium surgery for degenerative spinal disease at a single institution were enrolled. The patients were divided into two groups: Group A, consisting of those who developed ASD (n = 25), and Group B, those who remained normal (n = 27). Patients with preoperative high-grade adjacent-level disc degeneration (Pfirrmann grade ≥ III) were excluded. DIR was defined as the difference in the distance between the midpoints of the superior aspects of the spinous processes during flexion and extension. Demographic data and radiological spinopelvic parameters were compared between the two groups. Adjacent-level muscle quality and flexibility were additionally assessed and compared.

Results
The follow-up period was 13.2 ± 6.3 months in Group A and 11.7 ± 6.8 months in Group B (P = 0.522). There were no significant differences in demographic data between the two groups. In both groups, spinopelvic parameters

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were improved compared to preoperative measurements (P > 0.05), except for cervical lordosis and pelvic incidence. The correction of sagittal vertical alignment (SVA) in Group A was greater than in Group B, but the difference was not statistically significant (P = 0.05). There was no difference in adjacent-level muscle quality between the groups (P > 0.05). Changes in the proximal junctional angle during flexion and extension were also not significantly different between the two groups (P > 0.05). However, Group A exhibited a significantly larger DIR compared to Group B (10.1 ± 4.1 mm vs. 6.0 ± 3.5 mm, P = 0.004). The optimal cut-off value of preoperative DIR as a risk factor for ASD was >8.1 mm.

Conclusion
Our study demonstrated that patients who developed ASD had significantly larger DIR compared to those who did not, with an optimal preoperative DIR cut-off value of >8.1 mm as a potential risk factor for ASD.

268. Lumbar Scheuermann Disease: Prevalence and Clinical Characteristics from a Cohort of 11,891 Consecutive Children of a Tertiary Referral Institute

Greta Jurenaite, MD; Fabio Zaina, MD; Stefano Negrini, MD

Hypothesis
We need information on the prevalence and clinical appearance of Atypical Lumbar Scheuermann's Disease (ALSD) a subgroup of Scheuermann's Disease (SCHD) with unique clinical features.

Design
Cross-sectional study.

Introduction
While Scheuermann's Disease is well-documented, Atypical Lumbar Scheuermann's Disease (ALSD) is a rare and under-researched condition, with limited data on its prevalence and clinical features. This study aimed to investigate the prevalence and clinical characteristics of ALSD in a large cohort of children seeking care at a specialized spinal disorder center.

Methods
This cross-sectional study reviewed the electronic clinical charts of all children between 10 and 18 years old coming to consultation in an institute specialized in spinal disorders. We defined ALSD by lumbar vertebral wedging (≥5°) involving at least one lumbar vertebra. Exclusion criteria included other spinal conditions. Clinical (pain, stiffness, trunk deformity) and radiographic data (wedging angles, Cobb angles) were analyzed to assess the prevalence and characteristics of ALSD. Statistics included classical descriptive statistics, including 95% interval confidence (95IC) of percentages.

Results
We included 11,891 children. The prevalence of SCHD was 3.6% (95CI 3.3-4.0), of ALSD 0.39% (0.3-0.5%), corresponding to 10.8% of SCHD, (7.9-14.4). The mean age of children with ALSD was 13±2 years, with a male predominance (56.3%). Half of the ALSD patients reported back pain (mean SRS pain scale: 3.2±0.5) and had an average symptom duration of 7.2±2.7 months. Radiographic findings included lumbar vertebral wedging (mean angle: 7.6°±0.4), affecting 2-3 vertebrae. Clinical signs included lumbar stiffness and trunk deformity, with limitations in flexibility and posture. We observed scoliosis and hyperkyphosis in some cases.

Conclusion
ALSD represents a distinct subgroup of Scheuermann's Disease, characterized by significant clinical features such as lumbar vertebral wedging, back pain, and trunk deformities. These findings emphasize the need for early detection and appropriate management to address the impact of ALSD in affected children.

269. Dental Cement Augmentation Increases Pullout Strength with Comparable Removal Torque for Lateral Mass Screws

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Hypothesis
Augmentation with dental cement may present a viable solution for posterior cervical spinal screw fixation

Design
in vitro biomechanical study

Introduction
Premature loosening and fixation failure is a known problem of screw fixation of the spine, especially in cases of poor bone quality due to osteoporosis, tumor, or revision surgery. Cement augmentation of screws with PMMA, while described in the thoracolumbar spine, has limited utility in the cervical spine due to the small size of the bone and high risk of PMMA extravasation. Augmentation with dental cement may present a viable solution for posterior cervical spinal screw fixation.

Methods
15 fresh frozen human cadaveric cervical vertebra were prepared by stripping all soft tissues. Lateral mass screw fixation (3.5x12 mm) was performed bilaterally with standard freehand technique by an attending spine surgeon. For augmented screws, dental composite (self-cure Stela composite, a BPA-free resin monomers with specially surface-modified nanoparticles of amorphous silica) was applied into the screw hole before placement of the screw. 9 vertebrae were used for pull-out testing. Screws were attached to a material testing machine (E10000) and axially loaded until failure. In the remaining 6 vertebrae, peak torque required to remove the screws from bone was measured via a digital torque driver. A t test was used to analyze the results between the augmented and non-augmented groups with significance set to $p<0.05$.

Results
Augmented lateral mass screws exhibited significantly higher pullout strength (263.8 ± 79.4N) compared to non-augmented screws (127.7 ± 21.2N). (p=0.0005) There was no

significant difference in the mean torque required for screw removal between the augmented (4.20 ± 2.83 lb-in) and non-augmented groups (4.49 ± 2.09 lb-in) (p=0.9). The dental composite was radio-opaque and observable on xray.

Conclusion
Augmentation with dental composite enhanced pullout strength without altering removal torque of cervical lateral mass screws in human bone. Further investigation of dental composited augmented screws is needed to identify additional applications for and long term performance of this technique. Dental cement augmentation of lateral mass screws during subaxial cervical spine fusion may be a safe and effective method of improving fixation strength without affecting ease of revision.

270. Dynamic Cervical Spine MRI Safe in Children

Jeffrey Campbell, MD; Colleen Ditro, RN, DNP, CPNP; William G. Mackenzie, MD; W.G. Stuart Mackenzie, MD

Hypothesis
Dynamic cervical spine MRI is safe in children with risk of cervical instability despite frequent need for sedation.

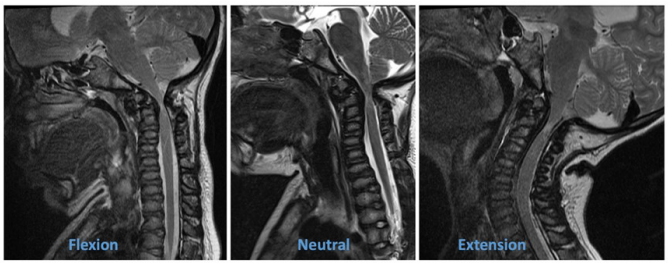
Design
Retrospective chart review

Introduction
Dynamic cervical spine MRIs with flexion and extension views have been used for over 20 years to evaluate cervical instability and better understand the dynamic nature of the spinal canal. This technique in young patients requiring sedation has been criticized due to concern for potential iatrogenic spinal cord injury, and many institutions will not attempt it.

Methods
All dynamic cervical spine MRIs performed at a quaternary referral pediatric hospital from 2010-2023 in patients under 21 years of age were reviewed. Diagnosis and cervical pathology of each patient was recorded, with review of post-procedural records for any neurologic symptoms: numbness, parasthesias, weakness or bowel/bladder incontinence. The MRI was performed by the technical staff under supervision of a neuroradiologist, who would halt the study if any sequence demonstrated myelomalcia or spinal cord compression. The scan was first performed with neutral positioning, followed by extension and then flexion if cleared by neuroradiology. Any child unable to remain still for the duration of the study was sedated with general anesthesia.

Results
Since 2010, 720 dynamic cervical spine MRIs have been performed in 531 patients. The median age at imaging was 6 years, with 104 scans performed in infants under a year. The most common diagnosis was achondroplasia (193) followed by other skeletal dysplasias (104), mucopolysaccharidoses (85), trauma (59), Down syndrome (30), osteogenesis imperfecta (23), and os odontoideum (10). Nearly 20% of studies did not include full flexion and extension series, either due to myelomalacia, spinal cord compression or concern about the airway by the anesthesia team. There was not a single transient or permanent neurological deficit recorded during the study period.

Conclusion
Dynamic cervical MRI with flexion and extension is safe in children, including those under anesthesia. This imaging modality is highly valuable in identifying cervical instability and cord compression in young patients, playing a key role in determining the need or type of surgical intervention. This 14 year experience will assist surgeons in convincing reluctant institutions that this valuable imaging study is safe in children.



Dynamic MRI demonstrating atlanto-axial instability with spinal cord compression and myelomalacia.

271. Growth-Friendly Vs. Primary Fusion Surgery for Congenital Kyphosis: A Multicenter Analysis of Complications, Reoperations, and Patient Outcomes

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Hypothesis
Fusion surgery for congenital kyphosis results in fewer complications, unplanned reoperations, and better patient-reported outcomes (EOSQ-24) compared to growth-friendly approaches.

Design
Retrospective Multicenter Cohort Study

Introduction
Surgical interventions for congenital kyphosis (CK) in the growing child can be divided into 2 groups: Growth-Friendly (GF) and Primary Fusion (PF). While GF approaches aim to preserve spinal growth, they may increase complications and unplanned reoperations (UPRORs). This study compares complications, UPRORs, and patient-reported outcomes between GF and PF approaches for CK.

Methods
An international, multicenter database for early-onset spinal deformity was queried to identify patients with CK who underwent operative management of the spinal deformity. Inclusion criteria were patients with a pre-intervention sagittal kyphosis greater than their major coronal deformity, with

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the major coronal deformity being < 35°, and were followed up for a minimum of 2 years.

Results
63 patients (35 PF; 28 GF) met inclusion criteria, with mean follow-up of 3.0 years for PF and 4.2 years for GF. Preoperative and postoperative sagittal and coronal deformity and the change in sagittal deformity was similar, but the change in coronal deformity (PF, -6.2°; GF, -0.1°) was significantly greater in the PF group. The change in T1-S1 length from preop to final increased 29.2 mm in the PF group (NS) and 42 mm in the GF group (p=0.0445), but was similar across groups. Complications occurred in 34.3% of PF patients vs. 64.3% of GF patients (p=0.0235), with the PF group experiencing a mean 0.46 complications/patient compared to 1.3 in the GF group (p=0.0043). UPRORs were documented in 14.3% of PF and 35.7% of GF patients (p=0.0369). Postop EOSQ-24 analysis demonstrated statistically higher scores across multiple dimensions for PF patients vs. GF.

Conclusion
In this study PF patients were older at surgery, had better coronal correction, and better EOSQ-24 scores. GF patients had similar sagittal deformity improvements, but greater complications and UPRORs. Though GF aims to preserve spinal growth, postoperative T1-S1 growth was similar. Clinicians should weigh these risk and benefits for shared decision making when discussing surgical treatments for CK.

	PF	GF	P-Value
# of Patients (female)	35 (16)	26 (16)	-
Age at Surgery (years)	6.9 (0.8-17.0)	4.6 (0.8-12.6)	p=0.0186
Mean age at f/u (years)	3.03	4.16	NS
3-column osteotomies	11 (31%)	4 (14%)	NS
Preop Sagittal Deformity (mean)	57.9°	62.6°	NS
Preop Coronal Deformity (mean)	24.1°	23.2°	NS
Postop Sagittal Deformity (mean)	46.6°	40.9°	NS
Postop Coronal Deformity (mean)	17.9°	23.1°	NS
Δ in Sagittal Deformity	-11.3° (p=0.0046)	-21.7° (p=0.0042)	NS
Δ in Coronal Deformity	-6.2° (p=0.0042)	-0.1° (NS)	p=0.0228
Preop T1-S1 Length (mean mm)	278.9	238.9	p=0.0260
Postop T1-S1 Length (mean mm)	297.1	250.1	NS
Final T1-S1 Length (mean mm)	306.5	282.0 (p=0.0445)	NS
Postop Growth: Δ in T1-S1 Length (mean mm/yr)	9.9	11.6	NS
# of Patients w/ Complications	12 (34.3%)	18 (64.3%)	p=0.0235
Total # Complications (avg/pt)	16 (0.46)	37 (1.3)	p=0.0043
Hardware Related	4 (25%)	16 (43.3%)	NS
Infection Related	6 (37.5%)	15 (40.5%)	NS
Pain Related	3 (18.8%)	2 (5.4%)	NS
Procedure Related - Other	3 (18.7%)	4 (10.8%)	NS
# of Patients w/ UPRORs	5 (14.3%)	10 (35.7%)	p=0.0389
Total # UPRORs (mean onset, months)	5 (8.4)	15 (21.0)	p=0.0369
Hardware Related	3 (60%)	4 (26.7%)	NS
Infection Related	2 (40%)	9 (60%)	NS
Procedure Related - Other	0 (0%)	2 (13.3%)	NS
EOSQ-24 Pulmonary Function	87.93	74.46	p=0.018
EOSQ-24 Energy Level	82.76	69.57	p=0.012
EOSQ-24 Child Satisfaction	81.03	65.22	p=0.042
EOSQ-24 Emotion	83.62	66.30	p=0.0120
EOSQ-24 Parental Impact	82.07	66.52	p=0.0173

Table 1. Primary Fusion vs. Growth-Friendly Constructs

272. Effect of Scoliosis on Pulmonary Function in Spinal Muscle Atrophy (SMA)

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Hypothesis
1) Pulmonary function represented by forced vital capacity (FVC) varies proportionately with spine height. Scoliosis affects this relationship: children with moderate scoliosis (Cobb ≤50°) follow this relationship, while children with severe scoliosis (Cobb >50°) do not; 2) correction by spinal instrumentation (SI) partially restores this relationship.

Design
Single-center retrospective study of SMA patients (SMN1 gene deletion chromosome 5q) evaluated 1975-2024, with minimum 2-year f/u.

Introduction
Patients with SMA develop Early Onset Scoliosis (EOS) and respiratory insufficiency. Pulmonary Function Tests (PFT) normalized by height are difficult to interpret in SMA due to associated skeletal deformities. Pelvic Inlet Width (PIW), a surrogate for spine height can be measured on spine X-rays. This study investigates the relationship between FVC and PIW in SMA and whether EOS severity or SI influences this relationship.

Methods
PFTs using a handheld device to measure FVC and sitting spine X-rays to measure scoliosis (Cobb) were obtained bi-annually. Severe scoliosis (Cobb >50°) was treated by SI using growing rods that allowed for spine growth or posterior spine fusion. Linear mixed modeling (LMM) assessed the relationship between FVC vs. PIW, accounting for repeated measures within the same patients. A log-transformation was performed to compensate for a heteroscedastic distribution in FVC. Accounting for interaction terms, models were evaluated for effect modification by scoliosis severity, dichotomized by Cobb ≥50° vs <50°, and SI.

Results
Of 204 eligible patients, 73 had sufficient X-ray and PFT data (median age =7.3 yrs, 53% □, 94% ≤3 SMN2 copies). FVC varied with PIW: multivariable modeling (Fig. 1A, Table 1) showed that a 1-unit increase in PIW was associated with a 22% increase in FVC (exp(β)=1.22; 95% CI=1.18–1.27; p<0.001). The FVC-PIW relationship was weaker in SI patients (Fig. 1B, Table 1), with a 15% increase in FVC (exp(β)=0.85; 95% CI=0.75–0.97; p=0.015). Cobb ≥50° lowered FVC 18.6% compared to Cobb <50° (exp(β)=0.81; 95% CI=0.69–0.97; p=0.032). There was no interaction between Cobb and PIW on FVC (p=0.98).

