Scoliosis Research Society presents

IMAST 2019 amsterdam

THE NETHERLANDS

26th International Meeting on Advanced Spine Techniques

July 17-20, 2019 • Amsterdam, the Netherlands

RAI Amsterdam Convention Centre

www.srs.org

FINAL PROGRAM

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WWW.SRS.ORG/IMAST2019

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GENERAL INFORMATION

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

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26TH IMAST VENUE

RAI Amsterdam Convention Centre
Europaplein 24, 101 GZ
Amsterdam, the Netherlands

FUTURE EDUCATIONAL EVENTS

54th Annual Meeting • September 18-21, 2019 • Montréal, Canada
Spine Deformity Solutions: A Hands-On Course • November 1-3, 2019 • Bangkok, Thailand
Current Concepts in Spine Deformity • December 13-14, 2019 • Tokyo, Japan
Current Concepts in Spine Deformity • February 27 - March 1, 2020 • Dubai, United Arab Emirates
27th IMAST • April 1-4, 2020 • Athens, Greece ***NEW DATES***

WELCOME

Dear Attendee,

We would like to personally welcome you to Amsterdam, the Netherlands for what promises to be a stimulating academic meeting. As a society we continue to make incredible strides in the field of spinal disorders with special regard to new technologies, and are excited to showcase these advancements at the 26th IMAST with our colleagues from around the world.

To continue providing a world-class meeting with the best educational value, we have streamlined the program, providing twin concurrent session tracks and general sessions to bring participants together each day. This year we will continue to incorporate opportunities for audience interaction within the sessions by allowing questions to be submitted electronically by the audience via the IMAST19 app; more information about using this feature in the app can be found on page 3.

We will also be introducing a new session format on Wednesday, July 17 from 19:15-20:30, called "Cases and Cocktails". It will be a great opportunity for attendees to discuss cases in small groups with an IMAST faculty member present at each table on innovative topics such as navigation, robotics and new approaches to common pathology. Libations will be served during this time so that all may enjoy a relaxed atmosphere during the discussions. Before the new session we encourage delegates to take part in the Welcome Reception in the exhibit hall.

The program will also include the popular complication and debates series, instructional course lectures (ICLs), and roundtable case discussions; all led by an international and multidisciplinary faculty. We encourage all delegates to come and experience the interactive and innovative program we have planned. Be sure to plan to stay through Saturday, as we have a full morning of general sessions including a video session, the always popular My Worst Complications, and Lunch with the Experts.

Along with this exciting program, Amsterdam is a must-see city with fascinating sites including the Rijksmuseum, Bloemenmarkt, Van Gogh Museum, canal cruises, and Anne Frank House. When you have time in your schedule, we invite you to take advantage of the opportunity to see what this great city has to offer!

We are both honored to serve as your IMAST Chair and Co-Chair this year. We want to thank those whose leadership and insights have created such a successful meeting, including Peter O. Newton, MD; Paul D. Sponseller, MD, MBA; Muharrem Yazici, MD; Todd J. Albert, MD; the IMAST Committee and SRS support staff.

With warmest personal regards,

Henry F. H. Halm, MD
IMAST Committee Chair

Han Jo Kim, MD
IMAST Committee Co-Chair

IMAST MOBILE APP

A mobile app will be available to all delegates during the 26th IMAST. The app is designed to enhance the attendee experience by providing all the information about IMAST in one convenient location that can be accessed from any smart phone or tablet with an internet connection.

TO DOWNLOAD THE 26TH IMAST MOBILE APP:

1. Search for IMAST19 in the App Store or Google Play Store and install
2. Open the downloaded app to begin using the app right away
3. To take full advantage of the app, login with your email address

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

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

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

ASK A QUESTION IN THE APP

Delegates will be able to ask questions, directly through the mobile app, during the all sessions at IMAST

To ask a question:

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

PARTICIPATE IN LIVE SESSION POLLS

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

Sessions Featuring live polls include:

-3A: Early Onset Scoliosis: Staying Current in 2019
-3B: Sagittal Balance: Angles Are Not Everything
-4B: Spinal Navigation: Increased Accuracy and Safety or Just Another Toy?
-5B: Disc Replacement in the Cervical Spine
-10: Challenges in Cervical Deformity: From Cradle to Cane

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

#SRSIMAST19

@srs_org @ScoliosisResearchSociety @srs_org /company/SRS_org

GENERAL MEETING INFORMATION

MEETING DESCRIPTION

IMAST gathers leading spine surgeons, innovative researchers and the most advanced spine technologies in an international forum. The IMAST program focuses on innovative and new methods/techniques for spinal pathology beyond deformity and is divided equally between adult deformity, pediatric deformity, degenerative lumbar and cervical pathology. Educational sessions include didactic presentations, panel discussions, papers and e-posters on current research, roundtable case discussions, debates, complication series and instructional course lectures, all lead by an international and multidisciplinary faculty. IMAST is sponsored by the Scoliosis Research Society (SRS).

LEARNING OBJECTIVES

Upon completion of IMAST, participants should be able to:

- Analyze spinopelvic parameters and apply them to a specific pathology
- Choose the appropriate growth-friendly technique for the pathology present in growing spines
- Describe how and strategize when to employ emerging techniques such as guidance and robotics
- Demonstrate potential techniques to avoid proximal junctional kyphosis
- Identify extended indications for Cervical Disc Replacement
- Recognize and mitigate hazards of radiation to the patient and surgical team

TARGET AUDIENCE

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

ACCME ACCREDITATION STATEMENT

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

CREDIT DESIGNATION

The Scoliosis Research Society (SRS) designates this live activity for a maximum of 16.5 *AMA PRA Category 1 Credit(s)*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

EACCME ACCREDITATION STATEMENT

The 26th International Meeting on Advanced Spine Techniques, Amsterdam, Netherlands, 17/07/2019-20/07/2019 has been accredited by the European Accreditation Council for Continuing Medical Education (EACCME®) with 14 European CME Credits (ECMEC®s). Each medical specialist should claim only those hours of credit that he/she actually spent in the educational activity.

Through an agreement between the Union Européenne des Médecins Spécialistes and the American Medical Association, physicians may convert EACCME® credits to an equivalent number of *AMA PRA Category 1 Credits*™. Information on the process to convert EACCME® credit to AMA credit can be found at www.ama-assn.org/education/earn-credit-participation-international-activities.

Live educational activities, occurring outside of Canada, recognised by the UEMS-EACCME® for ECMEC®s are deemed to be Accredited Group Learning Activities (Section 1) as defined by the Maintenance of Certification Program of the Royal College of Physicians and Surgeons of Canada.

DISCLOSURE OF CONFLICT OF INTEREST

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

FDA STATEMENT (UNITED STATES)

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

INSURANCE/LIABILITIES AND DISCLAIMERS

SRS will not be held liable for personal injuries or for loss or damage to property incurred by participants or guests at IMAST including those participating in tours and social events. Participants and guests are encouraged to take out insurance to cover loss incurred in the event of cancellation, medical expenses or damage to or loss of personal effects when traveling outside of their own countries. SRS cannot be held liable for any hindrance or disruption of IMAST proceedings arising from natural, political, social or economic events or other unforeseen incidents beyond its control. Registration of a participant or guest implies acceptance of this condition. The materials presented at this Continuing Medical Education (CME) activity are made available for educational purposes only. The material is not intended to represent the only, nor necessarily best, methods or procedures appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement or opinion of the faculty that may be helpful to others who face similar situations. SRS disclaims any and all liability for injury or other damages resulting to any individual attending a scientific meeting and for all claims that may arise out of the use of techniques demonstrated therein by such individuals, whether these claims shall be asserted by a physician or any other person.

CME INFORMATION

CME certificates will be available to pre-registered delegates upon the opening of the meeting at www.srs.org/imast2019/cme-evaluation. Delegates who registered onsite may access their certificates after August 14, 2019. Certificates are NOT available to delegates registering onsite until August 14.

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

GENERAL MEETING INFORMATION

Please note that certificates will not be mailed or emailed after the meeting. The online certificate program is the only source for this documentation. Please contact SRS at cme@srs.org for any questions. SRS asks that all CME certificates be claimed no later than December 31, 2019.

Certificates of attendance will be emailed to each delegate upon checking in at the registration desk at the meeting. Delegates will not receive a paper copy of the certificate in their registration materials. If you would like a paper copy, please stop at the printing stations before the close of the meeting. Evaluations are available to all attendees at the commencement of the meeting. Evaluations are available at www.srs.org/imast2019/ and the IMAST19 mobile app.

SESSION INFORMATION

INSTRUCTIONAL COURSE LECTURES (ICLS)

There are six (6) ICL sessions (Sessions 3A, 3B, 5A, 5B, 9A, 9B) highlighting the latest in surgical techniques and technologies. Each session will feature concurrent didactic sessions, programmed around thematic areas and will include a balanced discussion of multiple products, techniques and advances relevant to that topic.

DEBATES

There are two (2) sessions (Sessions 4A, 4B) featuring multiple debates per session. Expert faculty will be assigned to different treatment options available for specific conditions for each debate. Debate topics and faculty are listed in the Meeting Agenda.

CASE PRESENTATIONS

There are (3) Case Presentations sessions (Sessions 8A, 8B, 12); the sessions will highlight many of the significant sections that surgeons encounter when choosing which type of operation to perform. Expert faculty will present cases and encourage attendee participation in deciding how to optimize treatment for various scenarios. This will facilitate the insight and understanding that will ultimately benefit our patients.

E-POSTERS

There are over 100 E-Posters available for your review on the E-Poster kiosks in the Exhibit Hall. The E-Posters are also available on the USB included with your registration materials.

NEW THIS YEAR*
CASES & COCKTAILS SESSIONS

IMAST will kick off on Wednesday, July 17 with the Welcome Reception in the exhibit hall from 17:30-19:00 featuring beverages and heavy appetizers. The reception will be immediately followed by the new and highly anticipated Cases & Cocktails Concurrent Sessions from 19:15-20:30. Cases will be presented by faculty in four concurrent sessions. Attendees will have the opportunity to discuss cases in small groups with an IMAST faculty member present at each table. Each case presentation will be followed by small group discussions in which each table will debate the various treatment options and determine their action plan. Libations will continue to be served during this time so that all may continue to enjoy a relaxed atmosphere while discussing cases. All registered delegates are welcome and encouraged to attend and participate.

Cases & Cocktails Session Topics:

- PJK After Adult Deformity Surgery: How Can We Lower the Incidence?
- Current Pros and Cons of Robotics and Navigation of Today
- Tethering for Scoliosis: Does it Really Work and What are the Indications?
- Complex Pediatric Cases: Looking for a Solution

ADMISSION TO SESSIONS

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

LANGUAGE

Presentations and course materials will be provided in English.

NO SMOKING POLICY

Smoking is not permitted during any IMAST activity or event.

CELL PHONE PROTOCOL

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

EMERGENCY & FIRST AID

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

ATTIRE

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

LOST & FOUND

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

EXHIBITS & HANDS-ON WORKSHOPS (HOWS)

Many new spinal systems and products are on display in the Exhibit Hall. We encourage you to visit the exhibits throughout the meeting to learn more about the technological advances.

Each Hands-On Workshop (HOW) is supported and programmed by a single-supporting company and will feature presentations on topics and technologies selected by the corporate supporter. Breakfast, lunch, or beverages and snacks will be served in the back of each HOW room, as noted in the program.

Please note that HOWs are non-CME sessions.

INTERNET ACCESS

Wireless Internet access is available throughout the meeting space of the RAI Amsterdam.

To log on select…
Network = IMAST2019
Password = spine2019

Wireless Internet is supported, in part, by Zimmer Biomet.

GENERAL MEETING INFORMATION

PRINTING STATION

Delegates are welcome to use the complimentary printing stations, located next to the Exhibit Hall, to print their certificate of attendance and CME certificates (pre-registered delegates only; onsite registrants will have access to their certificates beginning August 14, 2019).

CHARGING STATION

Delegates are welcome to use the complimentary charging station in the Exhibit Hall to recharge smartphones and small tablets. Please do not leave your electronic devices or any personal belongings at the charging station unattended.

SPEAKER READY ROOM

Location: G102

Presenters may upload their PowerPoint presentations in the Speaker Ready Room located in G102 on the first floor (second level) of the RAI Amsterdam Convention Centre.

Hours:

Wednesday, July 17	12:00-20:30 (during Welcome Reception)
Thursday, July 18	7:30-18:00
Friday, July 19	7:30-17:00
Saturday, July 20	7:30-13:00

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

REGISTRATION DESK HOURS

Location: Auditorium Foyer – RAI Amsterdam Convention Centre, Ground Floor

Wednesday, July 17	14:00-19:00
Thursday, July 18	7:30-17:30
Friday, July 19	7:30-16:30
Saturday, July 20	8:30-11:00

ANNOUNCEMENT BOARD

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

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

VIDEO RECORDING PROHIBITED

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

VIDEO ARCHIVES

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

WELCOME RECEPTION

All registered delegates and registered guests are invited to pick up their registration materials and to attend the IMAST Welcome Reception on Wednesday, July 17 from 17:30-19:00. The reception will be hosted in the Exhibit Hall in the Auditorium & Onyx Foyer at the RAI Amsterdam Convention Centre, where beverages and light hors d' oeuvres will be served. There is no charge for registered delegates. Registered guests may purchase a Welcome Reception ticket for $20 USD at the time of registration. Dress for the Welcome Reception is business casual.

The Welcome Reception is supported, in part, by NuVasive.

We encourage delegates to take part in the new Cases & Cocktails Sessions immediately following the Welcome Reception on Wednesday, July 17 from 19:15-20:30.

Cases will be presented by faculty in four concurrent sessions. Attendees will have the opportunity to discuss cases in small groups with an IMAST faculty member present at each table. Each case presentation will be followed by small group discussions in which each table will debate the various treatment options and determine their action plan. Libations will continue to be served during this time so that all may continue to enjoy a relaxed atmosphere while discussing cases. All registered delegates are welcome and encouraged to attend and participate.

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- Tethering for Scoliosis: Does it Really Work and What are the Indications?
- Complex Pediatric Cases: Looking for a Solution

WELLNESS LOUNGE

The IMAST Wellness Lounge, located in the Exhibit Hall (booth #21) will be open during all exhibit hours to be used by the attendees to relax and recharge. The Wellness Lounge will include comfortable seating, healthy snacks and water. Make sure to stop by and "recharge" during the busy meeting.

SRS MEMBERSHIP INFORMATION

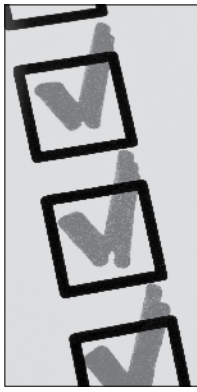
Prospective members and new candidate members are invited to attend a membership information session Friday, July 19 from 17:10-17:40 in Forum. Membership information will also be available at the SRS Membership Booth (booth #20) in the exhibit hall. Don't miss the opportunity to learn more about the SRS!

MEETING OVERVIEW

Subject to change

	Wednesday, July 17	Thursday, July 18	Friday, July 19	Saturday, July 20
Morning	8:00-12:00 Exhibit Set-up Board of Directors Meeting	7:30-17:30 Registration Open 8:00-9:00 Hands-on Workshops* *with Breakfast* 8:30-17:00 Exhibit Hall Open 9:00-11:15 General Session: Whitecloud Award Nominees & Presidential Address 11:15-11:50 Exhibit Viewing & Refreshment Break* 11:50-12:53 Concurrent Sessions	7:30-16:30 Registration Open 8:00-9:00 Hands-on Workshops* *with Breakfast* 8:30-15:45 Exhibit Hall Open 9:00-10:10 Concurrent Sessions 10:10-10:40 Exhibit Viewing & Refreshment Break* 10:40-12:05 Concurrent Sessions	8:30-11:00 Registration Open 9:00-10:00 General Session 10:00-10:15 Refreshment Break 10:15-11:15 General Session 11:15-11:30 Walking Break & Boxed Lunch Pick Up*
Afternoon	12:00-16:00 Exhibit Set-up 12:00-14:00 Exhibitor Registration Open 14:00-19:00 Delegate Registration Open	13:05-14:05 Hands-On Workshops* *with Lunch* Exhibit Viewing & Lunch* 14:10-15:10 Concurrent Sessions 15:20-16:20 Concurrent Sessions 16:20-16:50 Exhibit Viewing & Refreshment Break* 16:50-17:50 Concurrent Sessions	12:15-13:15 Hands-On Workshops* *with Lunch* Exhibit Viewing & Lunch* 13:25-14:10 Concurrent Sessions 14:10-14:50 Exhibit Viewing & Refreshment Break* 14:50-15:50 Concurrent Sessions 16:00-17:00 General Session 17:10-17:40 SRS Membership Info Session	11:30-13:00 General Session 13:00 Adjourn
Evening	17:30-19:00 Welcome Reception* *in the Exhibit Hall* 19:15-20:30 Cases & Cocktails Discussion Sessions- NEW SESSION	18:00-19:00 Hands-On Workshops* *with snacks & refreshments* Free Evening	17:30-19:00 Faculty Reception – *Invitation Only* Free Evening	

**Denotes non-CME session*



EVALUATIONS

WE NEED YOUR FEEDBACK!

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

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

On the App: *Session Evaluations:*
1. Select "Agenda" from the home screen
2. Select the Session you want to evaluate
3. Scroll to the bottom of the session description to find the evaluation

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

Online: www.srs.org/imast2019/cme-evaluation

MEETING SPACE FLOOR PLAN

GROUND FLOOR

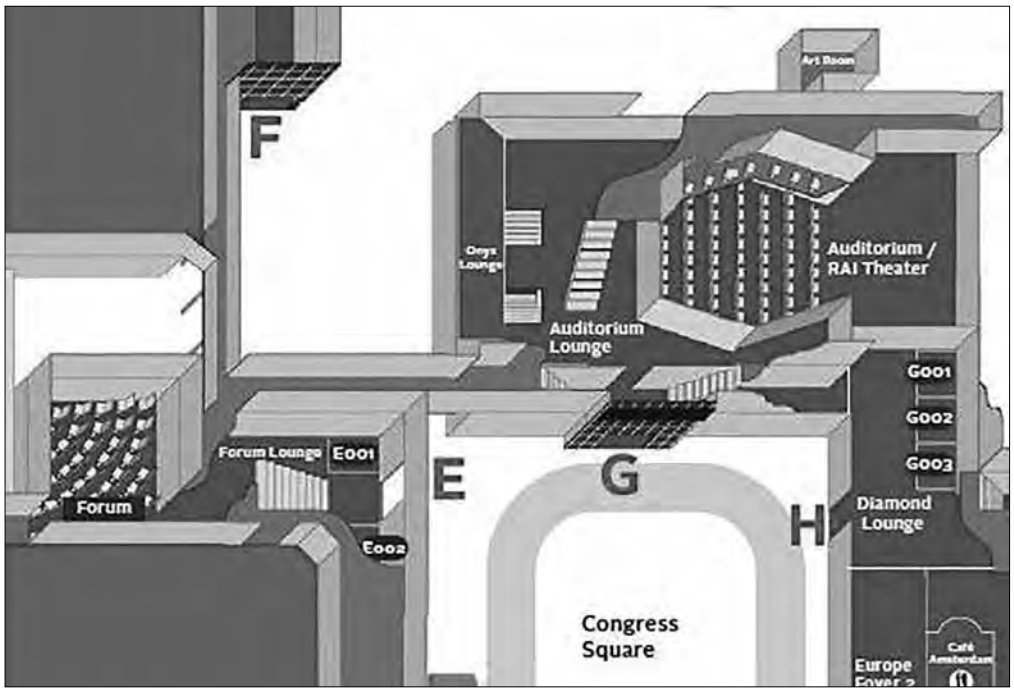
Registration: Auditorium Foyer

Exhibit Hall: Auditorium & Onyx Lounge

General/Concurrent Sessions: Auditorium

Concurrent Sessions: Forum

Meeting Rooms: E001 & E002

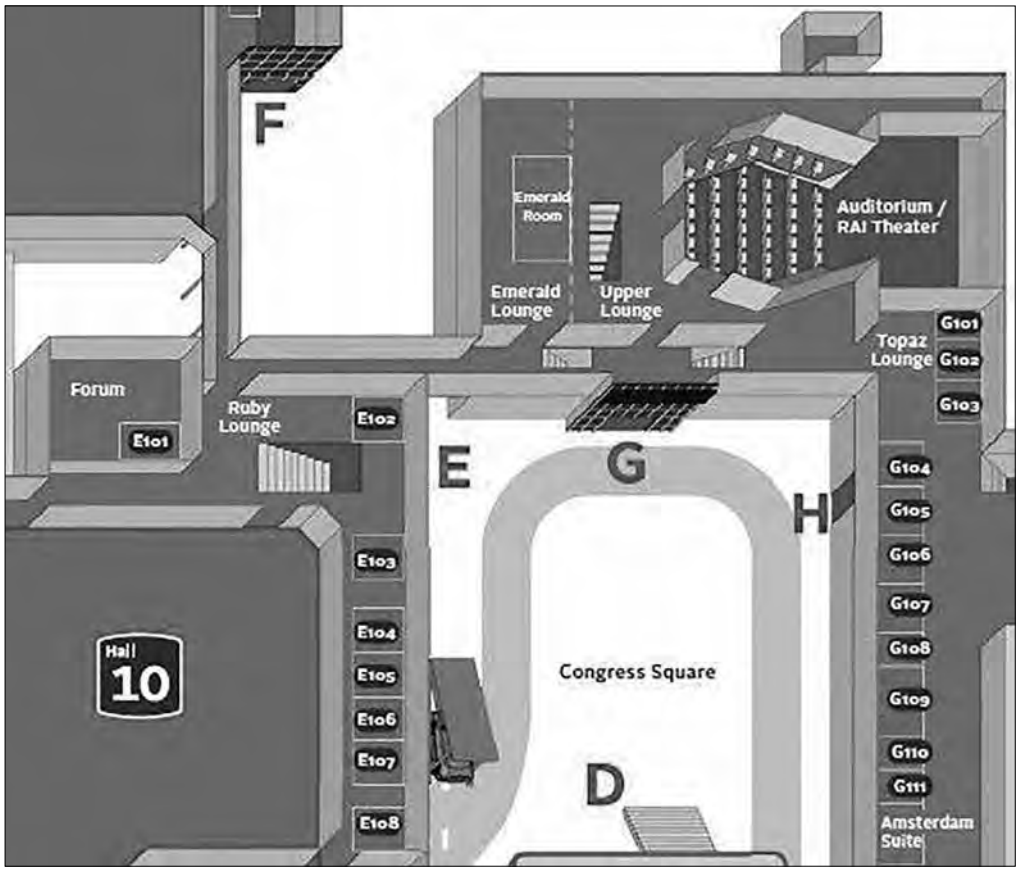


FIRST FLOOR

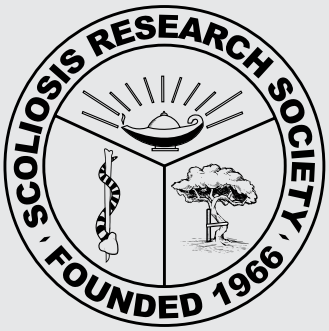
Speaker Ready Room: G102

Cases & Cocktails Sessions: G103, G104, G105, G106

Hands-On Workshops: G103, G104, G105, G106, G107



DISCLOSURES



The Scoliosis Research Society gratefully acknowledges K2M for their grant support of the IMAST Live Webcast

DISCLOSURES

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Paul D. Sponseller, MD, MBA	United States	DePuy Synthes (a, g); Globus Medical (g); JBJS (e); OrthoPediatrics (g)
Muharrem Yazici, MD	Turkey	No Relationships
IMAST COMMITTEE (IF NOT LISTED ABOVE)		
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Samuel K. Cho, MD	United States	Corentec (b); Globus Medical (b); Zimmer Biomet (b)
Jeffrey L. Gum, MD	United States	No Relationships
Munish C. Gupta, MD	United States	AOSpine-Paid to institution for fellowship (a); DePuy Synthes (b, e, g); Innomed (g); Johnson & Johnson (c); Medtronic (b, e); OMeGA-Paid to institution for fellowship (a); perForm Biologics (b, c); Proctor & Gamble (c)
Henry F.H. Halm, MD, PhD	Germany	NuVasive (b, g); Silony Medical (a, b)
Hamid Hassanzadeh, MD	United States	4Web (b, c); DePuy Synthes (b); Medtronic (b, d); NuVasive (b, c, d); Orthofix (a, d); Pfizer (a, b, e)

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DISCLOSURES

Han Jo Kim, MD	United States	AO Spine (e); ISSGF (a); K2M (g); Zimmer Biomet (g)
Tyler Koski, MD	United States	DePuy Synthes (b); Medtronic (b, g); NuVasive (b, c, g); Spinewave (g)
Ronald A. Lehman Jr., MD	United States	No Relationships
Scott John Luhmann, MD	United States	Globus Medical (g); Medtronic (b, d, g); OrthoPediatrics (b, d); Stryker Spine (b, d, g); Wishbone Medical (b); Wolters Kluwer (g)
Hossein SM Mehdian, MD, FRCS	United Kingdom	No Relationships
Stefan Parent, MD, PhD	Canada	Canadian Institute of Health Research (a); DePuy Synthes (a, b, g); EOS Imaging (a, b, c); K2M (a, b); Les Fonds de la recherche en santé du Québec (a); Medtronic (a); Orthopaedic Research and Education Foundation (a); Setting Scoliosis Straight Foundation (a); Spinologics Inc. (c); The Canada Foundation for Innovation (a); The Natural Sciences and Engineering Research Council of Canada (a)
Michael Ruf, MD	Germany	No Relationships
Rick C. Sasso, MD	United States	Medtronic (g); NuVasive (b)
Xu Sun, MD	China	No Relationships
Georgios A. Vastardis, MD, PhD	Greece	No Relationships
Jim A. Youssef, MD	United States	CTL (b, g); Globus Medical (a); Medtronic (a); Nuvasive (a, b, d, g); Providence Medical Technology (a, b); Seaspine (a, g); Vertiflex (a)
CME COMMITTEE (IF NOT LISTED ABOVE)		
Michael C. Albert, MD	United States	AMB Medical (b, e); OrthoPediatrics (b)
James T. Bennett, MD	United States	No Relationships
Woojin Cho, MD, PhD	United States	No Relationships
David H. Clements III, MD	United States	DePuy Synthes (a, b, d); NuVasive (a, b, d, g)
Ujjwal K. Debnath, MD, FRCS	India	No Relationships
Lori A. Dolan, PhD	United States	No Relationships
Bhavuk Garg, MBBS, MS, FACS	India	No Relationships
Ryan C. Goodwin, MD	United States	K2M (b); OrthoPediatrics (b); Stryker Spine (b)
Robert P. Huang, MD	United States	No Relationships
William F. Lavelle, MD	United States	4-Web (c); Cardan Robotics (c); DePuy Synthes (a); Empirical Spine (a); Innovasis (e); K2M (a); Medtronic (a); Prosydian (c, e); Signus, Inc. (a); Spinal Kinetics, Inc. (a); Vertebral Technologies, Inc. (a)
Praveen V. Mummaneni, MD	United States	AO Spine (a); DePuy Synthes (b, g); Globus Medical (b); NREF (a); Spineart (g); Spinicity/ISD (c); Springer publishers (g); Stryker Spine (b); Thieme Publishing (g)
Paul Park, MD	United States	Allosource (b); Globus Medical (b, g); Medtronic (b); NuVasive (b, g); Pfizer, Vertex (a)
Anthony M. Petrizzo, MD	United States	Altus Spine (b); CTL Medical (b); Stryker Spine (b)
Vishwas R. Talwalkar, MD	United States	No Relationships
Burt Yaszay, MD	United States	Biogen (b); DePuy Synthes (a, b, d, e); Globus Medical (g); K2M (a, b, d, e, g); Mazor Robotics (a); NuVasive (a, b, d, e, g); OrthoPediatrics (a, g); Stryker Spine (a, d)
PROGRAM COMMITTEE (IF NOT LISTED ABOVE)		
Lindsay M. Andras, MD	United States	Eli Lilly (b); Journal of Pediatric Orthopaedics (e); Medtronic (b, d); NuVasive (b, d); Orthobullets (g); Zimmer Biomet (b, d);
Keith Bachmann, MD	United States	NuVasive (g)
Sébastien Charosky, MD	France	Kisco (b); Medtronic (b)
Eugenio Dema, MD	Italy	No Relationships
Joseph P. Gjolaj, MD	United States	DePuy Synthes (b)

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DISCLOSURES

Stuart H. Hershman, MD	United States	DePuy Synthes (a, b, d); NuVasive (a)
Michael P. Kelly, MD, MS	United States	No Relationships
Deniz Konya, MD	Turkey	No Relationships
Stephen J. Lewis, MD	Canada	AO Spine (a, d); DePuy Synthes (d); L&K (b, d); Medtronic (d); Stryker Spine (b, e)
Isador H. Lieberman, MD, FRCS(C)	United States	Globus Medical (b); Mazor Robotics (b); Medtronic (b); Safe Orthopaedics (b); SI Bone (b); Stryker Spine (b)
Firoz Miyanji, MD, FRCS(C)	Canada	DePuy Synthes (a); OrthoPediatrics (b)
Gregory M. Mundis Jr., MD	United States	Allosource (b, e); Global Spine Outreach (e); K2M (b, c, g); NuVasive (b, g); San Diego Spine Foundation (e); Seaspine (b, e); Viseon(b, c)
Joshua S. Murphy	United States	DePuy Synthes (b); Medicrea (b); OrthoPediatrics (b)
Dominique A. Rothenfluh, MD, PhD	United Kingdom	DePuy Synthes (d); Medtronic (d, e); NuVasive (b, d)
Amer F. Samdani, MD	United States	DePuy Synthes (b); Ethicon (b); Globus Medical (b); NuVasive (b, g); Stryker Spine (b); Zimmer Biomet (b, g)
John T. Smith, MD	United States	DePuy Synthes (b); Globus Medical (b, g); NuVasive (b); SpineGuard (b); Wishbone (b)
Nicholas Spina, MD	United States	No Relationships
PROGRAM REVIEWERS (IF NOT LISTED ABOVE)		
D. Greg Anderson, MD	United States	DePuy Synthes (b); Integrity Spine (b); K2M (b)
Ravi S. Bains, MD	United States	No Relationships
Saumyajit Basu, MD, FRCS	India	No Relationships
Shay Bess, MD	United States	Allosource (a, b); DePuy Synthes (a); EOS Imaging (b); Globus Medical (a); K2M (a, b, d, e); Medtronic (a); Misonix (b); NuVasive (a); Orthofix (a)
Patrick J. Cahill, MD	United States	Biogen, Inc. (b); Children's Spine Study Group (a); NuVasive (b); Setting Scoliosis Straight Foundation (a)
Michael S. Chang, MD	United States	BK (b); Orthofix (b); Spinewave (b); Stryker Spine (b)
Vedat Deviren, MD	United States	Alphatec Spine (b); AO Spine (a); AOA (a); Guidepoint (b); Medicrea (b); NuVasive (a, b, g); Pfizer (b); Seaspine (b); Zimmer Biomet (b)
Bassel G. Diebo, MD	United States	No Relationships
Charla R. Fischer, MD	United States	Stryker Spine (b)
Sumeet Garg, MD	United States	No Relationships
Yong Hai, MD, PhD	China	No Relationships
Darrell S. Hanson, MD	United States	Alphatec Spine (d); DePuy Synthes (d, e, g); Medtronic (d);
Sajan K. Hegde, MD	India	Globus Medical (a, b, d, g)
Charles E. Johnston, MD	United States	Elsevier (g); Medtronic (g)
Khaled M. Kebaish, MD, FRCS(C)	United States	DePuy Synthes (b, g); K2M (b, g); Orthofix (g); SpineCraft (g)
Hak-Sun Kim, MD	Korea, South	No Relationships
John P. Lubicky, MD	United States	No Relationships
Jean-Marc Mac-Thiong, MD, PhD	Canada	DePuy Synthes (a); Medline (a); Medtronic (a); Spinologics (c, e, g)
Ahmad Nassr, MD	United States	AO Spine (a); DePuy Synthes (b); Pfizer (a); Premia Spine (a)
Colin Nnadi, FRCS, MBBS	United Kingdom	No Relationships
Bangping Qian, MD	China	No Relationships
Cristina Sacramento Dominguez, MD, PhD	Spain	No Relationships
Ricardo Acacio Santos, MD	Brazil	No Relationships

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DISCLOSURES

Dilip K. Sengupta, MD	United States	CTL Medical Inc. (b); Globus Medical (b, c, g)
Ahmed M. Shawky Abdelgawaad, MD	Germany	No Relationships
Osamu Shirado, MD, PhD	Japan	No Relationships
Surya Prakash Rao Voleti, MBBS, MS	India	No Relationships
Kota Watanabe, MD, PhD	Japan	No Relationships
Yat Wa Wong, FRCS, MBBS	China	No Relationships
FACULTY (IF NOT LISTED ABOVE)		
Kariman Abelin-Genevois, MD, PhD	France	Implanet (a); Medicrea (b); Medtronic (f)
Behrooz A. Akbarnia, MD	United States	DePuy Synthes (g); K2M (g); NociMed (c); NuVasive (a, b, c, g)
Ahmet Alanay, MD	Turkey	DePuy Synthes (a); Medtronic (a)
René M. Castelein, MD, PhD	Netherlands	K2M (a, d)
Michael B. Fehlings, MD, PhD, FRCSC, FACS	Canada	Fortuna Fix (b)
Azmi Hamzaoglu, MD	Turkey	Medtronic (b)
Ian J. Harding, BA, FRCS(Orth)	United Kingdom	Medtronic (b, g)
Ilkka J. Helenius, MD, PhD	Finland	K2M (a); Medtronic (a, b, e)
Philip Horsting, MD	Netherlands	No Relationships
Dezsoe J. Jeszenszky, MD, PhD	Switzerland	DePuy Synthes (b, g); Medacta (b, g)
Heiko Koller, MD	Germany	No Relationships
Moyo C. Kruyt, MD, PhD	Netherlands	No Relationships
Lawrence G. Lenke, MD	United States	AO Spine (g); broadwater (g); EOS Imaging (g); Evans Family Donation (g); Fox Family Foundation (g); Medtronic (b, g); Quality Medical Publishing (g); Scoliosis Research Society (g); Setting Scoliosis Straight Foundation (g); Stryker Spine (g)
Ulf R. Liljenqvist, MD	Germany	DePuy Synthes (d); Silony (b)
Baron S. Lonner, MD	United States	Apifix (b); DePuy Synthes (a, b, d, e, g); John and Marcella Fox Fund (a); K2M (d); OREF (a); Paradigm Spine (c, g); Spine Search (c, e); Unyq Align (b); Zimmer Biomet (b, g)
Bernhard Meyer, MD	Germany	DePuy Synthes (a, b); Icotec (a, b, e); Medtronic (a, b, e); Relievant (a, b); Spineart (b, e, g); Ulrich Medical (a, b, e)
Lotfi Miladi, MD	France	Euros Company (g)
Ibrahim Obeid, MD, MS	France	Alphatec Spine (g); Clariance (g); DePuy Synthes (a, b); Medtronic (b); Spineart (g)
Yong Qiu, MD	China	No Relationships
Pierre Roussouly, MD	France	smaio (b); Sylorus Robotics (c)
Yu-Mi Ryang, MD	Germany	AO Spine (d); Brainlab (b); DePuy Synthes (d); Icotec (b, d); Medtronic (d); Spineart (d); Ulrich Medical (d); Zeiss Medical (d)
Christopher I. Shaffrey, MD	United States	EOS Imaging (b); Medtronic (b, g); NuVasive (b, c, g); Zimmer Biomet (g)
Clément Silvestre, MD	France	No Relationships
Justin S. Smith, MD, PhD	United States	AlloSource (b); AO Spine (a); Cerapedics (b); DePuy Synthes (a); K2M (b); NREF (a); NuVasive (b); Zimmer Biomet (b, g)
Maarten Spruit, MD, PhD	Netherlands	No Relationships
Fernando Techy, MD	United States	Amedica (g); AO Spine (a); Orthofix (a, b); SI Bone (a); Spine Wave (b); Spine Way (b)
Juan S. Uribe, MD	United States	Misonix (b); NuVasive (a, b, c); SI Bone (b)
Luiz Roberto Vialle, MD	Brazil	No Relationships