Conclusion
Pulmonary function (FVC) increases proportionally with spine height (PIW). Severe scoliosis negatively affected FVC. SI only partly mitigated the deleterious effect of scoliosis on FVC. Before scoliosis becomes severe, SI may preserve lung function sufficiently to keep up with spine growth in SMA patients.

Table 1. Linear mixed model results for the effect of PIW on log-transformed FVC. Exp(β) represents the back-transformed effect, interpreted as the multiplicative change in FVC for each covariate.

Variable	Exp(β)	95% CI	P
PIW	1.22	(1.17-1.28)	<0.001
Spinal Instrumentation	4.69	(1.19-18.52)	0.029
Cobb ≥50	0.81	(0.68-0.98)	0.023
PIW*Spinal Instrumentation	0.85	(0.75-0.97)	0.016

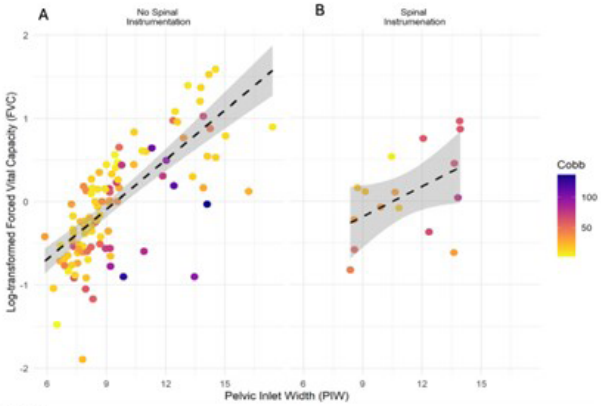

Fig. 1.
A) Scatterplot pelvic inlet width (PIW) versus log-transformed forced vital capacity (FVC) with overlaid linear mixed model stratified by Cobb angle severity (color heat map) for non-surgical patients (R^2=0.60)
B) Scatterplot PIW vs log-transformed FVC with overlaid linear mixed model stratified by Cobb angle severity (color heat map) for patients with spinal instrumentation (R^2=0.24)

R^2 indicate % variance in FVC explained by PIW by the model.

273. Rethinking Lowest Instrumented Vertebra (LIV) Selection for Lenke 1/2AR Curves: Is Adding-On Risk Overestimated when the Last Substantially Touched Vertebrae (LSTV) is L4?

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Hypothesis
The "rule" for LIV being at the LSTV to reduce add on risk does not apply for the 1/2AR curves where the LSTV is L4.

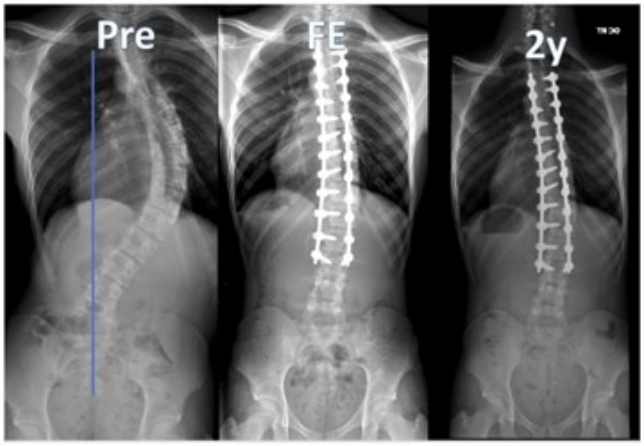
Design
Retrospective review of prospectively collected multicenter data

Introduction
In Lenke 1/2AR curves, prior work has suggested the rate of adding on is 29% when the LIV is proximal to the LSTV. Avoiding fusion to L4 in the AIS population is important for long-term spinal health. The aim of this study was to determine if this rule applies to the more atypical 1/2AR curves that are "long" and have an LSTV of L4.

Methods
We reviewed Lenke 1/2AR AIS patients who underwent PSF with a minimum 2y f/up, analyzing adding-on rates based on LIV relative to LSTV. In patients with an LSTV at L4, we compared the rate of adding on for those with an LIV of L4 (LSTV) vs those with LIV L3 or above. Adding-on was identified by established parameters: increase in Cobb of 5deg and distalization of the end vertebra or change in disc angulation of 5deg below the LIV from first erect to 2y. Statistics: descriptive and comparisons via Fisher's exact and Mann-Whitney U test.

Results
Of 337 Lenke 1/2AR patients, just 26 (8%) had an LSTV at L4, of whom 85% (n=22) had an LIV proximal to L4, mostly L3. Those fused to L4 had a median Risser 4.5 vs 3 in L3 (p=0.02). Mean pre-op Cobb angle was 70 +/- 21 in the LIV L4 group vs 59 +/- 10 in the LIV L3 group, (p=0.3). In those with an LSTV of L4, the adding-on rate was 4% (n=1). This case of adding on had LIV at L3. None of the 4 cases with an LIV of L4 had adding on. When the LSTV was at L3 or above, adding-on occurred in 25% (n=30) of patients with an LIV proximal to LSTV (n=122) and 12% (n=22) with LIV at or below LSTV (n=189) (p=0.005). Additionally, the 4% rate of adding on in the LSTV L4 group fused short of LSTV was significantly less than the 25% rate where the LSTV is more proximal and fused short (p=0.046).

Conclusion
In the less common "long" AR curve pattern where the LSTV is L4, LIV proximal to the LSTV does not carry the same high risk of adding-on seen in more typical AR curves. In these cases, LIV selection follows a pattern similar to Lenke 3-6C curves, where the decision is typically between L3 and L4. This suggests that fusion to L4 may not be necessary when the LSTV is L4 in Lenke 1/2AR curves, allowing for greater preservation of lumbar motion.



15yo M, Lenke 1AN-R, Risser 4
LTV: L4
LSTV: L4
LIV: L3
No adding on at 2y

Example of fusion to L3 in 1AR curve

274. Skull Femoral Traction for Severe Spinal Deformity: Imaging Features and Clinical Outcomes.

Yingsong Wang, MD; Jingming Xie, MD; *Zhibo Song, MD*; Zhi Zhao, MD; Tao Li, MD; Zhiyue Shi, MD; Li Zhang, MD; Yingliang Liu, MD; Zhaoquan Zhang, MD

Hypothesis
We hypothesize that the pre-and intraoperative skull

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femoral traction (PIOSFT) improves the correction rate and reduces neurological deficits without more complications.

Design
Retrospective study.

Introduction
Good correction effects and safe surgical procedure governs the long-term outcome of severe spinal deformity surgery. In our department, skull femoral traction facilitates operative steps and NeuroSAFE assessment, its long-term imaging features and clinical outcomes are an aid to clinical decision-making that requires sustained attention.

Methods
Fifty-six consecutive patients with severe spinal deformity(Cobb's angle≥90°) who underwent single-stage posterior spinal correction surgery from 2017 to 2020 at one hospital were identified. Thirty patients were operated with PIOSFT(traction group) and 26 patients were operated without PIOSFT (nontraction group). Outcome measures included imaging features and clinical events at least two years follow-up were compared.

Results
Significant differences between two groups were observed in the duration of the inhospital stay, operation time, grades of osteotomy, and coronal imbalance improvement (cobb's angle larger than 120°). However, no significant differences were found in the correction rate, sagittal imbalance improvement, apical vertebral rotation (AVR), and fusion rate. Seven complications happen in the traction group. Two patients with surgical site infection (SSI), the somatosensory evoked potentials disappeared in one case, three cases of postoperative pulmonary infections and one case of rod broken. Five complications happen in the nontraction group, one patient with SSI, two patients with rod broken, and two cases of decompensation curve.

Conclusion
For severe spinal deformity, PIOSFT was found safe and beneficial to reduce surgical invasiveness. Limited AVR change implies that the difficulty of exposure and insert screws were not significantly reduced by skull-femoral traction. In the long-term follow-up, PIOSFT is helpful for better coronal imbalance improvement in cases with the cobb's angle larger than 120°.

275. Spine Pathoanatomy in Spinal Muscular Atrophy (SMA): Effect of Disease Modifying Therapies (DMT) Vs. Genetic Skeletal Phenotype

Hiroko Matsumoto, PhD; Yuri Ota, MD, PhD; Yukiko Shibata, MD; Lennert Plasschaert, MD; Amy Pasternak, PT, DPT, ATC, CSCS; Basil Darras, MD; Brian D. Snyder, MD, PhD

Hypothesis
The increased incidence of thoracic kyphoscoliosis (TK) observed in SMA children reflects an SMA skeletal phenotype: 1) Children with 2 SMN2 copies have increased likelihood of TK compared to those with ≥3 SMN2 copies; 2) Early DMT initiation does not modify TK genetic phenotype.

Design
Single-center retrospective cohort study of consecutive SMA patients with severe spinal deformities necessitating surgery categorized into untreated (-DMT) and treated (+DMT).

Introduction
With the advent of DMT using adenovirus vector to transfect developing motor neurons with missing SMN1 gene administered to neonates, and/or augmenting production of functional SMN protein from SMN2 genes, SMA patients have improved survival and motor function. However, spine deformity continues to be a major concern. This study explores potential causal mechanisms underlying spinal pathoanatomy in SMA and the impact of DMT.

Methods
Patients were categorized into 2 SMN2 copies (severe) and with ≥3 SMN2 copies (mild). Spine pathoanatomy was assessed in the coronal and sagittal planes using sitting X-rays (Fig1). Based on the location of the inflection point proximal or distal to T7, deformities were classified as TK or thoracolumbar kyphoscoliosis (TLK).

Results
Of 66 patients, 28 were -DMT and 38 were +DMT. At surgery (mean age: -DMT=9.5 yrs; +DMT=8.6 yrs), scoliosis severity was similar: -DMT = 92°, +DMT = 90° groups. Kyphosis severity was greater for +DMT = 87° compared to -DMT = 60° (p=0.013) and the incidence of TK was greater for +DMT (37% vs 22%). However, more patients with 2 SMN2 gene copies were in the +DMT group (51%) compared to the -DMT group (18%) (p=0.032), suggesting survival bias for +DMT patients with 2 SMN2 copies. Children with 2 SMN2 copies treated <1yr of age had a higher risk of developing TK (75%) compared to those with ≥3 SMN2 copies and/or treated ≥1yr (50%) (Fig2).

Conclusion
The increased incidence of TK in +DMT patients likely reflects selection bias, as many children with severe SMA died at a young age before the DMT era. Children with 2 SMN2 copies are more likely to develop TK compared to those with ≥3 copies. Early DMT initiation did not alter this risk, suggesting TK may represent a genetic skeletal phenotype. Accelerated upright positioning in patients with insufficient muscle strength may benefit from bracing during sitting and standing, potentially mitigating spinal deformities.

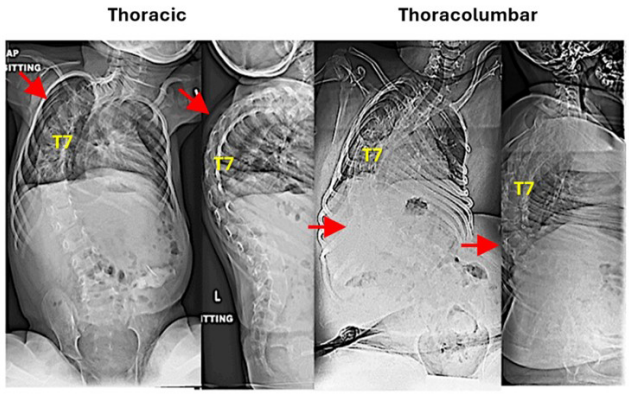


Fig 1. Preoperative coronal and sagittal radiographs

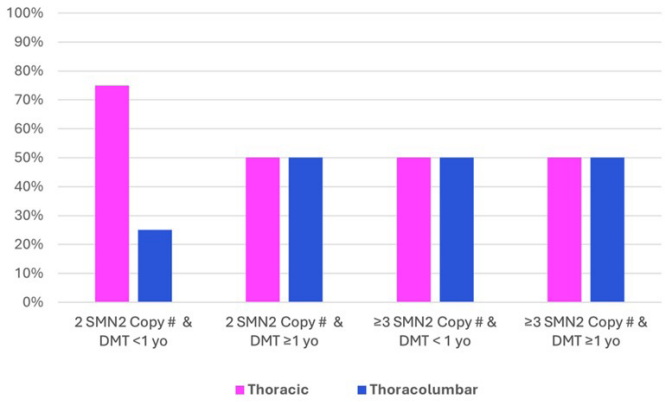


Fig 2. Interaction between SMN2 copy numbers and age at DMT initiation

276. Is Alignment Alone Sufficient to Predict Mechanical Complications After Adult Spinal Deformity Surgery? A Machine Learning Comparison of Alignment, Bone Quality, and Soft Tissue

Sameer Sundrani, BS; Derek J. Doss, BE; Graham Johnson, MD, PhD; Harsh Jain, MBBS; Omar Zakieh, MBBS; Julian Lugo-Pico, MD; Amir M. Abtahi, MD; Byron F. Stephens, MD; Scott Zuckerman, MD, MPH

Hypothesis
Most sensitive and specific way to predict mechanical complications after adult spinal deformity (ASD) surgery will include a combination of alignment, bone quality, and soft tissue data rather than alignment alone.

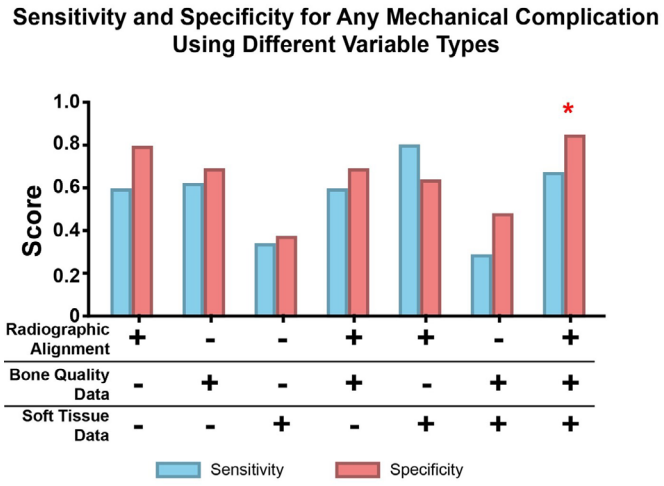
Design
Retrospective cohort study

Introduction
Mechanical complications are a vexing occurrence after adult spinal deformity (ASD) surgery. We sought to determine which combination of inputs produced the most sensitive and specific machine learning model to predict mechanical complications using postoperative alignment, bone quality, and soft tissue data.

Methods
A retrospective cohort study was performed for patients undergoing ASD surgery from 2009-21. Inclusion criteria were: ≥5-level fusion, sagittal/coronal deformity, and 2-year follow-up. The primary exposure variables were: 1)Alignment: sagittal and coronal plane using L1-pelvic angle±3°(L1PA), sagittal vertical axis(SVA), pelvic tilt(PT), and coronal vertical axis(CVA), 2)Bone Quality: DEXA scan t-score, and 3)Soft Tissue: paraspinal muscle-to-vertebral body ratio and fatty infiltration. The primary outcome was mechanical complications. Using demographic data in each model, a total of 7 machine learning models with all combinations of domains(alignment, bone quality, and soft tissue) were trained. Positive predictive value (PPV) was calculated for each model.

Results
Of 231 patients undergoing ASD surgery with a mean age of 64±17 and 24% male, 147 (64%) developed at least one mechanical complication. The model with alignment alone performed poorly, with a PPV of 0.77. However, the model with alignment, bone quality, and soft tissue achieved high PPV of 0.90, sensitivity of 0.67, and specificity of 0.84 (Figure 1). Moreover, the model with alignment alone failed to predict 23/100 complications, whereas a model with all three domains only failed to predict 10/100.

Conclusion
These results support the notion that not every mechanical failure is explained by alignment alone. We found that a combination of alignment, bone quality, and soft tissue provided the most accurate prediction of mechanical complications after ASD surgery. While achieving optimal alignment is essential, additional data including bone and soft tissue is necessary to minimize mechanical complications.



Sensitivity and specificity for any mechanical complication using different variable types

E-POINT PRESENTATION ABSTRACTS

277. Using Machine Learning to Predict Pseudarthrosis Following Corrective Surgery in Adult Spinal Deformity Patients

Ted Shi, BS; Varun Arvind, MD, PhD; Alexander Tward, BS; Daniel Ortega, BS; Hamzah Abbas, BS; Justin L. Reyes, MS; Roy Miller, MS; Cole Morrissette, MS; Yong Shen, BA; Mark Herbert, BS; Gabriella Greisberg, BS; Matan Malka, BA; Josephine R. Coury, MD; Fthimnir Hassan, MPH; Zeeshan M. Sardar, MD; Ronald A. Lehman, MD; Lawrence G. Lenke, MD; Joseph M. Lombardi, MD

Hypothesis
Machine learning (ML) can successfully predict the risk of pseudarthrosis (pseudo) in the preoperative period.

Design
Retrospective review of multi-surgeon, single-institution prospective and consecutively collected patient data.

Introduction
Pseudo of the spine following adult spine deformity (ASD) surgery is difficult to predict. Machine learning has the potential to aid in the clinical risk assessment for pseudo, although no clear ML tools currently exist.

Methods
We reviewed 336 ASD patients undergoing surgery. More than 100 variables were included (medical history, operative factors, labs, preoperative x-rays). A preoperative risk calculator to predict pseudarthrosis was developed using a stepwise ML approach. First, a random forest classifier model was trained on all variables. Then, Boruta, a feature selection algorithm, selected for the most important variables. Finally, a multivariate logistic regression model was trained and evaluated on the variables selected by Boruta. Model performances were evaluated using accuracy, sensitivity, specificity, and area under the receiver operating curve (AUROC) score metrics. Comparative statistics ($p<0.05$) were also conducted. Analysis was performed using scikit-learn (v.1.5.1) in Python (v.3.9.5).

Results
45 of the 336 (13.4%) patients developed pseudo. Traditional statistics determined that BMI, age, baseline ODI score, number of rods, amount of bone morphogenetic protein (BMP), decompression (yes/no), posterior cranial vertical line to sacrum, sacral slope, pelvic tilt, and fatty atrophy were significantly different in pseudo and non-pseudo cohorts. The Boruta feature selection method selected BMI, age, smoking history, osteopenia/osteoporosis, anti-inflammatory use, bone mineral density, BMP use, # of PCO levels, # of decompression levels, and # of TLIF levels as important variables to be included in the final regression model. When evaluating the model on the separate test cohort, the final model achieved an accuracy of 91.1%, sensitivity of 60.0%, specificity of 96.6%, and AUROC score of 0.86.

Conclusion
ML can be used to predict pseudo in the preoperative period. Despite not including "significant" variables, the ML model maintained a strong predictive performance (AUROC = 0.86), indicating its ability to look beyond traditional statistics to fine-tune decision-making and highlight important risk factors.

Table 1. Summary of variables selected by Boruta variable selection process

		Overall	Union	Nonunion	P-Value
BMI		25.4 ± 5.6	25.2 ± 5.7	26.8 ± 4.9	**0.047**
Age		50.1 ± 18.5	48.9 ± 19.1	57.3 ± 12.3	**<0.001**
Smoking History	None	255 (75.9%)	221 (75.9%)	34 (75.6%)	0.972
	Current	6 (1.8%)	5 (1.7%)	1 (2.2%)	
	Former	75 (22.3%)	65 (22.3%)	10 (22.2%)	
Osteopenia/Osteoporosis		93 (27.7%)	76 (26.1%)	17 (37.8%)	0.148
Chronic Anti-Inflammatory Use		154 (45.8%)	132 (45.4%)	22 (48.9%)	0.405
Bone Mineral Density (DXA Score)		-1.5 ± 0.9	-1.4 ± 0.9	-1.6 ± 0.9	0.366
BMP Use		228 (67.9%)	194 (66.7%)	34 (75.6%)	0.309
No. of PCO Levels		4.0 ± 3.1	4.1 ± 3.1	3.7 ± 3.2	0.481
No. of Decompression Levels		1.0 ± 1.4	1.0 ± 1.3	1.4 ± 1.7	0.581
No. of TLIF Levels		1.0 ± 1.0	1.0 ± 1.0	1.2 ± 1.0	0.093

278. Growth Modulation Does Not Improve 3D Axial Rotation After VBT: A 3D Multi-Center Analysis†

Melanie E. Boeyer, PhD; Samuel Hawkins, BS; Vladislav Husyev, BS; Stefan Parent, MD, PhD; Peter O. Newton, MD; Burt Yaszay, MD; Harms Study Group; Dan Hoernschemeyer, MD

Hypothesis
We hypothesize that axial rotation will improve from First Erect to Two-Years in only patients who exhibit growth modulation following Thoracic-Only Vertebral Body Tethering (VBT).

Design
Retrospective, multi-center.

Introduction
Adolescent Idiopathic Scoliosis is a three-dimensional deformity characterized by significant axial rotation. The correction of axial rotation following a Posterior Spinal Fusion is well documented; however, little is known about such correction after VBT. We quantified immediate and growth-related rotational correction, and its relationship to coronal plane measures, using three-dimensional reconstructions.

Methods
We included 43 patients treated with Thoracic VBT, all of whom had at least two years of follow-up and the required radiographic data needed at multiple postoperative timepoints. Patients received bi-planar stereo-radiographic images, reconstructed in sterEOS, preoperatively and at all postoperative timepoints. We quantified vertebral rotation in the axial plane at the apex of the deformity as well as changes in main thoracic deformity measures. Clinical changes in rotation were assessed using a scoliometer. We classified patients based on whether they exhibited postoperative growth modulation (≥6°of postoperative correction) or not. Statistical differences were assessed with a one-way analysis of variance.

Results
There was a significant decrease in main thoracic deformities for the whole cohort at all postoperative timepoints

†Louis A. Goldstein Best Clinical Research E-Point Presentation

(p<0.001). However, only patients who exhibited growth modulation showed continued deformity correction from First Erect to One (7.5±3.8°; p=0.026) and Two Years (10.9±5.1°p<0.001) with a mean overall correction of 30.8° at Two Years (19.7° for non-modulators). We observed no significant difference in sterEOS axial rotation measures at any timepoint for either the whole cohort (p=0.174) or those who modulated (p=0.425). However, we did observe slight improvement in clinical scoliometer measures at First Erect (5°; p<0.001), One Year (5°; p<0.001), and Two Years (4°; p=0.009) for the whole cohort. This was not influenced by modulation status (p=0.054).

Conclusion
Patients should expect 3–5° of improvement in clinical rotation after VBT. Though growth modulation results in significant coronal plane improvement after First Erect, it does not significantly improve three-dimensional axial rotation at One or Two Years.

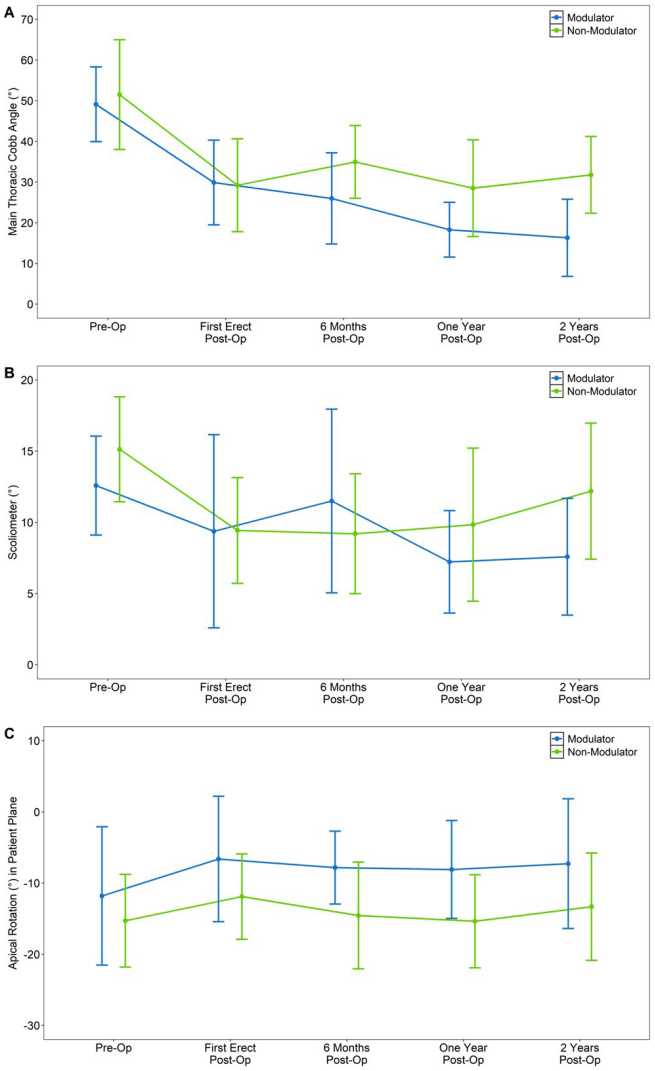


Figure 1

279. Automatization of Bone Age Calculation to Improve Children's Scoliosis Treatment

Sarita Sakoto; Amlin Charles, PhD; Reda Baroudi, MD; Marjolaine Roy-Beaudry, MSc; Marie-Lyne Nault, MD, PhD; Luc Duong, PhD; *Stefan Parent, MD, PhD*

Hypothesis
Automatization of bone age assessment shows promising results.

Design
Retrospective cohort study

Introduction
Bone age plays an important role in role in treating scoliosis. It remains the best investigation method (with Cobb angle) for determining a treatment. However, until today, bone age used to be calculated manually by healthcare professionals. On another hand, artificial intelligence is increasingly present in medical progress. Using AI for bone age calculation would offer more precision and gain of time for clinicians. Our study uses automate bone maturity assessments using artificial intelligence and deep learning to determine which bone age classification is the most suitable for automatization.

Methods
Patients were placed on the "hand-on-wall" position for the acquisition of full-body radiographs by the EOS machine. We manually calculated bone age according to 4 staging classifications: Sander, Risser, Tri-radiated cartilage and the modified Risser. Then, using the same data set, we worked with two different automatization AI models: pixel-based model (GLCM-SCM) and deep learning (VGG16). Finally, we validated our data and determined the accuracy and rapidity of convergence for each method.

Results
A total of 491 radiographs were analyzed on 467 patients who came to the clinic from March 2020 to June 2022, with an average age of 13.7 yo. 72,9% of girls and 27.1% of boys. We obtained high accuracy and efficiency combining Risser method and VGG16 program: 90.14% accuracy in 10 minutes. Modified Risser reached an 82.24% accuracy in 68 minutes with GLCM-SVM and 77.42% in 25 minutes with VGG16. Sanders' (widely used) reached a 73.95% accuracy in 36 minutes.

Conclusion
VGG16 program demonstrated the best accuracy and time when using standardized methods. Nevertheless, the modified Risser proved to be a promising approach especially when using VGG16. Patient's hands clearly exposed on radiographs is crucial for assessments. Automated bone age assessment could help minimize inter-rater variability and help standardize treatment algorithms especially in growth modulation treatments.

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		GLCM-SVM		VGG16	
	Region of interest	Accuracy	Computation time	Accuracy	Computation time
Sanders	Right hand	65.36%	141 minutes	73.95%	36 minutes
Risser	Right iliac crest	66.23%	164 minutes	90.14%	10 minutes
Tri-radiated	Tri-radiated cartilage	94.77%	27 minutes	83.55%	37 minutes
Modified Risser	Pelvic region	82.24%	68 minutes	77.42%	25 minutes

Table 1. Bone Age Automatization's Accuracy and Computer Time According to Both Systems.

280. Saving a Level in Scheuermann's Kyphosis Patients: Breaking the Sagittal Stable Vertebra Rule to Avoid L4 Fusion Level

Austin Montgomery, BS; Alicia Hymel, MS; Arun R. Hariharan, MD; John S. Vorhies, MD; Baron S. Lonner, MD; Burt Yaszay, MD; *Craig R. Louer, MD*

Hypothesis
For patients with a Stable Sagittal Vertebra (SSV) of L4, "rule-breaking" by choosing L3 as Lowest Instrumented Vertebra (LIV) results in acceptable outcomes.

Design
Retrospective review of a prospective registry.

Introduction
A common guideline for surgical treatment of Scheuermann's Kyphosis (SK) is extension of fusion to the SSV to reduce distal junctional complications such as kyphosis (DJK) or failure (DJF). However, extending lumbar fusions may limit function and increase risk of adjacent segment disease or revisions. We aim to study outcomes of instrumentation to L3 versus L4 when the SSV is located at L4.

Methods
We identified adolescent patients undergoing spine fusion for SK whose SSV was L4 on pre-operative imaging. Cohorts were defined by their selected LIV (L3 vs. L4). DJK was defined by a junctional angle >0° with 10° increase from preop. DJF was defined by symptomatic DJK or implant failure. Demographic data, deformity characteristics, surgical details, and minimum 2-yr outcomes data (including complications, DJK, DJF, revisions) were compared using Wilcoxon rank sum or Fisher's exact tests.

Results
Eighteen patients met inclusion criteria, with only 3/18 (17%) fused to L4. Most surgeons "broke the rule" and chose L3 LIV (15 patients, 83%). L3 and L4 cohorts had comparable pre-operative (83° vs. 77°, p=0.6) and post-operative (46° vs. 48°, p>0.9) maximum kyphosis. DJF occurred in 1/15 (7%) patient in L3 cohort. Failure was attributed to a hyperlordotic rod contour and not level selection—a fact reinforced by successful revision where L3 LIV was maintained (Figure 1). An additional 2/15 (13%) patients in the L3 group met DJK criteria at 2 years but did not require re-operation (both with hyperlordotic rods).

Conclusion
When SSV is L4 in SK, "rule-breaking" was common with 83% of patients having an L3 LIV. Patients with L4 LIV were so few that robust comparison is not possible. Rates of distal complications in this study (7% DJF and 13% DJK) for L3 LIV are comparable to published rates for patients fused to their SSV (6% and 11%, respectively). For this L4 SSV population, "rule-breaking" to save a lumbar level and fuse to L3 has acceptable outcomes. Future studies investigating the multifactorial nature of failures in SK should be emphasized over simplified guidelines like SSV.

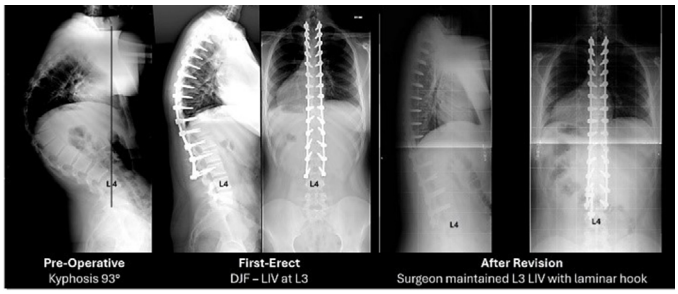

Figure 1: DJF in "rule breaking" patient

281. Identifying the Sweet Spot for Patient Selection in Vertebral Body Tethering

Dan Hoernschemeyer, MD; Nicole Tweedy, PNP; Melanie E. Boeyer, PhD

Hypothesis
We hypothesized that preoperative patient-specific characteristics, like curve magnitude and flexibility, should be specific for individual Sanders Scores leading to an increase in postoperative growth modulation and success.

Design
Retrospective, single center.