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DISCLOSURES

Sebastiaan P. J. Wijdicks, MD	Netherlands	No Relationships
AUTHORS (IF NOT LISTED ABOVE)		
Mark F. Abel, MD	United States	No Relationships
Jean-Jacques Abitbol, MD	United States	St.Teresa (c, e)
Edem J. Abotsi, BA	United States	No Relationships
Kadir Abul, MD	Turkey	No Relationships
Emre R. Acaroglu, MD	Turkey	AO Spine (d, e); DePuy Synthes (a); IncredX (c); Medtronic (a)
Owoicho Adogwa, MD	United States	No Relationships
Aakash Agarwal, PhD	United States	Joimax (g); Paradigm Spine (g); Spinal Balance (b)
Anand K. Agarwal, MD	United States	Joimax (g); Osteonovus (c); Paradigm Spine (g); Spinal Balance (c)
Naveen Agrawal, MS	India	No Relationships
Alaaeldin (Alaa) Azmi Ahmad, MD	Palestine	No Relationships
Fahad Ahmed, BS	Czech Republic	DiscitisDx, Inc. (c)
Remi M. Ajiboye, MD	United States	No Relationships
Tsutomu Akazawa, MD, PhD	Japan	No Relationships
Keyur Akbari	India	No Relationships
Yunus Emre Akman, MD	Turkey	No Relationships
Mona A. Al Faraidy, MD, MBBS	Saudi Arabia	No Relationships
Todd Alamin, MD	United States	DePuy Synthes (b); Empirical Spine (b, c); Globus Medical (b, g); Medtronic (e)
Haddy Alas, BS	United States	No Relationships
Benjamin A. Alman, MD	United States	No Relationships
Mohammed Ali Alvi, MD, MBBS	United States	No Relationships
Abdulmajeed Alzakri, MD, MS	Saudi Arabia	No Relationships
Dominic Amara, BS	United States	No Relationships
Terry D. Amaral, MD	United States	No Relationships
Christopher P. Ames, MD	United States	Biomet Zimmer (b); Biomet Zimmer Spine (g); DePuy Synthes (b); DePuy Synthes (g); DePuy Synthes (g); Global Spine Analytics (g); ISSG (g); ISSG (g); K2M (b); K2M (g); Medicrea (b); Medicrea (g); Medtronic (b); Next Orthosurgical (g); NuVasive (g); Operative Neurosurgery (g); SRS (g); Stryker Spine (b); Stryker Spine (g); Titan Spine (b, g)
Neel Anand, MD	United States	Bonovo (c); Globus Medical (c, e, g); GYS Tech (b, c); Medtronic (b, d, g); Paradigm Spine (c); Spinal Balance (b, c, e); Theracell (c, e)
Mikkel Ø. Andersen, MD	Denmark	No Relationships
Lisa Marie Andre, RN	United Kingdom	No Relationships
Christopher J. Andrecovich, MS	United States	No Relationships
Jessica Andres-Bergos, PhD	United States	No Relationships
Bryan Ang, BS	United States	No Relationships
Audrey Angelliaume, MD, MD Sc	France	No Relationships
M. Darryl Antonacci, MD	United States	Globus Medical (b, e)
Ariella Applebaum, BS	United States	No Relationships
Vahid Arbabi, PhD	Netherlands	No Relationships
Hideyuki Arima, MD, PhD	Japan	No Relationships
Can Berk Asaroglu	Turkey	No Relationships
Anthony L. Asher, MD	United States	Globus Medical (b); Stryker Spine (b)

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DISCLOSURES

Marc Asher, MD	United States	No Relationships
Aaron M. Atlas, BS	United States	No Relationships
Carl-Eric Aubin, PhD, ScD (h.c.); P.Eng.	Canada	Medtronic (a, b); Rodin4D (g)
Delphine Aubin	Canada	No Relationships
Guillaume Authier	France	No Relationships
Rachel Axman	United States	No Relationships
Binnaz Ay, MD	Turkey	No Relationships
Reed Ayers, PhD, MS, BS	United States	Verkko Biomedical LLC (c, f, g)
Selim Ayhan, MD	Turkey	No Relationships
Ethan W. Ayres, MPH	United States	No Relationships
Salam Bachour, BS	United States	No Relationships
Ryan K. Badiee, BS	United States	No Relationships
Vigneshwara M. Badikillaya, MS	India	No Relationships
Hyun W. Bae, MD	United States	DePuy Synthes (b); LDR Spine (b); Medtronic (a, b); NuVasive (b); OrthoRebirth (a); Prosidyan (e); Stryker Spine (b); Zimmer Biomet (b)
Sinan Bahadir, MD	Turkey	No Relationships
Howard Bailey, BS	United States	No Relationships
Keith Baldwin, MD	United States	JBJS reviews (e); Pfizer (c); Simple Therapy (g); Synthes (b)
Tomohiro Banno, MD, PhD	Japan	No Relationships
Mathieu Bannwarth, MD	United States	No Relationships
Hongda Bao, MD, PhD	China	No Relationships
Joseph Barbera, MD	United States	No Relationships
Jonathan Baré, MBBS, FRACS	Australia	360KS (b, c, d); Corin (b, c, d, e)
Carrie E. Bartley, MA	United States	No Relationships
Suriya Baskar, BA	United States	No Relationships
William Paul Bassett, MD	United States	No Relationships
Tracey P. Bastrom, MA	United States	No Relationships
Griffin R. Baum, MD, MS	United States	No Relationships
Marie Beausejour, PhD	Canada	No Relationships
Rachid Bech-Azeddine, PhD	Denmark	No Relationships
James D. Beckman, MD	United States	No Relationships
Phillip H. Behrens, MD	United States	No Relationships
John A. Bendo, MD	United States	No Relationships
Nicholas M. Benson, PhD	United States	FundRx (e); Medtronic (f)
Adam Benton, BA (Hons) BMBS	United Kingdom	Infinity Health Limited (c, f)
Ryan J. Berger, MD	United States	KCI (g); Lineage Medical (f)
Jason Bernard, MD, FRCS	United Kingdom	Globus Medical (d); K2M (a); Stryker Spine (a, d)
David N. Bernstein, MBAMA	United States	No Relationships
Sigurd H. Berven, MD	United States	AO Spine (a, e); Globus Medical (c, e); Green Sun Medical (c, e); Medtronic (b, e, g); Stryker Spine (b, e, g)
Randal R. Betz, MD	United States	Abyrx (c); ApiFix (b, c); DePuy Synthes (b, d, g); Electrocore (c); Globus Medical (b, d, g); Medovex (c); Orthobond (c); SpineGuard (b, c, g); Thieme Publishing (g); Wishbone Medical (b, c)
George A. Beyer, MS	United States	No Relationships

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DISCLOSURES

Nitin N. Bhatia, MD	United States	Alphatec Spine (g); Difusion (e); Orthofix (b); Seaspine (b, g); Stryker Spine (g); Zimmer Biomet (g)
Christof Birkenmaier, MD	Germany	Discitis Dx (b, c); EOS Imaging (c)
Tim Bishop, MBBS, FRCS	United Kingdom	No Relationships
Erica F. Bisson, MD, MPH	United States	nView (b, c)
Benjamin Blondel, MD, PhD	France	Implanet (b); Medicrea (b); Vexim (b)
Oheneba Boachie-Adjei, MD	Ghana	K2M (a, b, e, g); WEIGAO (b, d)
Nathan Boes, MD	United States	No Relationships
Michael Bohl, MD	United States	No Relationships
Michiel E.R. Bongers, MD	United States	No Relationships
Cole Bortz, BA	United States	No Relationships
Houssam Bouloussa, MD, MS	United States	No Relationships
Nathalie Bourassa	Canada	Medtronic (f)
Kristina C. Brady, Au.D	United States	No Relationships
Keith H. Bridwell, MD	United States	No Relationships
Samuel H. Brill	United States	No Relationships
Rob Cornelis Brink, MD	Netherlands	No Relationships
Stig Brorson, PhD, DMSc	Denmark	No Relationships
Avery Brown, BS	United States	No Relationships
Morgan Brown, MS	United States	No Relationships
Colin E. Bruce, FRCS	United Kingdom	No Relationships
Barry R. Bryant, BS	United States	No Relationships
Aaron J. Buckland, MBBS, FRACS	United States	EOS Imaging (b); K2M (b); NuVasive (b)
Brandon Bucklen, PhD	United States	Globus Medical (c, f)
Joshua Bunch, MD	United States	Bioventus (b)
Morenikeji Ayodele Buraimoh, MD	United States	No Relationships
Shane Burch, MD, MS, FRCS(C)	United States	Medtronic (b)
Evalina L. Burger, MD	United States	Medacta (b); Medicrea (a, b); Phizer (a); Spinal Kinetics (a); Spinewave (e)
Corey Burke, MD	United States	No Relationships
Marco D. Burkhard, MD	Switzerland	No Relationships
John Kenneth Burkus, MD	United States	No Relationships
Douglas C. Burton, MD	United States	Bioventus (a); DePuy Synthes (a, b); International Spine Study Group (e); Pfizer (a); Scoliosis Research Society (e); University of Kansas Physicians, Inc (e)
Mohamad Bydon, MD	United States	No Relationships
Alfonso Caetta, BS	United States	No Relationships
Christopher MJ Cain, MD, PhD	United States	DePuy Synthes (b, g); Medtronic (a); Orthofix (a); Pfizer (a); SeaSpine (b, c); SI Bone (a); Spinal Kinetics (a)
Jael Camacho, MD	United States	No Relationships

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DISCLOSURES

Frank P. Cammisa Jr, MD	United States	4WEB Medical (a, b); 7D Surgical, Inc. (a); Beatrice & Samuel A. Seaver Foundation (a); Bonovo Orthopedics, Inc. (g); Centinel Spine, Inc. (a); DePuy Synthes (a); Healthpoint Capital Partners, LP (e, g); ISPH II, LLC (g); Ivy Healthcare Capital Partners, LLC (g); Liventa Bioscience (g); Mallinckrodt Pharmaceuticals (a); NuVasive (a, b); Orthobond Corporation (e, g); Paradigm Spine (a, e, g); Pfizer, Inc. (a); Spinal Kinetics, Inc. (a); Tissue Differentiation Intelligence, LLC (g); VBVP VI, LLC (c); Vertical Spine, LLC (b, g); Viscogliosi Brothers, LLC (g); Woven Orthopedic Technologies (a, e, g)
Joseph Canner, MHS	United States	No Relationships
William A. Cantrell, BS	United States	No Relationships
Manu Capoor, MD	United States	Discitis Dx Inc. (a, c)
Mathilde Carignan, BS	Canada	No Relationships
Brandon B. Carlson, MD, MPH	United States	No Relationships
Alissa Carnelian, AuD	United States	No Relationships
Leah Yacat Carreon, MD, MS	United States	No Relationships
Frank S. Cautela, BS	United States	No Relationships
Michele Alessandro MA Cavallo, MD	Italy	No Relationships
Barbaros O. Cebeci	Turkey	No Relationships
Pelin Celiker, BS	United States	No Relationships
Meghan Cerpa, BS, MPH	United States	No Relationships
Janet L. Cerrone, PA-C	United States	No Relationships
Shelby P. Cerza, MA	United States	No Relationships
Vincent Challier, MD	France	No Relationships
Andrew K. Chan, MD	United States	Orthofix (a)
Andrew Y. Chan, MD	Canada	No Relationships
Chris Yin Wei Chan, MD, MS	Malaysia	No Relationships
Dong-Gune Chang, MD, PhD	Korea, South	No Relationships
Stuart Changoor, MD	United States	No Relationships
Chong Chen, MD	China	No Relationships
Lu Chen, MD	China	No Relationships
Zhongqiang Chen, MD	China	No Relationships
Ivan Cheng, MD	United States	Cytonics (c); Globus Medical (g); Notogen (b); NuVasive (b, c, g); SpinalCyte (c); Spine Innovations (c); Spine Wave (g); SpineCraft (b); Stryker Spine (b)
Jack CY Cheng, MD	Hong Kong	No Relationships
Jason Pui Yin Cheung, MBBS, FRCS, MS	Hong Kong	No Relationships
Robert H. Cho, MD	United States	DePuy Synthes (b, e); Ergobaby Inc. (e); NuVasive (b)
Seong Jin Cho, MD	Korea, South	No Relationships
Sung Hoon Choi, MD	Korea, South	No Relationships
Dean Chou, MD	United States	Globus Medical (b, g); Medtronic (b)
Katrina F. Chu, MD	United States	No Relationships
Winnie Chiu Wing Chu, MD	Hong Kong	No Relationships
Andrew Chung, DO	United States	No Relationships
Chun Kee Chung, MD, PhD	Korea, South	No Relationships
Weng Hong Chung, MD, MS	Malaysia	No Relationships

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DISCLOSURES

Ryan Coghlan, MS	United States	Shriners Hospital (f, g); Theracon (b)
David B. Cohen, MD, MPH	United States	No Relationships
Tyler S. Cole, MD	United States	No Relationships
Teresa L. Collins-Jones, PhD	United States	No Relationships
Hui Cong, MS	China	No Relationships
Ting Cong, MD	United States	No Relationships
Ian Corcoran-Schwartz, MD	United States	No Relationships
Domagoj Coric, MD	United States	Globus Medical (b, g); Integrity Implants (b, g); Medtronic (b, g); Premia Spine (c); RTI Surgical (g); Spine Wave (b, c, g); Stryker Spine (b, g)
Michael F. Coscia, MD	United States	DiscitisDX, Inc (b, c);
Marine Coste, BA	United States	BGF WLD Healthscience (c); Essilor (c); Fresenius (c); ISHS ETF NASDAQ Biotechnology (c); Johnson&Johnson (c); Korian (c); Orpea (c); Robeco Sust Healthy Living (c); Roche Holdi (c); Sanofi (c); Shire (c)
Dennis G. Crandall, MD	United States	Auctus (e); Handel (c); Medtronic (g); Spinewave (b, g)
Charles H. Crawford III, MD	United States	Alphatec Spine (g); DePuy Synthes (b); Medtronic (b, e); NuVasive (b)
Travis S. CreveCoeur, BS	United States	No Relationships
Alberto J. Criado, MD	United States	No Relationships
Madeline Cross, MPH	United States	No Relationships
Laury A. Cuddihy, MD	United States	No Relationships
Francesco Cultrera, MD	Italy	No Relationships
Matthew E. Cunningham, MD, PhD	United States	DePuy Synthes (d); K2M (a, d); NuVasive (b); RTI (a)
Somashekar D., MBBS, MS	India	No Relationships
Benny T. Dahl, MD, PhD, DMSci	United States	K2M (a, d, e)
Andrew T. Dailey, MD	United States	AO Spine (d); K2M (a); Zimmer Biomet (b)
Cecilia L. Dalle Ore, BS	United States	No Relationships
Alan H. Daniels, MD	United States	EOS Imaging (b); Orthofix (a, b); Spineart (b); Stryker Spine (b)
Christy L. Daniels, MS	United States	No Relationships
Qurratul-Ain Dar, BS	United States	No Relationships
Roy Davidovitch, MD, MD	United States	Medtronic (b); Radlink (g); schaerer medical (g)
Neil T. Davidson, FRCS, Consultant	United Kingdom	No Relationships
Manish De, MD, MBBS	India	No Relationships
Bernardo de Andrada, MD	United States	No Relationships
Pasquale De Bonis, MD, PhD	Italy	No Relationships
Arthur de Gast, MD, PhD	Netherlands	No Relationships
Federico De Iure, MD	Italy	No Relationships
Luuk de Klerk, MD, PhD	Netherlands	No Relationships
Joanne Dekis, MD	United States	No Relationships
Elizabeth A. Demers Lavelle, MD	United States	4-Web (c); Cardan Robotics (c); DePuy Synthes (a); Empirical Spine (a); Innovasis (e); K2M (a); Medtronic (a); Prosydian (c, e); Signus, Inc. (a); Spinal Kinetics, Inc. (a); Vertebral Technologies, Inc. (a)
Satoru Demura, MD	Japan	No Relationships
Anton Denisov, MD	Russia	No Relationships
John M. DePasse, MD	United States	No Relationships
Peter B. Derman, MD, MBA	United States	No Relationships
Christopher J. DeWald, MD	United States	Alphatec Spine (c); K2M (a, d); Kisco (e); Medtronic (c, d)

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DISCLOSURES

Nicholas R. Dick, BS	United States	No Relationships
Jon-Paul P. DiMauro, MD	United States	No Relationships
Aleksandra Djukic, MD	United States	No Relationships
Mladen Djurasovic, MD	United States	Medtronic (b); NuVasive (b); NuVasive (b)
Yusuke Dodo, MD	Japan	No Relationships
Brianna R. Doherty, PhD	United States	No Relationships
Roberto Donati, MD	Italy	No Relationships
Emily Dooley, BS	United States	No Relationships
James E. Dowdell, MD	United States	No Relationships
Casper Dragsted, MD	Denmark	No Relationships
Changzhi Du, MD	China	No Relationships
Michael G. Dubner, BA	United States	No Relationships
Conor J. Dunn, MD	United States	No Relationships
Wesley M. Durand, BS	United States	No Relationships
Garrett Easson, MS	United States	No Relationships
Robert K. Eastlack, MD	United States	Aesculap (b, e, g); Alphatec Spine (c); Baxter (b); Clear View (b, e); Globus Medical (g); K2M (b); Nocimed (c, e); NuVasive (a, b, c, g); Seaspine (a, b, g); SI Bone (a, b, g); Spine Innovation (c); Titan (a, b)
Alexander Edelstein, MD	United States	No Relationships
Max Egers, BS	United States	No Relationships
Charles Eichler, MD	United States	Medtronic (b); NuVasive (b)
Mostafa H. El Dafrawy, MD	United States	No Relationships
Jonathan Charles Elysée, BS	United States	No Relationships
Arash Emami, MD	United States	No Relationships
Haruka Emori, PhD	Japan	No Relationships
Kenji Endo, MD, PhD	Japan	No Relationships
Meric Enercan, MD	Turkey	No Relationships
Thomas N. Epperson, BA	United States	No Relationships
Barkin Erdogan	Turkey	No Relationships
Gokhan Ergene, MD	Turkey	No Relationships
Mark A. Erickson, MD	United States	No Relationships
Thomas J. Errico, MD	United States	Fastenetix (g); K2M (b, g); Pfizer (a)
Jace Erwin, BS	United States	No Relationships
European Spine Study Group	Spain	DePuy Synthes (a); Medtronic (a); PI16/01283, funded by Instituto de Salud Carlos III and co-funded by European Union (ERDF/ESF) (a)
Michael J. Faloon, MD, MS	United States	K2M (a, b, d)
S. Harrison Farber, MD	United States	No Relationships
James C. Farmer, MD	United States	No Relationships
Christine L. Farnsworth, MS	United States	No Relationships
Kathleen Fear, PhD	United States	No Relationships
Laviel Fernandez, MD	United States	No Relationships
Richard G. Fessler, MD, PhD	United States	Benvenue (d); DePuy Synthes (b); In Queue Innovations (g)
Vincent A. Fischetti, PhD	United States	DiskitisDx Corp. (b, c)
Robert D. Fitch, MD	United States	No Relationships
Yizhar Floman, MD	Israel	ApiFix (c)

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DISCLOSURES

Timothy Floyd, MD	United States	St. Teresa Medical, Inc. (c, f)
Kevin T. Foley, MD	United States	Discgenics (c, e); Duratap (c, e); Medtronic (b, c, g); NuVasive (c)
Carole Fortin, PhD	Canada	No Relationships
Richard Frisch, MD	United States	Globus Medical (a, b, g)
David K. Frome, BS	United States	No Relationships
Søren Fruensgaard, MD	Denmark	No Relationships
Sidsel Fruergaard, MD	Denmark	No Relationships
Kai-Ming Gregory Fu, MD, PhD	United States	DePuy Synthes (b); Globus Medical (b); SI Bone (b)
Shunsuke Fujibayashi, MD, PhD	Japan	No Relationships
Nobuyuki Fujita, MD, PhD	Japan	No Relationships
Satoshi Fukuzaki, PhD	Japan	Medtronic (a)
Rohan B. Gala, MS	India	No Relationships
Jesse Galina, BS	United States	No Relationships
(Catherine) Himo Gang, MPH	United States	No Relationships
Steven R. Garfin, MD	United States	DePuy Synthes (b); LifeWalker (b, c, e); NuVasive (b); Orthofix (b, c); SeaSpine (b, e); SI Bone (b, c); SpinalBalance (b); Thieme Publishing (g)
Rachel Gecelter, BS	United States	No Relationships
Martin Gehrchen, MD, PhD	Denmark	K2M (a); Medtronic (a)
Michael C. Gerling, MD	United States	CTL (g); Wolf Endoscopic (b)
Federico P. Girardi, MD	United States	Alphatec Spine (b, c); DePuy Synthes (b, c); NuVasive (b, c); Paradigm Spine (c)
Juliane D. Glaeser, PhD	United States	No Relationships
Steven D. Glassman, MD	United States	No Relationships
Jakub Godzik, MD	United States	No Relationships
Vijay K. K Goel, PhD	United States	No Relationships
Tae Sik Goh, MD, PhD	Korea, South	No Relationships
Ziya L. Gokaslan, MD	United States	AO Spine (a); Spinal Kinetics (c)
Jeffrey Andrew Goldstein, MD	United States	Globus Medical (b); Integrity Spine (b); NuVasive (b, g); RTI (b); Zimmer Biomet (b)
Joshua L. Golubovsky, BS	United States	No Relationships
Jorge L. Gonzalez	United States	No Relationships
Matthew F. Gornet, MD	United States	Aesculap (b); Bonovo (c); International Spine & Orthopedic Institute, LLC (c); Medtronic (b, g); Nocimed (c); OuroBoros (c); Paradigm Spine (c); RTI (g)
Caleb Gottlich, MS, BS	United States	No Relationships
Michael Grelat, MD	France	No Relationships
Pierre Grobost, MD	France	No Relationships
Jian Guan, MD	United States	No Relationships
Karishma Gupta, BS, MPH	United States	No Relationships
David P. Gurd, MD	United States	No Relationships
Richard D. Guyer, MD	United States	No Relationships
Camille Ratliff Guzel, MD	United States	No Relationships
Alex Ha, MD	United States	No Relationships
Yoon Ha, MD	Korea, South	No Relationships
Allison R. Haas, RN, BSN, CNOR, RNFA	United States	No Relationships

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DISCLOSURES

Sleiman Haddad, MD, PhD, FRCS	Spain	No Relationships
Ram Haddas, PhD, MS, MEng	United States	No Relationships
Jack M. Haglin, BS	United States	No Relationships
Regis W. Haid Jr., MD	United States	Elsevieer (g); Globus Medical (c, g); Medtronic (g); NuVasive (b, c, g); Paradigm Spine (c); Spinewave (c)
Shahnawaz Haleem, MBBS, MSc (Tr&Orth) MRCSEd, MRCSI, FRCS(Tr&Orth)	United Kingdom	No Relationships
Youssef J. Hamade, MD, MS	United States	No Relationships
D. Kojo Hamilton, MD	United States	No Relationships
ElAmir Bachar Harfouch, MD	Saudi Arabia	No Relationships
Harms Study Group	United States	DePuy Synthes (a); EOS Imaging (a); K2M (a); Medtronic (a); NuVasive (a); Zimmer Biomet (a)
Andrew B. Harris, BS	United States	No Relationships
Jonathan A. Harris, MS	United States	Globus Medical (f)
Robert A. Hart, MD	United States	DePuy Synthes (b, g); Globus Medical (b, g); ISSGF (a); Medtronic (b, g); Orthofix (b, g); Seaspine (g)
Sayyida Hasan, BS	United States	No Relationships
Tomohiko Hasegawa, MD, PhD	Japan	No Relationships
Jonathan Haskel, MD	United States	No Relationships
Terue Hatakenaka	Japan	No Relationships
Gerald M. Hayward II, BS	United States	Globus Medical (f)
Linda Helenius, MD	Finland	K2M (a); Medtronic (a)
Martin J. Herman, MD	United States	No Relationships
John Heydemann, MD	United States	No Relationships
Tetsuro Hida, MD	United States	No Relationships
Randall J. Hlubek, MD	United States	No Relationships
Scott D. Hodges, D.O.	United States	Medtronic (d)
Francis J. Hornicek, MD, PhD	United States	Amyrsis, McGraw Hill, UpToDate, Wiley (g); Biome Ai, Bone Solutions Inc. (c); Globus Medical (b); ISOLS, MSTS (e); Stryker Spine (a); Zimmer Biomet (g)
Jason A. Horowitz, BA	United States	No Relationships
William Horton, MD	United States	Ascendis (b, e); Biomarin (b)
Yushi Hoshino, MD, PhD	Japan	No Relationships
Naobumi Hosogane, MD, PhD	Japan	No Relationships
Richard Hostin, MD	United States	DePuy Synthes (b)
Michael T. Hresko, MD	United States	EOS Imaging (c); Medtronic (g)
Alex Liu Huang	United States	No Relationships
Jichen Huang, MD	China	No Relationships
Russel C. Huang, MD	United States	No Relationships
Alexander P. Hughes, MD	United States	4WEB Medical (a); Mallinckrodt Pharmaceuticals (a); NuVasive (a); Pfizer, Inc. (a)
Lik Hang Alec Hung, FRCS	Hong Kong	No Relationships
Kade T. Huntsman, MD	United States	NuVasive (c, e, g); Titan Spine (c, g)
Ki S. Hwang, MD	United States	Stryker Spine (b)
Steven W. Hwang, MD	United States	auctus (c); NuVasive (b, d); Zimmer Biomet (d)

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DISCLOSURES

Sung Hwan Hwang, MD	Korea, South	No Relationships
Corrado Iaccarino, MD	Italy	Finceramica S.p.A. - Italy (b)
Shoichi Ichimura, MD	Japan	No Relationships
Rivka C. Ihejirika, MD	United States	No Relationships
Yael Ihejirika, BA	United States	No Relationships
Yasushi Iijima, MD, PhD	Japan	No Relationships
Shota Ikegami, MD, PhD	Japan	No Relationships
Brice Ilharreborde, MD, PhD	France	Implanet (b); Medtronic (b); Zimmer Biomet (b)
Sang Kyu Im, MD	Korea, South	No Relationships
Meghan N. Imrie, MD	United States	No Relationships
Kazuhide Inage, MD, PhD	Japan	No Relationships
Serkan Inceoglu, PhD	United States	No Relationships
International Spine Study Group	United States	DePuy Synthes (a); Globus Medical (a); K2M (a); Medtronic (a); NuVasive (a); Orthofix (a)
Koji Ishikawa, MD, PhD	Japan	No Relationships
Mahee Islam	United States	No Relationships
Kenyu Ito, MD	Japan	No Relationships
Sravisht Iyer, MD	United States	No Relationships
Robert Sean Jackson, MD	United States	No Relationships
Amit Jain, MD	United States	No Relationships
Ishaan Jain, BS	United States	No Relationships
Mohit J. Jain, MD	United States	No Relationships
Garth James, PhD	United States	No Relationships
Radim Jancalek, MD, PhD	Czech Republic	DiscitisDx (c)
Megan Jeffords, MS	United States	NuVasive (f)
Yang Jiao, MBBS	China	No Relationships
Timothy A. Johnson, BS, BI Developer Sr.	United States	No Relationships
Kristen E. Jones, MD	United States	No Relationships
Nathalie Jourdain, MA	Canada	No Relationships
Jean-Luc Jouve, MD	France	No Relationships
Derek G. Ju, MD	United States	No Relationships
Sinan Kahraman, MD	Turkey	No Relationships
Udaya K. Kakarla, MD	United States	No Relationships
Linda E. A. Kanim, MA	United States	Medtronic (c)
Michelle Kannapel	United States	No Relationships
Adam S. Kanter, MD	United States	NuVasive (g); Zimmer Biomet (g)
Daniel James Kaplan, MD	United States	No Relationships
Chelsea Karacz, MS	United States	No Relationships
Selhan Karadereler, MD	Turkey	No Relationships
Duru Karasoy, PhD	Turkey	No Relationships
Mayur P. Kardile, MD	India	No Relationships
Jaret M. Karnuta, BS	United States	No Relationships
Lori A. Karol, MD	United States	Elsevier Publishing (g)
Lana Kass-Gergi, MS	United States	No Relationships

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DISCLOSURES

Karina M. Katchko, MD	United States	No Relationships
Hiroyuki Kato, MD, PhD	Japan	No Relationships
Satoshi Kato, MD	Japan	No Relationships
Chhavi Katyal, MD	United States	No Relationships
Harleen Kaur, BA	United States	No Relationships
Japsimran Kaur, BS	United States	No Relationships
Noriaki Kawakami, MD	Japan	Japan Spine Institute (a); Kisco International (b); Medtronic (b)
Floreana N. Kebaish, MD	United States	DePuy Synthes (b, g); K2M (b, g); Orthofix (g); SpineCraft (g)
Amey V. Kelkar, MS	United States	No Relationships
Brian P. Kelly, PhD	United States	DePuy Synthes (a); NuVasive (a); SI Bone (a)
Heather Kent, MSN, RN, CPNP	United States	No Relationships
Panagiotis Kerezoudis, MD	United States	No Relationships
Jad G. Khalil, MD	United States	Camber spine (b); Centinel Spine (a); DePuy Synthes (b); Innovasis (e); K2M (a); Limiflex (a); Medtronic (a); Relievant (a); Stryker Spine (a); Stryker Spine (b)
Yehia H. Khalil, PhD	United States	No Relationships
Sirish Khanal, BS	United States	No Relationships
Jay Khanna, MD	United States	Avitus Orthopaedics (c); Cortical Concepts (c); Globus Medical (b); New Era Orthopaedics (c); Ortho Development (g); Orthofix (b, g); Thieme Publishing (g)
Benjamin Khechen, BS	United States	No Relationships
Nejib Khouri, MD	France	No Relationships
Sara Khoyratty, MBBS, MRCS	United Kingdom	No Relationships
Duhan Kilickan	Turkey	No Relationships
Chi Heon Kim, MD, PhD	Korea, South	No Relationships
David Kim, BS	United States	No Relationships
David J. Kim, BS	United States	No Relationships
DongHwan Kim, MD	Korea, South	No Relationships
Dongyoung Kim, BS	United States	No Relationships
Nathan S. Kim, BA	United States	No Relationships
Soo Yeon Kim, MD	United States	No Relationships
Yong H. Kim, MD	United States	No Relationships
Christopher J. Kleck, MD	United States	Biocomposites (b); Globus Medical (a); Medacta (a, b); Medicrea (a, b); Orthofix (a); Pfizer (a); SI Bone (a, b)
Frank S. Kleinstueck, MD	Switzerland	DePuy Synthes (a)
Eric O. Klineberg, MD	United States	Allosource (b); AO Spine (a, d); DePuy Synthes (b); K2M (d); Medicrea (b); Springer (b); Stryker Spine (b); Trevena (b)
Dylan G. Kluck, MD	United States	No Relationships
John J. Knightly, MD	United States	No Relationships
Sho Kobayashi, MD, PhD	Japan	No Relationships
Manoj K. Kodigudla, MS	United States	No Relationships
Jayme Koltsov, PhD	United States	No Relationships
Hitoshi Kono, MD	Japan	No Relationships
Michihiko Koseki, PhD	Japan	No Relationships
Toshiaki Kotani, MD, PhD	Japan	No Relationships