Introduction
Vertebral Body Tethering (VBT) is a non-fusion alternative for AIS. The timing of surgical intervention, based on preoperative skeletal maturity status, is critically important to procedure success. The aim of this study was to determine the rate of growth modulation, suspected broken tethers, complications, revisions, and overall success for specific preoperative skeletal maturity stages based on Ideal Candidate Criteria (ICC).

Methods
We retrospectively reviewed clinical and radiographic data from patients treated with Thoracic-Only VBT, all of whom met our ICC (Table 1) and had at least two years of follow-up. We calculated the rate of growth modulation, suspected broken tethers, complications, and surgical revisions separately for each Sanders Stage. To determine differences

in deformity characteristics across Sanders Stages (SS), we performed a one-way analysis of variance.

Results
A total of 107 patients were reviewed, 43 of whom met our ICC. Patients exhibiting a SS2 modulated their deformity the most (16°), but 100% required revision. SS3A patients exhibited 9° of growth modulation; 82% were successful, but 73% required revision. SS3B were the best overall with a relatively high success rate (69%) and 6° of growth modulation with a decrease in revisions (23%) suspected broken tethers (15%). Outcomes deteriorated at and beyond SS4 with overall success ranging from 33%–64%; little to no postoperative growth modulation (1–5°) was observed and the suspected broken tether rate remained high (>30%).

Conclusion
We believe SS3B patients with flexible curves of 45°–55° are the most ideal candidates for VBT; larger curves can be successfully managed (82%–100%) when treating SS2 or SS3A, but families should be told prior to surgery that this is a two-stage procedure with most patients requiring a tether release (≥89%) in the future. Patients who exhibit a ≥SS4 should be fully corrected at the time of surgery given the relative lack of growth modulation and high rate of suspected broken tethers.

Table 1. Outcome Characteristics Based on Two-Year Follow-Up Variables.

Characteristic	SS2	SS3A	SS3B	SS4	SS5	SS6
Ideal Candidate Criteria	>65°	45°–60°	45°–55°	45°–55°	45°–55°	45°–55°
N	2	9	13	6	2	11
Growth Modulation	2 (100%)	4 (44%)	6 (46%)	3 (50%)	1 (50%)	0 (0%)
Correction with Modulation (°)	16.0 ± 0.0	9.4 ± 9.2	5.5 ± 6.0	5.2 ± 4.5	3.0 ± 4.2	1.1 ± 1.7
Complication	0 (0%)	3 (33%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Suspected Broken Tether	0 (0%)	3 (33%)	2 (15%)	2 (33%)	1 (50%)	6 (55%)
Surgical Revision	2 (100%)	7 (78%)	3 (23%)	1 (17%)	0 (0%)	1 (9%)
Overall Success (≤30°, No PSF)	2 (100%)	8 (89%)	9 (69%)	2 (33%)	1 (50%)	7 (64%)

Table 1.

282. Patients with Scheuermann's Kyphosis Have Greater Cervical and Lumbar Lordosis but Lower Pelvic Incidence than Young Asymptomatic Individuals at Baseline: A Locally-Supplemented HSG and MEANS Sagittal Alignment Study

Riley Sevensky, BS; *Zeeshan M. Sardar, MD*; Oluwademilade Tega, BA; Justin L. Reyes, MS; Fthimnir Hassan, MPH; Josephine R. Coury, MD; Joseph M. Lombardi, MD; Lawrence G. Lenke, MD

Hypothesis
Baseline sagittal alignment in patients with Scheuermann's Kyphosis (SK) is distinct from that of asymptomatic individuals.

Design
Retrospective review

Introduction
SK is characterized by rigid hyperkyphosis of the thoracic or thoracolumbar spine in adolescents or young adults. This study will examine the baseline radiographic parameters of SK patients in comparison with a normative cohort in order to investigate the inherent differences in the structural anatomy of SK prior to surgical intervention.

Methods
The Harms Study Group (HSG) database consisted of 97 total SK patients with preoperative visits in 2006-2011; we included only patients with available pelvic parameters [n=53]. This HSG SK cohort was supplemented by addition of local SK patients from our institution [n=42]. The total SK cohort [n=95] was then compared to a prospectively enrolled Multi-Ethnic Alignment Normative Study (MEANS) cohort. The MEANS database consisted of 467 asymptomatic individuals from five countries; we included only ages <40 years to promote meaningful comparison with the young SK cohort [n=254]. Existing HSG and MEANS radiographic imaging and parameters were obtained; additional radiographic fields were measured. Unpaired two-tailed t-tests and chi-squared tests were utilized.

Results
Baseline thoracic kyphosis (TK, T1-T12) was significantly higher in the SK cohort (SK; n=95) than in the normative cohort (MEANS; n=254). Cervical sagittal angle (CSA, C2-C7) and T1 vertebral slope (T1S) were significantly greater in SK than MEANS. All SK lumbar measures, including lumbar lordosis (LL, L1-S1), proximal LL (pLL, L1-L4), and distal LL (dLL, L4-S1), were significantly higher than MEANS. In contrast, SK pelvic parameters were significantly lower than MEANS in terms of pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS).

Conclusion
As anticipated, baseline TK in SK was significantly higher than the norm. Despite the high TK, PI and PT were found to be significantly lower in SK than in MEANS, suggesting fundamental differences in pelvic alignment. Compared with MEANS, SK was also found to have significantly greater CSA, T1S, LL, pLL, and dLL parameters secondary to TK compensation. The global sagittal alignment in SK patients is inherently different at baseline than that of a young asymptomatic population.

SK versus Normative Sagittal Alignment			
Study population	**HSG+LOCAL**	**MEANS**	
Population description	**Scheuermann's kyphosis**	**normative sample**	***p-value***
Total n	95	254	
Baseline demographics			
Age (years) [mean±SD]	17.3 (±3.6)	29.1 (±5.7)	*<0.00001
Sex [n,%]			*<0.00001
Male	70 (73.7%)	109 (42.9%)	
Female	25 (26.3%)	145 (57.1%)	
BMI (kg/m^2) [mean±SD]	26.2 (±6.8)	23.1 (±4.5)	*0.0002
Radiographic parameters (°) [mean±SD]	**[preoperative]**	**[baseline]**	
Cervical sagittal angle (CSA; C2-C7)	-13.7 (±14.3)	2.3 (12.4)	*<0.00001
T1 vertebral slope (T1S)	36.3 (±10.3)	21.5 (±7.3)	*<0.00001
Thoracic kyphosis (TK; T1-T12)	75.4 (±11.8)	41.9 (±10.2)	*<0.00001
Distal thoracic kyphosis (dTK; T4-T12)	75.4 (±11.5)	34.9 (±9.0)	*<0.00001
Lumbar lordosis (LL; L1-S1)	-69.7 (±13.6)	-57.3 (±11.1)	*<0.00001
Proximal lumbar lordosis (pLL; L1-L4)	-26.7 (±12.1)	-20.1 (±8.2)	*<0.00001
Distal lumbar lordosis (dLL; L4-S1)	-43.0 (±9.0)	-37.3 (±7.6)	*<0.00001
Pelvic incidence (PI)	40.1 (±11.3)	50.6 (±10.7)	*<0.00001
Pelvic tilt (PT)	6.7 (±8.7)	10.8 (±6.7)	*<0.00001
Sacral slope (SS)	33.3 (±9.7)	39.7 (±8.2)	*<0.00001

283. Prescribing Pelvic Tilt: In Pursuit of Patient-Specific Fusion Targets

Francis C. Lovecchio, MD; Michael P. Kelly, MD; Lawrence G. Lenke, MD; Zeeshan M. Sardar, MD; Kazuhiro Hasegawa,

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MD, PhD; Hee-Kit Wong, MD, PhD; Hwee Weng Dennis Hey, MD; Jeffrey M. Hills, MD

Hypothesis
Normal pelvic tilt varies by pelvic incidence.

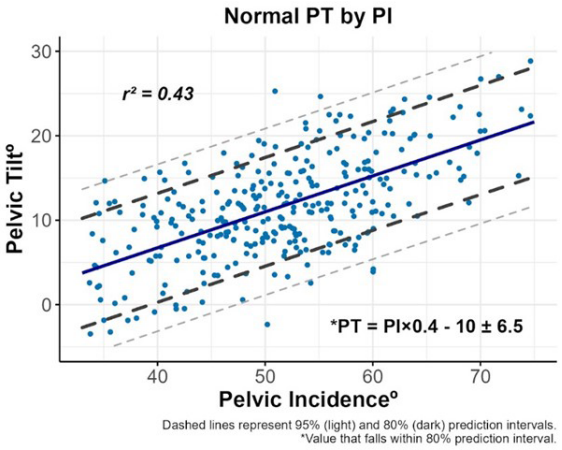
Design
Cross-sectional radiographic analysis

Introduction
Ideal sagittal spinal alignment targets should result in relaxation of compensatory mechanisms, such as pelvic retroversion. However, pelvic tilt (PT) varies widely among volunteers with similar pelvic incidences (PI), making it challenging to understand what degree of pelvic retroversion represents continued compensation. We aimed to define a normal range of PT based on PI in a normal population without spine pathology.

Methods
A cross-sectional radiographic analysis was conducted on a multicenter, multiethnic sample of volunteers with full-body standing radiographs. Study subjects with ODI >20, coronal Cobb angle >10°, spondylolisthesis, or radiographic disc degeneration were excluded. Spinopelvic parameters (PT, PI, vertebropelvic angles [VPAs]) were measured using a validated, automated software. After testing for normality, Pearson correlation analysis was performed between PT and spinopelvic parameters. Linear regression analysis was used to quantify the relationship between PT and PI.

Results
After exclusions, 319 subjects were available for analysis. Median age of the sample was 37 (IQR 27-47), BMI 23.3 (20.7-27.3), and 60% female. Normality of pelvic incidence, pelvic tilt, C2PA, and C2 tilt was assessed using the Shapiro-Wilk test, all parameters were normally distributed ($p > 0.05$ for all). Median PI and PT were 52° (45-58°) and 12° (8-16°), respectively, with 95% of patients standing with a PT between -1.6 and 25°. PI and PT were moderately correlated (r=0.64), with the strongest correlations seen at the most proximal VPAs (T4PA, r=0.92; T1PA, r=0.93; C2PA, r=0.93). Linear regression described PT (within an 80% confidence interval) using the following formula: PT=PI(0.4)-10±6.5 (r2=0.43).

Conclusion
80% of normal pelvic tilts are described by the equation PT=PI(0.4)-10±6.5. There is substantial variation around this prediction and other fixed anatomic parameters are needed to refine predictions.



284. A Novel External Hinge Correction Technique for Vertebral Column Resection in the Most Severe Thoracic Kyphoscoliosis

Hong Zhang, MD; David Ross, MFA; Daniel J. Sucato, MD, MS

Hypothesis
Integrating an adjustable and controllable external hinge (EH) mechanism at the apical region is essential for both spinal cord protection and optimizing correction in vertebral column resection (VCR) for the most severe thoracic kyphoscoliosis (STKS).

Design
Experimental study using life-size 3D-printed kyphoscoliosis models.

Introduction
Neurological complications frequently occur during VCR, particularly in cases of STKS. This study aims to develop and assess an EH correction system designed to protect the spinal cord at the apex while improving deformity correction during VCR.

Methods
Seven life-size 3D-printed thoracic spine models were created from CT scans of seven STKS patients (2 girls, 5 boys; mean age: 10.6 ± 3.7 years old). The average scoliosis and kyphosis angles were 88.1° ± 27° and 117.1° ± 22.4°, respectively. The apex was located at the upper (T4-T7, n=4), middle (T9-T10, n=2), and lower thoracic (T11, n=1) regions. A cable was inserted into the spinal canal of each model to simulate the spinal cord. The EH was applied to correct the deformities (Figure a - d), evaluating its efficacy and feasibility for VCR in STKS.

Results
In the 3D-printed models, scoliosis was corrected to 19.1° ± 9.7° (78.3% correction) and kyphosis to 22.7° ± 13° (80.6% correction). This correction resulted in a 52% elongation of the concave side (from 16.5 ± 4.2 mm pre-reduction to 25 ± 5 mm post-reduction), a 66.4% reduction in convexity (from 33.7 ± 7.3 mm to 11.3 ± 3.2 mm), and an 18.2% elongation of the anterior aspect at the resection gap (from 21.2 ± 8.7

mm to 25 ± 7.6 mm). The spinal cord length at the resection gap changed minimally, decreasing only 1.4 ± 1.5 mm (6.7%) from 21.2 ± 4.2 mm to 19.8 ± 2.6 mm during VCR correction. The apical spinal cord translated an average of 55.7 ± 3.3 mm from dorsal to ventral orientation. Overall, total spine segment height increased by 28.8%.

Conclusion
The external hinge correction technique effectively improved severe, challenging thoracic kyphoscoliosis while minimizing spinal cord strain during VCR. It provided controlled deformity correction, maintained spinal cord integrity, and enhanced overall spinal alignment. These findings suggest that EH may be a valuable adjunct in VCR, improving safety and correction efficacy in the most severe kyphoscoliosis deformities.

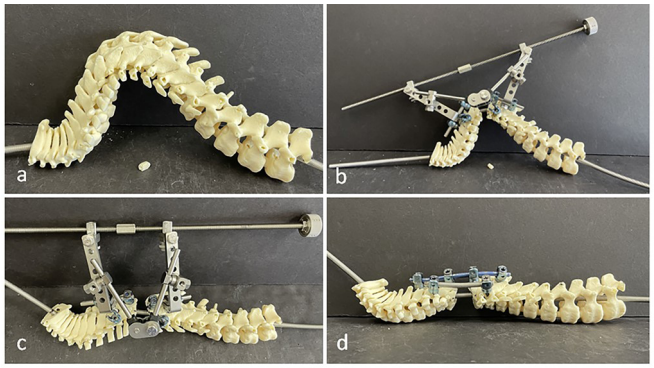


Figure: (a) A life-size 3D-printed model of severe thoracic kyphoscoliosis derived from CT scans of a 4.6 years old boy. A cable is inserted into the spinal canal to simulate the spinal cord. **(b)** Illustration of the external hinge correction system used to correct the thoracic kyphoscoliosis. Two clamps are attached to the provisional rods on the convex side of the deformity, with one clamp positioned at the cephalad and the other at the caudal end. The system includes a reduction rod with opposite pitch threads to enable compressive reduction. The external hinge is a dual-axis design to minimize translation during the reduction maneuver, providing two axes of rotation. Two universal-looking bolts connect and secure the external hinge to the clamps. Both clamps and the hinge are aligned parallel to the kyphoscoliosis plane. The hinge position can be adjusted within the resection area to accommodate different deformities by manipulating the universal bolts, and it is always positioned at the level of the spinal cord. The deformity is gradually corrected through step-by-step, counterclockwise rotation of the reduction rod knob. **(c)** shows the progression of the correction process. **(d)** shows the final correction of the deformity model.

286. Evolution of Surgery for Adolescent Idiopathic Scoliosis over Three Decades: Have Outcomes Improved?†

Baron S. Lonner, MD; Daniel Berman, MD; Olgerta Mucollari, BS; Tracey Bryan, MS; A. Noelle Larson, MD; Peter O. Newton, MD; Amer F. Samdani, MD; Firoz Miyanji, MD; Burt Yaszay, MD; Suken A. Shah, MD

Hypothesis
Operative morbidity will diminish as experience accrues and techniques evolve in operative AIS.

Design
Retrospective review of prospectively collected multi-center AIS registry.

Introduction
Surgical approaches for adolescent idiopathic scoliosis (AIS) have evolved extensively over the last century. Each surgical technique has its attendant operative morbidity and may result in variable correction of deformity. We set out to assess the evolution of techniques and their outcomes from an AIS registry spanning three decades.

Methods
4520 consecutive operated AIS patients with minimum 2-year follow-up (FU) from 1996-2022; posterior spinal fusion (PSF), vertebral body tethering (VBT), anterior fusion (ASF), and PSF with anterior release (PSF+AR) were included. Radiographic, perioperative parameters, and major complication rates were collected. Linear regression was used to assess the trend of changes over 5-year intervals, except the final interval (2016-2022).

Results
Mean age at surgery was 14.4 ± 2.2 years, 80.6% were females, remaining consistent. Over time, operative time (OT), estimated blood loss (EBL), (EBL/level) and length of stay (LOS) decreased ($p<0.001$), while % major curve correction (MCC) increased (54.3% to 62.2%; $p<0.001$). Differences were seen in MCC, OT and EBL/Level between all surgical approaches in all year groupings ($p<0.001$). VBT had the lowest mean MCC of 47.4% and PSF highest of 64.1%. Lowest mean total OT was seen in VBT of 238.6 ± 97.1, followed by 271.6 ± 99.2 in PSF (both $p<0.001$). EBL/Level was the lowest for VBT at 21.2 ± 17.8, and greatest decrease in EBL/Level over time is seen in PSF (119.7 ± 93.5 to 44.9 ± 28.4; $p<0.001$). Total 2-year total major complication rates were 6.8% in PSF, 20.2% in VBT, 15.2% in ASF, and 6.7% in PSF + AR, decreasing from 29.0% to 4.6%, 32.6% to 16.7%, 12.5% to 0.7%, and 22.2% to 9.5%, respectively (all but ASF, $p<0.001$). Total re-operations for PSF, VBT, ASF, and PSF+AR were 4.6%, 16.3%, 3.0%, and 4.2%, respectively, decreasing significantly in VBT (27.4% to 13.2%) and in PSF (6.5% to 3.5%) over time.

Conclusion
Operative morbidity associated with AIS surgery has diminished over time. Relatively high complication and re-operation rates in VBT parallel those seen early on in PSF and ASF and are diminishing presumably due to learning curve effects.

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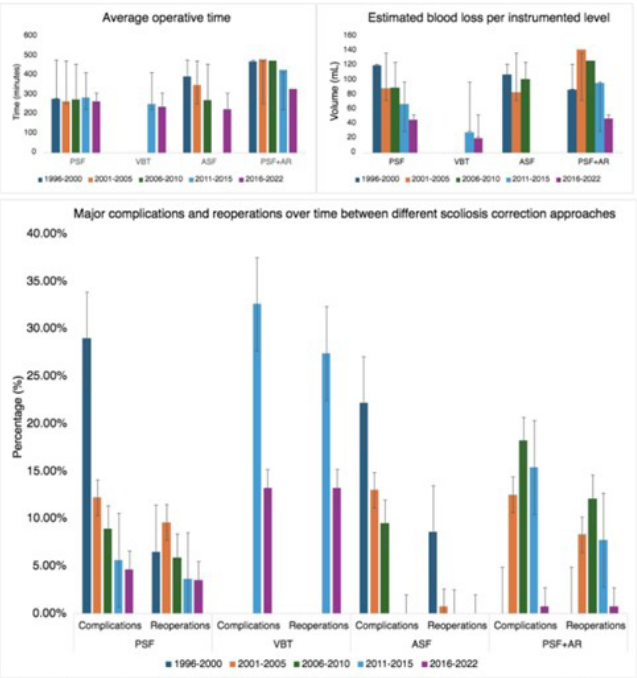

Figure 1: Perioperative outcomes for different scoliosis correction surgical approaches, 1996-2022.

287. Bone Density Variation Within Lumbar Vertebrae: The Effect of Coronal Deformity

Michael Mazzucco, BS; Han Jo Kim, MD; Stephane Owusu-Sarpong, MD; Luis F. Colon, MD; Atahan Durbas, MD; Gabrielle Dykhouse, BS; Robert Uzzo, MBA; Tejas Subramanian, BS; Andrea Pezzi, MD; Jung Mok, MD; Mihir Dekhne, MD; Matthew E. Cunningham, MD, PhD; Francis C. Lovecchio, MD

Hypothesis
Differential loading of the vertebral body (VB) will result in variation in bone density within the vertebral endplates.

Design
Cross-sectional CT analysis

Introduction
Bone density of the VB, measured in Hounsfield units (HU), has been shown to correlate with mechanical complications. However, as described by Wolff's Law, the variation in loading induced by coronal deformity may produce asymmetry in bone density within the same VB.

Methods
684 patients under consideration for adult spinal deformity surgery from 2014-2024 were reviewed. Inclusion criteria were CT scans performed at the same institution and no endplate defects (e.g., subchondral cysts). Patients were stratified by Cobb angle (<10°, 10–30°, >30°). A propensity match based on age, sex, and BMI created three balanced cohorts. HU measurements were performed in 4 quadrants (anterior right, anterior left, posterior right, and posterior left), at 2 mm below/above the superior/inferior endplates, respectively, from L1 to L5 (excluding the L1 superior endplate). Segmental disc angle (SDA) was measured at each level from (T12-L1 – L5-S1), and adjacent SDA (aSDA) was defined as the nearest neighboring SDA. Coronal HU (cHU) % difference was defined as the absolute L-R difference divided by overall VB endplate average.

Results
130 patients met inclusion criteria, with 17 patients in each matched cohort. There were no differences in age (p=0.7), sex (p=0.6), or BMI (p=0.6). SDA and cHU % difference showed a moderate-strong correlation (r=0.63), with ranges of 0.15-21° and 0-239.5%. On univariate analysis, cHU % differences were associated with age, BMI, CCI, SDA, and aSDA. In multivariate regression, only SDA and aSDA remained significant, while lumbar cobb was not associated with cHU % difference. Mean L-R % differences did not vary from L1 to L5 (p=0.35), or between superior and inferior endplates (p=0.68). Adding aSDA improved cHU % difference prediction (p<0.001). At SDAs <5°, cHU differences averaged 12.2%, while 5–10° averaged 39.7%, and ≥10° averaged 60.9%. Each 1° increase in SDA was associated with a 4.36% increase in cHU difference (p<0.001).

Conclusion
Even relatively small disc angles (5–10°) are associated with relatively large differences in the L-R bone density at the endplates. Future work should aim to understand how surgeons can take advantage of these differences to optimize implant placement and coronal correction.

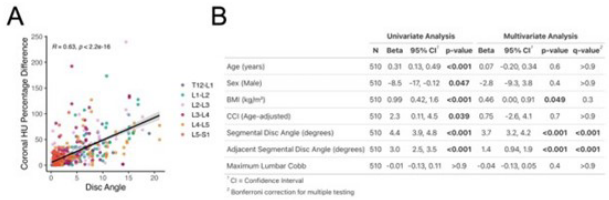

Figure 1: (A) Scatterplot of SDA vs cHU Difference (%) (B) Univariate and Multivariate Linear Regression for VB cHU Difference (%)

288. Pars Angle: Does a Novel Radiographic Measure Predict Progression of Spondylolisthesis?

Mutaleeb Shobode, MBBS; Adam Mansour, MD; Kirsten Tulchin-Francis, PhD; Allen Kadado, MD

Hypothesis
The anatomy of the pars interarticularis on plain radiographs will have predictive value as a novel radiographic measure in assessing the likelihood of spondylolisthesis and the risk of slip progression.

Design
Single-center, retrospective review.

Introduction
In addition to sporting activities that are implicated in the development of isthmic spondylolisthesis in adolescents, intrinsic factors such as increased lumbar lordosis, increased sacral slope and increased pelvic incidence are known to be associated with increased shear forces at the lumbo-pelvic

†Louis A. Goldstein Best Clinical Research E-Point Presentation

foundation, with resultant increased risk of stress fracture at the pars.

Methods
This is an IRB-approved retrospective review. Using plain radiographs, the angle subtended by the intersection of a line drawn along and parallel to the superior endplate of involved vertebrae and that drawn along and parallel to the anterior and posterior cortices of the pars interarticularis. Patients with spondylolisthesis were compare to those with low back pain without spondylolysis or spondylolisthesis. Demographics, spinopelvic parameters (pelvic incidence, lumbar lordosis), Dubosset's lumbosacral angle, Boxall's slip angle (if applicable), were measured. All patients with spondylolisthesis were evaluated at two time points to assess for progression. Initial radiographic values were used for descriptive and non-parametric statistics were used ($\alpha<0.05$).

Results
106/112 patients met the criteria for selection. There were 56 patients with spondylolisthesis (27M/29F, ave age: 15±2.1) and 50 patients without spondylolisthesis (24M/26F, 15±2.4). The L5-S1 was involved in 54 of the 56 patients with spondylolisthesis (96%). Lesions in the upper third of the pars interarticularis and in oblique orientation were more predominant (67%, 71%, respectively).The average pars angle for the spondylolisthesis group was not significantly different from the control group (113.8±6.7 vs. 113±5.9, $p=0.88$). The mean lumbar lordosis, however, was greater in the spondylolisthesis group (65.03±7.31 vs. 46.45±3.96, $p<0.05$). None of the 56 patients with spondylolisthesis had radiographic evidence of progression.

Conclusion
There is no correlation between pars angle values measured at the level of the spondylolysis and the progression of spondylolisthesis at short term follow-up. Unlike lumbar lordosis, the pars angle is not a predictor or risk factor for spondylolisthesis.

Pars Angle Measurement

289. Surgeon Preferences in the Treatment of EOS: A Discrete Choice Experiment

Anthony A. Catanzano, MD; Grant Cabell, MD; Isabel Prado, MD; Amy L. McIntosh, MD; Klane K. White, MD; Gregory Redding, MD; Walter H. Truong, MD, FRCS(C), FAOA; Pediatric Spine Study Group

Hypothesis
Surgeons will rely most on age and thoracic height when deciding between growth-friendly and definitive fusion for surgical treatment of EOS.

Design
Discrete choice experiment using pediatric spine surgeon respondents.

Introduction
Early Onset Scoliosis (EOS) poses the challenge of obtaining deformity correction while allowing thoracic growth for lung development. Given the variability in presentations, there is no clear algorithm to determine if definitive fusion or growth-friendly (GF) strategy is indicated. Classically, thoracic height (TH) served as a measure of pulmonary function, however more recently, forced vital capacity (FVC), along with consideration for etiology and function have become

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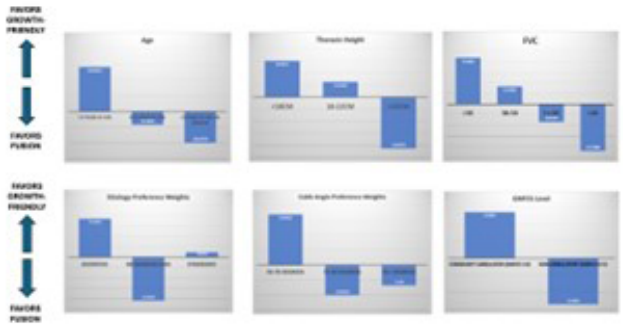
considerations. We sought to determine what elements most strongly influence surgeon decisions in EOS patients.

Methods
PSSG members determined 6 critical attributes (Age, Cobb Angle, Etiology, TH, FVC, and Modified GMFCS Level) considered in surgical EOS treatment an created stratified levels for each attribute. A discrete choice experiment was created to examine the most influential attributes in deciding between definitive fusion and GF surgery. The survey included 20 simulated clinical cases with random groups of attribute levels and was distributed to PSSG members who decided the best treatment for the simulated patient. Haversian Bayesian analyses were then used to calculate importance weights for each attribute and utility weights for each level.

Results
61 surgeons completed the survey. Age <9 was found to be the most influential factor in making the decision between definitive fusion and growth friendly surgery (importance weight 43.5±15.1), followed by TH of <18cm (15.7±6.3). Surgeons were more likely to offer GF surgery to Idiopathic patients (utility weight, UW 37.4± 19.2)than Neuromuscular (UW -42.2±27.8). and more likely to offer GF surgery for patients with lower FVC <30 (UW 21.9±39.4) and definitive fusion for those with FVC >50 (UW -8.4±27.2).

Conclusion
When deciding between GF and definitive fusion surgery in EOS, surgeons most often utilized age and TH when making this decision, despite recent literature showing TH to not be a suitable representation of pulmonary function. It is encouraging that FVC seems to factor into decision, but was of less importance than TH. These findings suggest a delay between published literature and changes in surgeon behavior, or possible skepticism about those findings.



290. Impact of Paraspinal Muscle Volume and Fatty Infiltration on Adult Spinal Deformity Outcomes

Omar Zakieh, MBBS; Harsh Jain, MBBS; Andrew G. Winsauer, MD; Richard S. Moore, MD; Hani Chanbour, MD; Iyan Younus, MD; Ranbir Ahluwalia, MD; Tyler Zeoli, MD; Amir M. Abtahi, MD; Julian Lugo-Pico, MD; Scott Zuckerman, MD, MPH; Byron F. Stephens, MD

Hypothesis
Smaller paraspinal muscle volume and greater fatty infiltration (FI) is associated with poorer outcomes.

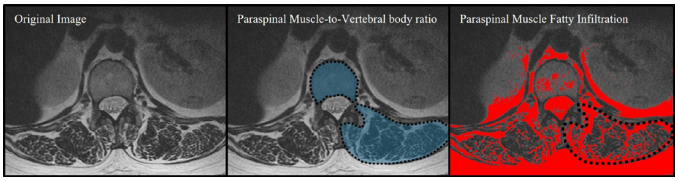
Design
Retrospective cohort.

Introduction
Paraspinal muscle degeneration and greater FI has been associated with proximal junctional kyphosis (PJK). This area is understudied among adult spine deformity (ASD) patients. In a cohort of patients undergoing ASD surgery, we analyzed the impact of preoperative paraspinal muscle volume and FI on mechanical complications, and reoperation.

Methods
A single-institution, retrospective cohort study was performed for patients undergoing ASD surgery from 2009-22. Inclusion criteria were: ≥5-level fusion, and minimum 2-year clinical follow-up. Primary exposures were preoperative paraspinal muscle-to-vertebral body ratio at L1 and FI assessed using axial T2 magnetic resonance imaging and ImageJ software. Outcomes included PJK, rod fracture, implant failure, pseudarthrosis, and reoperation. Multivariable logistic regression models controlled for age, BMI, upper instrumented vertebra and pelvic incidence.

Results
Among 175 patients undergoing ASD surgery, mean age was 64.1±16.1 and 132 (75.4%) were female. Of these patients, 97 (55.4%) experienced at least one mechanical complication and 45 (25.7%) reoperation. The mean paraspinal muscle to vertebral body ratio was 2.4±0.6. Mean FI was 31.0±7.7%. Patients with PJK had smaller muscle-to-body ratio (2.2±0.5 vs. 2.5±0.6, p=0.001) and greater FI (36.0±7.4% vs. 27.4±5.6±, p<0.001) than patients without PJK. No difference was observed in muscle-to-body ratio or FI between patients with and without other complications. Similarly, muscle-to-vertebral body ratio (2.4±0.5 vs. 2.4±0.6, p=0.986) and FI (32.0±6.7% vs. 30.7±8.0%, p=0.283) were comparable between patients with and without reoperation. On multivariable regression, smaller muscle-to-body ratio (OR=0.22, 95%CI=0.10-0.49, p<0.001) and greater FI (OR=1.29, 95%CI=1.12-1.40, p<0.001) were independently associated with PJK, with no association found with other mechanical complications or reoperation.

Conclusion
Smaller paraspinal muscle volume and greater FI were independently associated with PJK but not with other mechanical complications or reoperation. These findings highlight the potential role of muscle degeneration specifically for PJK prevention and may represent a target for a potential preoperative intervention.