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DISCLOSURES

Roman Kovalenko, PhD	Russia	No Relationships
Oscar Krol	United States	No Relationships
Yoshifumi Kudo, MD, PhD	Japan	No Relationships
Thomas Kuivila, MD	United States	No Relationships
Hiroshi Kumagai, MD	Japan	No Relationships
Calvin C. Kuo, MD	United States	No Relationships
Shugo Kuraishi, MD	Japan	No Relationships
Swamy Kurra, MBBS	United States	No Relationships
Mun Keong Kwan, MBBS, MS	Malaysia	No Relationships
Lawal A. Labaran, BS	United States	No Relationships
Hubert Labelle, MD, FRCS(C)	Canada	Canadian Institutes of Health Research (a); Spinologics Inc. (c)
Philippe Labelle	Canada	No Relationships
Renaud Lafage, MS	United States	Nemaris (c)
Virginie Lafage, PhD	United States	AO Spine (g); DePuy Synthes (a, g); Globus Medical (b); K2M (a, g); Nemaris INC (c); NuVasive (a); Stryker Spine (a)
Suna Lahut, PhD	Turkey	No Relationships
Kelly Ka-Lee LAI, BS	Hong Kong	No Relationships
Tsz-Ping Lam, MBBS	Hong Kong	No Relationships
Todd H. Lanman, MD	United States	Medtronic (g); NuVasive (b); Stryker Spine (g)
Todd Lansford, MD	United States	Globus Medical (a, b); NuVasive (b); Orthofix (a); Stryker Spine (b)
Francisco J. Laplaza, MD	United States	No Relationships
Nina, J. Lara, MD	United States	No Relationships
Joseph L. Laratta, MD	United States	Combination Biologic (c); Evolution Spine (b, g); Gerson Lehrman Group (b); ICBG/BMAC System (c); Medtronic (a); NuVasive (a); Orthopaedic Research and Education Foundation (a); Orthopaedic Science Research Foundation (a); Spineart (b, g); Stryker Spine (g)
Robert K. Lark, MD, MS	United States	DePuy Synthes (f); NuVasive (b)
Jeffrey Larson, MD	United States	Stryker Spine (b, g)
Jill E. Larson, MD	United States	No Relationships
Michael Rud Lassen, MD	Denmark	Bayer Healtcare (b); BMS (b); DePuy Synthes (e); Janssen Inc. (b); Medtronic (b, d, e); Stryker Spine (b, e)
Markus Lastikka, MD	Finland	No Relationships
Darryl Lau, MD	United States	No Relationships
Johnson YN Lau, MD, MBBS, FRCP	United States	OrthoSmart (c)
Joshua D. Lavian, BS	United States	No Relationships
David Lazarus, MD	United States	No Relationships
Phuc Le, PhD, MPH	United States	No Relationships
Darren R. Lebl, MD	United States	K2M (b); NuVasive (b)
Chang-Hyun Lee, MD, MS	Korea, South	No Relationships
Jung Sub Lee, MD, PhD	Korea, South	No Relationships
Jung-Hee Lee, MD, PhD	Korea, South	No Relationships
Ki-Young Lee, MD	Korea, South	No Relationships
Mark C. Lee, MD	United States	JBJS/NEJM (g)
Nathan J. Lee, MD	United States	No Relationships
Timothy Tin Yan Lee, MS	Hong Kong	No Relationships

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DISCLOSURES

Wayne YW Lee, PhD	Hong Kong	No Relationships
Jennifer N. Lehrman, MS	United States	No Relationships
Justin V.C. Lemans, MD	Netherlands	K2M (a)
Jack Leschke, MD	United States	No Relationships
Eric Leung, BA	United States	No Relationships
Jean-Christophe A. Leveque, MD	United States	No Relationships
Nicole L. Levine, BA	United States	No Relationships
Jie Li, MS	China	No Relationships
Tong Li, MD	China	No Relationships
Xudong Joshua Li, MD, PhD	United States	No Relationships
Barthelemy Liabaud, MD	United States	No Relationships
Jayson Lian, BS	United States	No Relationships
Hyun Jin Lim	Korea, South	No Relationships
James D. Lin, MD, MS	United States	No Relationships
Youxi Lin, MD	China	No Relationships
Breton G. Line, BS	United States	AlloSource (b); International Spine Study Group (b)
Quanfei Liu, MD	China	No Relationships
Shufen Liu, MD	China	No Relationships
Zhen Liu, MD	China	No Relationships
Zhuojie Liu, MD	China	No Relationships
Yungtai Lo, PhD	United States	No Relationships
Donovan Lockwood, BS	United States	No Relationships
Giorgio Lofrese, MD	Italy	No Relationships
Joseph M. Lombardi, MD	United States	No Relationships
Edmond H. Lou, PhD	Canada	No Relationships
Francis C. Lovecchio, MD	United States	No Relationships
Edwin Lu, BS	United States	No Relationships
Steven C. Ludwig, MD	United States	Advance Spinal Intellectual Property (ASIP) (c); American Board of Orthopedic Surgery (e); American Orthopedic Association (e); AO Spine (a); AOA Omega Grant (a); Cervical Spine Research Society (CSRS) (e); Contemporary Spine Surgery (e); DePuy Synthes (b, g); Globus Medical (a, b, g); Inovative Surgical Design (ISD) (c); Journal of Spinal Disorders and Techniques (e); K2M (b, g); Paradigm Spine (a); Society for Minimally Invasive Spine Surgery (e); The Spine Journal (e); Thieme, Quality Medical Publishers (g)
Darren F. Lui, MBBS, FRCS	United Kingdom	Stryker Spine (b)
Cristina Lupu, PA-C	United Kingdom	No Relationships
Tana Machakova, MS	Czech Republic	DiscitisDx (c)
Constance Maglaras, PhD	United States	No Relationships
Kamran Majid, MD, MBA	United States	No Relationships
Melvin C. Makhni, MD, MBA	United States	No Relationships
Tuula Manner, MD, PhD	Finland	No Relationships
Jordan Manning, BA	United States	No Relationships
Ayesha Maqsood, MD	United States	No Relationships
Damon Mar, PhD	United States	No Relationships
Michelle Claire Marks, MS, PT	United States	No Relationships

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DISCLOSURES

Majd Marrache, MD	United States	No Relationships
Antonio Martucci, MD	Italy	No Relationships
Hiroshi Maruyama, MD	Japan	No Relationships
Sergei Masevnin, PhD	Russia	No Relationships
Shuichi Matsuda, MD, PhD	Japan	No Relationships
Morio Matsumoto, MD, PhD	Japan	Kyocera (a); Medtronic (a); NuVasive (b); Zimmer Biomet (a)
Akira Matsuoka, MD	Japan	No Relationships
Yuji Matsuoka, MD, PhD	Japan	No Relationships
Yukihiro Matsuyama, MD, PhD	Japan	No Relationships
Konstantinos Mavromattis, PhD	United States	Celgene Corp (f); DiscitisDx (e)
Keyvan Mazda, MD, MS	France	No Relationships
Steven J. Mcanany, MD	United States	No Relationships
Scott McCarty, MD	United States	No Relationships
Anna McClung, BSN	United States	Food and Drug Administration (a); Growing Spine Foundation (a); NuVasive (a); Pediatric Orthopedic Society North America (a)
Jeffrey McConnell, MD	United States	Globus Medical (b, c, d, g); Institute for Musculoskeletal Medicine & Education (IMSE) (d); Medtronic (a)
Christopher B. McLeod, DO	United States	No Relationships
Ratnesh N. Mehra, DO	United States	No Relationships
Jan H. Mehrkens, MD	Germany	No Relationships
Dianna L. Mejia, BS	United States	No Relationships
Carolin Melcher, MD	Germany	No Relationships
Emmanuel N. Menga, MD	United States	Evolution Spine (b); Globus Medical (g)
Richard P. Menger, MD, MPA	United States	AEGIS Spine Socioeconomic Research Grant (a)
Maqdooda Merchant, MSc MA	United States	No Relationships
Addisu Mesfin, MD	United States	AO Spine (a); Axiomed (c); Corelink (a); LES Society (a)
James C. Messina, BS	United States	No Relationships
Newton H. Metcalf, BS	United States	Medtronic (c, f)
Melodie F. Metzger, PhD	United States	No Relationships
Yuki Mihara, MD	Japan	No Relationships
Dmitrii Mikhailov, PhD	Russia	No Relationships
Tetsuhiko Mimura, MD	Japan	No Relationships
Shohei Minami, MD, PhD	Japan	No Relationships
Cameron R. Moattari, BS	United States	No Relationships
Mohamed A. Moawad, MPH	United States	No Relationships
Marina Moguilevtch, MD	United States	No Relationships
Virender Kumar Mohan, MD, MBBS	India	No Relationships
Jung Mok, BS	United States	No Relationships
Annette Molinaro, PhD	United States	No Relationships
Sean Molloy, MBBS, FRCS, MSc (eng)	United Kingdom	DePuy Synthes (d); Globus Medical (b); Medtronic (b, d)
Dan Monessa, BS	United States	No Relationships
Blake K. Montgomery, MD	United States	No Relationships
Simon Morr, MD, MPH	United States	No Relationships
Steven J. Morrin, BS	United States	No Relationships

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DISCLOSURES

Matthew T. Morris, MD	United States	No Relationships
Martin Morrison, MD	United States	DePuy Synthes (b); OrthoPediatrics (a, b)
Patrick J. Morrissey, BS	United States	No Relationships
Michael J. Moses, MD	United States	No Relationships
Adriaan K. Mostert, MD, PhD	Netherlands	No Relationships
Ryo Munakata, MD	Japan	No Relationships
Sudarshan Munigangaiah, FRCS	United Kingdom	No Relationships
Hideki Murakami, MD, PhD	Japan	No Relationships
Kazuma Murata, MD, PhD	Japan	No Relationships
Antonio Musio, MD	Italy	No Relationships
Vugar Nabiyev, MD	Turkey	No Relationships
Narihito Nagoshi, MD	Japan	No Relationships
Masaya Nakamura, MD, PhD	Japan	No Relationships
Keita Nakayama, MD	Japan	No Relationships
Qais Naziri, MD	United States	No Relationships
Scott C. Nelson, MD	United States	K2M (b); NuVasive (b); Orthofix (b); Orthospin (b)
Adam Nessim, BS	United States	No Relationships
Brian J. Neuman, MD	United States	DePuy Synthes (a); Medtronic (d)
Anna Newcomb, MS	United States	No Relationships
Peter O. Newton, MD	United States	Alphatec Spine (a); DePuy Synthes (a, g); Electrocore (c); EOS Imaging (a); K2M (a, b, g); Mazor Robotics (a); Medtronic (a); NuVasive (a); OrthoPediatrics (a); Scoliosis Research Society (g); Setting Scoliosis Straight Foundation (a, e); Thieme Publishing (g)
Bobby Kinwah Ng, MD	Hong Kong	No Relationships
Wai Leong Ng, MBBS	Malaysia	No Relationships
Derek T. Nhan, BS	United States	No Relationships
Hongbin Ni, MD	China	No Relationships
Wendy M. Novicoff, PhD	United States	No Relationships
Pierce D. Nunley, MD	United States	Amedica (c); Axiomed (a); Camber Spine (b, c, d, g); Centinel Spine (a, b); Discgenics (a); Integrity Spine (b, g); K2M (a, b, d, g); Mesoblast (a); Organogenesis (a); Orthofix (a); Paradigm Spine (a, c); Pfizer (a); Simplify (a); Spineology (a, b, c, d, g); Vertiflex (b); Zimmer Biomet (a, b, d, g)
Madhu Oad, BS	United States	No Relationships
Hiroki Oba, MD	Japan	No Relationships
Brooke K. O'Connell, MS	United States	No Relationships
Shin Oe, MD	Japan	No Relationships
Paul T. Ogink, MD	United States	No Relationships
Yoji Ogura, MD	United States	No Relationships
Tetsuya Ohara, MD	Japan	No Relationships
Masayuki Ohashi, MD, PhD	Japan	No Relationships
Erin Ohliger, MD	United States	No Relationships
Soren Ohrt-Nissen, MD, PhD	Denmark	No Relationships
Seiji Ohtori, MD, PhD	Japan	No Relationships
Eijiro Okada, MD, PhD	Japan	No Relationships
Ichiro Okano, MD	United States	No Relationships

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DISCLOSURES

David O. Okonkwo, MD, PhD, Professor	United States	NuVasive (g); Stryker Spine (b); Zimmer Biomet (g)
Hanna Oksanen, RN	Finland	No Relationships
Omer Orhun	Turkey	No Relationships
Yusuke Oshita, MD, PhD	Japan	No Relationships
Joseph A. Osorio, MD, PhD	United States	No Relationships
Brittany A. Oster, BS	United States	No Relationships
Yahya A. Othman	United States	No Relationships
Bungo Otsuki, MD, PhD	Japan	No Relationships
David C. Ou-Yang, MD	United States	Globus Medical (g); medicrea (g); Seaspine (b)
Robert Owen, MD	United States	No Relationships
Kirk Owens, MD	United States	Intellirod (a); Medtronic (b); NuVasive (b); OREF (a); Pfizer (a)
Huseyin Ozturk, MD	Turkey	No Relationships
Rodolfo A. Padua, PhD	United States	St. Teresa Medical, Inc. (f)
Joshua M. Pahys, MD	United States	DePuy Synthes (b); NuVasive (b); Zimmer Biomet (b)
Olli T. Pajulo, MD, PhD	Finland	No Relationships
Jina Pakpoor, MD	United States	No Relationships
Rachelle Palkovsky, BS	United States	No Relationships
Aixing Pan, MD, PhD	China	No Relationships
Zhimin Pan, MD, MS	Korea, South	No Relationships
Kenneth J. Paonessa, MD	United States	No Relationships
Eric C. Parent, PhD	Canada	No Relationships
Daehyun Park, MD	Korea, South	No Relationships
Paul J. Park, MD	United States	No Relationships
Selena Pasadyn, BA	United States	No Relationships
Saba Pasha, PhD	United States	No Relationships
Peter G. Passias, MD	United States	Aesculap (a); Allosource (e); CSRS (a); Globus Medical (e); Medicrea (b); SpineWave (b); Zimmer Biomet (e)
Anuj Patel, MD	United States	No Relationships
Arpan A. Patel, BS	United States	No Relationships
Dil Patel, BS	United States	No Relationships
Neeraj M. Patel, MD	United States	No Relationships
Neil Patel, BS, BA	United States	No Relationships
Vikas V. Patel, MD, BS, MA	United States	Aesculap (b); Globus Medical (a); Mainstay (a); Medicrea (a); Orthofix (a); Pfizer (a); Premia (a); SI Bone (a); Zimmer Biomet (b)
Carl B. Paulino, MD	United States	DePuy Synthes (b)
Rune Tendal Paulsen, MD	Denmark	No Relationships
Ferran Pellisé, MD, PhD	Spain	AO Spine (a, e); DePuy Synthes (a, b); Medtronic (a)
Vamsi Krishna Varma Penumatsa, MS	India	No Relationships
Francisco Javier Sanchez Perez-Grueso, MD	Spain	DePuy Synthes (a); K2M (b)
Sebastien Pesenti, MD, PhD	France	No Relationships
Katherine E. Pierce, BS	United States	No Relationships
Nicolas Plais, MD	Spain	NuVasive (c); Spinewave (c)
James F. Policy, MD	United States	UNYQ (c)
David W. Polly, MD	United States	Springer textbook (g)

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DISCLOSURES

Selina C. Poon, MD	United States	NuVasive (a)
Kiley Frazier Poppino, BS	United States	No Relationships
Michaela S. Pott, BS	United States	Medicrea (a)
Eric Potts, MD	United States	Medtronic (b, g); Remedy Pharmaceuticals (c)
Ajay Premkumar, MD, MPH	United States	No Relationships
Virginia Prendergast, PhD, NP-C	United States	No Relationships
Solène Prost, MD	France	No Relationships
Themistocles S. Protopsaltis, MD	United States	Globus Medical (b); Innovasis (b, e); K2M (b); Medicrea (b); NuVasive (b)
Dmitrii Ptashnikov, MD, PhD	Russia	No Relationships
Varun Puvanesarajah, MD	United States	No Relationships
Weichen Qi, MS	Hong Kong	No Relationships
Xiaodong Qin, PhD	China	No Relationships
Junyin Qiu	China	No Relationships
Sheeraz Qureshi, MD	United States	Avaz Surgical (c); Globus Medical (b); K2M (b); RTI (g); Stryker Spine (b, g); Vital 5 (c); Zimmer Biomet (b, g)
Micheal Raad, MD	United States	No Relationships
Jacob M. Rabin	United States	No Relationships
Tahsin M. Rahman, BS	United States	No Relationships
Tina Raman, MD	United States	No Relationships
Brandon A. Ramo, MD	United States	NuVasive (d); OrthoPediatrics (d)
Sina Rashidi Kikanloo, BS	United States	No Relationships
Jesper Rasmussen, MD	Denmark	No Relationships
Ruwan Ratnayake, MD	United States	No Relationships
Bernard A. Rawlins, MD	United States	No Relationships
Assaf Raz, PhD	United States	DiscitisDX (b)
Nicole Record, DO	United States	No Relationships
Jay S. Reidler, MD	United States	No Relationships
Wei-Ping Ren, MD, PhD	United States	No Relationships
Jeroen Renkens, MD	Netherlands	No Relationships
Colleen Rentenberger, MD	United States	No Relationships
Maria I. Restrepo, PhD	United States	No Relationships
Jan Revella, RN	United States	No Relationships
Lawrence A Rinsky, MD	United States	Stryker Spine (d)
Kent R. Richter, BS	United States	No Relationships
Lee H. Riley, MD	United States	Avitus (c, e, g); LifeNet Health (e)
Joshua Rivera	United States	No Relationships
Leslie C. Robinson, MD, PharmD, MBA	United States	No Relationships
Tianhua Rong, MD	China	No Relationships
Brett D. Rosenthal, MD	United States	No Relationships
Marjolaine Roy-Beaudry, MSc	Canada	No Relationships
David Price Roye, MD	United States	No Relationships
Hui Bing Ruan, MD	China	No Relationships
Paul T. Rubery, MD	United States	AO Spine (a)

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DISCLOSURES

Jack H. Ruddell, BA	United States	No Relationships
Hayeem L. Rudy, BS	United States	No Relationships
Shawn Russell, PhD	United States	No Relationships
Joost Rutges, MD, PhD	Netherlands	No Relationships
Filip Ruzicka, PhD	Czech Republic	DiscitisDX, Inc. (b)
Cirous Sadeghi, MD	United States	No Relationships
Nikhil Sahai, MD	United States	No Relationships
Comron Saifi, MD	United States	Vertera/NuVasive (g)
Toshiki Saito, MD	Japan	No Relationships
Tsuyoshi Sakuma, MD, PhD	Japan	No Relationships
Pooria Salari, MD	United States	No Relationships
Khosrowdad Salehi, BS	United States	No Relationships
Stephan N. Salzmann, MD	United States	No Relationships
Andrew A. Sama, MD	United States	4WEB, Inc. (b); AO Spine (a); Clariance, Inc. (b, e); DePuy Synthes (b, e, g); Kuros Biosciences AG (b, e); MiMedx Group, Inc. (a, b); Ortho Development Corp. (b, g); Paradigm Spine (c); Sentio (b); Spinal Kinetics, Inc. (a, c)
Benjamin Martin Choi Sampedro, MS, CRNA	United States	No Relationships
Linsen T. Samuel, MD, MBA	United States	No Relationships
Jiri Sana, PhD	Czech Republic	No Relationships
Harvinder S Sandhu, MD, MBA	United States	Paradigm Spine (c); Prosydian (b, c); Providence Medical (c); Spinewave (c)
Tunay Sanli, MA	Turkey	No Relationships
Zeeshan M. Sardar, MD, MS, FRCS(C)	United States	No Relationships
Indra N. Sarkar, PhD	United States	No Relationships
Vishal Sarwahi, MD	United States	No Relationships
John F. Sarwark, MD	United States	No Relationships
Takeshi Sasagawa, MD	Japan	No Relationships
Tom P. Schlösser, MD, PhD	Netherlands	No Relationships
Abigail Carpenter Schmitt, MS	United States	No Relationships
Jacob F. Schulz, MD	United States	No Relationships
Frank J. Schwab, MD	United States	DePuy Synthes (a); Globus Medical (b); K2M (a, b, g); Medicrea (b, g); Medtronic (b, g); Nemaris INC (c); NuVasive (a, b); Stryker Spine (a); Zimmer Biomet (b)
Joseph H. Schwab, MD, MS	United States	No Relationships
Ran Schwarzkopf, MD	United States	Gauss Surgical (c); Intelijoint (b, c); Smith&Nephew (b)
Daniel M. Sciubba, MD	United States	Baxter (b); DePuy Synthes (b); Globus Medical (b); Medtronic (b); NuVasive (b); Stryker Spine (b)
Joseph P. Scollan, BS	United States	No Relationships
Peter R. Seevinck, PhD	Netherlands	MRIGuidance BV (c, f)
Frank A. Segreto, BS	United States	No Relationships
Richard J. Sekerak, BS	United States	No Relationships
Timothy Sell, PhD	United States	No Relationships
Jonathan N. Sembrano, MD	United States	No Relationships
Sahin Senay, MD	Turkey	No Relationships

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DISCLOSURES

Franco Servadei, MD	Italy	Finceramica (a, b); Integralife (a, b); Takeda (a, b)
Mark E. Shaffrey, MD	United States	No Relationships
Neil V. Shah, MD, MS	United States	No Relationships
Charu Sharma, MS, MHA	United States	No Relationships
Francis H. Shen, MD	United States	No Relationships
Jianxiong Shen, MD	China	No Relationships
Elian Shepherd MD, MD	United States	No Relationships
Dmitriy Sheyn, PhD	United States	No Relationships
Jinhui Shi, MD	United States	No Relationships
Takayoshi Shimizu, MD, PhD	Japan	No Relationships
Andrew J. Shimmin, MBBS, FRCS	Australia	Corin (b, c, e, g)
John H. Shin, MD	United States	AO Spine (a); DePuy Synthes (b); Stryker Spine (b)
Won-Ju Shin, MD	Korea, South	No Relationships
Toshiyuki Shirahata, MD, PhD	Japan	No Relationships
Maksim A. Shlykov, MD, MS	United States	No Relationships
Jennifer Shue, MS	United States	No Relationships
Gao Si, MD	China	No Relationships
Brenda A. Sides, MS	United States	No Relationships
Susan Sienko, PhD	United States	No Relationships
Breana Siljander, MD	United States	No Relationships
Anne Laure Simon, MD, MS	France	No Relationships
Kern Singh, MD	United States	K2M (b); Stryker Spine (g); Thieme Publishing (g); Zimmer Biomet (b, g)
Paramjit Singh, MD	United States	No Relationships
Anuj Singla, MD	United States	No Relationships
Kumar G. Sinha, MD	United States	No Relationships
David L. Skaggs, MD, MMM	United States	Biomet Spine (g); Grand Rounds (a Healthcare Navigation Company) (b); Green Sun Medical (c); Growing Spine Study Group/Growing Spine Foundation (e); Journal of Children's Orthopaedics (e); Medtronic (g); NuVasive (a, b); Orthobullets (b, c, e); Orthopedics Today (e); Spine Deformity (e); Wolters Kluwer Health - Lippincott Williams & Wilkins (g); Zimmer Biomet (b, d, g); Zipline Medical, Inc (c)
Richard L. Skolasky, Sc.D.	United States	No Relationships
Ondrej Slaby, PhD	Czech Republic	DiscitisDx, Inc. (c)
Jonathan R. Slotkin, MD	United States	Medtronic (b); Stryker Spine (b)
James Slover, MD	United States	PACIRA (d); Zimmer Biomet (a)
Oleg Smekalenkov, PhD	Russia	No Relationships
Michael L. Smith, MD	United States	No Relationships
William Smith, MD	United States	DJO Global (a); MDT (a); NuVasive (a, b, c, d, g); Ortho Bio Design (b); Pediguard (b, c, d); Providence (a, b); Spineology (a, b, g); SpineSmith (c)
Matthew Smuck, MD	United States	Phillips (a); Relievant Medsystems (a); ReWalk (a); State Farm (b)
Seung Min Son, MD, PhD	Korea, South	No Relationships
Simon T. Sørensen, MS	Denmark	No Relationships
Alex Soroceanu, MD, FRCS(C); MPH	Canada	No Relationships
Joshua N. Speirs, MD	United States	No Relationships
Shreya Srinivas, FRCS	United Kingdom	No Relationships

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DISCLOSURES

Agnita Stadhouder, MD	Netherlands	No Relationships
Portia A. Steele, MS	United States	No Relationships
Dan Stein, BS	United States	Medtronic (f)
Michael E Steinhaus, MD	United States	No Relationships
Nicholas Stekas, MS	United States	No Relationships
Jeffrey G. Stepan, MD, MS	United States	No Relationships
Philip S. Stewart, PhD	United States	No Relationships
Paul Stey, PhD	United States	No Relationships
Jonathan R. Stieber, MD	United States	Intrinsic Therapeutics (a); Stryker Spine (b, d)
Sarah Stroud, AB	United States	No Relationships
Peter F. Sturm, MD, MBA	United States	DePuy Synthes (b, e); Green Sun Medical (c); NuVasive (b)
Daniel E. Suarez	United States	No Relationships
Daniel J. Sucato, MD, MS	United States	Globus Medical (g)
Atsushi Sugino, PhD	Japan	Medtronic (f)
Brian T. Sullivan, MD	United States	No Relationships
Katherine H. Sullivan	United States	DePuy Synthes (f)
Assem A. Sultan, MD	United States	No Relationships
Mike H. Sun, MD	United States	No Relationships
Satoshi Suzuki, MD, PhD	Japan	No Relationships
Chia-Hung Sze, BS	United States	No Relationships
Jun Takahashi, MD, PhD	Japan	No Relationships
Takashi Takizawa, MD, PhD	Japan	No Relationships
Kevin Taliaferro, MD	United States	No Relationships
Richard A. Tallarico, MD	United States	DePuy Synthes (a); Empirical Spine (a); K2M (a); Spinal Kinetics, Inc. (a); Stryker Spine (b); Vertebral Technologies, Inc. (a)
Haining Tan, MD	China	No Relationships
Lee A. Tan, MD	United States	No Relationships
Oliver Y. Tang, BS	United States	No Relationships
Simon Y. Tang, PhD	United States	No Relationships
Saad Tarabichi, BS	United States	No Relationships
Sandip P. Tarpada, MD	United States	No Relationships
Ryoji Tauchi, MD	Japan	No Relationships
Bobby Tay, MD	United States	AO Spine (g); Lumetra (b); NuVasive (g); Omega (g); Stryker Spine (b); Zimmer Biomet (b)
Khoi D. Than, MD	United States	Bioventus (b); Medtronic (b)
Daniel J. Thibaudeau, MD	United States	No Relationships
J. Alex Thomas, MD	United States	NuVasive (b, g)
David C. Thornberg, BS	United States	No Relationships
Beverly Thornhill, MD	United States	No Relationships
Kali Tileston, MD	United States	No Relationships
Daisuke Togawa, MD, PhD	Japan	Japan Medical Dynamic Marketing Inc (g); Journal of Bone and Joint Surgery American (e); Medtronic (g); Meitoku Medical Institute Jyuzen Memorial Hospital (g)
Luigino Tosatto, MD	Italy	No Relationships
Tomoaki Toyone, MD, PhD	Japan	No Relationships

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DISCLOSURES

Dong-Phuong Tran, MS	United States	No Relationships
Stacie Tran, MPH	United States	No Relationships
Jayesh Trivedi, FRCS	United Kingdom	No Relationships
ChangChun Tseng, MD	China	No Relationships
Hiroyuki Tsuchiya, MD, PhD	Japan	No Relationships
Osahiko Tsuji, MD, PhD	Japan	No Relationships
Takashi Tsuji, MD, PhD	Japan	No Relationships
Luis Manuel Tumialán, MD	United States	LessRay (c); Medtronic (b)
Olivier Turcot, BS	Canada	No Relationships
Isabelle Turgeon, BS	Canada	No Relationships
Jay D. Turner, MD, PhD	United States	NuVasive (a, b); SeaSpine (b)
Peter Muhareb Udby, MD, DC	Denmark	No Relationships
Masashi Uehara, MD, PhD	Japan	No Relationships
Vidyadhar V. Upasani, MD	United States	DePuy Synthes (a, d); EOS Imaging (a, d); NuVasive (d); OrthoPediatrics (a, b, d, g); Wolters Kluwer Health (g)
Hiroki Ushirozako, MD	Japan	No Relationships
Mohammad Farooq Usmani, MS	United States	No Relationships
Avani S. Vaishnav, MBBS	United States	No Relationships
Joost HJ van Erp, MD	Netherlands	No Relationships
Marijn van Stralen, PhD	Netherlands	MRIguidance BV (c, f)
Jeffrey J. Varghese, MD, BS	United States	No Relationships
Christopher G. Varlotta, BS	United States	No Relationships
Dennis Vasquez-Montes, MS	United States	No Relationships
Muralidharan Venkatesan, FRCS	India	No Relationships
Stephane Verdun, PhD	France	No Relationships
Christophe J. Vidal, MD	France	Implanet (b)
Elke Viehweger, MD, PhD	France	No Relationships
Jonathan Vigdorchik, MD	United States	Corin (b); Intellijoint (b)
Alba Vila-Casademunt, MS	Spain	No Relationships
Nicole R. Vingan, BS	United States	No Relationships
Michael S. Virk, MD, PhD	United States	DePuy Synthes (g); Globus Medical (g)
Sohrab Virk, MD	United States	No Relationships
John S. Vorhies, MD	United States	No Relationships
Corey T. Walker, MD	United States	No Relationships
Bin Wang, MD	China	No Relationships
Erik Wang, BA	United States	No Relationships
Jeffrey C. Wang, MD	United States	Amedica (g); Bone Biologics, Expanding Ortho, Pearldiver, Fziomed, Electrocore, Surgitech (c); DePuy Synthes (g); seaspine (g); Zimmer Biomet (g)
Michael Y. Wang, MD	United States	DePuy Synthes (b, g); ISD (c); K2M (b); Medical Device Partners (c); Spineology (b); Stryker Spine (b); Vallum (e)
Xiaoyu Wang, PhD	Canada	Medtronic (a)
Bernd Wegener, MD	Germany	No Relationships
Harrie Weinans, PhD	Netherlands	No Relationships
Michelle C. Welborn, MD	United States	DePuy Synthes (b); POSNA (a)

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DISCLOSURES

Stephen F. Wendolowski, BS	United States	No Relationships
Kerry Wilder, RN	United States	No Relationships
Marcel R. Wiley, MD	United States	DePuy Synthes (g); Medtronic (g)
Christopher G. Wilkerson, MD, BS	United States	No Relationships
Fabian Winter, MD	United States	No Relationships
Timothy F. Witham, MD	United States	AO Spine (g); DePuy Synthes (b); Eli Lilly and Co (a); The Gordon and Marilyn Macklin Foundation (a)
Adam J. Wolfert, BA	United States	No Relationships
Yi-Shun Wong, BSc (Hons)	Hong Kong	No Relationships
Dainn Woo, BS	United States	No Relationships
Zhichong Wu, PhD	China	No Relationships
Zhuo Xi, MD, PhD	United States	No Relationships
Lei-Lei Xu, PhD	China	No Relationships
Nanfang Xu, MD	China	No Relationships
Alem Yacob, MD, MS	United States	No Relationships
Mitsuru Yagi, MD, PhD	Japan	Medtronic (b); Zimmer Biomet (b)
Tomohiro Yamada, MD	Japan	No Relationships
Ryo Yamamura, MD	Japan	No Relationships
Yu Yamato, MD, PhD	Japan	No Relationships
Jingyan Yang, MHS	United States	No Relationships
Seung Heon Yang, MD	Korea, South	No Relationships
Yang Yang, MD	China	No Relationships
Walid K. Yassir, MD	United States	No Relationships
Tatsuya Yasuda, MD	Japan	No Relationships
Yasemin Yavuz, PhD	Turkey	No Relationships
Kelvin Yeung, PhD	Hong Kong	OrthoSmart (c, g)
Kwong Hang Yeung, MS, BS	Hong Kong	No Relationships
Caglar Yilgor, MD	Turkey	No Relationships
Benjamin Hon Kei Yip, PhD	Hong Kong	No Relationships
Sanar S. Yokhana, MD	United States	No Relationships
Joonho Yoon, MD	Korea, South	No Relationships
Philip J. York, MD	United States	No Relationships
Go Yoshida, MD, PhD	Japan	No Relationships
Haiming Yu, MD	China	No Relationships
Keyi Yu, MD	China	No Relationships
Miao Yu, MD	China	No Relationships
Yang Yu, MD	China	No Relationships
Wangshu Yuan	China	No Relationships
Altug Yucekul, MD	Turkey	No Relationships
Selcen Yuksel, PhD	Turkey	No Relationships
Nikita Zaborovskii, MD, PhD	Russia	No Relationships
Yan Zeng, MD	China	No Relationships
Zhi-min Zeng, MD	China	No Relationships
Evangelia M. Zgonis, BS	United States	No Relationships

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

DISCLOSURES

Jianguo Zhang, MD	China	No Relationships
Yangpu Zhang, MD	China	No Relationships
Yuancheng Zhang, MS	China	No Relationships
Yong-Ping Zheng, PhD	Hong Kong	Telefield Medical Imaging Limited (b, g)
Feng Zhenhua, MS	China	No Relationships
Junlong Zhong, MD	China	No Relationships
Peter L. Zhou, MD	United States	No Relationships
Rongping Zhou, MD, PhD	China	No Relationships
Zezhang Zhu, MD	China	No Relationships
Joseph Zuckerman, MD	United States	No Relationships
Tais Zulemyan, MSc	Turkey	No Relationships
Corinna Zygourakis, MD	United States	No Relationships
STAFF		
Lily Atonio	United States	No Relationships
Alysha Chapman, CNP	United States	No Relationships
Ann D'Arienzo, CMP	United States	No Relationships
Tressa Goulding, CAE	United States	No Relationships
Jenifer Heller	United States	No Relationships
Courtney Kissinger	United States	No Relationships
Lauren Kritter	United States	No Relationships
Ashtin Neuschaefer	United States	No Relationships
Shawn Storey	United States	No Relationships

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

MEETING AGENDA

The Scoliosis Research Society gratefully acknowledges Medtronic for their grant support of the IMAST Lunch with the Experts Session.

MEETING AGENDA

WEDNESDAY, JULY 17, 2019

14:00-19:00

Registration Open

17:30-19:00

Welcome Reception in the Exhibit Hall

19:15-20:30

Concurrent Sessions: Cases & Cocktails

Cases & Cocktails 1: PJK After Adult Deformity Surgery: How Can We Lower the Incidence?
G106
Moderator: Pierre Roussouly, MD
Faculty Discussion Leaders: Munish C. Gupta, MD; Ian J. Harding, BA, FRCS (Orth); Han Jo Kim, MD; Ibrahim Obeid, MD; Ferran Pellisé, MD, PhD; Dominique A. Rothenfluh, MD, PhD; Christopher I. Shaffrey, MD

Cases & Cocktails 2: Current Pros and Cons of Robotics and Navigation of Today
G103
Moderator: Bernhard Meyer, MD
Faculty Discussion Leaders: Kariman Abelin-Genevois, MD, PhD; René M. Castelein, MD, PhD; John R. Dimar II, MD; Yu-Mi Ryang, MD; Rajiv K. Sethi, MD; Justin S. Smith, MD, PhD; Juan S. Uribe, MD

Cases & Cocktails 3: Tethering for Scoliosis: Does it Really Work and What are the Indications?
G104
Moderator: Ahmet Alanay, MD
Faculty Discussion Leaders: Laurel C. Blakemore, MD; Ilkka J. Helenius, MD, PhD; Moyo C. Kruyt, MD, PhD; Baron S. Lonner, MD; Peter O. Newton, MD; Stefan Parent, MD, PhD; Amer F. Samdani, MD

Cases & Cocktails 4: Complex Pediatric Cases: Looking for a Solution
G105
Moderator: Behrooz A. Akbarnia, MD
Faculty Discussion Leaders: Marinus de Kleuver, MD, PhD; Ron El-Hawary, MD; Dezsoe J. Jeszenszky, MD, PhD; Heiko Koller, MD; Suken A. Shah, MD; Paul D. Sponseller, MD, MBA, Muharrem Yazici, MD

THURSDAY, JULY 18, 2019

7:30-17:30

Registration Open

8:00-9:00

***Hands-On Workshops with Breakfast (Non-CME)**
DePuy Synthes – Room: G103

(See the "Exhibits and Hands-On Workshops (HOW)" section on page page 200 for more information.)

8:30-17:00

Exhibit Hall Open

MEETING AGENDA

THURSDAY, JULY 18, 2019

9:00-11:15

Session 1: Whitecloud Award Nominees & Presidential Keynote Address
Auditorium
Moderators: Henry F.H. Halm, MD & Peter O. Newton, MD

9:00-9:05 Welcome Address
Henry F.H. Halm, MD

9:05-9:09 Paper #1: Safety of Pedicle Screw Placement in a Large Series of AIS Patients: Is Navigation Necessary?†
Daniel J. Sucato, MD, MS; Kiley Frazier Poppino, BS; Lori A. Karol, MD

9:09-9:13 Paper #2: Preemptive Pregabalin Does Not Reduce Postoperative Opioid Consumption or Pain in Children and Adolescents Undergoing Posterior Instrumented Spinal Fusion†
Linda Helenius, MD; Hanna Oksanen, RN; Markus Lastikka, MD; Olli T. Pajulo, MD, PhD; Tuula Manner, MD, PhD; Ilkka J. Helenius, MD, PhD

9:13-9:17 Paper #3: Computer-assisted Surgical Navigation is Associated with an Increased Risk of Neurological Complications: A Review of 67,264 Posterolateral Lumbar Fusion Cases†
Remi M. Ajiboye, MD; Jayme Koltsov, PhD; Ivan Cheng, MD

9:17-9:26 Discussion

9:26-9:30 Paper #4: Two-level Cervical Disc Arthroplasty vs. Anterior Cervical Discectomy and Fusion: Ten Year Outcomes for a Prospective, Randomized IDE Clinical Trial†
Jeffrey McConnell, MD; Scott D. Hodges, DO; Matthew F. Gornet, MD; Todd H. Lanman, MD; John Kenneth Burkus, MD

9:30-9:34 Paper #5: Effect of Topical Steroid on Swallowing Following ACDF: Results of a Prospective Double Blind Randomized Control Trial (RCT)†
Dan Stein, BS; Han Jo Kim, MD; Darren R. Lebl, MD; Russel C. Huang, MD; Renaud Lafage, MS; Todd J. Albert, MD

9:34-9:38 Paper #6: Assessment of the Efficacy of Teriparatide in Patients Undergoing Posterolateral Lumbar Spinal Fusion: A Randomized Double-blind Pilot Study†
Shane Burch, MD, MS, FRCS(C); Kevin Taliaferro, MD; Paramjit Singh, MD; Rachelle Palkovsky, BS; Vedat Deviren, MD; Sigurd H. Berven, MD; Bobby Tay, MD

9:38-9:47 Discussion

9:47-9:51 Paper #7: Intravenous Ketorolac Substantially Reduces Opioid Use Following Lumbar Spinal Fusion: Early Results of a Randomized, Double-blinded, Placebo Controlled Trial†
Sravisht Iyer, MD; Evangelia M. Zgonis, BS; Michael E. Steinhaus, MD; Jeffrey J. Varghese, MD, BS; Dan Stein, BS; Jingyan Yang, MHS; Todd J. Albert, MD; Frank J. Schwab, MD; Darren R. Lebl, MD; Han Jo Kim, MD; Matthew E. Cunningham, MD, PhD; James C. Farmer, MD; Federico P. Girardi, MD; Russel C. Huang, MD; Sheeraz Qureshi, MD; Bernard A. Rawlins, MD; James D. Beckman, MD; Harvinder S. Sandhu, MD, MBA

9:51-9:55 Paper #8: Clinical Outcomes, Recovery and Return to Work After Surgery for Lumbar Disk Herniation: A Randomized Clinical Trial Comparing the Effect of Supervised Rehabilitation Versus Home Exercise†
Rune Tendal Paulsen, MD; Jesper Rasmussen, MD; Leah Yacat Carreon, MD, MS; Mikkel Ø Andersen, MD

9:55-9:59 Paper #9: Does Degenerative Lumbar Spondylolisthesis Require an Instrumented Fusion? A 5-Year Follow-up Study†
Calvin C. Kuo, MD; Maqdooda Merchant, MSc, MA; Mayur P. Kardile, MD; Alem Yacob, MD, MS; Kamran Majid, MD, MBA; Ravi S. Bains, MD

9:59-10:08 Discussion

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

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

MEETING AGENDA

THURSDAY, JULY 18, 2019

10:08-10:12 Paper #10: Unraveling the Hip-spine Dilemma: Is Pelvic Incidence Linked to Hip Morphology and Pathology?*
Joost HJ van Erp, MD; Tom P. Schlösser, MD, PhD; Vahid Arbabi, PhD; René M. Castelein, MD, PhD; Arthur de Gast, MD, PhD; Harrie Weinans, PhD

10:12-10:16 Paper #11: Controlled Dynamic Spine Distraction Increases Vertebral Body Growth, Intervertebral Disc Height and Volume and Nucleus Pulposus Proliferation: An in Vivo Study on Rodent Tail Model*
Pooria Salari, MD; Garrett Easson, MS; Simon Y. Tang, PhD

10:16-10:20 Paper #12: The Effect of Surgical Decompression on Spine and Lower Extremity Range of Motion during Gait in Patients with Cervical Spondylotic Myelopathy*
Ram Haddas, PhD, MS, MEng; Isador H. Lieberman, MD, FRCS(C); Peter B. Derman, MD, MBA

10:20-10:29 Discussion

10:29-10:33 Paper #13: Correlation of Collagen X Biomarker (CXM) with Peak Height Velocity and Radiographic Measures of Growth in Idiopathic Scoliosis*
Michelle C. Welborn, MD; Susan Sienko, PhD; Ryan Coghlan, MS; William Horton, MD

10:33-10:37 Paper #14: Electrospun Synthetic Bone Scaffolds Promote Mesenchymal Stem Cell Function and Spinal Fusion*
Derek G. Ju, MD; Juliane D. Glaeser, PhD; Khosrowdad Salehi, BS; Linda E. A. Kanim, MA; Phillip H. Behrens, MD; Melodie F. Metzger, PhD; Dmitriy Sheyn, PhD; Hyun W. Bae, MD

10:37-10:41 Paper #15: A Comparison of Propionibacterium Acnes Survival on Cobalt-Chromium Alloy and Titanium Alloy*
Kota Watanabe, MD, PhD; Satoshi Fukuzaki, PhD; Atsushi Sugino, PhD; Satoshi Suzuki, MD, PhD; Osahiko Tsuji, MD, PhD; Narihito Nagoshi, MD; Eijiro Okada, MD, PhD; Nobuyuki Fujita, MD, PhD; Mitsuru Yagi, MD, PhD; Nicholas M. Benson, PhD; Newton H. Metcalf, BS; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD, PhD

10:41-10:51 Discussion

10:51-10:54 Preview of 54th Annual Meeting
Stefan Parent, MD, PhD

10:54-10:57 Preview of 27th IMAST Meeting
Henry F.H. Halm, MD

10:57-11:00 Introduction of President
Paul D. Sponseller, MD, MBA

11:00-11:15 Keynote Address
Peter O. Newton, MD

11:15-11:50

Refreshment Break and Exhibit Viewing

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

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

MEETING AGENDA

THURSDAY, JULY 18, 2019

11:50-12:53

Concurrent Sessions 2A-B: Abstract Presentations

11:50-12:53

2A: Innovations in Early Onset Scoliosis and Neuromuscular Scoliosis
Forum
Moderators: René M. Castelein, MD, PhD & Marinus de Kleuver, MD, PhD

11:50-11:54 Paper #16: Clinical Effectiveness of Distraction Measurements with Ultrasonography in Magnetic Controlled Growing Rods
Shreya Srinivas, FRCS; Lisa Marie Andre, RN; Colin E. Bruce, FRCS; Jayesh Trivedi, FRCS; Sudarshan Munigangaiah, FRCS; Neil T. Davidson, FRCS

11:54-11:58 Paper #17: Novel Technique for Early Onset Scoliosis Casting Using Jackson Table
Blake K. Montgomery, MD; Kali Tileston, MD; Japsimran Kaur, BS; Meghan N. Imrie, MD; James F. Policy, MD; Lawrence A. Rinsky, MD; John S. Vorhies, MD

11:58-12:02 Paper #18: Analysis of Respiratory Motion in Preoperative Early Onset Scoliosis by Dynamic MRI
Toshiaki Kotani, MD, PhD; Noriaki Kawakami, MD; Toshiki Saito, MD; Ryoji Tauchi, MD; Tetsuya Ohara, MD; Tsuyoshi Sakuma, MD, PhD; Keita Nakayama, MD; Yasushi Iijima, MD, PhD; Tsutomu Akazawa, MD, PhD; Kazuhide Inage, MD, PhD; Seiji Ohtori, MD, PhD; Shohei Minami, MD, PhD

12:02-12:11 Discussion

12:11-12:15 Paper #19: Contouring the Expandable End of the Growing Rod Increases the Risk of Proximal Junctional Kyphosis in Early Onset Scoliosis
Saba Pasha, PhD

12:15-12:19 Paper #20: Upper Instrumented Vertebrae Distal to T2 Leads to a Higher Incidence of Proximal Junctional Kyphosis During Growing-rod Treatment for Early Onset Scoliosis
Aixing Pan, MD, PhD; Yong Hai, MD, PhD

12:19-12:23 Paper #21: Using Ultrasound for Screening Scoliosis to Reduce Unnecessary X- ray Exposure: A Prospective Diagnostic Accuracy Study on 442 Schoolchildren from a Scoliosis Screening Program
Tsz-Ping Lam, MBBS; Yi-Shun Wong, BSc (Hons); Benjamin Hon Kei Yip, PhD; Bobby Kinwah Ng, MD; Lik Hang Alec Hung, FRCS; Winnie Chiu Wing Chu, MD; Yong-Ping Zheng, PhD; Kelly Ka-Lee Lai, BS; Wayne Y.W. Lee, PhD; Yong Qiu, MD; Jack C.Y. Cheng, MD

12:23-12:32 Discussion

12:32-12:36 Paper #22: Slow Correction of Severe Adult Spastic Scoliosis by Stepwise Distraction of Magnetically Controlled Growing Rods (MCGR) and Final Posterior Spinal Fusion
Christof Birkenmaier, MD; Bernd Wegener, MD; Jan H. Mehrkens, MD; Carolin Melcher, MD

12:36-12:40 Paper #23: Ambulatory NMS Patients have Similar Rates of Infection, Revision, Overall Complication, and Revision Rates to AIS Patients.
Vishal Sarwahi, MD; Francisco J. Laplaza, MD; Jesse Galina, BS; Aaron M. Atlas, BS; Sayyida Hasan, BS; Chhavi Katyal, MD; Marina Moguilevtch, MD; Jon-Paul P. DiMauro, MD; Yungtai Lo, PhD; Aleksandra Djukic, MD; Terry D. Amaral, MD

12:40-12:44 Paper #24: Using a Novel Augmented Reality and Artificial Intelligence Surgical Guidance System for Pedicle Screw Placement: A Cadaveric Study
Karina M. Katchko, MD

12:44-12:53 Discussion

MEETING AGENDA

THURSDAY, JULY 18, 2019

11:50-12:53

2B: Cervical and Lumbar Degenerative Spine
Auditorium
Moderators: Christopher I. Shaffrey, MD & Clement Silvestre, MD

11:50-11:54 Paper #25: Towards a Cervical Deformity-specific Outcome Instrument: Use of the Patient-generated Index to Capture the Disability of Cervical Deformity
Nicholas Stekas, MS; Themistocles S. Protopsaltis, MD; Ethan W. Ayres, MPH; Gregory M. Mundis Jr., MD; Justin S. Smith, MD, PhD; Robert A. Hart, MD; D. Kojo Hamilton, MD; Eric O. Klineberg, MD; Daniel M. Sciubba, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Frank J. Schwab, MD; Virginie Lafage, PhD; Christopher P. Ames, MD; International Spine Study Group

11:54-11:58 Paper #26: Comparison of Perioperative Complications Following Posterior Column Osteotomies Versus Posterior Based Three Column Osteotomy for Correction of Moderate to Severe Cervical Sagittal Deformity in 95 Patients at Single Center
Darryl Lau, MD; Cecilia L. Dalle Ore, BS; Vedat Deviren, MD; Christopher P. Ames, MD

11:58-12:02 Paper #27: Does One Year Post-operative Cord Signal Changes in MRI Correlate with Neurological Recovery in Patients with Cervical Spondylotic Myelopathy (CSM)?
Saumyajit Basu, MD, FRCS; Naveen Agrawal, MS; Somashekar D., MBBS, MS

12:02-12:11 Discussion

12:11-12:15 Paper #28: Transforaminal Epidural Injection of Local Anesthetic and Dorsal Root Ganglion Pulsed Radiofrequency Treatment in Lumbosacral Radicular Pain: A Randomized, Triple-blind, Active-control Trial
Manish De, MD, MBBS; Bhavuk Garg, MS, MRCS, FACS; Virender Kumar Mohan, MD, MBBS

12:15-12:19 Paper #29: Outcomes of Decompression without Fusion in Patients with Lumbar Spinal Stenosis with Back Pain
Rachid Bech-Azeddine, PhD; Søren Fruensgaard, MD; Mikkel Ø Andersen, MD; Leah Yacat Carreon, MD, MS

12:19-12:23 Paper #30: Which MRI Findings are Associated with Long-term Disability in Low Back Pain Patients?
Peter Muhareb Udby, MD, DC; Soren Ohrt-Nissen, MD, PhD; Michael Rud Lassen, MD; Stig Brorson, PhD, DMSc; Leah Yacat Carreon, MD, MS; Mikkel Ø Andersen, MD

12:23-12:32 Discussion

12:32-12:36 Paper #31: Lateral Lumbar Interbody Fusion with Percutaneous Pedicle Screw Fixation (LLIF-PPS): Are We Getting the Sagittal Alignment Right?
Jonathan N. Sembrano, MD; Nicholas R. Dick, BS; J. Alex Thomas, MD; Breana Siljander, MD

12:36-12:40 Paper #32: Does ACR Result in Greater Morbidity than LLIF Alone When Treating Adult Spinal Deformity?
Robert K. Eastlack, MD; Dean Chou, MD; Juan S. Uribe, MD; Richard G. Fessler, MD, PhD; Khoi D. Than, MD; Stacie Tran, MPH; Paul Park, MD; Kai-Ming Gregory Fu, MD, PhD; Michael Y. Wang, MD; Adam S. Kanter, MD; David O. Okonkwo, MD, PhD; Pierce D. Nunley, MD; Neel Anand, MD; Gregory M. Mundis Jr., MD; Praveen V. Mummaneni, MD; International Spine Study Group

12:40-12:44 Paper #33: Economic Analysis of 90-day Return to the Emergency Room and Readmission After Elective Lumbar Spine Surgery: A Single Center Analysis of 5,444 Patients
Marcel R. Wiley, MD; Leah Yacat Carreon, MD, MS; Mladen Djurasovic, MD; Steven D. Glassman, MD; Yehia H. Khalil, PhD; Michelle Kannapel; Jeffrey L. Gum, MD

12:44-12:53 Discussion

12:53-14:05

Exhibit Viewing & Lunch

13:05-14:05

***Hands-On Workshops with Lunch (Non-CME)**
K2M – Room: G103
NuVasive – Room: G104
Medtronic – Room: G105
Globus Medical, Inc. – Room: G106
Zimmer Biomet – Room: G107

(See the "Exhibits and Hands-On Workshops (HOW)" section on page page 200 *for more information.)*

MEETING AGENDA

THURSDAY, JULY 18, 2019

14:05-14:10

Walking Break

14:10-15:10

Concurrent Sessions 3A-B: Instructional Course Lectures

14:10-15:10

3A: Early Onset Scoliosis: Staying Current in 2019
Forum
Moderators: Ilkka J. Helenius, MD, PhD & Paul D. Sponseller, MD, MBA

14:10-14:12 Introduction
Behrooz A. Akbarnia, MD

14:12-14:18 Early Onset Scoliosis: Trends and Challenges
Paul D. Sponseller, MD, MBA

14:18-14:27 Casting Indications and Contra-indications, the Role of Bracing in EOS and Techniques for Both
Suken A. Shah, MD

14:27-14:37 Refining What Works: Best Indications for Shilla, Growing Rods and VEPTR: Tips and Novel Constructs for Special Needs
Laurel C. Blakemore, MD

14:37-14:44 Discussion

14:44-14:53 MCGR Best and Worst Indications: Timing, Tips and Tricks
Kenneth MC Cheung, MD

14:53-15:02 When to Perform Final Fusion and Other Options after Growing Rod Lengthening
Muharrem Yazici, MD

15:02-15:10 Discussion

14:10-15:10

3B: Sagittal Balance: Angles Are Not Everything
Auditorium
Moderators: Sébastien Charosky, MD & Pierre Roussouly, MD

14:10-14:18 Sagittal Balance and Spinopelvic Parameters: Important Basics
Clement Silvestre, MD

14:18-14:26 Sagittal Balance in the Pediatric Population
Kariman Abelin-Genevois, MD, PhD

14:26-14:34 From Degenerative to Deformity, How Misunderstanding the Principles Can Get You in Trouble
Ronald A. Lehman Jr., MD

14:34-14:42 Sagittal Balance: Do the Goals Always Justify the Means?
Ian J. Harding, BA, FRCS (Orth)

14:42-14:50 Is PJK as Multifactorial as We Think or are We Just Not Getting the Balance Right?
Sébastien Charosky, MD

14:50-15:10 Discussion

15:10-15:20

Walking Break

15:20-16:20

Concurrent Sessions 4A-B: Debates

MEETING AGENDA

THURSDAY, JULY 18, 2019

15:20-16:20

4A: Growth Modulation Techniques for Deformity: Here to Stay or Flash in the Pan?
Forum
Moderators: Kenneth MC Cheung, MD & Dezsoe J. Jeszenszky, MD, PhD

15:20-15:25 Introduction
Kenneth MC Cheung, MD

15:25-15:33 Anterior Vertebral Body Tethering for Adolescent Scoliosis
Amer F. Samdani, MD

15:33-15:41 Case Discussion
Ahmet Alanay, MD

15:41-15:49 Posterior Motion Sparing Techniques for Adolescent Scoliosis
Ron El-Hawary, MD

15:49-15:57 Voice of Reason: Posterior Fusion for Adolescent Scoliosis is the Gold Standard
Suken A. Shah, MD

15:57-16:05 Wait…What?! Anterior Vertebral Body Tethering for Adult Scoliosis?
Baron S. Lonner, MD

16:05-16:20 Discussion

15:20-16:20

4B: Spinal Navigation: Increased Accuracy and Safety or Just Another Toy?
Auditorium
Moderators: Ulf R. Liljenqvist, MD & Rajiv K. Sethi, MD

15:20-15:28 Pro Navigation in Instrumented Spine Surgery: For the Safety of the Patient and Less Radiation to the Surgeon
Bernhard Meyer, MD

15:28-15:36 Counterpoint Navigation in Instrumented Spine Surgery: We Are Getting the Same Patient Outcomes with Less Radiation for the Patient with Less Cost and Faster OR Times
Henry F.H. Halm, MD

15:36-15:44 Increased Safety for Patients with Navigation in Cervical Spine Pathology, Especially Rheumatoid Arthritis
Yu-Mi Ryang, MD

15:44-15:55 Discussion

15:55-16:03 Spinal Stenosis and Degenerative Spondylolisthesis: Pro-decompression and Stabilization
Ulf R. Liljenqvist, MD

16:03-16:11 Spinal Stenosis and Degenerative Spondylolisthesis: Pro-decompression without Stabilization
Yu-Mi Ryang, MD

16:11-16:20 Discussion

16:20-16:50

Refreshment Break & Exhibit Viewing

16:50-17:50

Concurrent Sessions 5A-B: Instructional Course Lectures

MEETING AGENDA

THURSDAY, JULY 18, 2019

16:50-17:50

5A: Innovations in Spinal Implant Technology: Opportunities and Risks
Auditorium
Moderators: René M. Castelein, MD, PhD & Marinus de Kleuver, MD, PhD

16:50-17:00 Bridging the Spine with Bipolar Fixation Instead of All Level Fixation and Fusion
Lotfi Miladi, MD

17:00-17:05 Discussion

17:05-17:10 Innovative Methods for Magnetic Controlled Growing Rods in EOS: Pearls and Pitfalls
Phillip Horsting, MD

17:10-17:15 Hybrid use of Magnetically Controlled Growing Rods
Sebastiaan P.J. Wijdicks, MD

17:15-17:25 Spring Distraction System and its Applications
Moyo C. Kruyt, MD, PhD

17:25-17:35 Discussion

17:35-17:45 Application of 3D Printed Spinal Implants
Maarten Spruit, MD

17:45-17:50 Discussion

16:50-17:50

5B: Disc Replacement in the Cervical Spine: Is it the New Gold Standard?
Forum
Moderators: Bernhard Meyer, MD & Fernando Techy, MD

16:50-17:00 ACDF is Better to Treat Radiculopathy
Luiz Roberto Vialle, MD

17:00-17:10 Disc Replacement is Better to Treat Radiculopathy
Fernando Techy, MD

17:10-17:20 It's OK to Treat Myelopathy with Disc Replacement Surgery
Ronald A. Lehman Jr., MD

17:20-17:30 I Prefer the Stability of Fusion to Treat Myelopathy
Michael G. Fehlings, MD, PhD, FRCSC, FACS

17:30-17:50 Discussion

17:50-18:00

Walking Break

18:00-19:00

***Afternoon Hands-On Workshops with Beverages and Snacks (Non-CME)**
K2M – Room: G103

(See the "Exhibits and Hands-On Workshops (HOW)" section on page page 200 for more information.)

MEETING AGENDA

FRIDAY, JULY 19, 2019

7:30-16:30

Registration Open

8:00-9:00

***Hands-On Workshop with Breakfast (Non-CME)**
K2M – Room: G103
Medtronic – Room: G104
DePuy Synthes – Room: G105
Zimmer Biomet – Room: G106

(See the "Exhibits and Hands-On Workshops (HOW)" section on page page 200 for more information.)

8:30-15:45

Exhibit Hall Open

9:00-10:10

Concurrent Sessions 6A-B: Abstract Presentations

9:00-10:10

6A: AIS Complications, Kyphosis, Miscellaneous
Forum
Moderators: Ron El-Hawary, MD & Ilkka J. Helenius, MD, PhD

9:00-9:05	Announcements
9:05-9:09	Paper #34: Incidence of PJK with Pedicle Screws at Upper Instrumented Vertebrae in Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis *Yoji Ogura, MD; Steven D. Glassman, MD; Daniel J. Sucato, MD, MS; Michael T. Hresko, MD; Leah Yacat Carreon, MD, MS*
9:09-9:13	Paper #35: Incidence of Delayed Spinal Cord Injury in Pediatric Spine Deformity Surgery Seems to be Higher than Previously Assumed *Jeroen Renkens, MD; Tom P. Schlösser, MD, PhD; Agnita Stadhouder, MD; Moyo C. Kruyt, MD, PhD; Adriaan K. Mostert, MD, PhD; Luuk de Klerk, MD, PhD; Marinus de Kleuver, MD, PhD; René M. Castelein, MD, PhD; Joost Rutges, MD, PhD*
9:13-9:17	Paper #36: Under-contoured Proximal Rod: A Potential Risk Factor of PJK in Scheuermann's Kyphosis *Michael Grelat, MD; Changzhi Du, MD; Xu Sun, MD; Yong Qiu, MD*
9:17-9:26	Discussion
9:26-9:30	Paper #37: Can One-level Pedicle Subtraction Osteotomy (PSO) Provide Satisfied Outcomes for Severe Thoracolumbar Kyphosis with Global Kyphosis≥80° in Ankylosing Spondylitis: A Comparison with Two-level PSO *Bangping Qian, MD; Jichen Huang, MD; Yong Qiu, MD; Bin Wang, MD; Yang Yu, MD; Feng Zhenhua, MS; Junyin Qiu; Hongbin Ni, MD*
9:30-9:34	Paper #38: Same Old Pain for Posterior Spinal Fusion in Adolescent Idiopathic Scoliosis: A Quality Safety Value Journey to Less Inpatient Opioids *Heather Kent, MSN, RN, CPNP; Christopher B. McLeod, DO; Brandon A. Ramo, MD; Charu Sharma, MS, MHA; Kerry Wilder, RN; Lori A. Karol, MD*
9:34-9:38	Paper #39: Sports-related Cervical Spine Fracture and Spinal Cord Injury: A Review of Nationwide Pediatric Trends *Haddy Alas, BS; Avery Brown, BS; Katherine E. Pierce, BS; Cole Bortz, BA; Michael J. Moses, MD; Dennis Vasquez-Montes, MS; Bassel G. Diebo, MD; Carl B. Paulino, MD; Aaron J. Buckland, MBBS, FRACS; Michael C. Gerling, MD; Peter G. Passias, MD*
9:38-9:47	Discussion

MEETING AGENDA

FRIDAY, JULY 19, 2019

9:47-9:51 Paper #40: Pedicled Omental Flaps for Complex Wound Reconstruction for Chordoma of the Mobile Spine and Sacrum
John H. Shin, MD; Joseph H. Schwab, MD, MS; Francis J. Hornicek, MD, PhD

9:51-9:55 Paper #41: The Use of Autologous Free Vascularized Fibula Grafts in Reconstruction of the Mobile Spine Following Tumor Resection: Surgical Technique and Outcomes
Michiel E.R. Bongers, MD; Paul T. Ogink, MD; Katrina F. Chu, MD; Anuj Patel, MD; Brett D. Rosenthal, MD; John H. Shin, MD; Francis J. Hornicek, MD, PhD; Joseph H. Schwab, MD, MS

9:55-9:59 Paper #42: Bridging the Pay Gap: An Assessment of Medicare Procedure Volume and Reimbursement Among Spine Surgeons
Marine Coste, BA; George A. Beyer, MS; Sarah Stroud, AB; Harleen Kaur, BA; Qurratul-Ain Dar, BS; Nicole R. Vingan, BS; Lana Kass-Gergi, MS; Joanne Dekis, MD; Neil V. Shah, MD, MS; Bassel G. Diebo, MD; Virginie Lafage, PhD; Carl B. Paulino, MD

9:59-10:10 Discussion

9:00-10:10

6B: Adult Spine Considerations
Auditorium
Moderators: Han Jo Kim, MD & Luiz Roberto Vialle, MD

9:00-9:05 Announcements

9:05-9:09 Paper #43: Machine Learning Models to Predict Operative versus Non-operative Management of Adult Spinal Deformity Patients
Wesley M. Durand, BS; Alan H. Daniels, MD; D. Kojo Hamilton, MD; Peter G. Passias, MD; Han Jo Kim, MD; Themistocles S. Protopsaltis, MD; Virginie Lafage, PhD; Justin S. Smith MD, PhD; Christopher I. Shaffrey, MD; Munish C. Gupta, MD; Eric O. Klineberg, MD; Frank J. Schwab, MD; Michael P. Kelly, MD, MS; Douglas C. Burton, MD; Shay Bess, MD; Christopher P. Ames, MD; Robert A. Hart, MD; International Spine Study Group

9:09-9:13 Paper #44: Prospective Enumeration of Opioid Consumption Patterns after Lumbar Decompression or Microdiscectomy Using a Novel Text Messaging System
Francis C. Lovecchio, MD; Ajay Premkumar, MD, MPH; Jeffrey G. Stepan, MD, MS; Dianna L. Mejia, BS; Dan Stein, BS; Dil Patel, BS; Benjamin Khechen, BS; Sravisht Iyer, MD; Darren R. Lebl, MD; Sheeraz Qureshi, MD; Virginie Lafage, PhD; Russel C. Huang, MD; Kern Singh, MD; Todd J. Albert, MD

9:13-9:17 Paper #45: Patient-controlled Analgesia Following Lumbar Spinal Fusion Surgery is Associated with Increased Opioid Consumption and Opioid-related Adverse Events
Corey T. Walker, MD; Arpan A. Patel, BS; Virginia Prendergast, PhD, NP-C; Jakub Godzik, MD; Udaya K. Kakarla, MD; Juan S. Uribe, MD; Jay D. Turner, MD, PhD

9:17-9:26 Discussion

9:26-9:30 Paper #46: Initiation of a Standardized Escalation Pain Protocol after 1-2 Level Lumbar Fusion Reduces In-hospital Opioid Consumption
Portia A. Steele, MS; Jeffrey L. Gum, MD; Morgan Brown, MS; Christy L. Daniels, MS; Mladen Djurasovic, MD; Charles H. Crawford III, MD; Steven D. Glassman, MD; Leah Yacat Carreon, MD, MS

9:30-9:34 Paper #47: A Predictive Model for Early Reoperations and Readmissions in Adult Spinal Deformity
Nathan J. Lee, MD; Meghan Cerpa, BS, MPH; Joseph M. Lombardi, MD; Alex Ha, MD; Paul J. Park, MD; Eric Leung, BA; Zeeshan M. Sardar, MD, MS, FRCS(C); Lawrence G. Lenke, MD; Ronald A. Lehman Jr., MD

9:34-9:38 Paper #48: Propionibacterium Acnes Biofilm in Human Lumbar Discectomy Material Supports the Existence of Low-grade Infection over Sample Contamination
Manu Capoor, MD; Filip Ruzicka, PhD; Garth James, PhD; Tana Machakova, MS; Radim Jancalek, MD, PhD; Fahad Ahmed, BS; Todd Alamin, MD; Neel Anand, MD; Nitin N. Bhatia, MD; Robert K. Eastlack, MD; Steven R. Garfin, MD; Ziya L. Gokaslan, MD; Calvin C. Kuo, MD; Konstantinos Mavromattis, PhD; Assaf Raz, PhD; Jiri Sana, PhD; Philip S. Stewart, PhD; Jeffrey C. Wang, MD; Timothy F. Witham, MD; Michael F. Coscia, MD; Christof Birkenmaier, MD; Vincent A. Fischetti, PhD; Ondrej Slaby, PhD

9:38-9:47 Discussion

MEETING AGENDA

FRIDAY, JULY 19, 2019

9:47-9:51 Paper #49: Fat Infiltration and Spine Flexibility are Risk Factors for Proximal Junctional Kyphosis
Jonathan Charles Elysée, BS; Renaud Lafage, MS; Mathieu Bannwarth, MD; Alex Liu Huang; Bryan Ang, BS; Katherine E. Pierce, BS; Jessica Andres-Bergos, PhD; Peter G. Passias, MD; Han Jo Kim, MD; Frank J. Schwab, MD; Virginie Lafage, PhD

9:51-9:55 Paper #50: Relaxed Sitting-standing Lumbopelvic Mechanics in the Setting of Lumbar Spinal Pathology and Fusion
Edem J. Abotsi, BA; Ran Schwarzkopf, MD; Joseph Zuckerman, MD; Roy Davidovitch, MD; Dennis Vasquez-Montes, MS; Erik Wang, BA; Jordan Manning, BA; Christopher G. Varlotta, BS; Ethan W. Ayres, MPH; Dainn Woo, BS; Max Egers, BS; Jonathan Vigdorchik, MD; Constance Maglaras, PhD; Aaron J. Buckland, MBBS, FRACS

9:55-9:59 Paper #51: Does Matching Roussouly Spinal Shape and Improvement in SRS-Schwab Modifier Contribute to Improved Patient-reported Outcomes?
Peter G. Passias, MD; Katherine E. Pierce, BS; Cole Bortz, BA; Haddy Alas, BS; Avery Brown, BS; Dennis Vasquez-Montes, MS; Ethan W. Ayres, MPH; Erik Wang, BA; Jordan Manning, BA; Christopher G. Varlotta, BS; Dainn Woo, BS; Edem J. Abotsi, BA; Max Egers, BS; Constance Maglaras, PhD; Bassel G. Diebo, MD; Tina Raman, MD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; Michael C. Gerling, MD

9:59-10:10 Discussion

10:10-10:40

Refreshment Break & Exhibit Viewing

10:40-12:05

Concurrent Sessions 7A-B: Abstract Presentations

10:40-12:05

7A: Innovations in Adolescent Idiopathic Scoliosis
Forum
Moderators: Kariman Abelin-Genevois, MD, PhD & Laurel C. Blakemore, MD

10:40-10:44 Paper #52: Treatment of Immature Idiopathic Scoliosis Patients with a Non-fusion Anterior Scoliosis Correction (ASC) Technique
William Paul Bassett, MD; M. Darryl Antonacci, MD; Laury A. Cuddihy, MD; Janet L. Cerrone, PA-C; Allison R. Haas, RN, BSN, CNOR, RNFA; Randal R. Betz, MD

10:44-10:48 Paper #53: Clinical Judgment of Initial Correction Need and Follow-up Curve Behavior after VBT According to Sanders Classification & Comparison to Fusion in a Matched Cohort
Ahmet Alanay, MD; Altug Yucekul, MD; Kadir Abul, MD; Gokhan Ergene, MD; Sahin Senay, MD; Binnaz Ay, MD; Barbaros Omer Cebeci; Ömer Orhun; Barkın Erdogan; Murat Pekmezci, MD; Suna Lahut, MSc, PhD; Tais Zulemyan, MSc; Yasemin Yavuz, PhD; Caglar Yilgor, MD

10:48-10:52 Paper #54: Non-fusion Anterior Scoliosis Correction (ASC): Comparison of Outcomes in Skeletally Immature vs. Skeletally Mature Patients with Adolescent Idiopathic Scoliosis
William Paul Bassett, MD; M. Darryl Antonacci, MD; Laury A. Cuddihy, MD; Janet L. Cerrone, PA-C; Allison R. Haas, RN, BSN, CNOR, RNFA; Randal R. Betz, MD

10:52-11:01 Discussion

11:01-11:05 Paper #55: Vertebral Body Tethering in Lumbar Curves. Minimum 2 Year Follow-up
Darren F. Lui, MBBS, FRCS; Shahnawaz Haleem, MBBS, MSc (Tr&Orth), MRCSEd, MRCSI, FRCS(Tr&Orth); Cristina Lupu, PA-C; Tim Bishop, MBBS, FRCS; Jason Bernard, MD, FRCS

11:05-11:09 Paper #56: Minimally Invasive Surgery Versus Open Posterior Approach for Adolescent Idiopathic Scoliosis: A Multi-center, Retrospective, Cohort Study
Gao Si, MD; Tong Li, MD; Miao Yu, MD