Paraspinal Muscle-to-Vertebral Body Ratio and Fatty Infiltration

291. Masseter Sarcopenia and Mortality Following Type II Odontoid Fractures in the Elderly: A 5-Year Follow-Up Study

Joseph Nassar, BS; Manjot Singh, BS; Michael Farias, BS; Mohammad Daher, BS; Lama Ammar, BS; Abel De Varona-Cocero, BS; Jinseong Kim, MD; Simbarashe Peresuh, MD; Kaitlyn Crow, BS; Gabriel Gonzalez, BS; Peter G. Passias, MD; Bassel G. Diebo, MD; Alan H. Daniels, MD

Hypothesis
Masseter sarcopenia is associated with increased mortality in elderly patients with Type II odontoid fractures.

Design
Retrospective cohort study

Introduction
Sarcopenia, defined as low muscle mass with reduced function, is linked to poor trauma outcomes. Routine head CT scans in elderly trauma patients enable masseter sarcopenia assessment. However, its relationship with mortality after Type II odontoid fractures remains unclear. This study examines the association between masseter sarcopenia and mortality in elderly patients with Type II odontoid fractures.

Methods
This study included patients aged ≥50 years with a Type II odontoid fracture who had a head CT scan within 7 days of presentation. Collected data included demographics, Charlson Comorbidity Index (CCI), treatment type, Injury Severity Score (ISS), Modified Frailty Index-5 (mFI-5), fracture characteristics (angulation, displacement, gap, comminution), and masseter cross-sectional area (MCSA). Multivariate Cox regression assessed associations between MCSA and mortality, adjusting for age, gender, BMI, CCI, ISS, mFI-5, and treatment type. Kaplan-Meier survival curves illustrated survival outcomes. Sensitivity analysis defined sarcopenia as 1 standard deviation below gender-specific means.

Results
A total of 72 patients (mean age: 80.9±9.5 years, 58.3% female) were included, with 14 (19.4%) classified as sarcopenic. By 1 year post-injury, 16 (22.2%) patients had died, increasing to 22 (30.6%) by 2 years. Masseter sarcopenia was associated with 1-year mortality (adjusted hazard ratio [aHR]: 5.31, 95% CI: 1.44–19.62, p=0.01), while mFI-5 predicted 2-year mortality (aHR: 1.96, 95% CI: 1.09–3.52, p=0.02). By 5 years, 38 (52.8%) patients had died, including 9 (40.9%) treated operatively and 29 (58.0%) conservatively (p=0.18). Among sarcopenic patients, 9 (64.3%) had died, compared to 29 (50.0%) non-sarcopenic (p=0.34). Age consistently predicted mortality at 3–5 years (aHR: 1.08, 95% CI: 1.03–1.13, p<0.01).

Conclusion
Masseter sarcopenia is strongly associated with 1-year mortality after Type II odontoid fractures in elderly patients. In this cohort, 30.6% died within 2 years, and 52.8% within 5 years. Early MCSA-based sarcopenia identification may enhance prognostication and guide post-injury management strategies.

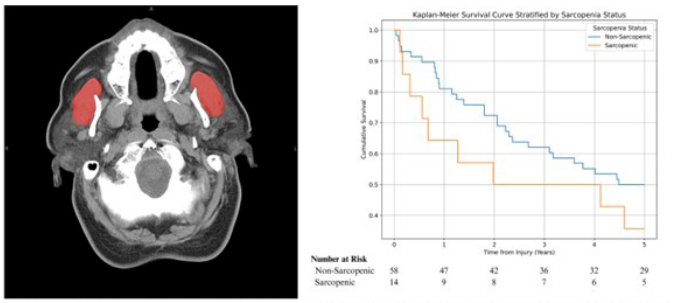


Figure: (Left) Axial CT-scan of the head showing how the masseter muscle cross-sectional area was measured, 2 cm below the inferior edge of the zygomatic arch. The masseter area is highlighted in red. (Right) Kaplan-Meier Survival Curve at 1, 2, 3, 4 and 5 years from injury based on Sarcopenia Status.

292. Pediatric Spine Surgeons Report High Mental Health Burden and Limited Support for Scoliosis Patients

Matthew Weintraub, BS; Omar Taha, BS; Julia Rakin, BA; Amber S. Mizerik, PA-C; Mehdi Elfilali, BA; Benjamin D. Roye, MD; *Michael G. Vitale, MD, MPH*

Hypothesis
Pediatric spine surgeons recognize mental health burden associated with scoliosis, yet mental health screening and follow-up is limited.

Design
Survey of spine surgeons associated with an international adolescent idiopathic scoliosis (AIS) registry.

Introduction
Adolescents seeking treatment for scoliosis often present with comorbid mental health concerns. However, we lack standardized screening, evaluation and treatment protocols to address mental health issues during treatment. This study investigates mental health screening practices among experienced pediatric orthopedic providers treating spine deformity patients.

Methods
54 pediatric spine surgeons were anonymously surveyed. The survey included a mix of question types: closed-ended responses were tallied, and a sentiment analysis was performed on open-ended responses.

Results
28 of 54 surgeons (52%) responded, with the majority having over ten years of experience in high-volume pediatric spine deformity practices (1000+ patients, 76-100 cases per year). Notably, most estimated that up to half of their patients face mental health challenges and reported a slight increase in mental health burden. Despite the perceived burden, only 12 (42%) perform structured mental health screenings and 6 (21%) use informal methods. Among the 16 (57%) who reported screening practices, PROMIS and depression/suicide screens were most common. Only 2 (7%) reported that their teams "probably" follow up on low scores, while 11 (39%) indicated follow-up as unlikely. Most (64%) felt they were not adequately addressing mental health concerns. Referrals are typically prompted by positive screenings or clinical observations, but barriers such as limited provider availability, access

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issues, and insurance concerns hinder referrals. When made, referrals are usually directed to in-house providers.

Conclusion
This study reveals significant gaps in mental health care for pediatric scoliosis patients. Although providers overwhelmingly recognize the mental health burdens associated with scoliosis, most do not conduct routine screenings. Referrals, typically made to internal providers, are often hindered by barriers such as limited provider availability, access issues, and insurance constraints. These findings underscore the need for standardized mental health screening protocols and improved access to mental health resources within scoliosis care.

Total Responses		28
Does your practice utilize any structured mental health screening practices?	Yes	12
	No	16
Types of Structured Screening Used	PROMIS	4
	SRS	3
	Depression/Suicide Screen	4
	PHQ	2
What type of Patient Reported Outcomes (PRO's), if any, does your practice employ?	SRS	23
	PROMIS	12
	EOSQ	7
	PHQ	2
	CP Child	2
	ODI	2
	SAQ	1
	SF-12	1
Does your clinical team follow-up on low mental health scores (including mental health domain scores for general questionnaires)?	Definitely not	5
	Probably not	11
	Might or might not	10
	Probably yes	2
	Definitely yes	0
What percentage of your patients do you feel experience mental health burden in relation to their diagnosis/treatment?	0-24%	8
	25-49%	17
	50-74%	2
	75-100%	1
Do you perceive that mental health is being adequately responded to in the patients with scoliosis that you treat?	Definitely not	2
	Probably not	16
	Might or might not	6
	Probably yes	3
	Definitely yes	1

Select Survey Question Responses

293. The Influence of BMI on Brace Adherence in Idiopathic Scoliosis

Erica Olfson, BS; Anne Boeckmann, BS; Lydia Klinkerman, BS; *Megan E. Johnson, MD*

Hypothesis
Patients with idiopathic scoliosis and higher BMIs will be less adherent with bracing.

Design
Retrospective chart review

Introduction
As bracing has become the non-operative standard of care treatment for idiopathic scoliosis, ensuring patient adherence with brace prescriptions is crucial for effective outcomes. This study examined the relationship between brace adherence and body mass index (BMI).

Methods
285 children (48 M, 217 F) with IS ages 7-18yrs, curves 15°-50°, treated with full time thoracic-lumbar-sacral orthosis (TLSOs), either anterior or posterior opening, between 2019 and 2020 were reviewed until skeletal maturity or surgery. Brace adherence was measured using iButton temperature sensors. Patient demographic data and radiographic data was also collected.

Results
There were 285 full time TLSO braces prescribed during the study period (20 anterior opening; 265 posterior opening). Average age at brace prescription was 12.2+/-1.6yrs. Overall brace adherence for the cohort was 66.5%, with an average wear time of 12.2+/-5.8hrs. 47 patients failed bracing and progressed to surgery, whereas 218 had their braces discontinued due to success. There was no significant difference in brace compliance between genders (female 67.2% vs. male 62.0%, p=0.308) or brace type (anterior 70.2% vs. posterior 66.3%, p =0.592). Average BMI was 19.79+/-4.36. BMI was however significantly associated with brace adherence, with each 1 kg/m² increase in BMI associated with a 2% decrease in brace adherence (p = 0.00001). Linear regression analysis demonstrated that 6.5% of variability in brace adherence is described by differences in BMI (r2 = 0.0657). There was no significant correlation between BMI and failure of bracing, and thus progression to surgery (p=0.969, correlation coefficient = 0.002).

Conclusion
Adherence with bracing is crucial for preventing progression to surgery for patients with idiopathic scoliosis. These data show that as BMI increases, brace adherence decreases, which may be useful when counseling patients at the time of brace prescription and during brace treatment.

294. Stretch Neuropraxia After L5-S1 Anterior Lumbar Interbody Fusion: Effect of Cage Height and Lordosis

Manjot Singh, BS; Phillip Schmitt, BS; Naya Melvani, BS; Joseph Nassar, BS; Michael Farias, BS; Simbarashe Peresuh, MD; Kaitlyn Crow, BS; Lachlan Kirby, BS; Margaret Wang, BS; Bryce A. Basques, MD; Eren Kuris, MD; Bassel G. Diebo, MD; Alan H. Daniels, MD

Hypothesis
Large changes in disc heights and segmental lordosis during L5-S1 anterior lumbar interbody fusion (ALIF) may contribute to the development of postoperative neuropraxia.

Design
Retrospective cohort study.

Introduction
ALIF restores intervertebral DH and segmental lordosis but may lead to supraphysiologic increase in DH which has been associated with stretch-related nerve root injury.

Methods
Adults with degenerative spine pathology who underwent L5-S1 ALIF were identified. Anterior and posterior DHs were measured, and associations with segmental and global lumbar lordosis were evaluated using multivariate regression

analyses. Postoperative neuropraxia, whether transient or persistent, was identified up to one-year postoperatively. Receiver operating characteristic (ROC) curve analyses were performed to establish thresholds for DHs that predicted postoperative neuropraxia.

Results
In total, 101 patients were included with mean age of 52.5 years, 55% were females, and mean CCI of 1.7. After ALIF, DHs increased by mean of 8.7mm anteriorly and 3.0mm posteriorly, L5-S1 segmental lordosis increased by mean of 7.0°, and L1-S1 lumbar lordosis increased by mean of 3.6° (Figure). A 1mm improvement in anterior DH was associated with 0.3° increase in L5-S1 segmental lordosis ($p<0.001$) and 0.2° increase in L1-S1 lordosis ($p=0.019$). Among this cohort, 28% developed neuropraxia, of which 75% were transient that resolved by 3 months postoperatively. ROC analyses identified cutoffs of 18.9mm and 8.6mm for postoperative anterior and posterior DH, and 9.5mm and 8.6mm for change in preoperative to postoperative anterior and posterior DH, respectively. Patients above these thresholds had nearly 4-fold higher likelihood of developing postoperative neuropraxia ($p<0.01$).

Conclusion
Large increases in anterior or posterior disc heights during ALIF achieved improvements in lumbar lordosis but were associated with increased odds of neuropraxia postoperatively. Patients with a postoperative anterior disc height of 19mm and a posterior disc height of 9mm had 4-fold higher odds of developing neuropraxia. While three-fourth of neuropraxias were transient and resolved spontaneously in the early postoperative period, the high incidence of neuropraxia following ALIF may inform preoperative planning and counselling.

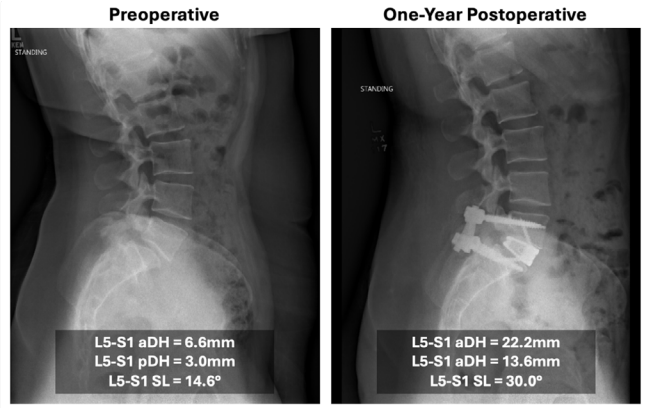


Figure. Preoperative (left panel) and one-year postoperative (right panel) standing lateral lumbar radiographs demonstrating a patient who underwent L5-S1 anterior lumbar interbody fusion, with 15.6mm correction in anterior disc height (aDH), 10.6mm correction in posterior disc height (pDH), and 25.4° correction in segmental lumbar lordosis (SL), and developed transient neuropraxia.

295. Wearing the Stress: Monitoring Surgeon Strain with Wearable Technology

Suhas Etigunta, BS; Katherine Sborov, MD; Andy M. Liu, BS; David L. Skaggs, MD, MMM; *Kenneth D. Illingworth, MD*

Hypothesis
Longer and more complex pediatric spinal deformity surgeries increase surgeon physiological stress - both intra- and post-operatively.

Design
Retrospective Cohort

Introduction
The demands of surgery impose physiological stress on surgeons, potentially affecting performance and long-term health. There is a dearth of research into how intraoperative case complexity and workload influence a surgeon's physiological metrics.

Methods
This study analyzed 35 pediatric spinal deformity procedures performed by a single surgeon wearing a WHOOP device, a wearable physiological tracker. WHOOP data parameters were extracted for intraoperative periods, day of, and night following surgery, including heart rate (HR), heart rate variability (HRV), strain, recovery, and sleep metrics. Patient and operative data, including case duration, estimated blood loss, and case complexity, were collected. Surgical factors and surgeon physiological responses correlations were analyzed.

Results
Average patient age was 15.7±5.0 years, with a mean BMI of 18.4 ± 5.3. Mean surgical time was 325.5±147.6 mins, with an average of 11.15±6.0 spinal levels fused and 2.4±3.2 osteotomies per case. Surgical complexity was classified as level I (6), II (17), and III (12) (most complex). Average surgeon HR during surgery was 102.4±7.8 bpm, with a peak HR of 128.4 ± 8.1 bpm. Mean intraoperative strain was 10.80±3.5, with an average of 987.6±561.1 calories burned per case. Postoperative WHOOP recovery scores averaged 66.9±20.6%, with a resting HR of 59.7±2.8 bpm and HRV of 21.9±3.0 ms. Post-clinic day control data showed higher recovery scores (73.8±15.3%), with a resting HR of 59.0 ± 2.2 bpm and HRV of 23.1 ± 2.6 ms. Longer surgeries correlated with increased resting HR ($r=0.67$) and decreased HRV ($r=-0.63$), indicating heightened physiological stress. Prolonged operative time correlated with lower WHOOP recovery scores ($r=-0.52$), suggesting persistent postoperative strain. Greater case complexity was associated with higher baseline resting HR ($r=0.40$), reflecting increased physiological demand in more challenging procedures.

Conclusion
Extended and high-complexity procedures result in increased cardiovascular strain and reduced HRV, which may contribute to surgeon fatigue and long-term risks. Wearable monitoring technology provides an objective means to assess surgeon stress, with potential applications towards strategies to improve surgeon endurance and recovery.

E-POINT PRESENTATION ABSTRACTS

Patient demographic and operative data (N=35)	
Gender (%)	
Female	22 (62.9)
Male	13 (37.1)
Age at surgery (years), mean ± SD	15.7 ± 5.0
BMI (kg/m²), mean ± SD	18.4 ± 5
Major curve magnitude (°), mean ± SD	84.6 ± 31.7
Preoperative halo traction (%)	10 (28.6)
Surgeon case complexity score	
I	6 (17.1)
II	17 (48.6)
III	12 (34.3)
Perioperative transfusion (%)	12 (34.3)
Estimated blood loss (mL), mean ± SD	480.1 ± 519.0
Levels fused, mean ± SD	11.2 ± 6.0
Number of osteotomies, mean ± SD	2.4 ± 3.2
Neuromonitoring changes (%)	5 (14.3)
Surgeon Whoop band data	
Surgery duration (mins), mean ± SD	325.5 ± 147.6
Heart rate in surgery (BPM), mean ± SD	102.4 ± 7.8
Max HR in surgery (BPM), mean ± SD	128.4 ± 8.1
Strain in surgery, mean ± SD	10.8 ± 3.5
Calories burned in surgery (kcal), mean ± SD	987.6 ± 561.1
Calories burned per hour in surgery (kcal/hr), mean ± SD	172.4 ± 63.7
Day after surgery recovery score (%), mean ± SD	66.9 ± 20.6
Day after surgery resting heart rate (BPM), mean ± SD	59.7 ± 2.8
Day after surgery heart rate variability (ms), mean ± SD	21.9 ± 3.0
Day after clinic recovery score (%), mean ± SD	73.8 ± 15.3
Day after clinic resting heart rate (BPM), mean ± SD	59.0 ± 2.2
Day after clinic heart rate variability (ms), mean ± SD	23.1 ± 2.6

Table 1. Data

296. Novel Unipolar Shilla Technique for Complex EOS Provides Lasting Correction and Controlled Growth

Omar Taha, BS; Matthew Weintraub, BS; Ritt Givens, BS; Mehdi Elfilali, BA; Edwin Kulubya, MD; *Benjamin D. Roye, MD*; Lawrence G. Lenke, MD; Michael G. Vitale, MD, MPH

Hypothesis
The "unipolar" Shilla technique corrects severe and complex spinal deformity with an acceptable safety profile while allowing for spinal growth

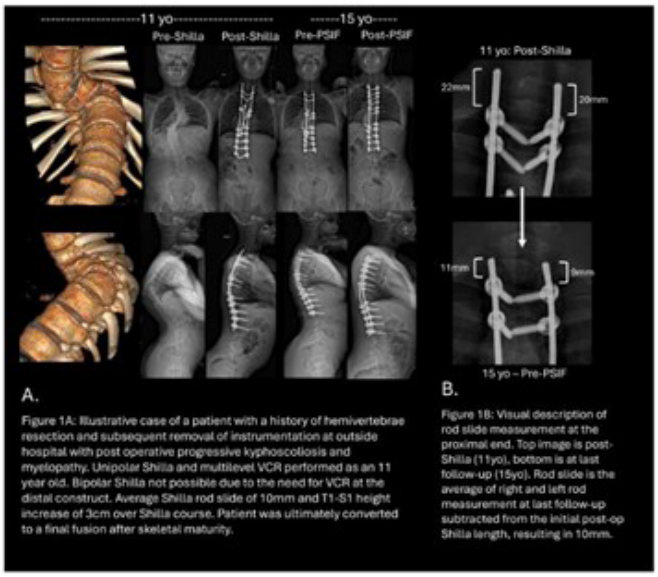
Design
Retrospective Cohort

Introduction
The Shilla technique provides direct apical control while allowing continuous cranial and caudal guided growth in early onset scoliosis (EOS). Its advantage over traditional growing rods is avoidance of repeated surgeries for manual distraction. When certain curve patterns preclude the possibility of bipolar growth, we used a novel "unipolar" Shilla technique, allowing for asymmetric growth modulation with fusion at the opposite end (Figure 1).

Methods
All unipolar Shilla cases performed at a single institution over an 8-year period with 2-year follow up were identified. Demographic variables, radiographic parameters, and metrics of spinal growth were collected. "Rod slide" was measured to determine intra-Shilla construct growth (Figure 1).

Results
Eight patients with a mean age of 9.7 [8-12] at Shilla were identified. All were Risser 0 and 7/8 had open triradiate cartilage. Average time from Shilla to skeletal maturity or fusion was 4.1 ± 1.3 years. Vertebral column resection (VCR) was performed in 3 patients at index Shilla. The mean major Cobb was 69°± 12 pre-Shilla, 17° ± 17 post-Shilla, and 26° ± 18 prior to fusion or final follow-up. Mean T1-12 kyphosis was 59° pre-Shilla, 31° post-Shilla, and 33° at final follow-up. There was an average rod slide of 8.1 mm, with 85% of patients having at least 5 mm of rod slide. Thoracic height (T1-T12) increased from 17.6 ± 1.4 cm pre-operatively, to 22.5 ± 2.1 cm at final Shilla f/u. T1-S1 height increased from 26.1 ± 2.7 cm to 34.5 ± 3.3 cm. There were no complications apart from one unplanned return to OR for elective trimming of a prominent rod.

Conclusion
The "unipolar" technique maintains Shilla's key advantage of allowing spinal growth without repeat procedures. While our cohort is limited due to the narrow indication, in appropriately selected patients it offers excellent and lasting correction of severe spinal deformities, with an acceptable safety profile. All patients had some Shilla growth, but the magnitude was modest in most cases. We recommend considering the unipolar Shilla technique in patients with limited growth remaining and complex deformities requiring definitive apical control, or those for whom close follow-up may be challenging.



Case Example of Unipolar Shilla

297. Natural History of Atlantoaxial Instability in Skeletal Dysplasias: Longitudinal Radiographic and MRI Measures

Bryan Menapace, MD; Anuj Gupta, MD; Sadettin Ciftci, MD; Colleen Ditro, RN, DNP, CPNP; Jeffrey Campbell, MD; William G. Mackenzie, MD; *W.G. Stuart Mackenzie, MD*

Hypothesis
The natural history of atlantoaxial instability (AAI) in skeletal dysplasia (SD) will follow patterns, allowing for customized surveillance to improve care.

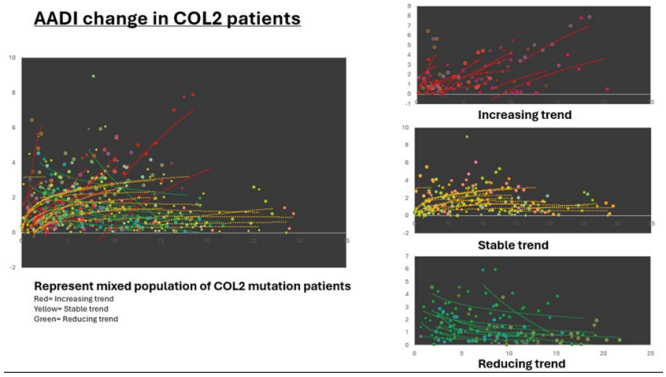
Design
Retrospective database

Introduction
AAI can cause significant morbidity in SD and may present early, making clinical diagnosis difficult. Imaging is often required with dynamic x-rays and MRI. This study is the first to report the natural history of SD AAI.

Methods
An institutional database was queried for collagen 2 (COL2) mutation or mucopolysaccharidoses (MPS) with at least 3 imaging episodes. If patients had surgery, only preop images were included. X-ray measurements included change in anterior and posterior atlantodens interval (AADI, PADI) and for MRI, space occupied by cord (SOC) and dynamic change in space available for cord (SAC). Scatter plots trended instability with age and were categorized by trend line slope: increasing, stable, or decreasing instability.

Results
85 patients (49 COL2, 36 MPS) were included. Mean index age of x-ray and MRI was 5.9 and 5.6 years. The average number of xrays for COL2 and MPS were 8.9 and 6.1. The average number of MRIs for COL2 patients were 3.0 and for MPS were 3.4. A total of 6 measurements (Fig 1) were graphed against time and categorized. Collectively, the measurement's distributions were averaged. For COL2 patients: 30% increasing instability, 33% stable, 38% decreasing. For MPS: 42% increasing, 24% stable, 34% decreasing. Surgery was performed in 21 (25%) patients (COL2: 18.3%, MPS: 33.3%). Measures of AADI and PADI in COL2 patients correlated significant with instability pattern and surgical rate (p=0.001).

Conclusion
COL2 and MPS demonstrated a variability in AAI trends over time. For COL2, there was nearly balanced distribution between the three patterns, whereas MPS patients more often had worsening instability. Early x-rays with regular follow-up revealed a patient's trajectory. Those with increasing instability may warrant subsequent close x-ray follow-up, due to higher rates of surgery. For those with stable or decreasing trends, x-rays could be performed less frequently. Since trends in MRI were less corollary, it's possible that a baseline screening MRI may be sufficient. This novel natural history data will aid in better understanding AAI progression in children with SD, resulting in improved patient screening and care.



298. Impact of Multipoint Pelvic Fixation and Multirod Distal Constructs on Proximal Junction Biomechanics

Robert Rudy, BS; Anna Sawa, PhD; Sarah McBryan, MS; Luke Mugge, MD; Katherine Thielen, BS; Temesgen G. Assefa, MD; David W. Polly Jr., MD; Juan S. Uribe, MD; Brian P. Kelly, PhD; Jay D. Turner, MD

Hypothesis
Multipoint pelvic fixation may increase the proximal rod strain

Design
Biomechanics study in human cadavers

Introduction
Multipoint pelvic fixation with multirod constructs are increasingly being utilized for long segment deformity constructs to reduce rates of distal failure. However, more robust distal fixation may negatively impact proximal junction biomechanics and this potential relationship has not been extensively studied.

Methods
Standard nondestructive flexibility tests (7.5 Nm) were performed on 7 cadaveric specimens (L1-pelvis) to assess intervertebral flexibility (ROM), rod strains, and screw bending moments along a posterior fusion construct (PSR) spanning L2-S, supplemented by bilateral primary S2AI fixation, and lastly multipoint pelvic fixation with four total S2AI fixation points and accessory rods spanning L4-S2AI. Four conditions were tested in each group: (1) intact; (2) L2-S1 PSR; (3) L2-S2AI PSR; and (4) L2-S2AI+L4-S2AI. Data were analyzed using t-tests.

Results
Proximal rod strain at the L2-3 level did not change across the varying test conditions in the seven specimens tested ($P > 0.05$ for all conditions). There was no significant difference detected in proximal screw strain across conditions ($P > 0.05$) or adjacent segment ROM ($P > 0.05$).

Conclusion
Cadaveric biomechanics testing suggests that pelvic fixation with 2 or 4 sacral-alar-iliac screws and 2 or 4 rods across the lumbosacral junction does not significantly alter proximal

E-POINT PRESENTATION ABSTRACTS

junction rod strain, ROM, or proximal screw strain. Robust pelvic fixation may protect against distal failure without deleterious effects at the proximal rod and junction.

299. Evaluation of Segmental Lordosis Following Lumbar PSO and Its Impact on Proximal Junction Failure

Christopher Diaz, BS; Lane H. McCoy, BS; Steven Zhang, MD; Nicholas A. Pallotta, MD, MS; Neset Tang, MD; Munish C. Gupta, MD; *Brian J. Neuman, MD*

Hypothesis
Increasing segmental lordosis in the proximal lumbar spine increase the risk of PJF.

Design
Retrospective Review

Introduction
Proximal Junctional Failure (PJF) is a common long-term complication in patients undergoing ASD surgery. Various factors have been identified as potential risk factors for PJF such as obesity, inadequate postoperative sagittal balance, advanced age, and osteoporosis. This study aims to evaluate the impact of sagittal alignment parameters and segmental lordosis distribution on the risk of PJF in upper thoracic fusion patients instrumented to the pelvis who underwent a PSO.

Methods
The cohort consisted of 67 ASD patients who underwent upper thoracic fusion (T1-T8) to the sacrum with PSO. Patients were grouped based on if they underwent revision surgery for PJK (PJF). Preoperative and postoperative sagittal parameters, including thoracic kyphosis (TK), pelvic tilt (PT), lumbar lordosis (LL), C7 sagittal vertical axis (SVA), C2 SVA, L1 pelvic angle (L1PA), alignment using L1PA and T4PA, segmental lordosis of each lumbar level, and Roussouly types, were analyzed. To determine segmental lordosis, we measured from the upper endplate of each vertebra. Statistical correlations were made to identify significant differences in these parameters between patients with and without PJF.

Results
Of the 67 ASD patient, 30 had 2-year follow up. The percentage of patients who developed PJF within 2 years was 13.4%. Patients with L3 PSOs who had less change in LL from preoperative to postoperative (17.4 vs 39.8, p=0.006), and had less postoperative LL (38.5° vs 59.2°, p<0.001) were more likely to develop PJF. Increasing segmental lordosis at L2-L3 increased the risk of developing PJF after a PSO (PJF:7.25, No PJF 2.19, p = 0.0395). Assessment of other sagittal parameters, including TK, PT, C7 SVA, C2 SVA, L1PA, L1PA alignment (aligned vs malaligned), L1PA + T4PA alignment, Roussouly types, or segmental lordosis at other levels; these factors did not show any significant correlation with PJF occurrence.

Conclusion
In patients undergoing ASD surgery extending to the upper thoracic region, inadequate correction of lumbar lordosis following a PSO increases the risk of revision surgery for PJK. However, restoring this lumbar lordosis more proximal to the PSO within the lumbar spine may also elevate the risk of PJF.

	PJF	No PJF	p-value
TK	15.38	10.19	0.266
PT	15.13	16.91	0.616
C7SVA	34.38	40.55	0.761
C2SVA	78.50	72.21	0.815
L1PA	5.63	8.32	0.396
LL	65.25	59.02	0.110
L1-2	-0.38	0.15	0.650
L2-3	7.25	2.19	**0.040**
L3-4	23.38	17.74	>0.5
L4-5	15.88	19.60	>0.5
L5-S1	25.37	19.93	>0.5
L1PA Aligned (n)	1	15	>0.9
L1PA Malaligned (n)	8	43	>0.9
L1PA+T4PA Aligned (n)	1	6	>0.9
L1PA+T4PA Malaligned (n)	8	50	>0.9
Roussouly 1 or 2 (n)	1	9	>0.9
Roussouly 3 or 4 (n)	7	38	>0.9

Table 1. Comparison of Saggital Parameters and Alignment Classification of Patient With and Without Proximal Junctional Failure (PJF)
*L1PA Aligned = 0.5PI - 19 ± 2
*T4PA Aligned = T4-L1PA mismatch between -3 and +1

Industry

Industry Workshops 230
Industry Networking Sessions 232

The Scoliosis Research Society gratefully acknowledges Orthofix for their support of the Welcome Reception.

INDUSTRY WORKSHOPS

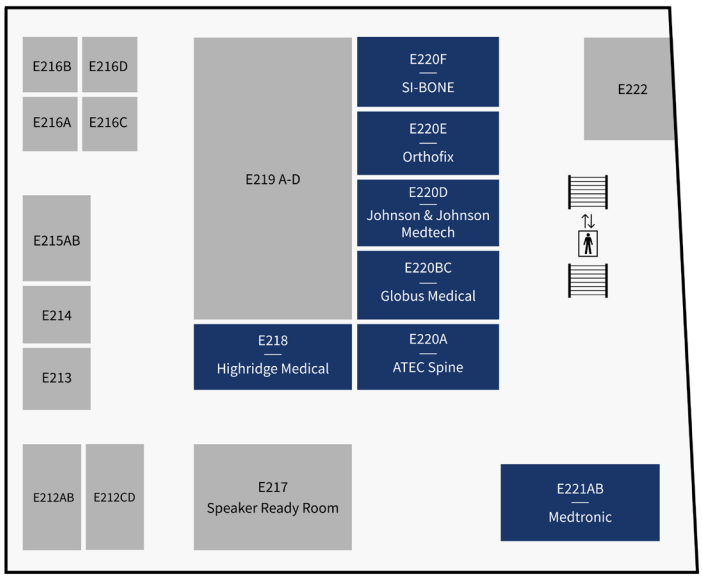
Annual Meeting delegates are encouraged to attend the Industry Workshops. Each workshop is programmed by a single-supporting company and will feature presentations on topics selected by the company.