11:09-11:13 Paper #57: Minimally Invasive Surgery in AIS has Better Functional Outcomes, Decreased Costs, and Similar Radiographic Correction
Vishal Sarwahi, MD; Jesse Galina, BS; Rachel Gecelter, BS; Sayyida Hasan, BS; Stephen F. Wendolowski, BS; Yungtai Lo, PhD; Terry D. Amaral, MD; Aaron M. Atlas, BS

11:13-11:22 Discussion

MEETING AGENDA

FRIDAY, JULY 19, 2019

11:22-11:26 Paper #58: Are Postoperative Standing Radiographs Relevant Before Hospital Discharge in Adolescent Idiopathic Scoliosis?
Audrey Angelliaume, MD, MD Sc; Anne Laure Simon, MD, MS; Christophe J. Vidal, MD; Brice Ilharreborde, MD, PhD

11:26-11:30 Paper #59: Removal of Urinary Catheter Prior to Epidural Analgesia Discontinuation is Associated with Increased Risk of Post-operative Urinary Retention in Patients Undergoing Correction of Adolescent Idiopathic Scoliosis
Assem A. Sultan, MD; Ryan J. Berger, MD; William A. Cantrell, BS; Linsen T. Samuel, MD, MBA; Erin Ohliger, MD; Joshua L. Golubovsky, BS; Salam Bachour, BS; Selena Pasadyn, BA; Jaret M. Karnuta, BS; Jacob M. Rabin; Phuc Le, PhD, MPH; Thomas Kuivila, MD; David P. Gurd, MD; Ryan C. Goodwin, MD

11:30-11:34 Paper #60: One-stage Posterior Multiple Level Asymmetrical Ponte Osteotomies vs. Single Level Posterior Vertebral Column Resection for Severe and Rigid Adult Idiopathic Scoliosis: A Minimum 2-year Follow-up Comparative Study
Yangpu Zhang, MD; Yong Hai, MD, PhD; Aixing Pan, MD, PhD

11:34-11:43 Discussion

11:43-11:47 Paper #61: Patient Specific Designed and Manufactured Rods for AIS Surgical Correction: Applying the Principles of the New AIS Sagittal Classification
Pierre Grobost, MD; Stephane Verdun, PhD; Kariman Abelin-Genevois, MD, PhD

11:47-11:51 Paper #62: Progressive Correction Following Anterior Vertebral Body Growth Modulation of the Spine for Idiopathic Scoliosis: Prospective Evaluation of 50 Patients with Minimum 2-year Follow-up.
Marjolaine Roy-Beaudry, MSc; Abdulmajeed Alzakri, MD, MS; Isabelle Turgeon, BS; Olivier Turcot, BS; Stefan Parent, MD, PhD

11:51-11:55 Paper #63: Image Registration of 3D Ultrasound (3DUS) Vertebral Surfaces onto CT Vertebrae for Pedicle Screw Navigation in Adolescent Idiopathic Scoliosis (AIS) Surgery
Andrew Y. Chan, MD; Edmond H. Lou, PhD; Eric C. Parent, PhD

11:55-12:05 Discussion

10:40-12:05

7B: Innovations in Adult Spinal Deformity
Auditorium
Moderators: Heiko Koller, MD & Yong Qiu, MD

10:40-10:44 Paper #64: Single-position Adult Spinal Deformity Surgery with Minimally Invasive Lateral Lumbar Interbody Fusion and Lateral Segmental Screw-rod Fixation
Joseph L. Laratta, MD; Karishma Gupta, BS, MPH; William Smith, MD

10:44-10:48 Paper #65: Surgical Result of Adult Spinal Deformity Patients Treated with Lateral Interbody Fusion Combined with Posterior Fusion: Comparison with Propensity-score Matched Patients Treated with Posterior-only Approach
Naobumi Hosogane, MD, PhD; Mitsuru Yagi, MD, PhD; Hitoshi Kono, MD; Nobuyuki Fujita, MD, PhD; Shoichi Ichimura, MD; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD, PhD; Kota Watanabe, MD, PhD

10:48-10:52 Paper #66: Intraoperative Neuromonitoring for Lateral Lumbar Interbody Fusion: An Intra-operative Protocol to Avoid Postoperative Neurologic Deficit
Nicole Record, DO; Robert K. Eastlack, MD; Stacie Tran, MPH; Daniel J. Thibaudeau, MD; Alissa Carnelian, AuD; Kristina C. Brady, Au D; Behrooz A. Akbarnia, MD; Gregory M. Mundis Jr., MD

10:52-11:01 Discussion

11:01-11:05 Paper #67: Does Patient Frailty Status Influence Recovery Following Spinal Fusion for Adult Spinal Deformity?
Katherine E. Pierce, BS; Peter G. Passias, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Christopher P. Ames, MD; Douglas C. Burton, MD; Robert A. Hart, MD; D. Kojo Hamilton, MD; Michael P. Kelly, MD, MS; Richard Hostin, MD; Shay Bess, MD; Eric O. Klineberg, MD; Breton G. Line, BS; Christopher I. Shaffrey, MD; Praveen V. Mummaneni, MD; Justin S. Smith, MD, PhD; Frank J. Schwab, MD; International Spine Study Group

11:05-11:09 Paper #68: Efficacy of Multi-rod Constructs: Comparison of Two Different 4-Rod and 3-Rod Configurations in Adult Spinal Deformity Patients with Long Fusions to the Sacrum
Mostafa H. El Dafrawy, MD; Owoicho Adogwa, MD; Maksim A. Shlykov, MD, MS; Michael P. Kelly, MD, MS; Keith H. Bridwell, MD; Munish C. Gupta, MD

11:09-11:13 Paper #69: The Approach to Pseudarthrosis after Adult Spinal Deformity Surgery: Is a Multiple-rod Construct Necessary?
Tina Raman, MD; Khaled M. Kebaish, MD, FRCS(C); Thomas J. Errico, MD; Peter G. Passias, MD

11:13-11:22 Discussion

MEETING AGENDA

FRIDAY, JULY 19, 2019

11:22-11:26 Paper #70: Interbody Use Provides No Added Benefit Over 3-Rod Constructs in Adult Spinal Deformity Surgery
Philip J. York, MD; Michael E. Steinhaus, MD; Renaud Lafage, MS; Alex Liu Huang; Bryan Ang, BS; Jonathan Charles Elysée, BS; Frank J. Schwab, MD; Virginie Lafage, PhD; Han Jo Kim, MD

11:26-11:30 Paper #71: Does Interbody Support at L5-S1 Matter in Long Fusions to the Pelvis? A 5 Year Analysis
Nina J. Lara, MD; Donovan Lockwood, BS; Andrew Chung, DO; Jan Revella, RN; Dennis G. Crandall, MD; Michael S. Chang, MD

11:30-11:34 Paper #72: Supplemental Rods are Needed to Maximally Reduce Rod Strain Across the Lumbosacral Junction with TLIF but not ALIF in Long Constructs
Jakub Godzik, MD; Randall J. Hlubek, MD; Anna Newcomb, MS; Jennifer N. Lehrman, MS; Bernardo de Andrada, MD; S. Harrison Farber, MD; Lawrence G. Lenke, MD; Brian P. Kelly, PhD; Jay D. Turner, MD, PhD

11:34-11:43 Discussion

11:43-11:47 Paper #73: Effect of Supine Alignment on Post-operative Sagittal Alignment Following ASD Surgery
Jonathan Charles Elysée, BS; Renaud Lafage, MS; Mathieu Bannwarth, MD; Bryan Ang, BS; Alex Liu Huang; Haddy Alas, BS; Jessica Andres-Bergos, PhD; Peter G. Passias, MD; Han Jo Kim, MD; Frank J. Schwab, MD; Virginie Lafage, PhD

11:47-11:51 Paper #74: Gait Improvements in Adult Degenerative Scoliosis Patients at Three and Twelve Month Following Surgical Realignment
Damon Mar, PhD; Isador H. Lieberman, MD, FRCS(C); Ram Haddas, PhD, MS, MEng

11:51-11:55 Paper #75: First Application of the Dubousset Functional Test in Patients with Spinal Pathologies: The Future of Objective Clinical Outcomes is Now
Bassel G. Diebo, MD; Neil V. Shah, MD, MS; David Kim, BS; Oscar Krol; David J. Kim, BS; Michael G. Dubner, BA; Neil Patel, BS, BA; Rachel Axman; Harleen Kaur, BA; Adam J. Wolfert, BA; Barthelemy Liabaud, MD; Renaud Lafage, MS; Carl B. Paulino, MD; Peter G. Passias, MD; Vincent Challier, MD; Frank J. Schwab, MD; Virginie Lafage, PhD

11:55-12:05 Discussion

12:05-13:15

Exhibit Viewing & Lunch

12:15-13:15

***Hands-On Workshops with Lunch (Non-CME)**
K2M – Room: G103
Globus Medical, Inc. – Room: G104
Medicrea – Room: G105

(See the "Exhibits and Hands-On Workshops (HOW)" section on page page 200 for more information.)

13:15-13:25

Walking Break

13:25-14:10

Concurrent Sessions 8A-B: Case Presentation Series

13:25-14:10

8A: Pediatric Deformity: Important Lessons and Challenges from the Masters
Forum
Moderators: Moyo C. Kruyt, MD, PhD & Stefan Parent, MD, PhD

13:25-13:30 Case 1
Marinus de Kleuver, MD, PhD

13:30-13:35 Case 2
Baron S. Lonner, MD

13:35-13:40 Case 3
Suken A. Shah, MD

13:40-13:45 Case 4
Dezsoe J. Jeszenszky, MD, PhD

13:45-14:10 Discussion

MEETING AGENDA

FRIDAY, JULY 19, 2019

13:25-14:10

8B: Adult Deformity: Important Lessons and Challenges from the Masters
Auditorium
Moderators: John R. Dimar II, MD & Han Jo Kim, MD

13:25-13:30 Case 1
Yong Qiu, MD

13:30-13:35 Case 2
Pierre Roussouly, MD

13:35-13:40 Case 3
Ferran Pellisé, MD, PhD

13:40-13:45 Case 4
Ibrahim Obeid, MD

13:45-14:10 Discussion

14:10-14:50

Refreshment Break & Exhibit Viewing

14:50-15:50

Concurrent Sessions 9A-B: Instructional Course Lectures

14:50-15:50

9A: Complications and Management of Complex Pediatric Deformities
Forum
Moderators: Azmi Hamzaoglu, MD & Peter O. Newton, MD

14:50-14:58 Management of Intraoperative Neuromonitoring Alerts: Is it a False Positive?
Peter O. Newton, MD

14:58-15:06 Management of Distal Junctional Failures Including Adding On: What Does the Literature Say?
Ahmet Alanay, MD

15:06-15:14 Complications from Anterior Vertebral Body Tethering: Strategies for Management
Stefan Parent, MD, PhD

15:14-15:24 Pelvic Fixation Strategies in Early Onset Deformities: Which is Best? When and Why?
Muharrem Yazici, MD

15:24-15:34 Management of Crankshaft Phenomenon in Pediatric Deformities
Azmi Hamzaoglu, MD

15:34-15:50 Discussion

MEETING AGENDA

FRIDAY, JULY 19, 2019

14:50-15:50

9B: Coronal Plane Balance in Adult Deformity Surgery: Planning and Execution is as Important as Sagittal Plane Balance
Auditorium
Moderators: John R. Dimar II, MD & Henry F.H. Halm, MD

14:50-14:59 Recognizing and Correcting the Stiff Fractional Lumbosacral Curve
Yong Qiu, MD

14:59-15:08 How Do We Analyze and Confirm Optimal Coronal Balance Intraoperatively and Can We use Minimally Invasive Techniques?
Juan S. Uribe, MD

15:08-15:17 Preoperative Coronal Balance: How to Analyze and Treat
Munish C. Gupta, MD

15:17-15:26 Techniques for Optimizing Intra-operative Coronal Balance
Rajiv K. Sethi, MD

15:26-15:35 Postoperative Coronal Imbalance: Analysis and Strategies for Correction
Sebastien Charosky, MD

15:35-15:50 Discussion

15:50-16:00

Walking Break

16:00-17:00

Session 10: Challenges in Cervical Deformities: From Cradle to Cane
Auditorium
Moderators: Michael G. Fehlings, MD, PhD, FRCSC, FACS & Paul D. Sponseller, MD, MBA

16:00-16:08 Diagnosis, Planning and Techniques for Pediatric Cervicothoracic Scoliosis
Muharrem Yazici, MD

16:08-16:16 Instrumentation and Reconstructive Techniques in the Pediatric Cervical Spine: Challenges, Pitfalls and Solutions
Heiko Koller, MD

16:16-16:24 Complications in the Pediatric Cervical Spine: Why They Happen and How to Avoid
Dezsoe J. Jeszenszky, MD, PhD

16:24-16:32 Discussion

16:32-16:40 Osteotomy Selection in Adult Cervical Deformities
Han Jo Kim, MD

16:40-16:48 Complications in Adult Cervical Deformity Surgery
Justin S. Smith, MD, PhD

16:48-17:00 Discussion

MEETING AGENDA

SATURDAY, JULY 20, 2019

8:30-11:00

Registration Open

9:00-10:00

Session 11: Surgical Video Session: The Five Most Important Tricks for Specific Procedures and Techniques
Auditorium
Moderators: Munish C. Gupta, MD & Ferran Pellisé, MD, PhD

9:00-9:10	Posterior Vertebral Column Resection in Severe Deformity *Lawrence G. Lenke, MD*
9:10-9:20	Anterior Tethering *Stefan Parent, MD, PhD*
9:20-9:30	Robotic Assisted Spine Surgery in Deformities *Yu-Mi Ryang, MD*
9:30-9:40	Minimally Invasive Direct Lateral Approaches in Degenerative Deformity *Juan S. Uribe, MD*
9:40-10:00	Discussion

10:00-10:15

Refreshment Break

10:15-11:15

Session 12: My Worst Complication: Lessons Learned from the Masters
Auditorium
Moderators: Kenneth MC Cheung, MD & Lotfi Miladi, MD

10:15-10:17	Presentation of Whitecloud Awards *Henry F.H. Halm, MD*
10:17-10:24	Case 1 *Lawrence G. Lenke, MD*
10:24-10:31	Case 2 *Amer F. Samdani, MD*
10:31-10:38	Case 3 *Ibrahim Obeid, MD*
10:38-10:45	Case 4 *Dominique A. Rothenfluh, MD, PhD*
10:45-11:15	Discussion

11:15-11:30

Walking Break & Boxed Lunch Pick Up

MEETING AGENDA

SATURDAY, JULY 20, 2019

11:30-13:00

Session 13: Lunch with the Experts: PJK Prevention Strategies from the Experts: What is the Evidence?
Auditorium
Moderators: Peter O. Newton, MD & Justin S. Smith, MD, PhD

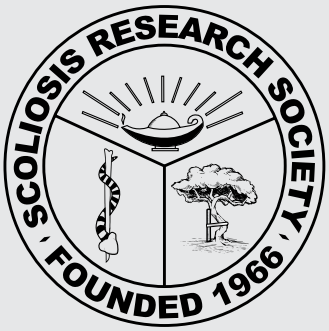
11:30-11:40	Vertebral Body Augmentation with Cement	*Henry F.H. Halm, MD*
11:40-11:50	Proximal Dynamic Stabilization	*Christopher I. Shaffrey, MD*
11:50-12:00	Age-Adjusted Alignment Correction	*Han Jo Kim, MD*
12:00-12:15	Discussion	
12:15-12:25	Instrumentation at the UIV	*Munish C. Gupta, MD*
12:25-12:35	Adhering to the GAP Score for PJK Prevention	*Ferran Pellisé, MD, PhD*
12:35-12:45	PJK Prevention in Pediatric Neuromuscular Deformity	*Paul D. Sponseller, MD, MBA*
12:45-13:00	Discussion	

13:00

Adjourn

NOTES

PODIUM PRESENTATION ABSTRACTS



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

PODIUM PRESENTATION ABSTRACTS

1. Safety of Pedicle Screw Placement in a Large Series of AIS Patients: Is Navigation Necessary?

Daniel J. Sucato, MD, MS; Kiley Frazier Poppino, BS; *Lori A. Karol, MD*

SUMMARY

In a consecutive series of 1667 AIS surgeries, the incidence of misplaced screws is 0.72% of patients and 0.14% of screws with only 2 patients having transient neurologic symptoms and no permanent adverse outcomes due to misplaced screws. These data call into question the use of navigation systems for these relatively routine AIS surgeries; would safe time, expense and radiation to the patient.

HYPOTHESIS

Pedicle screws can be safely placed in AIS surgery using fluoroscopy and/or free-hand technique.

DESIGN

Retrospective

INTRODUCTION

Pedicle screw placement during spinal deformity surgery can be dangerous leading to the utilization of navigation, however, its use for adolescent idiopathic scoliosis (AIS) surgery has not been fully embraced, in part, due to safe alternatives. The purpose of this study was to determine the safety of placing pedicle screws in AIS surgery without navigation and to describe risk factors for misplaced screws.

METHODS

An IRB-approved review of a consecutive series of AIS patients who underwent posterior spinal fusion and instrumentation (PSFI) with pedicle screws was conducted at a single institution over a 16-year period. Patients who had misplaced screws during or following surgery were identified, and risk factors for misplacement were characterized.

RESULTS

There were 1667 patients at an average age of 14.5 years (F:1339,M:328) with a preoperative major curve of 62.5°. There were 16,125 thoracic and 4,858 lumbar screws placed by 9 surgeons using fluoroscopically-guided (n=15,927 screws) or free-hand technique (n=5,056 screws). Twelve of 1667 patients (0.72%) had screws revised due to being too medial (3), or lateral (9). A total of 27/20,983 (0.13%) screws required intervention with 23/16,125 (0.14%) thoracic and 4/4,858 (0.08%) lumbar. Concave screws were involved in 18/11,271 (0.16%) and convex in 9/9,701 (0.09%). Three patients (7 screws) had medial screws (1 transient sensory, 1 transient motor, 1 no symptoms), while 9 patients (20 screws) had laterally placed screws (3 with pleural effusions with no treatment and 6 without symptoms). Patients with larger preoperative major Cobb angle (72° v 62.5, p=0.04) and combined anterior/posterior surgery (7.7% v 0.6%, p=0.002) were at higher risk for screw misplacement.

CONCLUSION

In a large consecutive series of AIS surgical patients, the incidence of misplaced thoracic (0.14%) and lumbar screws (0.08%) is low without permanent adverse sequelae. These data call into question the use of expensive, time-consuming navigation systems for AIS surgery.

TAKE HOME MESSAGE

In a large consecutive series (N=1667) of AIS surgical patients, pedicle screw placement is deemed safe and calls into question the routine use of navigation in this setting.

2. Preemptive Pregabalin Does Not Reduce Postoperative Opioid Consumption or Pain in Children and Adolescents Undergoing Posterior Instrumented Spinal Fusion

Linda Helenius, MD; Hanna Oksanen, RN; Markus Lastikka, MD; Olli T. Pajulo, MD, PhD; Tuula Manner, MD, PhD; Ilkka J. Helenius, MD, PhD

SUMMARY

We evaluated the effect of pregabalin on postoperative pain after posterior instrumented spinal fusion in children and adolescents in a randomized, double-blind, placebo-controlled study. Pregabalin did not reduce the postoperative opioid consumption in this population. The pain scores were similar in pregabalin and placebo group.

HYPOTHESIS

Pregabalin as part of a multimodal pain management may reduce the need for opioids after major spinal surgery in children.

DESIGN

Prospective, randomized, double blind placebo controlled trial.

INTRODUCTION

Pregabalin as part of a multimodal pain management has been shown to reduce opioid consumption after spinal surgery in adults. The use of pregabalin in children and adolescents is off-label and no previous studies was found on pregabalin and postoperative pain in the pediatric population.

METHODS

Adolescents, aged 10 to 21 years, undergoing posterior spinal fusion with all pedicle screw instrumentation were randomized to receive preoperatively and five days after surgery either pregabalin 2mg/kg twice daily or placebo. Opioid consumption was measured using patient-controlled analgesia. Pain scores and opioid adverse effects were registered.

RESULTS

Sixty-three patients (51 AIS, 8 spondylolisthesis, and 4 Mb Scheuermann) out of 77 eligible were included and analyzed. Total oxycodone consumption per kilogram was similar in the study groups during the first 24 h (pregabalin 0.72 ± 0.25 vs. placebo 0.76 ± 0.28, p=0.540) and 48 hours postoperatively (pregabalin 1.49 ± 0.47 vs placebo 1.59 ± 0.54, p=0.487). The postoperative pain scores (1hour to 48 hours) did not differ statistically between the study groups. No differences were found between the groups for any measured opioid-related adverse effects.

CONCLUSION

The use of perioperative pregabalin does not reduce the opioid consumption or affect the pain scores in adolescents after posterior spinal fusion surgery.

TAKE HOME MESSAGE

Pregabalin can not add value as part of multimodal pain management in pediatric spinal surgery.

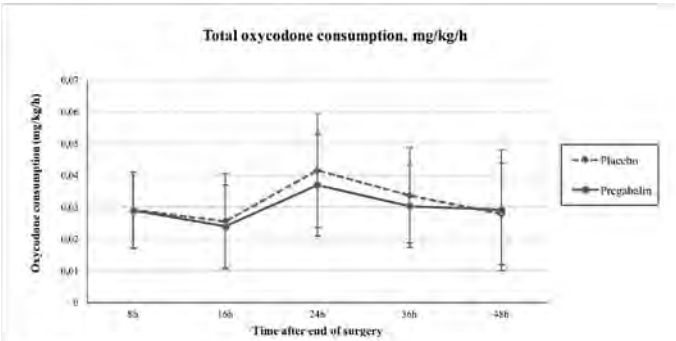


Figure 2. Oxycodone consumption per hour, data shown in mean and SD

3. Computer-assisted Surgical Navigation is Associated with an Increased Risk of Neurological Complications: A Review of 67,264 Posterolateral Lumbar Fusion Cases

Remi M. Ajiboye, MD; Jayme Koltsov, PhD; *Ivan Cheng, MD*

SUMMARY

Although the overall risk of neurological complications following posterolateral lumbar fusion is low, the use of computer-assisted navigation only was associated with an increased risk of neurological complications compared to the use of intraoperative neuromonitoring only or no use of either modality.

HYPOTHESIS

There is no difference in the risk of neurological complications following posterolateral lumbar fusions (PLFs) with or without computer-assisted navigation (NAV) and/or intraoperative neuromonitoring (ION).

DESIGN

Retrospective database study.

INTRODUCTION

Pedicle screw malposition may result in neurological complications following posterolateral lumbar fusions. While computer-assisted navigation and intraoperative neuromonitoring have been shown to improve safety in deformity surgeries, their use in routine PLFs remain controversial.

METHODS

A retrospective analyses were performed using the Truven Health MarketScan® databases to identify patients that had primary PLF with and without NAV and/or ION for degenerative lumbar disorders from years 2007-2015. Patients undergoing

concomitant interbody fusions, spinal deformity surgery or fusion to the thoracic spine were excluded. Complications and reoperation for pedicle screw revision within 90 days of surgery were assessed.

RESULTS

During the study period, 67,264 patients underwent PLFs. NAV only was used in 3.5% of patients, ION only in 17.9% and both NAV and ION in 0.8% of patients. In univariate analyses, there was a difference in the risk of neurological injuries among groups (NAV only: 1.4%, ION only: 0.8%, NAV and ION: 0.5%, No NAV or ION: 0.6%, p<0.001). In multivariable models, the use of NAV was associated with a higher risk of neurological complications when compared to ION only or no ION or NAV [NAV vs. ION only: odds ratio (OR) and 95% confidence interval (CI) = 2.1 (1.4, 3.2), p=0.002; NAV vs. no ION or NAV: OR and 95% CI = 2.5 (1.7, 3.5), p<0.001]. There was no difference in reoperation rates among the groups (p=0.135).

CONCLUSION

Although the overall risk of neurological complications following PLFs is low, the use of NAV only was associated with an increased risk of neurological complications. No differences were observed in the rates of pedicle screw revision among groups.

TAKE HOME MESSAGE

The use of computer-assisted navigation only was associated with an increased risk of neurological complications compared to the use of intraoperative neuromonitoring only or no use of either modality.

4. Two-level Cervical Disc Arthroplasty vs. Anterior Cervical Discectomy and Fusion: Ten Year Outcomes for a Prospective, Randomized IDE Clinical Trial

Jeffrey McConnell, MD; Scott D. Hodges, DO; Matthew F. Gornet, MD; Todd H. Lanman, MD; John Kenneth Burkus, MD

SUMMARY

Cervical spondylosis is one of the most common painful disorders and leads to billions of dollars in direct and indirect costs each year. It has been associated with and is one of the reasons for the opioid crisis. Reducing complications and side effects of surgical treatment should be a high priority. Level 1 data is showing reduced cost, faster return to work and reduced re-operation rates in patients with maintenance of motion. When possible, avoid spinal fusion.

HYPOTHESIS

Cervical spondylosis should be better treated by CDA vs ACDF by allowing preservation of motion

DESIGN

A prospective, randomized level 1, IDE study comparing Prestige LP CDA vs. ACDF . Bayesian statistical analysis was utilized.

INTRODUCTION

Long-term data from multiple Level-1 FDA IDE trials established cervical disc arthroplasty (CDA) as a proven alternative to anterior cervical discectomy and fusion (ACDF) for appropriately selected patients with single-level cervical degenerative disc disease (DDD). Long-term studies now also demonstrate the safety and efficacy of CDA at two contiguous levels. This paper reports the 10-year results of the Prestige LP FDA trial (clinicaltrials.gov: NCT00637156) comparing the safety and efficacy of CDA and ACDF.

METHODS

397 patients with two-level radiculopathy and/or myelopathy between C3 and C7 were treated with investigational CDA (n=209) or control ACDF (n=188). The primary endpoint was Overall Success, a composite variable that included 4 criteria: 1) (NDI) score improvement of ≥ 15 points, 2) maintenance or improvement in neurological status, 3) no serious adverse event caused by the implant or by both implant and surgical procedure, 4) no additional surgery (supplemental fixation, revision, or non-elective implant removal). Numerical rating scales, SF-36, range of motion, and adverse events (AE)were evaluated. Bayesian analyses were used

to demonstrate the non-inferiority of CDA to ACDF and superiority, if noninferiority was established.

RESULTS

Patient follow-up at 10 years was 86.0% for investigational and 84.9% for control patients. From 2 to 10 years postoperative, the rates of Overall Success demonstrated statistical superiority for CDA over ACDF (80.4% vs 62.2%). At 10 years, NDI Success and Neurological Success rates also demonstrated statistical superiority for CDA over ACDF. At all postoperative time points, NDI, neck and arm pain, and SF-36 score improvements were statistically significant.

CONCLUSION

In appropriately selected patients cervical disc arthroplasty is at least as safe and effective as ACDF for symptomatic cervical DDD at 2 contiguous levels

TAKE HOME MESSAGE

Two-level cervical disc arthroplasty is a reliable, and perhaps better, alternative to fusion. Arthroplasty maintains improved clinical outcomes and segmental motion at 10 years.

5. Effect of Topical Steroid on Swallowing Following ACDF: Results of a Prospective Double Blind Randomized Control Trial (RCT)

SUMMARY

Dan Stein, BS: *Han Jo Kim, MD*; Darren R. Lebl, MD; Russel C. Huang , MD; Renaud Lafage, MS; Todd J. Albert, MD

SUMMARY

We report the preliminary results of our double-blinded RCT in the utility of corticosteroids mixed in an absorbable gel-matrix administered in the retropharyngeal space immediately after multi-level ACDFs resulted in less dysphagia compared to controls in the immediate post-op period and was sustained at one month measured by domains of the SWAL-QOL, Eat-10 and Bazaz patient reported outcomes

HYPOTHESIS

Local Intraoperative Corticosteroids (LIC) application has no effect on early Post op dysphagia

DESIGN

Double Blinded RCT

INTRODUCTION

Dysphagia is a common complication in ACDF surgery. There is controversy regarding the effectiveness of Local Intraoperative Corticosteroids (LIC) in reducing post-operative dysphagia. We aimed to evaluate the effectiveness of LIC in decreasing dysphagia after ACDF

METHODS

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

RESULTS

Of the 106 enrolled pts, 95 (90%) had complete dataset and were included for analysis (57.6 yo, BMI: 29.4kg/m2, 48.4% F). The comparison of the C arm (n=47) and S arm (n=48) revealed no significant differences in demographics, diagnosis, or surgical information in terms of # of levels fused (p=0.521), Op time (p=0.065), or EBL (p=0.358). Significant change in dysphagia scores were observed from pre to post-op. Post-operative PRO across the study arms revealed that the S arm had significantly better dysphagia scores than the control arm at POD1 (SWALL-QOL Food selection: p=0.049; Fear: p=0.027), at POD2 (Burden: p=0.02; Eat Duration: p=0.008; Fear: p=0.017; Fatigue: p=0.047; modified Eat-10: p=0.013) and M1 (Eat Desire: p=0.015; East duration: p=0.046; Fear Swallow: p=0.016; and Fatigue: p=0.003)

CONCLUSION

Our study demonstrates the benefit of LIC delivered in a gel matrix in reducing dysphagia following multi-levels ACDFs. Early Post-op results were superior for treatment group, especially post-op day 2, and maintained at 1 month

TAKE HOME MESSAGE

Corticosteroids mixed with a gel-matrix administered in the retropharyngeal space reduced dysphagia in our double-blinded RCT

		Food Selection	Fear Swallow	Burden	Eat duration	Eat Desire	EAT10
Control	Pre	100 (100|100)	100 (100|100)	100 (100|100)	100 (100|100)	100 (100|100)	0 (0|0)
	POD1	75 (37.5|100)	94 (75|100)	63 (25|88)	75 (25|100)	83 (58|100)	14 (6|19)
	POD2	75 (25|100)	86 (57|100)	63 (25|88)	50 (13|87)	92 (58|100)	14 (7|21)
	1M	100 (75|100)	84 (81|100)	88 (63|100)	88 (38|100)	100 (83|100)	4 (0|9)
Treatmen	Pre	100 (100|100)	100 (100|100)	100 (100|100)	100 (100|100)	100 (100|100)	0 (0|0)
	POD1	86 (50|100)	100 (89|100)	75 (50|100)	75 (41|100)	82 (67|100)	10 (4|18)
	POD2	75 (63|100)	100 (81|100)	75 (50|87)	81 (50|100)	96 (77|100)	7 (3|17)
	1M	100 (75|100)	100 (88|100)	88 (75|100)	100 (75|100)	100 (100|100)	2 (0|5)

6. Assessment of the Efficacy of Teriparatide in Patients Undergoing Posterolateral Lumbar Spinal Fusion: A Randomized Double-blind Pilot Study

Shane Burch, MD, MS, FRCS(C); *Kevin Taliaferro, MD;* Paramjit Singh, MD; Rachelle Palkovsky, BS; Vedat Deviren, MD; Sigurd H. Berven, MD; Bobby Tay, MD

SUMMARY

While there are several animal models analyzing the effect of teraparatide on lumbar fusions there have been little research in humans. We compared the efficacy of teriparatide vs placebo in fusion formation in thoracolumbar fusions. We found teriparatide in multi-level fusion ≥2 levels appears to provide minimal benefit to high-risk patients with relatively low risk based upon 1 year CT scans and reported Adverse and Serious Adverse Events

HYPOTHESIS

Teriparatide, when compared to placebo, will increase the rate of fusion in thoracolumbar fusion surgery

DESIGN

Prospective randomized double-blind placebo-controlled

INTRODUCTION

Lumbar spinal fusion is an increasingly common procedure for treating degenerative diseases of the lumbar spine. Non-solid fusion, or pseudarthrosis, at one year is a common complication associated with poor clinical outcomes and need for revision surgery. The risk of pseudarthrosis depends on the number of levels fused, the fusion material, and patient risk factors (osteoporosis, smoking, diabetes, etc.). Although there are multiple options for bone graft and osteoinductive materials, all have their benefits, side-effects and cost. Teriparatide is an injectable recombinant analog of parathyroid hormone that has been well-studied in its treatment of osteoporosis. However, no clinical studies of its effect on spinal fusion in humans have been published to date.

METHODS

Prospective randomized double-blind placebo-controlled pilot study performed at two large academic centers, UCSF and McGill University (Montreal). Included patients were aged 60-90 years with degenerative lumbar disease who were scheduled to undergo two-level or greater posterolateral lumbar spinal fusion. Patients were randomized in a 2:1 (Teriparatide:Placebo) manner. Fusions at 1 year were analyzed by helical CT. ODI, VAS and Eq5D were taken at 3, 6, 9 and 12 mo.

RESULTS

35 patients completed the study. 58.3% (n=21) received teriparatide. 42.8% (n=9) reported an Adverse Event. Fusion rate of patients was 52.4% (n=11); the remaining 47.6% (n=10) demonstrated pseudoarthrosis (n=8) or non-fusion (n=2) at 1 year. Of the patients who received placebo (n=14), 42.9% (n=6) reported an Adverse Event. At 1 year, 50.0% (n=7) had a solid fusion mass. 50.0% had a pseudoarthosis (n=5) or were fused anteriorly only (n=2).

CONCLUSION

The use of teriparatide in multi-level fusion ≥2 levels appears to provide minimal benefit to high-risk patients with relatively low risk based upon 1 year CT scans and reported Adverse and Serious Adverse Events.

TAKE HOME MESSAGE

Teriparatide, alone, appears to not impact thoracolumbar fusions at 1 year.Further larger studies are warranted to evaluate the conclusions from this study.