Please note: CME credits are not available for Industry Workshops.

Thursday, September 18 | 12:30-14:00

Location: Level 3

Company	Room
ATEC Spine	Room E220A
Globus Medical	Room E220BC
Highridge Medical Highridge Medical	Room E218
Johnson & Johnson MedTech	Room E220D
Medtronic	Room E221AB
Orthofix	Room E220E
SI-BONE	Room E220F



ATEC SPINE

Room E220A

PRO Informatix: Predict. Restore. Optimize. Your deformity practice with EOS Insight®

Faculty: Han Jo Kim, MD; Juan Uribe, MD; Darryl Lau, MD

Join us to explore how EOS Insight® supports the full spectrum of spine care - helping surgeons Predict imbalance with advanced imaging and AI, Restore alignment through 3D planning and patient-specific strategies, and Optimize outcomes via intraoperative reconciliation and post-op review. Discover how automated data-driven precision can elevate decision-making - because when every degree matters, every decision counts.

GLOBUS MEDICAL

Room E220BC

Stability Without Sacrifice: Treatment Strategies for Complex Spinal Deformity

Moderators: David L. Skaggs, MD, MMM; Ferran Pellise, MD, PhD; Gregory M. Mundis Jr., MD; Laurel C. Blakemore, MD; Per Trobisch, MD

This session explores motion preservation in pediatric deformity and fixation strategies in complex pediatric and adult fusion cases. Topics include pediatric fixation, selective fusion in major deformity patients, and techniques that may help to avoid complications. Faculty will use case-based discussion to examine how to balance stability and mobility in deformity correction.

HIGHRIDGE MEDICAL

Room E218

Lumbar VBT: Indications and Outcomes

Moderators: Firoz Miyanji, MD, John Braun, MD, Ryan Goodwin, MD, Jaren Riley, MD

Join an expert panel—bringing over 50 years of combined experience in vertebral body tethering (VBT)—to deepen your knowledge of motion-preserving techniques in the lumbar spine.

INDUSTRY WORKSHOPS

JOHNSON & JOHNSON MEDTECH

Room E220D

Johnson & Johnson MedTech evolving solutions for the moving target | sagittal plane correction in adult & pediatric complex spine

Moderator: Suken A. Shah, MD, FAAOS, FAOA
Faculty: Ioannis A. Avramis, MD; Jennifer M. Bauer, MD, MS; Munish Gupta, MD, MBA; Craig R. Louer, MD; Daniel M. Sciubba, MD, MBA

Please join our expert surgeon panel for an interactive case-based discussion focused on sagittal plane correction in pediatric and adult complex cases. Covering a range of topics from early-onset neuromuscular to sagittal revision in over lordosed patients, our faculty will discuss the unique challenges in addressing this ever-moving target in scoliosis correction. Participants will be able to engage in conversation centered on treatment options, what has and has not worked and the technology that can be leveraged today and in the future.

MEDTRONIC

Room E221AB

The Medtronic AiBLE Platform: From Planning to Precision

Moderator: Marinus de Kleuver, MD
Panel: Christopher P. Ames, MD; Amer F. Samdani, MD; David Stockwell, MD; Brian J. Neuman, MD

The AiBLE™ Smart Ecosystem is the first spine ecosystem to "close the loop" by seamlessly integrating advanced pre- and postoperative capabilities with core intraoperative technologies. This workshop will explore how the preoperative offering—leveraging full-body imaging with the Siemens Multitom Rax and AI-driven planning through the UNiD™ ASI platform—is shaping the future of deformity surgery.

ORTHOFIX

Room E220E

Zero Radiation, All Precision: Advancing Spinal Deformity Surgery with 7D FLASH Navigation

Moderators: Venu Nemani, MD; Rajiv Sethi, MD; A. Noelle Larson, MD; Paul J. Holman, MD

The future of spinal deformity surgery is clear — safe, precise, and free from the risks of intraoperative radiation. Join leading surgeons as they discuss how 7D FLASH Navigation is pioneering this future with its radiation-free, machine vision–based guidance system. This session will highlight how 7D FLASH Navigation enables optimal accuracy and surgical insight. Through case presentations and clinical data, learn how the platform is reshaping spinal deformity procedures by combining cutting-edge technology with improved safety and workflow efficiency. Discover why radiation-free navigation is not just a goal — it's the new standard for tomorrow's spine surgery, delivered today.

SI-BONE

Room E220F

Advancing Spinopelvic Fixation: Implant Innovations | Surgical Techniques | Clinical Outcomes

Faculty: David Polly, Jr., MD; CJ Kleck, MD; Jay Turner, MD, PhD

Join us for "Advancing Spinopelvic Fixation: Implant Innovations | Surgical Techniques | Clinical Outcomes," a dynamic panel featuring leading spine surgeons who will share their expertise and key learnings from years of clinical experience with the Bedrock® technique and iFuse Bedrock Granite® porous fixation/ fusion implant system. Panelists will present cases, highlight challenges encountered, and offer clinical insights. This interactive discussion provides an invaluable opportunity to ask questions and gain practical takeaways that can be immediately implemented in your own practice. If you want to enhance your understanding of spinopelvic fixation and the evolving role of iFuse Bedrock Granite, don't miss this session.

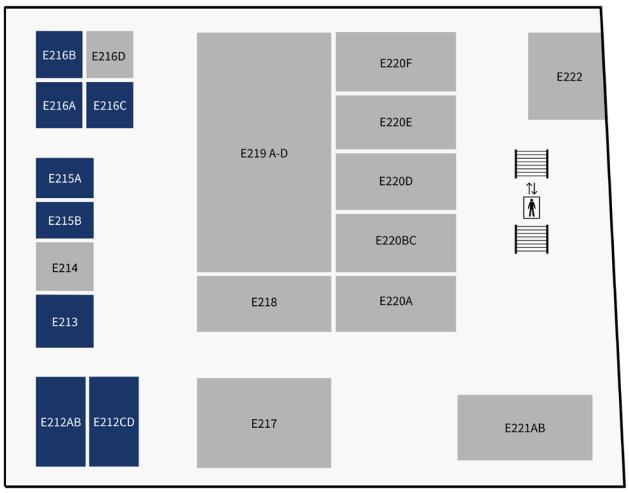
INDUSTRY NETWORKING SESSIONS

NETWORKING SESSIONS | THURSDAY, SEPTEMBER 18 | 16:00 - 17:30

Delegates are encouraged to attend hosted Networking Sessions immediately following the last session of the day. Networking Sessions will be hosted by:

Company	Room
ATEC Spine	Room E216A
Carlsmed	Room E215A
Globus Medical	Room E216C
Highridge Medical	Room E212CD
Johnson & Johnson MedTech	Room E216B
Medtronic	Room E212AB
Proprio	Room E215B
VB Spine	Room E213

Please note: CME credits are not available for Industry Networking Sessions.



ATEC Spine

ATEC Networking Reception: Predict. Restore. Optimize. Join ATEC for an evening focused on the next era of deformity care. From the Valence™ Navigation System and SafeOp™ 3 neuromonitoring to EOS Insight® alignment planning and Patient-Specific Approaches, see how ATEC's integrated PRO platform is built to Predict pathology, Restore alignment, and Optimize outcomes. Connect with peers, preview new technologies, and explore how PRO is redefining what's possible in spine.

Carlsmed

Discover the New Standard of Care: Personalized Spine Surgery with aprevo® by Carlsmed

Join us during the SRS Networking Session for an engaging opportunity to connect with leading surgeons advancing the field of personalized spine care. Meet Dr. Joseph Osorio (UCSD), Dr. Richard Menger (USA Health), and Dr. Scott Zuckerman (Vanderbilt University Medical Center) as they share insights on integrating the aprevo® technology platform into clinical practice.

Attendees will gain firsthand perspectives on pre-operative AI-Enabled surgical planning, intra-op surgical execution with patient-specific devices, and post-operative outcomes and clinical data—while discovering how aprevo® creates a data-driven, iterative feedback loop that elevates patient outcomes.

Enjoy drinks and small bites, and be part of the conversation shaping the future of spine surgery.

Highridge Medical

Join the lively Highridge team, including Rebecca Whitney and Eric Major, for an informal networking session with Charlotte-inspired drinks, music, and food to celebrate our Triple Diamond Sponsorship of SRS and to learn more about our comprehensive spine product portfolio.

Medtronic

Join us for a unique, art-inspired exhibition featuring powerful surgeon voices that showcase the value of AiBLE and spark meaningful discussion. Enjoy drinks and hors d'oeuvres as you connect with business and surgeon leaders in an engaging, thought-provoking setting.

Propio

Come experience two of the best from the state of Washington: Wine and AI! Join Proprio's CEO, Gabriel Jones and other AI luminaries over a glass of wine to experience firsthand how the Proprio Paradigm system leverages multi-modal sensor data and AI to go way beyond static spinal navigation guiding surgeons to achieve goals in and out of the operating room.

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Chasing Solutions in Spinal Deformity

We invite you to our hospitality suite, E213, for drinks, hors d'oeuvres, and an engaging discussion with Dr. Peter Newton on challenging cases in deformity and the pursuit of meaningful solutions to complex spinal pathologies.

You'll also hear from John Viscogliosi, Co-CEO, and Josh Johnson, Global President, as they share VB Spine's vision for the future and our commitment to advancing spine care, together.

Disclosures

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FINANCIAL RELATIONSHIP DISCLOSURES

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FINANCIAL RELATIONSHIP DISCLOSURES

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SRS OVERVIEW

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 1,600 health care professionals.

MISSION STATEMENT

The purpose of the Scoliosis Research Society is to foster the optimal care of all patients with spinal deformities.

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.

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/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 includes 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 http://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.

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A HANDS-ON COURSE
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MEETING OUTLINE

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MONDAY, SEPTEMBER 15, 2025		
08:00 - 16:00	SRS Board of Directors Meeting*	Room E222
TUESDAY, SEPTEMBER 16, 2025		
07:00 - 08:00	Committee Chair Breakfast* (by invitation only)	Room E222
08:00 - 16:30	Committee and Council Meetings*	Rooms
10:30 - 17:00	Registration Open	Ballroom Pre-function 1
12:00 - 17:00	Speaker Ready Room Open	Room E217
13:00 - 17:00	Hibbs Society Meeting	Room E219
17:00 - 18:00	Traveling Fellows Reception* (by invitation only)	Room E222
18:30 - 21:30	SRS Leadership Dinner* (by invitation only)	Offsite
WEDNESDAY, SEPTEMBER 17, 2025		
07:00 - 19:00	Registration Open	Ballroom Pre-function 1
07:00 - 18:30	Speaker Ready Room Open	Room E217
07:00 - 08:00	Women in Spine Breakfast*	Room E222
08:00 - 12:00	Pre-Meeting Course (PMC) | The Future is Now: New Technology in Our Practice ***Please note: Pre-Meeting Course 1* is a non-CME session***	Richardson Ballroom CD
12:00 - 12:15	Lunch Pick-Up	Ballroom Pre-function 1
12:15 - 13:15	LTS1: Lumbosacral Obliquity: A Case-Based Symposium LTS2: The Time Has Come to Transition from 2D to 3D in AIS Understanding and Treatment LTS3: How Much is Enough: Multirod Constructs and Pelvic Fixation in Adult Spinal Deformity	Richardson Ballroom AB Richardson Ballroom CD Room E219
13:30 - 15:00	Abstract Session 1 | Adolescent Idiopathic Scoliosis I	Richardson Ballroom CD
15:00 - 15:20	Refreshment Break*	Ballroom Pre-function 1
15:20 - 17:05	Abstract Session 2 | Adult Spinal Deformity I	Richardson Ballroom CD
17:20 - 19:00	Opening Ceremonies*	Richardson Ballroom AB
19:00 - 21:00	Welcome Reception*	Ballroom Pre-function 1
THURSDAY, SEPTEMBER 18, 2025		
07:00 - 16:00	Registration Open	Ballroom Pre-function 1
07:00 - 16:00	Speaker Ready Room Open	Room E217
07:00 – 08:00	L.E.A.D. SRS Alumni Breakfast* (by invitation only)	Room E222
08:00 - 09:50	Abstract Session 3 | Neuromuscular/Syndromic Deformity	Richardson Ballroom CD
09:50 - 10:10	Refreshment Break*	Ballroom Pre-function 1
10:10 - 12:15	Abstract Session 4 | Cervical Deformity, ASLS II Update, Harrington Lecture & Lifetime Achievement Award	Richardson Ballroom CD
12:15 - 12:30	Lunch Pick-Up	East Pre-function 3
12:30 - 14:00	Industry Workshops* (7 Concurrent Sessions)	Varied: see page 230
14:10 - 15:55	L.E.A.D. SRS Cohort Session* (by invitation only)	Room E222
14:10 - 15:55	Abstract Session 5A | Adult Spinal Deformity II Abstract Session 5B | Adolescent Idiopathic Scoliosis II: Newer Technology VBT + AI	Richardson Ballroom CD Richardson Ballroom AB
16:00 - 17:30	Industry Networking Sessions*	Varied: see page 230232
FRIDAY, SEPTEMBER 19, 2025		
07:00 - 17:30	Registration Open	Ballroom Pre-function 1
07:00 - 18:00	Speaker Ready Room Open	Room E217
07:00 - 08:00	Past Presidents' Breakfast* (by invitation only)	Room E222
08:00 - 09:50	Abstract Session 6 | Hibbs Award-Nominated Papers	Richardson Ballroom CD
09:50 - 10:10	Refreshment Break*	Ballroom Pre-function 1
10:10 - 11:50	Abstract Session 7 | Adult Spinal Deformity III and Presidential Address	Richardson Ballroom CD
12:15 - 13:30	Member Business Meeting (lunch pick-up at 11:50)	Room E219
12:15 - 12:45	Non-Member Information Session (lunch pick-up at 11:50)	Room E221AB
13:45 - 15:30	Abstract Session 8A | Early Onset Scoliosis Abstract Session 8B | Kyphosis, Spondylolysis + -listhesis, other Pathologies	Richardson Ballroom CD Richardson Ballroom AB
15:30 - 15:50	Refreshment Break*	Ballroom Pre-function 1
15:50 - 18:00	Abstract Session 9 | Adolescent Idiopathic Scoliosis III & Non-Operative Treatment Methods	Richardson Ballroom CD
18:30 - 19:30	President's Reception* (by invitation only)	Offsite
19:30 - 22:00	Farewell Reception* (ticket required)	Offsite
SATURDAY, SEPTEMBER 20, 2025		
07:00 - 08:00	SRS Board of Directors Meeting*	Room E222
07:30 - 11:30	Registration Open	Ballroom Pre-function 1
07:30 - 11:30	Speaker Ready Room Open	Room E217
08:00 - 10:10	Abstract Session 10 | Adult Spinal Deformity IV, Hibbs Award Presentation & Transfer of Presidency	Richardson Ballroom CD
10:10 - 10:30	Refreshment Break*	Ballroom Pre-function 1
10:30 - 12:15	Abstract Session 11 | Quality/Safety/Value/Complications & Miscellaneous (Spondy, Trauma, Tumor, etc.)	Richardson Ballroom CD
12:15	SRS 60th Annual Meeting Concludes	

**denotes non-CME Session/Activity*