7. Intravenous Ketorolac Substantially Reduces Opioid Use Following Lumbar Spinal Fusion: Early Results of a Randomized, Double-blinded, Placebo Controlled Trial

Sravisht Iyer, MD; Evangelia M. Zgonis, BS; Michael E. Steinhaus, MD; Jeffrey J. Varghese, MD, BS; Dan Stein , BS; Jingyan Yang, MHS; Todd J. Albert , MD; Frank J. Schwab , MD; Darren R. Lebl , MD; Han Jo Kim, MD; Matthew E. Cunningham, MD, PhD; James C. Farmer, MD; Federico P. Girardi, MD; Russel C. Huang, MD; Sheeraz Qureshi, MD; Bernard A Rawlins, MD; James D. Beckman, MD; Harvinder S. Sandhu, MD, MBA

SUMMARY

Early results of this double-blind, randomized, placebo-controlled trial show that intravenous ketorolac (IV-K) results in a substantial reduction in opioid use and improved pain control compared to placebo (IV-P) and IV acetaminophen (IV-A). IV-K did not increase rates of hematoma, drain output, transfusions or serum creatinine. There was a trend toward decreased length of stay (LOS) with IV-K

HYPOTHESIS

Intravenous Ketorolac (IV-K) would decrease in hospital opioid use compared to IV Placebo (IV-P) and IV Acetaminophen (IV-A)

DESIGN

Randomized, double-blind trial

INTRODUCTION

Lumbar spine fusions are rated among the most painful surgical procedures. Adequately controlling post-operative pain while minimizing opioid use is an important public health objective

METHODS

Patients (Pts) were randomized to receive IV-K, IV-P or IV-A. The inclusion criteria were: age 18-75, 1-2 level lumbar fusion and no history of long-term opioid use. Smokers and pts with contraindications to IV-A or IV-K were excluded. IV-K pts received 15mg (age >65) or 30mg (age <65) IV-K every 6 hours (q6h) for 48h. IV-A received 1000mg IV-A q6h and IV-P received IV-P q6h for 48h. All study personnel and pts were blinded to assignment. Block randomization scheme was utilized. We recorded demographic and surgical details, opioid use, opioid related adverse events (ORAE) and length of stay (LOS). The primary outcome was in-hospital opioid use up to post-operative day 3 (POD3). The secondary outcomes were ORAE and LOS

RESULTS

115 pts met inclusion criteria (39 IV-K, 39 IV-A, 37 IV-P). There was no difference between pts with regards to demographic or surgical variables. IV-K group had substantially lower opioid use at 72h (181±156mg) compared to IV-A (268±176mg) and IV-P (315±183mg) (p=0.003). IV-K was superior to IV-A (p=0.030) and IV-P (0.001). IV-A was not superior to IV-P (p=0.234). Similar trends were observed for opioid use per-hour (IV-K: 3.0±2.4mg/h; IV-A: 4.1±2.3mg/h; IV-P: 4.7±2.5mg/h, p=0.009). IV-K pts reported improved pain control on POD1 (p=0.050). IV-K pts trended toward shorter LOS (IV-K: 75±44h; IV-A: 93±60h; IV-P:88±35h, p=0.231). There were no differences in ORAE, drain output, hematocrit levels, serum creatinine, and transfusion rates

CONCLUSION

IV-K results in a substantial reduction in opioid use (>40% vs. IV-P, >30% vs. IV-A) and improved pain control on POD1. There is a trend toward decreased LOS; there appears to be no increase in in-hospital complications. Longer term FU will asses impact of IV-K on pseudoarthrosis

TAKE HOME MESSAGE

Intravenous ketorolac (IV-K) reduces opioid use after spinal fusion by >40% compared to placebo and >30% compared to IV acetaminophen. There is a trend toward decreased LOS with IV-K

8. Clinical Outcomes, Recovery and Return to Work After Surgery for Lumbar Disk Herniation: A Randomized Clinical Trial Comparing the Effect of Supervised Rehabilitation Versus Home Exercise

Rune Tendal Paulsen, MD; Jesper Rasmussen, MD; Leah Yacat Carreon, MD, MS; Mikkel Ø Andersen, MD

SUMMARY

This randomized controlled trial found surgery for lumbar disc herniation (LDH) effective in improving pain, disability, working ability and quality of life but outcomes were not altered by participating in supervised rehabilitation compared to no rehabilitation.

HYPOTHESIS

Postoperative rehabilitation improves patient reported outcomes after surgery for LDH.

INTRODUCTION

Lumbar discectomy is one of the most frequent interventions to treat symptomatic LDH. Patients are typically referred to physical rehabilitation at discharge but the usefulness of postoperative rehabilitation remains controversial. This study investigated the effects of referring patients to postoperative supervised rehabilitation compared to no referral in patients recovering after surgery for LDH.

METHODS

This single center randomized controlled trial investigated differences in disability, working ability, quality of life and pain between two groups: patients referred for supervised rehabilitation at the municipal facility starting 4-6 weeks postoperative (REHAB) versus patients sent home after surgery without any planned rehabilitation course (HOME). Outcome measures consisted of Oswestry Disability Index (ODI), EuroQoL-5D (EQ-5D), Visual Analogue Scale (VAS), working ability on a 0-10 point scale, return to work (RTW) rates and length of postoperative sick leave. Follow-up questionnaires were obtained after 1, 3-6, 12 and 24 months.

RESULTS

146 patients were included in the study, equally divided between the two groups. Follow-up rates were 78% after one and two years. The REHAB-group had significantly worse leg pain at 6 months, but no other clinically relevant or statistical significant differences were observed between the groups on any parameter at any follow-up period. RTW rates during the first year (HOME:79%, REHAB:74%) and duration of postoperative sick leave (9 weeks) were similar in both groups.

CONCLUSION

Surgery for LDH is effective in improving pain, disability, working ability and quality of life. Postoperative outcomes are not further improved by participating in supervised rehabilitation.

TAKE HOME MESSAGE

Surgery for LDH is effective in relieving pain, improving functional status and quality of life but the postoperative outcome is not improved by participating in supervised rehabilitation

9. Does Degenerative Lumbar Spondylolisthesis Require an Instrumented Fusion? A 5-year Follow-up Study

Calvin C. Kuo, MD; Maqdooda Merchant, MSc MA; Mayur P. Kardile, MD; Alem Yacob, MD, MS; Kamran Majid, MD, MBA; Ravi S. Bains, MD

SUMMARY

For patients with grade I/II (low-grade) lumbar degenerative spondylolisthesis and spinal stenosis, controversy exists on the optimal surgical treatment. Structure sparing decompression techniques may obviate the need for supplementary fusion to prevent instability or reoperation. In this retrospective review of a large integrated healthcare delivery system, patients with low-grade, stable lumbar degenerative spondylolisthesis and stenosis who underwent unilateral approach for bilateral decompression had lower reoperation rates at 5-year follow-up compared with patients who had posterior decompression and instrumented fusion.

HYPOTHESIS

Within a 5-year follow-up period, patients with lumbar degenerative spondylolisthesis and spinal stenosis who have unilateral laminotomy for bilateral decompression (ULBD) will have lower reoperation rates compared to posterior decompression with instrumented fusion (Fusion).

DESIGN

Retrospective cohort study

INTRODUCTION

Controversy exists regarding whether fusion should be used to augment decompression surgery in patients with symptomatic lumbar spinal stenosis with low-grade degenerative spondylolisthesis. For years, the standard has been fusion with laminectomy in order to prevent postoperative instability. However, instability and reoperations may be reduced or prevented using structure sparing decompression techniques without the need for fusion

METHODS

We identified 164 patients with degenerative spondylolisthesis and lumbar stenosis who underwent ULBD from 2007 to 2011 in a large integrated healthcare system. These patients were propensity score matched on age, gender, race and smoking status with patients who underwent Fusion (n=437). The primary outcome was 5-year reoperation rate. Secondary outcome measures included postoperative complication rates, blood loss during surgery, and length of stay.

RESULTS

The reoperation rate within 5-year follow-up was significantly lower at 10.4% for ULBD compared to 17.2% for Fusion ($p=0.0393$). Patients that underwent ULBD had significantly less mean estimated blood loss compared to Fusion (82 vs. 445 ml, $p<0.0001$) and significantly shorter mean length of stay (2.3 vs 4.6 days, $p<0.0001$). The two types of operations had similar postoperative complication rates, with less surgical site infections for ULBD compared with Fusion (1 vs. 11 cases).

CONCLUSION

For patients with stable degenerative spondylolisthesis and lumbar stenosis, ULBD is a viable, durable option compared to Fusion with

a lower reoperation rate within a 5-year follow-up period, as well as decreased blood loss and length of stay. Further prospective studies are required to determine the optimal clinical scenario for ULBD in the setting of degenerative spondylolisthesis.

TAKE HOME MESSAGE

For carefully selected patients with stable degenerative lumbar spondylolisthesis and stenosis, structure sparing decompression alone is a viable and durable option compared to posterior decompression with instrumented fusion.

10. Unraveling the Hip-spine Dilemma: Is Pelvic Incidence Linked to Hip Morphology and Pathology?

Joost H.J. van Erp, MD; Tom P. Schlösser, MD, PhD; Vahid Arbabi, PhD; René M. Castelein, MD, PhD; Arthur de Gast, MD, PhD; Harrie Weinans, PhD

SUMMARY

This study investigated the relation between sagittal pelvic morphology (pelvic incidence) and the onset of common lumbar, hip and knee degenerative disorders in a prospective cohort of 423 patients with early symptomatic hip or knee osteoarthritis. Low pelvic incidence was related with hip osteoarthritis, whereas patients with a high pelvic incidence had more spondylolisthesis. Knee osteoarthritis was not linked with pelvic incidence.

HYPOTHESIS

The epidemiology of common degenerative lumbar, hip and knee pathologies is linked to the 'pelvic incidence'.

DESIGN

A population-based prospective cohort study

INTRODUCTION

The etiological pathways of the most common spino-pelvic, hip and knee degenerative pathologies are still not completely understood. For some decades, mechanical theories are postulated that indicate that those diseases are related to pelvic morphology and spino-pelvic-femoral dynamics. To date, the link of sagittal pelvic morphology has not been studied in a large scale setting.

METHODS

All subject from the CHECK-database (Cohort Hip and Cohort Knee), a population-based observational cohort of patients with pain and/or stiffness of the knee and/or hip for less than 6 months, aged 45–65 years and followed for 8 years, were included in this study if lateral lumbar radiographs were obtained at t=8. Spinal parameters and pathologies (degenerative disc disease, spondylysis/-listhesis) were measured on lateral lumbar radiographs at t=8, characteristics of hip- and knee osteoarthritis and femoro-acetabular impingement at t=0 and t=8. Epidemiology of the various degenerative disorders were compared between low pelvic incidence (<50°), normal pelvic incidence (50°-60°) and high pelvic incidence (>60°) using Odds ratio's.

RESULTS

There were no baseline difference between the groups. Spondylolisthesis was more present in patients with a high pelvic incidence (14,4%) compared to patients with normal (5,0%, OR 3.11) or low pelvic incidence (2,4% OR 6,66). Hip osteoarthritis and femoro-acetabular impingement were more present in patients with a low pelvic incidence (46,8%), compared to patients with normal (40,8%, OR 1,28) or high pelvic incidence (37,9%, OR 1,33). The prevalence of knee osteoarthritis and degenerative disc disease did not differ between the groups.

CONCLUSION

High pelvic incidence is a risk factor for spondylolisthesis, whereas low pelvic incidence is linked to hip osteoarthritis and femoralacetabular impingement. There is no link with knee osteoarthritis or degenerative disc disease.

TAKE HOME MESSAGE

Sagittal pelvic morphology is related to the onset of most common lumbar and hip degenerative disorders.

11. Controlled Dynamic Spine Distraction Increases Vertebral Body Growth, Intervertebral Disc Height and Volume and Nucleus Pulposus Proliferation: An in Vivo Study on Rodent Tail Model

Pooria Salari, MD; Garrett Easso, MS; Simon Y. Tang, PhD

SUMMARY

Continuous distraction forces increase vertebral body growth and disc height in immature spine. Primary data on disc and growth plates do not show significant negative effect. Histologic and biomechanical studies are underway to further investigate effect of distraction on these structures.

HYPOTHESIS

Distraction will cause significant changes in disc height, growth plate and disc viscoelastic behavior in immature spine when compared to control group.

DESIGN

Biomechanical animal study

INTRODUCTION

Growth friendly and growth modulation techniques are routinely used in treatment of scoliosis in immature spine. Despite common use of these techniques the effect of distraction on immature spine is unknown. The purpose of this study is to evaluate the effect of distraction on bone, growth plates, disc height and disc biomechanical characteristics in immature spine.

METHODS

Sixteen, 6 weeks old mice were randomly assigned to distraction and control groups. Instrumentation was applied to the tails spanning over two-disc space. (Image-1a) In distraction group the instrumented levels distracted under continuous distraction forces of 200% of the animals body weight for 14 weeks. Radiographs and MicroCT were obtained weekly. Vertebral body length and disc height were measured on imaging. At the conclusion of study, histology and immunohistology studies were done on all samples to evaluate growth plates and disc. Disc viscoelastic behavior was studied using dynamic mechanical testing. Contrast enhanced MicroCT was done to study nucleus pulposus and annulus fibrosus.

RESULTS

There were no complications in either group. Vertebral length and disc height as measured on imaging were significantly increased in distraction group at all data point. (Image-1a,b,c) Primary histology

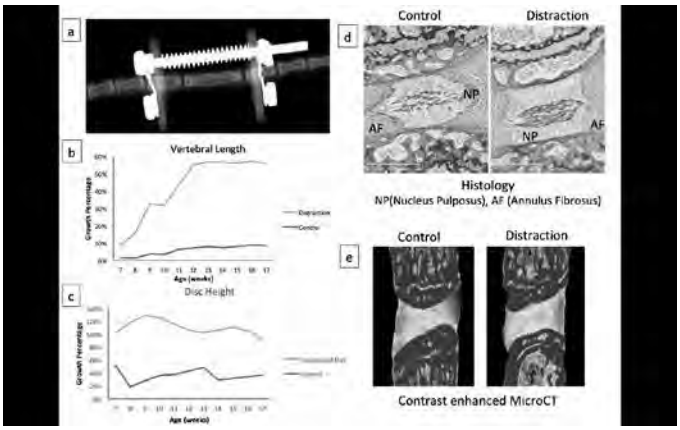
studies on limited number of samples showed increased nucleus pulposus proliferation in distraction group. (Image-1d) Disc volume as measured on contrast enhanced Micro CT increased (Image-1e). Immunohistology and biomechanical studies on disc were underway at the time of abstract submission.

CONCLUSION

Growth modulation using distraction forces shown to increase vertebral body growth and disc height in immature spine. Primary data on disc and growth plates do not show significant negative effect. Histologic and biomechanical studies are underway to further investigate effect of distraction on these structures.

TAKE HOME MESSAGE

Growth modulation techniques using distraction forces increase vertebral body growth and disc height in immature spine with no significant negative effect on disc and vertebral body.



a: Instrumentation, b,c: Vertebral length and disc height increased significantly in distraction group, d: Histologic studies shows increase NP proliferation with distraction, e: Contrast enhanced MicroCT shows increase disc volume with distraction

12. The Effect of Surgical Decompression on Spine and Lower Extremity Range of Motion during Gait in Patients with Cervical Spondylotic Myelopathy

Ram Haddas, PhD, MS, MEng; *Isador H. Lieberman, MD, FRCS(C);* Peter B. Derman, MD, MBA

SUMMARY

Limited information is available on the effect of surgical intervention on the gait of patients with cervical spondylotic myelopathy (CSM). Thirty-eight CSM patients performed gait evaluation one week before surgery and three months after surgery. While surgeons should remain conservative with respect to how they counsel patients and set expectations pre-operatively, cautious optimism regarding improvements in gait may be warranted in the setting of surgery for CSM.

HYPOTHESIS

Surgical intervention will approve spine and lower extremity range of motion (RoM) during gait in patients with cervical spondylotic myelopathy (CSM).

DESIGN

Non-randomized, prospective, concurrent cohort study.

INTRODUCTION

The natural history is typically one of progressive decline in neurologic function, so surgery to decompress the spinal cord is generally indicated to prevent progression in symptomatic patients. Despite the prevalence of this condition, relatively little quantitative kinematic information is available on the effect of surgical intervention on the gait of patients with CSM.

METHODS

Thirty-eight CSM patients performed gait evaluation one week before surgery (Pre) and three months after surgery (Post). Neck and mid-back visual analogue scale (VAS), Oswestry Disability Index (ODI), and Neck Disability Index (NDI) scores were also collected at both time points.

RESULTS

When comparing pre-operative to post-operative gait parameters, significant increases in walking cadence (98.28 vs 103.37 steps/minutes, p=0.004), stride length (1.02 vs 1.07 m, p=0.018), and walking speed (0.86 vs 0.94 m/s, p=0.001) were observed. The amount of time spent in double support decreased after surgery (0.37 vs 0.32 s, p=0.032). The only significant difference in spine and lower extremity joint RoM measures was a decline in coronal RoM of both the knees and ankles post-operatively. VAS neck and mid-back as well as ODI improved significantly post-operatively, while the reduction in NDI did not attain statistical significance.

CONCLUSION

Despite conventional teaching that the goal of surgical intervention for CSM is to halt symptomatic progression, the presented here data demonstrates that significant improvements in gait are frequently observed after surgical management of CSM. Post-operative patients walk more quickly as a result of increased stride length and cadence. Furthermore, they lift their knees and dorsiflex/plantarflex their ankles less, consistent with a more efficient gait pattern.

TAKE HOME MESSAGE

The result of this study demonstrates that significant improvements in gait are frequently observed after surgical management of cervical spondylotic myelopathy.

13. Correlation of Collagen X Biomarker (CXM) with Peak Height Velocity and Radiographic Measures of Growth in Idiopathic Scoliosis

Michelle C. Welborn, MD; Susan Sienko, PhD; Ryan Coghlan, MS; William Horton, MD

SUMMARY

Currently, the gold standards for assessing skeletal maturity are all based on radiographic measures. CXM, as a direct measure of enchondral ossification represents a revolutionary departure from the established techniques. Early results indicate that CXM correlates with anthropometric and radiographic measures. Thus, CXM may serve as a real time patient specific measure of growth velocity and may ultimately help guide decision-making in bracing and growth friendly surgery.

HYPOTHESIS

CXM levels will correlate with anthropometric and radiographic measures of growth and patient specific growth velocity

DESIGN

Prospective comparative study

INTRODUCTION

Assessment of growth status of patients with pediatric spinal deformity is critical. Current techniques poorly predict growth and have a large standard error (SE). Type X collagen is produced in the growing physis during enchondral ossification. CXM is a breakdown product from type X collagen that can be measured in serum. Theoretically higher levels of CXM would correlate with rapid longitudinal bone growth while lower CXM levels with growth cessation

METHODS

IRB approved prospective study. Q6mo anthropometrics (height, arm span, ulnar length) and spine PA biplanar slot scanner images including the hand were assessed for major curve magnitude, Risser score, triradiate cartilage status (TRC), Greulich and Pyle bone age (BA), and Sanders Stage (SS). Longitudinal Serial Dried Blood Spots (DBS) were collected on 3 consecutive days Q1-2months based on SS to obtain CXM levels

RESULTS

44 pts with idiopathic scoliosis, Cobb >20 were enrolled. Mean age at first visit was 11.99 years (range 7.08-15.70 years). CXM levels were assayed in quadruplicate for a total of 2566 samples. CXM results were highly reproducible with an ICC amongst all CXM samples of 0.932, and within plate ICC range=0.988- 0.994. Pearson correlation coefficients showed that the CXM 3-day average was significantly correlated with Risser score R= -0.609, p=0.000, and Sanders Score R= -0.699, p=0.000. The CXM 3-day average significantly correlated with height R= -0.459, p=0.001, arm span R=-0.450, p=.001 and ulnar length R= -0.448, p=0.001

CONCLUSION

Early work shows CXM closely follows the growth curve, is statistically correlated to Risser and Sanders Scores and it is highly reproducible with a low SE. Furthermore, it demonstrated that while patients appear to follow the growth trajectory established in the population data that they are doing so at distinct time frames. Longer term follow-up is required to determine the ability of CXM to predict real time changes in growth velocity.

TAKE HOME MESSAGE

CXM is the first identifiable measure of longitudinal bone growth. Early results indicate that it's a patient-specific real time measure of growth velocity with high correlation to current radiographic markers

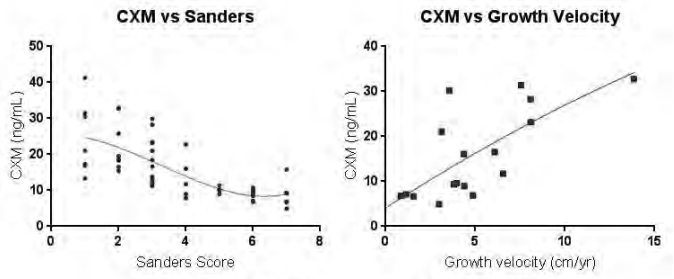


Figure: CXM levels plotted against Sanders score and growth velocity: CXM level was performed ave within 2 weeks of Sanders score and growth velocity measurement demonstrating decreasing variability of CXM levels with increasing Sanders score and linear correlation of CXM with growth velocity

14. Electrospun Synthetic Bone Scaffolds Promote Mesenchymal Stem Cell Function and Spinal Fusion

Derek G. Ju, MD; Juliane D. Glaeser, PhD; Khosrowdad Salehi, BS; Linda E. A. Kanim, MA; Phillip H. Behrens, MD; Melodie F. Metzger, PhD; Dmitriy Sheyn, PhD; Hyun W. Bae, MD

SUMMARY

Synthetic bone grafts are being developed to lessen the need for autograft and allograft. Electrospun bone grafts (ESBG) are highly porous with a large surface area-to-volume ratio. Here, we report the first in vitro and in vivo characterization of ESBG for spinal applications. In vitro, ESBGs support stem cell binding, proliferation, and osteogenic differentiation. In a rat spine fusion model, ESBG facilitates BMP-2 mediated spinal fusion. ESBGs represent a promising synthetic graft and should be further investigated for clinical feasibility.

HYPOTHESIS

Electrospun synthetic bone grafts (ESBG) stimulate mesenchymal stem cell (MSC) function and facilitate BMP-2 mediated spinal fusion.

DESIGN

In vitro analysis of MSC adhesion, proliferation, and differentiation seeded in ESBG. In vitro analysis of ESBG-facilitated posterolateral spine fusion in a rat model.

INTRODUCTION

Synthetic bone grafts are being developed to lessen the need for autograft and allograft. ESBGs have a highly porous nanofibrous structure with a large surface area-to-volume ratio, potentially improving its osteoconductive and osteoinductive properties. Here, we investigate the potential of ESBG to stimulate MSC function in vitro, and to facilitate BMP-2 mediated spinal fusion in a rat model.

METHODS

Adhesion, proliferation, and osteogenic differentiation of MSCs seeded with and without ESBG for 7 days was analyzed. In vivo, 36 rats underwent posterolateral spine fusions in the following groups: (I) ESBG+bone marrow aspirate (BMA), (II) ESBG+BMA+BMP-2 (low-dose), and (III) BMA. Rats were followed for 3 months and the fusion masses were characterized with manual palpation, biomechanical tests, micro-CT and histological evaluation.

RESULTS

90% of cultured MSCs adhered to ESBG. When seeded in ESBG, there was a significant increase in MSC proliferation (0.18 to 0.43, $p<0.01$) and osteoblastic activity (2.3 to 5.2; $p<0.02$). In the rat model, fusion rates at 3 months were 29% (group I), 100% (group II), and 0% (group III). Biomechanical stiffness was highest in group II vs I (286 vs. 198 N/mm, $p<0.05$). Group II had increased bone volume (216.0 vs. 133.9), bone volume/total volume (0.085 vs. 0.01) and increased connectivity density (1.26 vs 0.28; all $p<0.05$). Histological evaluation demonstrated new bone formation within the graft only in group II.

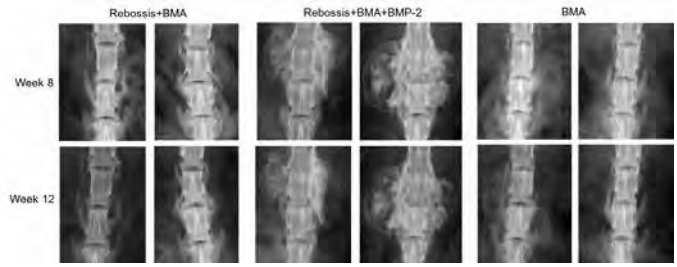
CONCLUSION

This is the first reported characterization of ESBG for spinal applications. ESBGs provide a novel scaffold that supports MSC binding, proliferation, and differentiation. In a rat fusion model, ESBG impregnated with BMA and low-dose BMP-2 allowed for

100% fusion with strong biomechanical properties. ESBGs represent a promising synthetic graft and should be further investigated for clinical feasibility.

TAKE HOME MESSAGE

Electrospun synthetic bone grafts are a novel scaffold that support MSC binding, proliferation, and differentiation in vitro. In a rat spine fusion model, ESBG facilitates low-dose BMP-2 mediated spinal fusion.



Radiographic evidence of new bone formation at the implantation side at 8 and 12 weeks post-surgery

15. A Comparison of Propionibacterium Acnes Survival on Cobalt-chromium Alloy and Titanium Alloy

Kota Watanabe, MD, PhD; Satoshi Fukuzaki, PhD; Atsushi Sugino, PhD; Satoshi Suzuki, MD, PhD; Osahiko Tsuji, MD, PhD; Narihito Nagoshi, MD; Eijiro Okada, MD, PhD; Nobuyuki Fujita, MD, PhD; Mitsuru Yagi, MD, PhD; Nicholas M. Benson, PhD; Newton H. Metcalf, BS; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD, PhD

SUMMARY

Propionibacterium acnes is a common pathogen causing surgical site infections in spine surgery. The purpose of this study was to compare Propionibacterium acnes survival rates using common spinal implant materials, cobalt-chromium alloy and titanium alloy. Standardized in vitro antibacterial testing and an in vivo infection model both demonstrate that cobalt-chromium alloy significantly inhibits Propionibacterium acnes growth as compared with titanium alloy.

HYPOTHESIS

The bacterial proliferation of Propionibacterium acnes will be significantly lower on cobalt-chromium alloy than titanium alloy.

DESIGN

Basic studies: in vitro & in vivo experiments

INTRODUCTION

Propionibacterium acnes (P. acnes) is a common pathogen causing surgical site infection in spine surgery. P. acnes is a gram-positive bacteria present in skin flora that has been associated with late onset loosening of spinal implants. The purpose of this study was to compare Propionibacterium acnes survival on the surface of discs made of common spinal implant materials, cobalt-chromium alloy (CC) and titanium alloy (Ti).

METHODS

Japanese Industrial Standard testing (JIS Z 2801: 2010 "Antibacterial products – Test for antibacterial activity and efficacy) was followed for the in vitro test. Discs made of CC or Ti were incubated with P. acnes for 24 hours. The inoculum was then diluted and smeared on a GAM agar plate to determine the number of viable cells. In the in vivo infection model, CC or Ti discs were implanted into the subcutaneous layer of BALB/c mice. After skin closure, a cell suspension of P. acnes was used to directly inoculate the implanted discs. The discs were retrieved and sonicated to determine the number of viable bacteria 0.5, 1, and 3 days after inoculation.

RESULTS

The mean number of viable P. acnes cultured from CC and Ti discs were $1.9x10^3$ CFU/Disc and $180x10^3$ CFU/Disc, respectively. Statistical differences in the number of viable P. acnes between CC and Ti were observed using the standardized in vitro protocol ($p < 0.01$, Two sample t-test). In vivo testing revealed the number of viable P. acnes on Ti and CC for 0.5 days after inoculation to be 2.8×10 CFU/mm² and 0.5×10 CFU/mm² respectively ($p < 0.01$, Wilcoxon rank-sum test). The significant trend in reduced numbers of viable P. acnes on CC discs was maintained 1 and 3 days after inoculation ($p < 0.01$).

CONCLUSION

In vitro antibacterial testing and an in vivo infection model both show that CC significantly reduces bacterial proliferation of P. acnes as compared with Ti. Clinical studies would be required to determine the surgical site infection differences, if any, between the implant materials.

TAKE HOME MESSAGE

In vitro antibacterial testing and an in vivo infection model both show that cobalt-chromium alloy significantly reduces bacterial proliferation of P. acnes as compared with titanium alloy.

16. Clinical Effectiveness of Distraction Measurements with Ultrasonography in Magnetic Controlled Growing Rods

Shreya Srinivas, FRCS; Lisa Marie Andre, RN; Colin E. Bruce, FRCS; Jayesh Trivedi, FRCS; Sudarshan Munigangaiah, FRCS; Neil T. Davidson, FRCS

SUMMARY

Magnetically controlled growing rods (MCGR) used in the management of early onset scoliosis (EOS) offers the advantage of allowing non-invasive distractions to maintain spinal growth and prevent curve progression. Use of ultrasound(U/S) for distraction measurements offers a effective and safer alternative that reliably monitors distraction achieved over time and minimises radiation exposure .

HYPOTHESIS

Ultrasonography measurements are safer and effective way of monitoirng distraction length achieved over time with MCGR compared to plain radiographs.

DESIGN

Retrospecitve review of prospecitvely collected data on consecutive patients with MCGR for EOS.

INTRODUCTION

MCGR used in the management of early onset scoliosis (EOS) offers the advantage of allowing non-invasive distractions to maintain spinal growth. Use of ultrasound(U/S) for distraction measurements

can offer a safer alternative to radiographs and minimise ionizing radiation exposure. Purpose of this study is to report on clinical utility and effectiveness of U/S distraction measurements in evaluation of MCGR treatment.

METHODS

Retrospective review of prospectively collected data on patients with EOS with MCGR instrumentation a tertiary academic centre. Distractions were performed at three-monthly intervals, targeting 3mm of distraction at each visit. Assessment of distraction length was monitored by ultrasound. Plain radiographs were usually taken every 8 months (and were compared with U/S measurements.

RESULTS

We evaluated 23 patients (12 females and 11 males) with average age of 8.1 years (3.9-12 y) who had MCGR insertion and underwent distractions for average 37 months (24-52months). Ultrasound measurements were available at 174 data points and radiographs at 110 data points. Linear regression analysis showed perfect fit between radiographic and U/S measurements at each time (R2 0.723). The two measurements distribution was not different (p 0.001).

CONCLUSION

MCGR distraction lengths can be effectively measured with U/S and can optimise the process of monitoring the growth achieved. It improves patient safety as it can minimise radiation exposure.

TAKE HOME MESSAGE

Ultrasound measurements in evaluation of MCGR distraction is safe, effective and reproducible in the clinical setting.

17. Novel Technique for Early Onset Scoliosis Casting Using Jackson Table

Blake K. Montgomery, MD; Kali Tileston, MD; Japsimran Kaur, BS; Meghan N. Imrie, MD; James F. Policy, MD; Lawrence A. Rinsky, MD; *John S. Vorhies, MD*

SUMMARY

Serial body casting for early onset scoliosis can be performed on a Jackson table modified to function as a traction frame. This study retrospectively reviewed 25 patients that underwent body casting on either a Risser frame or a modified Jackson table. There was no difference in outcomes or complications between the two groups. The modified Jackson table is a safe and effective way to apply body casts without the need for a specialized casting table.

HYPOTHESIS

Early onset scoliosis casting using a Jackson table has similar outcomes and complications compared to casting on a Risser frame.

DESIGN

This was a retrospective cohort study. Patients with early onset scoliosis who underwent elongation-derotation-flexion (EDF) body casting on a Risser or modified Jackson table were included. Patients who had non-EDF casting or were casted on multiple different tables during serial casting were excluded. 32 patients were eligible and 7 were excluded. Primary outcome measures were Cobb angle changes after casting and complications.

INTRODUCTION

Early onset scoliosis (EOS) can have harmful effects on pulmonary function and quality of life. Serial EDF casting is an effective treatment, delaying surgical intervention and, at times, curing EOS. Most described casting techniques call for the use of a specialized frame or casting table, not available at many institutions. We describe a novel technique for EDF casting on a Jackson table modified to function as a traction frame (MJ). Here, we compare results of casting using this table to a traditional Risser frame (RF).

METHODS

We identified and retrospectively reviewed all patients who had EDF casting for EOS at our institution between January 2015 and January 2019. We stratified patients by type of table used and compared clinical and radiographic outcomes. Standard descriptive statistics were calculated.

RESULTS

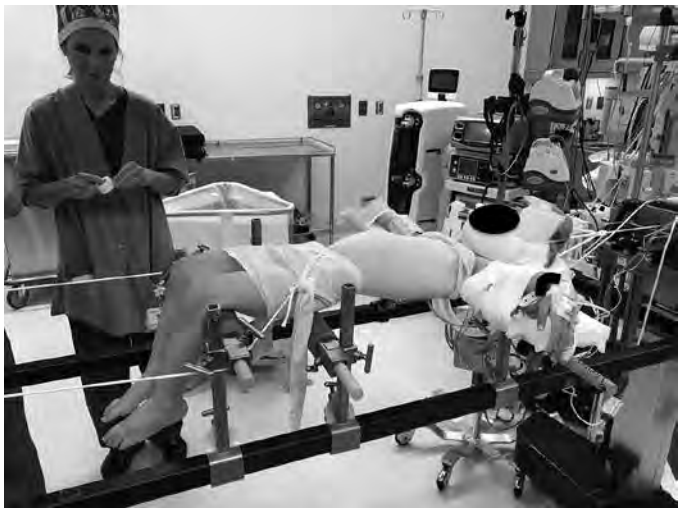
We identified 25 patients who underwent 74 casting events, 11 on an MJ table and 14 on a RF. Mean follow-up was 17 months (range 1 week-46 months). 28% of patients had idiopathic scoliosis. There was no significant difference in age at initiation of casting (P=0.298), initial Cobb angle (P=0.965), or rate of idiopathic scoliosis between the MJ and RF groups. There was no significant difference in cast related complications or in initial coronal Cobb angle correction (P=0.789) between the two groups. There was a significant difference in surgical time, with the MJ group 16 minutes shorter than the RF (P=0.010).

CONCLUSION

The MJ table is a safe and effective alternative for applying EDF casts under traction without the need for a specialized table.

TAKE HOME MESSAGE

The modified Jackson table is a safe and effective alternative for applying elongation-derotation-flexion casts under traction without the need for a specialized table.



Body cast application on modified Jackson table with halter traction cranially and hip traction caudally.

18. Analysis of Respiratory Motion in Preoperative Early Onset Scoliosis by Dynamic MRI

Toshiaki Kotani, MD, PhD; Noriaki Kawakami, MD; Toshiki Saito, MD; Ryoji Tauchi, MD; Tetsuya Ohara, MD; Tsuyoshi Sakuma, MD, PhD; Keita Nakayama, MD; Yasushi Iijima, MD, PhD; Tsutomu Akazawa, MD, PhD; Kazuhide Inage, MD, PhD; Seiji Ohtori, MD, PhD; Shohei Minami, MD, PhD

SUMMARY

We aimed to analyze the motions of the chest wall and the diaphragm in patients with preoperative early onset scoliosis by dynamic MRI. We found significant negative relationships between the Cobb angle and chest wall motion on the convex side. Furthermore, concave and convex chest wall motions were significantly less in patients with fused ribs than without fused ribs.

HYPOTHESIS

Negative relationships exist between the Cobb angle and respiratory motions, i.e. chest wall motion and diaphragm motion, in patients with preoperative early onset scoliosis. Respiratory motions are less in patients with fused ribs than in patients without fused ribs.

DESIGN

Cross-sectional study

INTRODUCTION

Studies have shown deficient pulmonary function in patients with early onset scoliosis. However, little is known about the associated respiratory motion. The objectives of the present study in patients with preoperative early onset scoliosis were (1) to evaluate the motions of the chest wall and the diaphragm and (2) to determine if patients with fused ribs have greater impairment in respiratory motion than those without fused ribs.

METHODS

The chest wall and diaphragm motions of 61 patients (29 female, 32 male; age 5.3 ± 1.8 years; Cobb angle 70.0 ± 26.5 degrees) with preoperative early onset scoliosis were analyzed quantitatively with dynamic MRI by measuring displacements using a cineloop view. Patients were divided into a severe scoliosis group (Cobb angle: 70 degrees or more) and a mild scoliosis group (Cobb angle: less than 70 degrees). Patients were also divided into a fused rib group (n=27) and a non-fused rib group (n=34).

RESULTS

Significant negative relationships were found between the Cobb angle and chest wall motion on the convex side (correlation coefficient -0.299, p=0.020); in the severe scoliosis group, chest wall motion was significantly less than that in the mild scoliosis group (p=0.024). There was no correlation between the Cobb angle and diaphragm motion on either side. Concave and convex chest wall motions were significantly less in patients with fused ribs than without fused ribs (p=0.002, 0.01). No difference in diaphragm motion was found between the fused rib group and the non-fused rib group.

CONCLUSION

Significant negative relationships existed between the Cobb angle and chest wall motion on the convex side. Furthermore, concave and convex chest wall motions were significantly less in patients with fused ribs than without fused ribs, which may cause respiratory deterioration.

TAKE HOME MESSAGE

Patients with preoperative early onset scoliosis with severe curvature or fused ribs have restricted chest wall motion.

19. Contouring the Expandable End of the Growing Rod Increases the Risk of Proximal Junctional Kyphosis in Early Onset Scoliosis

Saba Pasha, PhD

SUMMARY

The relationship between the contouring of the magnetically controlled growing rods (MCGR) and its expansion capacity was studied. The 3D curve of 48 MCGR in 25 early onset scoliosis patients was related to the rod expansion. Increased 3D curve at the expandable end of the MCGR was significantly related to the imparted expansion and the increased in proximal junctional kyphosis. .

HYPOTHESIS

It was hypothesized that contouring the expandable end of the MCGR can reduce the axial loading of the rod, increasing its expansion capacity however it is linked to imparting gradual kyphosis and risk of PJK.

DESIGN

retrospective cohort

INTRODUCTION

The impact of several patient- dependent factors such as the tissue depth, previous surgery, curve severity and flexibility on the expansion capacity of the rod has been studied. However, the mechanical impact of the rod contouring on the expansion of the rod in consecutive intervals has not been evaluated clinically

METHODS

A total number 25 patients with early onset scoliosis who had received MCGRs for their scoliosis were included retrospectively. All patients had 2 view X-ray images and at least 3 expansions after their initial surgery. The rod expansions was measured on 2D ultrasounds. A 3D model of the MCGR rods was created from the frontal and sagittal X-ray images and the 3D rod curve only on the expandable side was measured. The rod expansion at each visit was correlated to the 3D curve of the rod. The PJK at the final follow-up was correlated to the 3D curve of the rod.

RESULTS

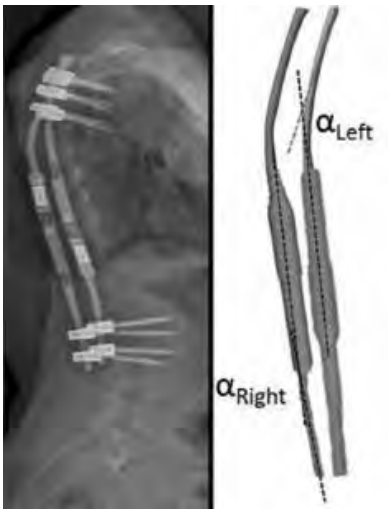
A total number of 48 rods with at least 3 expansion [range 3-7 time, average 5.1 expansion visits] were analyzed. The average 3D curve of the rods at the expandable end was 6.2±11.3 degrees and 13.0±16.9 degrees for the convex and concave rods, respectively. The correlation between the rod 3D curve and its expansion was significant third and fourth visits only for the rod on the concave side (r (3rd visit) = 0.52, r (forth visit) =0.48, $p<0.05$). the changes in the PJK angle between the first and 4th expansions was significantly related to the angle between expandable end of the rod and the actuator, R2=0.56, p=0.01.

CONCLUSION

The mechanics of the rod, described by the 3D contour of the expandable section of the rod with respect to the actuator was found to be a significant factor in rod expansion capability. Unloading the rod axially on the concave side seemed to be linked to improved the expansion capacity of the rod however it was linked to an increase in the risk of PJK in this cohort.

TAKE HOME MESSAGE

Contouring of the MCGRs can allow for larger expansions but at a cost of an increase in PJK.



Calculating the 3D angle at the expandable end of the MCGR on the concave and convex rods

20. Upper Instrumented Vertebrae Distal to T2 Leads to a Higher Incidence of Proximal Junctional Kyphosis During Growing-rod Treatment for Early Onset Scoliosis

Aixing Pan, MD, PhD; Yong Hai, MD, PhD

SUMMARY

The study analyzed the incidence and risk factors of proximal junctional kyphosis(PJK) after growing-rod surgery for early-onset scoliosis(EOS). The incidence of PJK was 28% during growing-rod treatment in EOS. The independent risk factors of developing PJK were UIV distal to T2 and postoperative UTS greater than 50°.

HYPOTHESIS

We sought to evaluate the prevalence and risk factors of proximal junctional kyphosis (PJK) after growing-rod surgery in patients with early onset scoliosis (EOS).

DESIGN

Retrospective case series.

INTRODUCTION

Growing-rod surgery is the primary treatment in patients with progressive EOS when conservative treatment fails. PJK is one of the most commonly reported postoperative complications.

METHODS

We retrospectively evaluated 50 patients (24 boys and 26 girls) diagnosed with EOS who underwent growing-rod surgery. Preoperative and follow-up demographic data, surgical strategies, and radiographic parameters were recorded and early-onset to identify PJK risk factors.

RESULTS

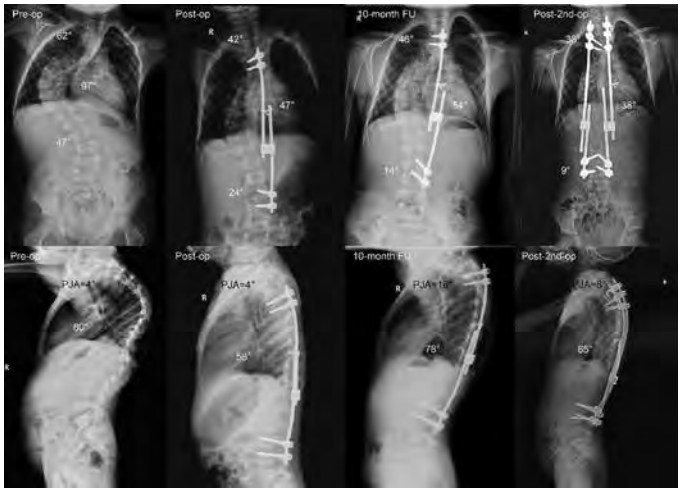
The mean age of patients at the time of the initial surgery was 8.6±2.5 years. Mean follow-up was at 33.5±10.8 months, and mean number of lengthening surgeries were 2.14±1.52. Twenty-eight of the surgical procedures were single growing-rod surgeries, of which 22 were dual growing-rod surgeries. The upper instrumented vertebrae (UIV) ranged from C6 to T6, and the lower instrumented vertebrae (LIV) ranged from L1 to S1. Ultimately, PJK developed in 14 (28%) of 50 patients. Taller patients, UIV distal to T2, and greater postoperative upper thoracic scoliosis (UTS) were suspected potential risk factors of PJK during the univariate analysis ($P<0.1$). Multi-factorial regression analysis confirmed that UIV distal to T2 (HR=5.474, p=0.044) and postoperative UTS greater than 50° (HR=1.049, p=0.046) were independent risk factors of PJK during growing-rod treatment in patients with EOS.

CONCLUSION

The prevalence of PJK was 28% during growing-rod treatment in EOS. The independent risk factors for PJK were UIV distal to T2 and postoperative UTS greater than 50°. It is early-onset for spine surgeons to recognize these risk factors when planning surgeries, and counselling patients and families about this possible complication.

TAKE HOME MESSAGE

The prevalence of postoperative PJK in patients with EOS undergoing growing-rod surgery is 28%. UIV distal to T2 and postoperative UTS >50 ° were significant risk factors for PJK.



A 7 years old boy diagnosed with idiopathic EOS. 10 months after operation, PJK occurred on the sagittal plane with the PJA increased to 16°. 2 years after the first operation, dual growing-rod revision surgery was performed with the UIV extended to T3.

21. Using Ultrasound for Screening Scoliosis to Reduce Unnecessary X-ray Exposure: A Prospective Diagnostic Accuracy Study on 442 Schoolchildren from a Scoliosis Screening Program

Tsz-Ping Lam, MBBS; Yi-Shun Wong, BSc (Hons); Benjamin Hon Kei Yip, PhD; Bobby Kinwah Ng, MD; Lik Hang Alec Hung, FRCS; Winnie

Chiu Wing Chu, MD; *Yong-Ping Zheng, PhD;* Kelly Ka-Lee Lai, BS; Wayne Y.W. Lee, PhD; Yong Qiu, MD; Jack C.Y. Cheng, MD

SUMMARY

Ultrasound is useful for identifying schoolchildren with Cobb angle≥20° before subjecting to confirmatory radiographic assessment and specialist referral in a scoliosis screening program.

HYPOTHESIS

Ultrasound is accurate in determining the Referral Status for scoliosis screening, ie "for specialist referral" or "not for specialist referral"

DESIGN

Prospective diagnostic accuracy study

INTRODUCTION

In our governmental scoliosis screening program, Angle of Trunk Rotation (ATR) measured with a Scoliometer and Moiré Topography are evaluated. Those screened positive for suspected scoliosis will have x-ray assessment. Subjects with Cobb angle≥20° are referred for specialist care. There were cases with Cobb angle < referral threshold of 20° thus being subjected to unnecessary x-ray exposure. Our objective is to determine if ultrasound can identify subjects "for specialist referral" or "not for specialist referral" to reduce unnecessary x-ray exposure.

METHODS

442 schoolchildren screened positive for suspected scoliosis were recruited from the scoliosis screening program. In addition to whole spine radiography, ultrasound of the spine was independently performed on the same day. X-ray-based Referral Status, i.e. "Cobb≥20°-for specialist referral" or "Cobb<20°-not for specialist referral", was the gold standard. The Spinous Process Angle (SPA, Fig 1) measured by ultrasound was used to determine the ultrasound-based Referral Status to be compared with the gold standard. ATR was also measured.

RESULTS

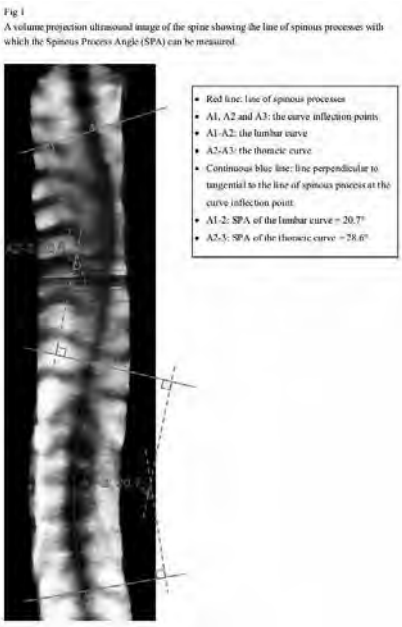
There were 243 females and 199 males with a mean age of 13.2±1.8 years old. Maximum Cobb angle and ATR had a mean of 14.0±6.6° and 5.7±2.4° respectively. 78 subjects (17.6%) had Cobb angle≥20°. Curve-based logistic regression analysis showed the area under ROC curve was 0.749 when only SPA was used, as compared with 0.854 when both SPA and ATR were used. At a probability cut-off of 0.11, patient-based analysis showed the sensitivity and specificity of ultrasound were 92.3% & 51.6% while the positive and negative predictive values were 29.0% & 96.9% respectively.

CONCLUSION

Results indicate accuracy of ultrasound for screening scoliosis and identifying subjects with Cobb angle≥20° for specialist referral. Adding ATR will increase prediction accuracy. Funded by HKG HMRF (04152896)

TAKE HOME MESSAGE

Ultrasound can be incorporated into a scoliosis screening program to reduce unnecessary x-ray exposure



Measurement of Spinous Process Angle (SPA) with ultrasound

22. Slow Correction of Severe Adult Spastic Scoliosis by Stepwise Distraction of Magnetically Controlled Growing Rods (MCGR) and Final Posterior Spinal Fusion

Christof Birkenmaier, MD; Bernd Wegener, MD; Jan H. Mehrkens, MD; Carolin Melcher, MD

SUMMARY

MCGR were developed for and are labeled for use in growing children with spinal deformities where final fusion should be postponed. We have previously used MCGR off-label for the slow correction of severe adult spastic hyperlordosis. Based on that positive experience, we applied the technology in another off-label setting where it proved to be extremely helpful to our treatment strategy. While these devices are expensive and certainly not a panacea, there might be indications in adults that deserve consideration.

HYPOTHESIS

Based on previous experience with the use of the slow powerful distraction that can be achieved by using MCGR, we hypothesised that this approach might also be useful and safe in a case of severe spastic lumbar scoliosis (as presented at 51st Annual Meeting and published in Eur Spine J 2018;27:1671-8).

DESIGN

case study, off-label treatment

INTRODUCTION

A 19-year-old male, with severe CP (GMFCS 5) presented with a neglected and rigid lumbar curve of 118°. His complaints were severe pain from rib-pelvis impingement and the lost sitting ability. Examination under GA showed only 10° flexibility and halo-gravity traction was not tolerated. After neurologic testing, a Baclofen pump was implanted as a preparatory step and informed consent about the experimental nature of the treatment was obtained.

METHODS

In a first surgery, a concave apical facet and interlaminar release was performed, a proximal anchor of 4 unilateral pedicle screws and a rod was constructed and 2 MCGR were placed in parallel between the iliac crest and the proximal anchor. After wound healing, stepwise distraction was performed over a period of 4 months. The deformity slowly reduced while the abdominal wall and flank were stretched and eventually, sitting capability was achieved. When a balanced spine in the sitting position was reached, final posterior fusion to the pelvis was performed in a second surgery with 55° residual Cobb.

RESULTS

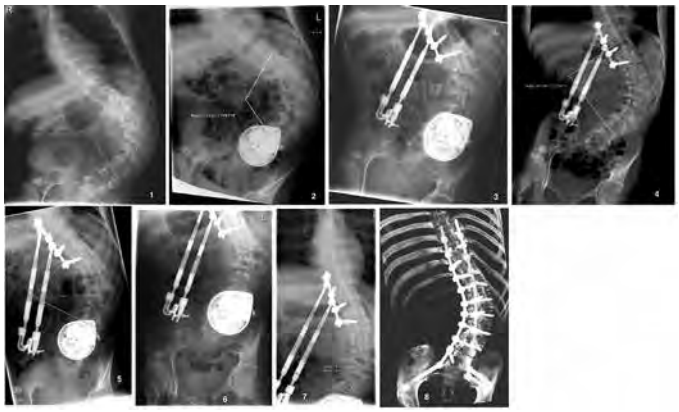
Early surgical site infection was treated by debridement, washout and antibiotics, implants were maintained. At 2 years FU, the patient is free of back pain, and capable of sitting. A CT showed a solid fusion with asymptomatic radiolucent seams around both cranial screws, but no signs of PJK or PJF and no loss of correction.

CONCLUSION

In this particular case, this experimental treatment was successful. The stepwise correction process (combined with a Baclofen pump) overcame the high muscle tone, slowly stretched the soft tissue envelope and reduced the deformity. A functional and balanced final situation could be dialed in and the final fusion was performed with minimal stress on the implants.

TAKE HOME MESSAGE

While there rarely is only one sensible approach for treating a spinal deformity, there are situations where a slow and controlled correction may be preferable over a single-step procedure.



1: 120° at presentation, 2: after implantation of Baclofen pump, 3: after release and implantation of 2 MCGR, 4: CT recon of situation in image 3:. With radical release and implantation MCGR 90°, 5-7: distraction over 4 months, 8: final result

23. Ambulatory NMS Patients have Similar Rates of Infection, Revision, Overall Complication, and Revision Rates to AIS Patients

Vishal Sarwahi, MD; *Francisco J. Laplaza, MD;* Jesse Galina, BS; Aaron M. Atlas, BS; Sayyida Hasan, BS; Chhavi Katyal, MD; Marina Moguilevtch, MD; Jon-Paul P. DiMauro, MD; Yungtai Lo, PhD; Aleksandra Djukic, MD; Terry D. Amaral, MD

SUMMARY

NMS patients usually have severe curves with more comorbidities and procedural complexity. These patients require extensive fusion levels, increased blood loss, and suffer increased periop complications. However, NMS patients have a variable spectrum of severity. Our study finds that ambulatory NMS patients can achieve periop outcomes similar to AIS patients with regards to surgical complication rate, infections, revisions, and blood loss.

HYPOTHESIS

Following posterior spinal fusion (PSF), ambulatory NMS cases compare similarly in their safety profile to AIS patients.

DESIGN

Ambispective review

INTRODUCTION

As a collective group, NMS has a worse prognosis and surgical outcomes than its AIS counterpart. However, not all operative patients with NMS necessarily suffer the same poor outcomes associated with the class. Our aim with this study is to examine mildly affected NMS patients to determine whether their surgical outcomes are comparable to AIS.

METHODS

Radiograph and retrospective chart review of NMS and AIS patients undergoing PSF with pedicle screws from 2005-2018 was done. Group 1 (G1), NMS patients who could ambulate without assistance (GMFCS I-III). Group 2 (G2) was AIS patients. Demographics, intra-op parameters, and radiographic measurements were collected at pre- and post-op. Wilcoxon rank sums tests and chi-square tests were performed.

RESULTS

G1 (n=48) and G2 (n=159) were similar in age, sex, preop kyphosis, pre- and postop Cobb angle, and Cobb correction. Additionally, EBL ($p=0.143$), postop transfusions ($p=0.5$), and periop complications within 30 days ($p=0.5$) were similar between groups. Specifically, infections ($p=0.592$), DVT ($p=0.232$), revisions ($p=1.0$), and mortality ($p=1.0$) were statistically similar. However, G2 NMS patients did have increased fusion levels ($p<0.001$), fixation points ($p=0.002$), pelvic fixation ($p=0.002$), anesthesia ($p<0.001$) and surgery time ($p<0.001$), ICU ($p<0.001$) and hospital stay ($p<0.001$), intraop transfusions, pulmonary complications ($p=0.012$) and fewer patients extubated in the OR ($p<0.001$).

CONCLUSION

NMS inherently confers high risk of blood loss, longer surgeries and fusions, complications, ICU and hospitals stays. Our data confirms longer fusion levels, surgical time, and hospital stay, with lower extubation rates. Infection rate, revisions, and overall complications were similar to the AIS population as were the radiographic outcomes. This suggests that NMS patients who are ambulating can expect surgical outcomes quite comparable to AIS patients with further room for improvement in surgical duration and anesthesia protocols.

TAKE HOME MESSAGE

Despite increased risk, the ambulating population of NMS patients have comparable surgical radiographic outcomes, rates of infection, revision, and overall complication to AIS patients.

24. Using a Novel Augmented Reality and Artificial Intelligence Surgical Guidance System for Pedicle Screw Placement: A Cadaveric Study

Karina M. Katchko, MD

SUMMARY

Use of a novel surgical navigation system using augmented reality and artificial intelligence technology resulted in accurate identification and precise 3D visualization of lumbar pedicles directly in the surgical field while performing percutaneous pedicle instrumentation in all attempted levels of 5 cadaveric spine specimens. Use of augmented-reality technology during minimally invasive spine surgery may lead to better patient outcomes, reduce surgical time, and decrease the learning curve for percutaneous screw placement.

HYPOTHESIS

An augmented reality (AR) navigation system can accurately identify and precisely display lumbar pedicles in 3D on the surgical field while performing percutaneous instrumentation.

DESIGN

Lumbar pedicles in 5 cadavers were instrumented using a novel augmented-reality navigation system.

INTRODUCTION

Minimally invasive spine surgery (MISS) has advantages over open procedures however, all currently available navigation systems force surgeons to look away from the surgical field to verify instrument position. This requires development of complex coordination skills with a steep learning curve. Augmented, reality-based display of virtual spinal anatomy over patient spinal anatomy may serve as a more user-friendly navigation system.

METHODS

The navigation system consisted of a projection screen that hovers over the surgical field and 3D goggles to visualize the virtual spine model collocated with the cadaver's anatomy. An optical tracker determined the orientation of all components. Using CT the system computed the spatial relationship between internal anatomy and registration arrays. Five cadaveric spine specimens were used. A Jamshidi needle was introduced into the lumbar pedicles at the precise location identified by the navigation system as the entry point, followed by a pedicle screw mounted on a navigated screwdriver. CT was then used to evaluate the 3D position of the screw with respect to the actual pedicles.

RESULTS

This novel surgical navigation system using AR and artificial intelligence technology resulted in accurate identification and precise 3D visualization of lumbar pedicles directly in the surgical field while performing percutaneous pedicle instrumentation on cadavers. All attempted pedicle screws (N=20) were placed in acceptable position. There were no breaches on post-instrumentation CT or aborted attempts.

CONCLUSION

Accurate percutaneous pedicle screw placement provides optimal mechanical strength while improving patient safety and decreasing the morbidity of open spine procedures. AR technology may lead to better patient outcomes, reduce surgical time, and decrease the learning curve for MISS.

TAKE HOME MESSAGE

Augmented, reality-based navigation systems using virtual spinal anatomy overlying patient anatomy may lead to better outcomes, reduce surgical time, and decrease the learning curve for minimally invasive spine surgery.

Figure 1.

Figure 1. A. Surgeon wearing active 3D goggles for visualization of internal anatomy. B. Jamshidi needle position correlated to intraoperative scan. C. Virtual anatomy overlying cadaver as seen by surgeon through 3D goggles.

25. Towards a Cervical Deformity-specific Outcome Instrument: Use of the Patient-generated Index to Capture the Disability of Cervical Deformity

Nicholas Stekas, MS; *Themistocles S. Protopsaltis, MD*; Ethan W. Ayres, MPH; Gregory M. Mundis Jr., MD; Justin S. Smith, MD, PhD; Robert A. Hart, MD; D. Kojo Hamilton, MD; Eric O. Klineberg, MD; Daniel M. Sciubba, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Frank J. Schwab, MD; Virginie Lafage, PhD; Christopher P. Ames, MD; International Spine Study Group

SUMMARY

Existing health outcome (HRQL) metrics fail to correlate with malalignment of the cervical spine and do not adequately capture disability from cervical deformity (CD). The Patient Generated Index (PGI) where patients report their greatest difficulties related to their CD, was used to determine items that should be included in a CD specific HRQL. Problems that are disabling to CD patients, but not captured in existing questionnaires, were found to be Horizontal Gaze/Walking Safety and Sagittal Discomfort/ROM.

HYPOTHESIS

PGI can reveal the aspects CD disability not captured by existing HRQLs.

DESIGN

Retrospective review of a prospective multicenter database

INTRODUCTION

HRQL metrics have failed to adequately capture disability from CD. The purpose of this study is to utilize PGI to identify aspects CD disability not captured by existing HRQL.

METHODS

CD patients completed the PGI by describing aspects of their disability that bother them the most. The responses were weighted and scored (Figure). PGI responses were categorized and compared to HRQLs of patients in a prospective CD database. PGI and HRQLs were correlated to alignment.

RESULTS

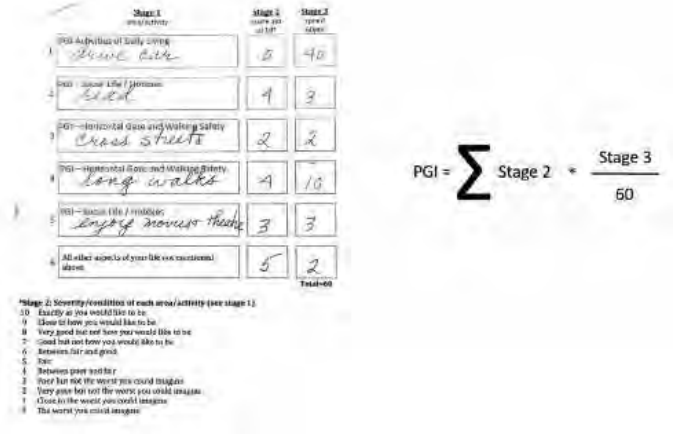
139 CD pts (46.2mm mean cSVA) and 12 PGI pts (62mm mean cSVA) were included. PGI responses were grouped into 6 categories: Pain, Sagittal Discomfort/ROM, Horizontal Gaze/Walking Safety, Activities of Daily Living (ADL), Social Life and Hobbies and Neurologic. mJOA correlated with CL (r=0.21, p=0.01), TS-CL (r=-0.20, p=0.02), and C2S (r=-0.18, p=0.03). PGI scores did not correlate with any HRQLs. 34/60 PGI responses (57%) were found to be captured by existing HRQLs. The EQ5D addressed 53% of PGI responses compared to 43% for NDI, 3% for mJOA address and 0% for SWALQOL. PGI-Pain, -neurologic, -social life, and -ADL responses were addressed by existing HRQLs. However, only 40% horizontal gaze and 0% sagittal discomfort responses were addressed. The main drivers of NDI score were Reading, Pain, and Recreation questions, explaining 80% of variability (r^2=0.80). The main drivers of PGI were ADL, sagittal discomfort, and social life, explaining 75% of variability (r^2=0.75). NDI-Concentration and NDI-Sleep correlated with multiple individual PGI items (r>.75, p<.05).

CONCLUSION

Existing HRQL do not adequately capture CD disability and do not correlate with cervical malalignment. PGI items not addressed in existing HRQLs include Sagittal Discomfort/ROM and Horizontal Gaze/Walking Safety. In addition, the most important categories driving PGI scores were found to be ADLs, Sagittal Discomfort/ROM, and Social Life/Hobbies.

TAKE HOME MESSAGE

The patient generated index describes the most important aspects of disability from cervical deformity that are not captured in existing outcome metrics: Sagittal Discomfort/ROM and Horizontal Gaze/ Walking Safety.



26. Comparison of Perioperative Complications Following Posterior Column Osteotomies Versus Posterior Based Three Column Osteotomy for Correction of Moderate to Severe Cervical Sagittal Deformity in 95 Patients at Single Center

Darryl Lau, MD; Cecilia L. Dalle Ore, BS; Vedat Deviren, MD; Christopher P. Ames, MD

SUMMARY

The senior author performed 95 cervical deformity corrections utilizing posterior column osteotomy (PCO) or posterior three column osteotomy (3CO) (Cervical Osteotomy Ames Grades 2-PCO or 5/6-CWO). Complication and neurologic deficit rate was 37.9% and 16.8%. There were higher rates of overall, neurologic, and surgical complications with 3CO compared to PCO but this was not significant. Independent risk factors for complications include male gender, cSVA >8 cm, and anterior-posterior approaches. Kyphosis >20 degrees was an independent risk factor for neurologic deficit.

HYPOTHESIS

Posterior based 3CO (Cervical Osteotomy Ames Grades 5-OWO or 6-CWO) are associated with higher perioperative complication rates and neurologic complications compared to PCO (Cervical Osteotomy Ames Grade 2-PCO).

DESIGN

Single surgeon, retrospective study.

INTRODUCTION

Correction of severe cervical sagittal deformity with osteotomies can be challenging and associated with significant morbidity. The difference in high- and low-grade osteotomy complication profile and risk factors has yet to be defined.

METHODS

A retrospective comparison of complication profile between posterior based 3CO and PCO was performed in a single surgeon experience from 2011 to 2018 of all patients with cSVA of >4 cm who underwent correction for cervical deformity. Multivariate analysis was utilized.

RESULTS

95 patients were included: 49 3CO and 46 PCO. 12 of PCO had anterior releases. Mean age was 63.2 years and 60.0% were female. Preoperative and postoperative parameters: cSVA (6.2 cm and 3.5 cm, p<0.001), cervical lordosis (-6.8 degrees and 7.5 degrees, p<0.001), and T1-slope (40.9 degrees and 35.2 degrees, p=0.026). Complication rate was 37.9% and neurologic deficit was 16.8%. Surgical and medical complication rates were 17.9% and 23.2%. Overall, surgical, and neurologic complication rate was higher with 3CO compared to PCO but this was not significant (42.9% vs 32.6%, p=0.304, 18.4% vs 10.9%, p=0.303, and 20.4% vs 13.0%, p=0.338). Medical complication rates were similar (23.9% vs 22.4%, p=0.866). Independent risk factors for surgical complication were male gender (OR 10.88, p=0.014) and cSVA >8 cm (OR 10.36, p=0.037). Anterior-posterior surgery was independently associated with medical complications (OR 10.30, p=0.011). Kyphosis >20 degrees was an independent risk factor for neurological deficit (OR 2.08, p=0.011).

CONCLUSION

There was no significant difference in complication rates between 3CO and PCO. Preoperative cSVA > 8 cm and kyphosis >20 degrees are risk factors for surgical and neurologic complications, respectively. Large prospective studies are needed.

TAKE HOME MESSAGE

Posterior 3CO have higher rates of complications than PCO but this was not statically significant. cSVA >8 cm, combined anterior-posterior surgery, and kyphosis >20 degrees are risk factors for complication.

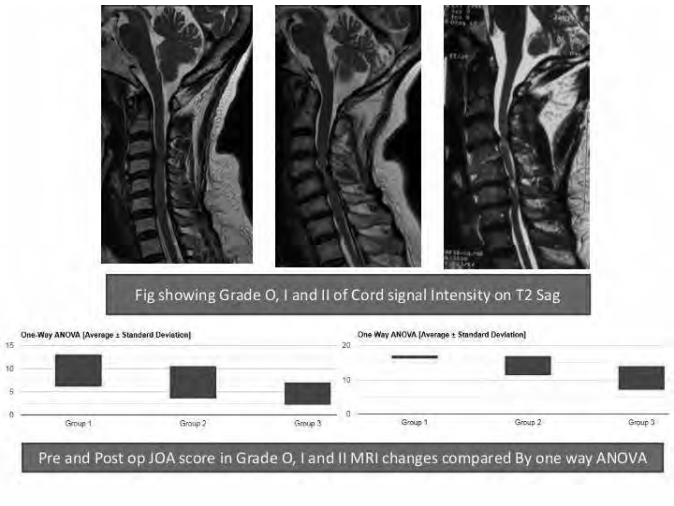


Fig showing Grade O, I and II of Cord signal Intensity on T2 Sag

Pre and Post op JOA score in Grade O, I and II MRI changes compared By one way ANOVA

27. Does One Year Post Operative Cord Signal Changes in MRI Correlate with Neurological Recovery in Patients with Cervical Spondylotic Myelopathy (CSM)?

Saumyajit Basu, MD, FRCS; Naveen Agrawal, MS; Somashekar D., MBBS, MS

SUMMARY

MRI provides variety of diagnostic information and increased cord signal intensity is often seen in patients with CSM. After decompressive surgery, disappearance or decrease of signal changes has been observed in some cases, but there are not many studies which have compared pre and post opeartive MRI Cord signal intensity and correlation of surgical outcome. In our study we correlation was statistically insignificant. Cord signal changes persisted in almost 2/3rd of the patients even though they had significant neurological

HYPOTHESIS

Neurological outcome does not correlate with one year Post op MRI cord signal changes in CSM.

DESIGN

Retrospective

INTRODUCTION

In CSM, MRI provides variety of diagnostic information & increased Cord Signal Intensity is often seen in patients with CSM. After decompressive surgery, the disappearance or decrease in cord signal intensity has been observed in some cases. There are not many studies in the literature which had investigated changes in CSI between pre- & postoperative MRI with Neurological outcome. Therefore, the purpose of our study is to evaluate degree and CSI changes in patients with CSM before & after surgery and whether postop alteration of CSI changes reflects the neurological outcome.

METHODS

The medical records & MRI of operated patients of CSM(62 patients) from Jan 2014 to Dec 2017 were retrospectively reviewed. 36 operated by Anterior (ACDF/ACCF) and 26 by posterior approach (Laminectomy with fusion/Laminoplasty). MRI performed in all patients preoperatively and at one year follow up. CSI were studied & divided into 3 grades (Chen) based on sagittal T2 weighted MRI as : Grade 0, none; 1, light ; & 2, intense. Neurological changes were evaluated by JOA score and its recovery rate.

RESULTS

Cord signal changes were seen in 91.9% of patients pre and in 64.5 % postoperatively. Pre-op, 5 patients had Grade 0 CSI, 35 with Grade 1, and 22 with Grade 2; postoperatively, there were 22 with Grade 0, 29 with Grade 1, and 11 with Grade 2. Postop JOA scores and recovery rates (%) were 16.6 and 94% in Grade 0, 14.02 and 70.1% in Grade 1, 10.45 and 47.2% in Grade 2. Pre-op JOA in different MRI grades was statistically Significant ($p < 0.0001$) but no statistical significant difference in post-op JOA. CSI grade improved in 29 patients, unchanged in 32 (51.6%) and worsened in 1. CSI changes persisted in 64.5% of patients even with significant improvement in Neurology

CONCLUSION

Pre op MRI changes can predict the recovery rates CSM. But post op MRI changes do not correlate with post op neurological recovery. No significant correlation was seen between Post op CSI alterations & surgical outcomes.

TAKE HOME MESSAGE

MRI can predict the percentage of recovery in CSM patients pre opeartively, but cannot be used as monitoring tool for Neurological recovery in Post opeartive period.

28. Transforaminal Epidural Injection of Local Anesthetic and Dorsal Root Ganglion Pulsed Radiofrequency Treatment in Lumbosacral Radicular Pain: A Randomized, Triple-blind, Active-control Trial

Manish De, MD, MBBS; *Bhavuk Garg, MS, MRCS, FACS;* Virender Kumar Mohan, MD, MBBS

SUMMARY

Pulsed radiofrequency treatment of dorsal root ganglion for 180 seconds was compared with transforaminal epidural injection of local anaesthetic in patients with chronic lumbosacral radicular pain. Patients were assessed at 2 weeks, 1, 2, 3 and 6 months for pain intensity and functional improvement by VAS (0-100) and ODI

HYPOTHESIS

Dorsal root ganglion pulsed radiofrequency (DRG-PRF) treatment is more effective than transforaminal epidural local anaesthetic in relieving lumbar radicular pain (LRP)

DESIGN

Prospective, triple-blind, parallel group, randomized active-control trial

INTRODUCTION

LRP results from inflammation and irritation of lumbar spinal nerves and DRG. No study has compared the efficacy of transforaminal epidural local anaesthetic and DRG-PRF in LRP till date.

METHODS

Patients having LRP with failed conservative management > 3months first received selective diagnostic nerve root block with 1 ml 2% lignocaine. Patients showing positive response were divided into two groups. Group LA received transforaminal epidural 1 ml of 0.5% bupivacaine. Group LPRF received transforaminal epidural 1 ml of 0.5% bupivacaine with DRG pulsed radiofrequency. Both groups were compared, Primary outcome: ≥20 point reduction in 0-100 point VAS (Visual Analogue Scale) at 2 weeks, 1- 2 - 3 and 6 months post procedure. Secondary outcome: Improvement in functional status as measured by Modified Oswestry Disability Questionnaire (MODQ) at respective time intervals.

RESULTS

At the end of recruitment process, fifty patients were enrolled and randomized into two groups- LA and LPRF. All baseline variables were comparable between two groups. Statistically significant reduction in both the outcomes were seen in LPRF group compared to LA group from 2 weeks to 6 months. More than 20 point decrease was found in 100% patients in LPRF group at all time intervals up to 6 months whereas it was 80% and 28% patients in LA group at 3 and 6 months respectively. Reduction in ODI percentage was observed more in LPRF group. No complications in patients of either group

CONCLUSION

PRF of DRG applied for a longer duration results in long-term pain relief and improvement in functional quality of life in patients with chronic lumbosacral radicular pain. Further research is warranted to confirm whether gradually increasing duration of PRF application results in long-lasting symptom relief.

TAKE HOME MESSAGE

Dorsal root ganglion pulsed radiofrequency (DRG-PRF) treatment is more effective than transforaminal epidural local anaesthetic in relieving lumbar radicular pain (LRP)

29. Outcomes of Decompression without Fusion in Patients with Lumbar Spinal Stenosis with Back Pain

Rachid Bech-Azeddine, PhD; Søren Fruensgaard, MD; Mikkel Ø Andersen, MD; *Leah Yacat Carreon, MD, MS*

SUMMARY

From the DaneSpine database, 1891 patients with lumbar stenosis and back pain VAS > 50 underwent decompression without fusion. There were significant improvements from baseline to 12 months post-operative for back pain (72.1 to 42.1), leg pain (71.2 to 41.3), EQ-5D (0.35 to 0.61) and ODI (44.1 to 27.8).

HYPOTHESIS

Back pain in patients with lumbar spinal stenosis (LSS) improves after decompression alone without fusion.

DESIGN

Longitudinal observational cohort

INTRODUCTION

Some surgeons believe that the presence of substantial back pain in LSS patients is an indication for fusion; and that decompression alone may lead to worsening of the back pain from destabilization associated with facet resection. The purpose of this study is to determine if LSS patients with clinically significant back pain can obtain substantial improvements in back pain after a decompression alone without fusion.

METHODS

The DaneSpine database was used to identify 2737 patients with LSS without segmental instability and a baseline back pain VAS ≥ 50 who underwent a decompression procedure alone without fusion. Standard demographic and surgical variables and patient outcomes, including back and leg pain VAS (0 to 100), Oswestry Disability Index (ODI) and EuroQOL-5D (EQ-5D) at baseline and 12 months post-op were collected.

RESULTS

A total of 1891 (69%) patients had 12 month follow-up data available for analysis; mean age of 66.4 years; 860 (46%) were male; mean BMI was 27.8kg/m2; 508 (27%) were current smokers. At twelve months post-operative, there were statistically significant improvements ($p<0.001$) from baseline for back pain (72.1 to 42.1), leg pain (71.2 to 41.3), EQ-5D (0.35 to 0.61) and ODI (44.1 to 27.8).

CONCLUSION

Patients with LSS and clinically substantial back pain can obtain improvement in back pain after decompression only surgery and may not need a concomitant fusion.

TAKE HOME MESSAGE

Patients with Lumbar Spinal Stenosis without instability and clinically substantial back pain can obtain improvement in back pain after decompression only surgery and may not need a concomitant fusion.

30. Which MRI Findings are Associated with Long-term Disability in Low Back Pain Patients?

Peter Muhareb Udby, MD, DC; Soren Ohrt-Nissen, MD, PhD; Michael Rud Lassen, MD; Stig Brorson, PhD, DMSc; Leah Yacat Carreon, MD, MS; Mikkel Ø Andersen, MD

SUMMARY

This study evaluates which baseline MRI changes are associated with long-term disability. In total, 204 cases with low back pain, including 82 (40%) with MC, were enrolled in 2004 and 170, including 67 (39%) with MC, 88 with disc degeneration (52%) and 86 with facet degeneration (81%), were available for follow-up in 2017. MC was the only radiologic finding associated with better 13-year RMDQ scores. Disc degeneration and the presence of facet joint degeneration showed no association with 13-year disability.

HYPOTHESIS

There are associations between long-term RMDQ and baseline Pfirmman, Modic and Fujiwara classifications.

DESIGN

Longitudinal observational cohort study with 13-year follow-up.

INTRODUCTION

Multiple MRI classifications are used to assess lumbar degenerative disease. The most widely used are the Pfirmann classification, the presence or absence of Modic Change (MC) and the Fujiwara classification of facet joint degeneration. The purpose of this study was to examine the associations between long-term RMDQ and baseline Pfirmann classification, Modic Changes (MC) and Fujiwara classification.

METHODS

In 2004-2005, patients aged 18-60 with daily LBP were enrolled in an RCT and lumbar MRI was performed. Patients completed numeric rating scales (NRS, 0-10) for LBP and leg pain (LP), Roland-Morris Disability Questionnaire (RMDQ) at baseline and 13-years after the MRI. We performed a linear regression to determine associations with long-term disability (13-yr RMDQ). The MRI parameters included baseline disc degeneration (Pfirmann grade>3 on any lumbar level), Modic changes and facet joint degeneration (Fujiwara grade>2 on any lumbar level). Demographic variables at baseline included BMI, alcohol consumption, smoking and weekly physical activity.

RESULTS

Of 204 cases with baseline MRI, 170 (83%) were available for follow-up. 88 had disc degeneration (52%), 67 had MC (39%) and 86 had facet joint degeneration (81%). The presence of MC was the only radiologic finding that was statistically significantly associated with better 13-year RMDQ scores (p=0.003). Baseline disc degeneration and the presence of facet joint degeneration showed no significant association with 13-year disability. Baseline weekly physical activity was also significantly associated with better 13-year RMDQ scores (p<0.000).

CONCLUSION

Presence of MC and weekly physical activity was significantly associated with less long-term disability. Baseline MRI findings of disc degeneration and facet joint degeneration were not associated with long-term disability.

TAKE HOME MESSAGE

Baseline disc degeneration and the presence of facet joint degeneration showed no association with 13-year disability in LBP cases. Baseline MC was associated with statistically significant better 13-year RMDQ scores

31. Lateral Lumbar Interbody Fusion with Percutaneous Pedicle Screw Fixation (LLIF-PPS): Are We Getting the Sagittal Alignment Right?

Jonathan N. Sembrano, MD; Nicholas R. Dick, BS; J. Alex Thomas, MD; Breana Siljander, MD

SUMMARY

Among patients who underwent lateral lumbar interbody fusion with percutaneous pedicle screw fixation (LLIF-PPS), radiographic analysis showed no difference in number of sagittal alignment goals met between pre- and postoperative. Patients with preoperative sagittal malalignment should be considered for alternative procedures that may provide better lordosis restoration.

HYPOTHESIS

Mean number of sagittal alignment goals met will increase after LLIF-PPS surgery.

DESIGN

Retrospective radiographic review.

INTRODUCTION

LLIF-PPS is a circumferential minimally-invasive surgery (MIS) that achieves indirect decompression, stabilization and interbody fusion for treatment of lumbar pathologies. Advantages of MIS include lower blood loss, less postoperative pain, and quicker recovery. Attaining proper sagittal alignment with spinal fusion is important. We evaluated the efficacy of LLIF-PPS in achieving optimal sagittal alignment.

METHODS

84 patients who underwent LLIF-PPS at 1-4 levels from L1-L5 (115 total levels; 71 patients included L4-5) by 2 surgeons at 2 institutions (2009- 2018) were reviewed. Exclusion criteria were: concomitant ALIF/TLIF; corrective osteotomies; pre-psoas approach; planned anterior longitudinal ligament release; extension of fixation to the thoracic spine or pelvis; and fusion for diskitis, osteomyelitis or acute trauma. Pre- and 6-12 week post-operative standing x-rays were analyzed for the following: lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT), and L4-S1 lordosis. The frequency of meeting the following goals was determined: (1) PI-LL < 10 ; (2) PT < 20; and (3) L4-S1 >= 60% of PI.

RESULTS

There was no difference in rates of meeting specific alignment goals before and after LLIF-PPS (p > 0.05, Table 1). Mean number of goals met was higher pre- than postoperative (1.68 vs 1.48, p = 0.03). Postoperative, 51% of patients met the same number of alignment goals, 17% met more and 31% met fewer, compared to the preoperative state.

CONCLUSION

There was no difference in mean number of alignment goals met before and after LLIF-PPS. Fewer cumulative alignments goals were met after LLIF-PPS. These findings suggest that LLIF-PPS generally is unable to correct preoperative sagittal malalignment.

TAKE HOME MESSAGE

Patients with preoperative sagittal malalignment should be considered for alternative procedures that may provide better lordosis restoration, as LLIF-PPS is shown to have limited ability to correct sagittal malalignment.

Table 1: Numbers of patients that met each alignment goal pre- and post-operative

Alignment Goal	Pre-Op	Post-op	P-value
PI-LL < 10	53 (63.1%)	51 (60.7%)	0.87
PT < 20	46 (56.1%)	39 (46.4%)	0.28
L4-S1 ≥ 0.6(PI)	43 (51.2%)	34 (40.5%)	0.22

32. Does ACR Result in Greater Morbidity than LLIF Alone When Treating Adult Spinal Deformity?

Robert K. Eastlack, MD; Dean Chou, MD; Juan S. Uribe, MD; Richard G. Fessler, MD, PhD; Khoi D. Than, MD; Stacie Tran, MPH; Paul Park, MD; Kai-Ming Gregory Fu, MD, PhD; Michael Y. Wang, MD; Adam S.

Kanter, MD; David O. Okonkwo, MD, PhD; Pierce D. Nunley, MD; Neel Anand, MD; Gregory M. Mundis Jr., MD; *Praveen V. Mummaneni, MD;* International Spine Study Group

SUMMARY

Anterior column realignment (ACR) and lateral lumbar interbody fusion (LLIF) are both used for adult spinal deformity (ASD) correction. ACR provides for normalization of spinopelvic parameters, similar to LLIF alone, with a lower postoperative SVA achieved via ACR technique. Overall, neurologic, and vascular complication rates were similar when comparing ACR via lateral approach vs. LLIF alone when correcting ASD.

HYPOTHESIS

Anterior column realignment (ACR) for correction of adult spinal deformity (ASD) results in similar complication rates while achieving spinopelvic parameter goals when compared to lateral lumbar interbody fusion LLIF.

DESIGN

Prospective multicenter database review

INTRODUCTION

ACR can be utilized for correction of ASD, but the additional benefit over LLIF alone is unclear

METHODS

Inclusion criteria: age ≥18yrs, and one of the following: coronal cobb>20°, SVA>5cm, PT>20°, PI-LL >10°. Patients were treated with circumferential MIS (cMIS) surgery or hybrid MIS surgery & had 1yr min f/u. HRQOL (Oswestry Disability Index (ODI), visual analog score (VAS), SRS-22) & spinopelvic parameters were captured

RESULTS

127 patients met inclusion criteria, 101 underwent LLIF and 26 had ACR. Average age & BMI were 66.3/27.7 and 67.8/27.4 (p=0.654/0.957). The groups had similar rates of prior spine surgery (48.5% vs 57.7%; p=0.403), cMIS (58.7% vs 73.1%; p=0.222), posterior osteotomies (43.6% vs 34.6%; p=0.409), levels instrumented (7.8 vs 8; p=0.895), & interbody fusion levels (3.4 vs 3.6; p=0.478). Preop (PT: 23.6/26.3;p=0.373, SVA: 77.6/54.6mm;p=0.151, PI-LL: 17.3/20;p=0.692) & postop spinopelvic parameters were similar between groups, except for postop SVA which was higher in the LLIF group (40mm vs 13mm; p = 0.028). 1yr PI-LL (3.8 vs 5.8; p=0.555), PT (20.6 vs 22.9; p=0.536), & SVA were normalized in both groups. Preop & postop ODI, VAS, and SRS -22 scores were similar between groups. Complication rates between groups were similar as well (57.4% LLIF vs 57.7% ACR; p=0.98), including neurologic (16.8% vs 15.4%; p=0.859) & vascular (0% for both groups) injuries

CONCLUSION

Use of ACR via lateral approach for correction of ASD results in no increase in neurologic, vascular, or other overall complications rates, when compared to using LLIF alone, but is a more complex procedure and should be performed by highly experienced surgeons. Optimization of spinopelvic parameters was achieved regardless of the technique employed. Segmental radiographic changes were not specifically evaluated, but regional and global parameters were not differentially impacted when comparing ACR and LLIF impact

TAKE HOME MESSAGE

Anterior column realignment via lateral approach allows for normalization of spinopelvic parameters without additive complication risk when compared to LLIF alone.

	LLIF	LLIF w/ACR	p
N	101	26	
Preop Back Pain	7.5	7	0.287
Preop Leg Pain	5	5.9	0.136
Preop ODI	46.6	47.6	0.638
Preop SRS-22	2.7	2.8	0.788
Preop Sacral Slope	31.3	29.5	0.413
Preop Cobb	34	32.5	0.766
Preop Pelvic Tilt	23.6	26.3	0.373
Preop Pelvic Incidence	54.9	55.9	0.927
Preop PI-LL	17.3	20	0.692
Preop Lumbar Lordosis	37.6	35.9	0.74
Preop SVA	77.6	54.5	0.151
1Y Back Pain	3.4	2.6	0.175
1Y Leg Pain	2.7	3	0.549
1Y ODI	28.3	28.3	0.734
1Y SRS-22	3.7	3.8	0.349
1Y Sacral Slope	34.8	32.4	0.255
1Y Cobb	17.9	19	0.582
1Y Pelvic Tilt	20.6	22.9	0.536
1Y Pelvic Incidence	55.4	55.3	0.808
1Y PI-LL	3.8	5.8	0.555
1Y Lumbar Lordosis	51.6	49.5	0.569
1Y SVA	40	13	0.028
Complication	58 (57.4%)	15 (57.7%)	0.98
Reop	24 (23.8%)	3 (11.5%)	0.174
Major	42 (41.6%)	7 (26.9%)	0.171
Minor	27 (26.7%)	9 (34.6%)	0.426

33. Economic Analysis of 90-day Return to the Emergency Room and Readmission After Elective Lumbar Spine Surgery: A Single Center Analysis of 5,444 Patients

Marcel R Wiley, MD; Leah Yacat Carreon, MD, MS; Mladen Djurasovic, MD; Steven D. Glassman, MD; Yehia H. Khalil, PhD; Michelle Kannapel; Jeffrey L. Gum, MD

SUMMARY

A prospective, multi-surgeon, single-center database and hospital administrative data showed that predictors for 90-day ER visit after elective lumbar spine surgery included prior ER visit, zip code and multiple chronic medical conditions. Predictors for readmission were obesity, race, prior ER visits, multiple chronic medical conditions, ER admission and elevated hemoglobin A1C. Proper patient selection, appropriate post-op pain management and optimization of modifiable risk factors prior to surgery can lower 90-day ER visits and readmissions and reduce healthcare costs.

HYPOTHESIS

Patients who return to the emergency room (ER) or are readmitted within 90-days after elective lumbar spine surgery are costly, but have identifiable risk factors that could facilitate better management.

DESIGN

Retrospective longitudinal cohort.

INTRODUCTION

In the future, payers may not cover unplanned 90-day ER visits or readmissions after elective lumbar spine surgery. Prior studies

using large administrative databases lack granularity, and/or use a proxy for actual cost. We analyzed a large, single-center database to identify risk factors and subsequent costs associated with 90-day ER visits and readmissions.

METHODS

A prospective, multi-surgeon, single-center database merged with hospital administrative data was queried for elective lumbar spine surgeries from 2013-2017. Predictive models were created for 90-day ER visits and readmissions.

RESULTS

Of 5,444 patients, 729 (13%) returned to the ER, most often for pain (144, 32%). Predictors of an ER visit were prior ER visit (pER, OR:2.4), zip code (OR:1.4) and number of chronic medical conditions (OR:1.4). 421 (8%) patients were readmitted, most frequently for wound infection (123, 2%), COPD exacerbation (24, 0.4%), and sepsis (23, 0.4%). Predictors for readmission were pER (OR:1.96), multiple chronic conditions (OR:1.69), obesity (Non-obese, OR:0.49), race (African American, OR:1.43), admission status (ER admission, OR:2.29) and elevated HbA1c (OR:1.80). Average direct hospital cost for an ER visit was $1659 and readmission was $7322, costing the institution $5.1 million over the five-year study period.

CONCLUSION

Risk factors for 90-day ER visit and readmission after elective lumbar spine surgery include medical comorbidities and socioeconomic factors. Proper patient selection, appropriate post-op pain management and optimization of modifiable risk factors prior to surgery can lower 90-day ER visits and readmissions and reduce healthcare costs.

TAKE HOME MESSAGE

Predictors for return to ER and readmission within 90 days after elective spine surgery include prior ER visit, zip code, multiple chronic medical conditions, obesity, race and elevated HbA1c.

34. Incidence of PJK with Pedicle Screws at Upper Instrumented Vertebrae in Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

Yoji Ogura, MD; Steven D. Glassman, MD; Daniel J. Sucato, MD, MS; Michael T. Hresko, MD; Leah Yacat Carreon, MD, MS

SUMMARY

Proximal junctional kyphosis (PJK) is a common complication in adolescent idiopathic scoliosis (AIS). It remains unclear whether a specific instrumentation type influences the incidence of PJK. From a prospective database 345 AIS patients who underwent PSF were grouped by instrumentation type; all-pedicle screw constructs, hook at UIV with distal all-pedicle screw constructs, and hybrid constructs. All-pedicle screw constructs had significantly higher incidence pf PJK (11%) compared to hybrid (1%) and hook at UIV (0%) constructs.

HYPOTHESIS

All-pedicle screw constructs increase the incidence of PJK following PSF for AIS, as pedicle screw placement at the UIV may violate the supra-adjacent facet capsules.

DESIGN

Longitudinal cohort study

INTRODUCTION

Posterior spinal fusion (PSF) using all-pedicle screw constructs has become the standard surgical treatment for adolescent idiopathic scoliosis (AIS). However, some studies have shown that all-pedicle screw constructs or the use of pedicle screws at the upper instrumented vertebrae (UIV) increases the incidence of proximal junctional kyphosis (PJK). The purpose of this study is to examine the impact of different instrumentation types on the incidence of PJK following PSF for AIS.

METHODS

A multicenter database of surgically treated AIS was used. A stratified random sampling was done to obtain a representative sample from all curve types. Patients were included if they underwent PSF, and if immediate postoperative and final follow-up radiographs were available. The patients were grouped by instrumentation type: all-pedicle screw (PS), hook at UIV with distal all-pedicle screw (HT), and hybrid (HB). Proximal junctional angle (PJA) was measured as the angle between UIV and UIV+2 on lateral full-length standing radiographs immediately post-op and at the final follow-up. PJK was defined as PJA $\geq 10°$ and PJA progression of $\geq 10°$ at the final follow-up.

RESULTS

The PS, HT and HB groups included 128, 111 and 106 patients respectively. There was no difference in baseline demographic and radiographic characteristics among the groups. Fifteen cases (4.3%) developed PJK at the latest follow-up (average 2.2 years). PJK was more common in the PS group ($p<0.000$), with 14 (11%) in the PS group, 1 (1%) in the HB group, and none in the HT group. No revision surgery was required during the follow-up period.

CONCLUSION

The incidence of PJK following PSF for AIS was 4.3% and was more common in an all-pedicle screw constructs compared to hybrid or UIV-hook distal pedicle screw constructs. Using hooks at UIV might be a treatment strategy to limit PJK.

TAKE HOME MESSAGE

The use of bilateral pedicle screws at UIV increased PJK. Using bilateral hooks or at least one hook at the UIV may prevent PJK.

35. Incidence of Delayed Spinal Cord Injury in Pediatric Spine Deformity Surgery Seems to be Higher than Previously Assumed

Jeroen Renkens, MD; Tom P. Schlösser, MD, PhD; Agnita Stadhouder, MD; Moyo C. Kruyt, MD, PhD; Adriaan K. Mostert, MD, PhD; Luuk de Klerk, MD, PhD; Marinus de Kleuver, MD, PhD; René M. Castelein, MD, PhD; Joost Rutges, MD, PhD

SUMMARY

Delayed spinal cord injury (dSCI) is a rare and devastating complication after pediatric deformity surgery. This cross -sectional survey in The Netherlands indicates that the incidence might be higher than previously assumed with a calculated incidence of 1:763 in idiopathic scoliosis, 1:269 in secondary scoliosis, and 1:160 in neuromuscular scoliosis.

HYPOTHESIS

The incidence of dSCI after pediatric deformity surgery might be higher than previously assumed.

DESIGN

Cross-sectional survey of pediatric spine surgeons from The Netherlands.

INTRODUCTION

dSCI is a rare and devastating complication with an estimated incidence ranging from 1:3000 - 1:10.000 surgeries. The incidence of dSCI after pediatric deformity surgery is currently unknown. Based on anecdotal evidence the incidence in this group might be higher.

METHODS

All Dutch hospitals that perform paediatric deformity surgery were contacted. From the patients with a known dSCI, the following data were collected: patient characteristics, details about the SCI, surgical procedure, management and degree of improvement. Additionally, from the Dutch Hospital Database all surgical procedures linked to the ICD9 and ICD10 codes for paediatric deformity were obtained to determine the total number of performed surgeries between 2007-2017. Descriptive statistics were used.

RESULTS

In total, 2703 pediatric deformity surgeries were identified in The Netherlands between 2007-2017. Six patients with dSCI were identified; 2 idiopathic, 2 neuromuscular, 2 secondary scoliosis. Median age: 15 yrs (range: 7-17), median Cobb angle: 70 degrees (range: 51– 130) and the median surgical time: 260 min, (range: 161– 367). All patients had a documented normal neurological exam after surgery; neurological deficits were first diagnosed median 14 hrs after surgery (range: 6-40). Five patients had an incomplete SCI (range AIS B-C) and one patient had a complete SCI (AIS A). Median improvement was 2 AIS grades (range -2 - +3). The calculated incidence of dSCI after pediatric deformity surgery was 1:763 in idiopathic scoliosis, 1:269 in secondary scoliosis and 1:160 in neuromuscular scoliosis.

CONCLUSION

The current study indicates that the incidence of dSCI after pediatric deformity surgery might be higher than previously assumed, especially in non-idiopathic scoliosis. It is vital to include this information in the informed consent discussion. Strict post-operative observation for late neurologic deficit is crucial for timely diagnosis and management of this devastating complication

TAKE HOME MESSAGE

The incidence of delayed spinal cord injury after pediatric deformity surgery might be higher than previously assumed.

36. Under-contoured Proximal Rod: A Potential Risk Factor of PJK in Scheuermann's Kyphosis

Michael Grelat, MD; Changzhi Du, MD; Xu Sun, MD; Yong Qiu, MD

SUMMARY

The influence of the proximal rod contouring on the occurrence of PJK has not been investigated in SK patients.

HYPOTHESIS

The aim of this study was to evaluate the influence of the proximal rod contouring on the radiographic results in patients with Scheuermann's Kyphosis (SK).

DESIGN

Single-center retrospective study.

INTRODUCTION

Correction of kyphosis in SK patients can be effectively achieved via a multi-level Ponte osteotomies pedicle-screw-based instrumentation. However, the risk of developing proximal junctional kyphosis (PJK) remains an important issue after surgeries for SK.

METHODS

This study included 59 patients with SK, treated by posterior instrumentation and correction between 2002 and 2015, with more than 1 year of follow-up (FU). The Proximal Contouring Rod Angle (PCRA) is the angle between the upper endplate of the upper instrumented vertebra (UIV) and the lower endplate of the second vertebra caudal to UIV (UIV-2). A PJK was defined by a proximal junctional angle (PJA) greater than 10° at the latest FU, and the increase of this angle by more than 10°. Patients were separated into 2 groups: PJK group and non-PJK group. Comparisons were achieved in terms of T test. ROC curve and regression analysis were performed.

RESULTS

The mean age was 20.24 ± 9.4 years old. No significant difference was found between two groups with regards to their ages, the PJA and the PCRA at preoperative time. At the last FU, 31,7% of the patients developed PJK (mean value of PJA: 19.21° ± 4.6 in PJK group and 7.76 °± 3.7 in non-PJK group, $p<0.0001$). Significant difference was found in the post-operative PCRA between the PJK group and the non-PJK group (respectively, 9.52° ± 5.3 and 14.3° ± 6.6, p= 0.008). A PRCA less than 10.05° predicted significant high risk of PJK (Se=80%, Sp=73.7%; p=0.023, OR=1.143, CI=1.019-1.283).

CONCLUSION

Patients whose PCRA are lower than 10 degrees after surgery are more likely to develop PJK, demonstrating that under-contouring of the proximal rod is a risk factor for PJK in SK. So, proximal portion of the rod should be bent more kyphotic.

37. Can One-level Pedicle Subtraction Osteotomy (PSO) Provide Satisfied Outcomes for Severe Thoracolumbar Kyphosis with Global Kyphosis≥80° in Ankylosing Spondylitis: A Comparison with Two-level PSO

Bangping Qian, MD; Jichen Huang, MD; Yong Qiu, MD; Bin Wang, MD; Yang Yu, MD; Feng Zhenhua, MS; Junyin Qiu; Hongbin Ni, MD

SUMMARY

The present study aimed to figure out when one-level PSO was suitable for severe thoracolumbar kyphosis (global kyphosis, GK≥80°) caused by ankylosing spondylitis (AS).

HYPOTHESIS

One-level PSO may provide satisfied clinical and radiographic outcomes in selected AS patients with severe thoracolumbar kyphosis.

DESIGN

A retrospective study.

INTRODUCTION

In our practice, we observed that one-level PSO might provide satisfied clinical and radiographic outcomes in AS patients with GK≥80°; therefore, the purpose of present study was to determine the indications of one-level PSO for severe thoracolumbar kyphosis.

METHODS

Fifty-five AS patients (48 males and 7 females) with thoracolumbar kyphosis who had undergone one- or two-level PSO from January 2007 to November 2016 were reviewed. The radiographic parameters included TK, LL, GK, PT, SS, PI, SVA, and femoral obliquity angle (FOA). Clinical outcomes was evaluated by ODI and VAS. ROC curves were applied to determine the ideal cutoff points of preoperative radiographic parameters for selecting one- or two-level PSO.

RESULTS

Thirty-four patients underwent one-level PSO and twenty-one patients underwent two-level PSO. The average age at surgery was 37.0±10.8 years (range, 17-63 years). The mean follow-up period was 39.7±20.2 months (range, 24-120 months). In both one-level and two-level PSO group, the radiographic parameters and clinical outcomes were significantly improved after surgery ($P<0.05$). Patients who underwent one-level PSO have significantly smaller preoperative GK, SVA, FOA, and larger preoperative LL and SS compared to those who underwent two-level PSO ($P<0.05$). The optimal cutoff points of preoperative radiographic parameters for selecting one-level PSO were: GK<94°, SVA<18.0 cm, and LL<18°. No significant difference was found between the two groups with regard to the preoperative ODI and VAS ($P>0.05$), and the improvement of ODI and VAS ($P>0.05$). Also, there was no significant difference in the incidence of complications between the two groups ($P>0.05$).

CONCLUSION

The potential candidates of one-level PSO for severe thoracolumbar kyphosis (GK≥80°) secondary to AS were: GK<94°, SVA<18.0 cm, and LL<18°.

TAKE HOME MESSAGE

One-level PSO can provide satisfied radiographic and clinical outcomes for AS patients with preoperative GK<94°, SVA<18.0 cm, and LL<18°.

38. Same Old Pain for Posterior Spinal Fusion in Adolescent Idiopathic Scoliosis: A Quality Safety Value Journey to Less Inpatient Opioids

Heather Kent, MSN, RN, CPNP; Christopher B. McLeod, DO; Brandon A. Ramo, MD; Charu Sharma, MS, MHA; Kerry Wilder, RN; *Lori A. Karol, MD*

SUMMARY

The purpose of this quality value safety initiative (QVSI) is to compare the analgesic techniques of epidural ropivacaine combined with intravenous (IV) dexmedetomidine (DEX) versus (IV) hydromorphone patient-controlled analgesia (PCA) combined with IV DEX within our institution. Postoperative AIS patients that had epidural ropivacaine with IV DEX showed significantly lower use of opioids and equal pain control despite six times less opioid usage when compared to patients that had a PCA with IV DEX.

HYPOTHESIS

Will postoperative AIS patients in the epidural ropivacaine with IV DEX group have lower pain scores and less postoperative nausea and vomiting (PONV) as compared to patients in the PCA with IV DEX group?

DESIGN

A retrospective chart review (n=62) on a consecutive series of AIS patients who underwent posterior spinal fusion (PSF) between January – August 2018.

INTRODUCTION

Optimal postoperative pain control after PSF that limits opioids remains a challenge. Multimodal analgesia, such as epidural ropivacaine, can alleviate acute pain while reducing side effects of opioid medications including PONV, itching and over-sedation.

METHODS

Patients with a surgeon placed epidural catheter for post-operative pain control were compared to those with a PCA. Both groups had IV DEX infusions as adjunctive analgesia. The epidural group had nurse administered IV hydromorphone available as rescue analgesia. Presence of PONV and administration of anti-emetics were reviewed. The Pasero Opioid Sedation Scale (POSS), Oxford Scale, and Wong-Baker FACES Pain Rating Scale (FACES) scores were analyzed to evaluate the effect of analgesic techniques on sedation, motor function, and pain.

RESULTS

Among 62 AIS patients, 32 patients had an epidural and 30 patients had an IV PCA. There was no statistical difference in FACES pain scores (1.66 vs. 1.74, $p=0.612$), despite significant differences in hydromorphone dosing (0.92 mg vs. 5.25mg, $p=0.0001$). There was no statistically significant difference in anti-emetic use or incidence of PONV between groups. 9% of patients showed transient, incomplete nurse-documented motor changes (Oxford scale) in the epidural group as compared to 7% in the PCA group. Epidural patients experienced lower rates of over-sedation that did not reach statistical significance (POSS ≥3; 3% vs 13%, $p=0.150$).

CONCLUSION

Epidural ropivacaine with IV DEX demonstrated similar pain relief to hydromorphone PCA with IV DEX. Epidural ropivacaine with IV DEX is a safe and effective mode of pain relief while significantly reducing opioid use and potentially reducing side effects such as over-sedation in postoperative AIS patients.

TAKE HOME MESSAGE

A multimodal analgesic strategy including epidural ropivacaine combined with intravenous dexmedetomidine yielded six times less opioid use and achieved similar pain scores as hydromorphone patient controlled analgesia with intravenous dexmedetomidine.

39. Sports-related Cervical Spine Fracture and Spinal Cord Injury: A Review of Nationwide Pediatric Trends

Haddy Alas, BS; Avery Brown, BS; Katherine E. Pierce, BS; Cole Bortz, BA; Michael J. Moses, MD; Dennis Vasquez-Montes, MS; Bassel G. Diebo, MD; Carl B. Paulino, MD; Aaron J. Buckland, MBBS, FRACS; Michael C. Gerling, MD *Peter G. Passias, MD*

SUMMARY

Physical activity and sports participation are common causes of emergency room visits in the pediatric population. Injuries sustained may include cervical spine trauma such as fractures and spinal cord injury (SCI), which are associated with significant morbidity and mortality. Large database studies analyzing sports-related cervical trauma in the pediatric population are currently lacking. We assessed trends in sports-related cervical spine trauma across age groups using a nation-wide pediatric inpatient database (HCUP Kid's Inpatient Database).

HYPOTHESIS

Rates of cervical injury with and without SCI increase with adolescent age

DESIGN

Retrospective review

INTRODUCTION

As youth athletic sports continue to be played at a highly competitive level, more attention is called to potentially fatal cervical spine injuries.

METHODS

KID was queried for patients with E-Codes (ICD-9-CM codes) pertaining to external causes of injury secondary to sports-related activities from 2003-2012. Patients were further grouped by cervical spine injury type [C1-4 & C5-7 fracture w/& w/o spinal cord injury (SCI), dislocation, and SCI without radiographic abnormality (SCIWORA). Patients were grouped by age into Children(4-9),Pre-Adolescents(Pre,10-13),and Adolescents(14-17). Sports included by E-Code: American football, other team sports, individual, winter, water, and martial arts. Kruskall-Wallis tests with post-hocs identified differences in cervical injury type across age groups and sports. Logistic regression assessed predictors of TBI and cervical injury type.

RESULTS

38,539 pts with sports injuries were identified (12.76 yrs,24.5%F). Adolescents had the highest rate of sports injuries per year, but rates decreased in Pre and Adolescents and increased in Children. Adolescents had the highest rate of any type of cervical spine injury and TBI(Table1). Adolescence increased odds for C1-4 fx w/ & w/o SCI, C5-7 fx w/ & w/o SCI, cervical dislocation, and cervical SCIWORA(all $p<0.05$). Cervical fx of any type tended to occur in disproportionately higher rates via team, winter, or water sports($p<0.001$). Martial arts had significantly higher rates of cervical dislocations compared to other sports($p=0.039$). Football injuries rose from 5.83% to 9.14% (2009-2012)($p<0.001$) and had significantly more SCIWORA than non-football sports (1.6vs1.0%,$p=0.012$). Football increased odds of SCI by 1.56x compared to any other sport(OR:1.56 [1.11–2.20],$p=0.011$). SCIWORA was a significant predictor for concurrent TBI across all sports (OR: 2.35[1.77-3.11],$p<0.001$).

CONCLUSION

Adolescent athletes had the highest rates of upper/lower cervical fracture, dislocation, and SCIWORA. Adolescence and SCIWORA were significant predictors of concurrent TBI across sports.

TAKE HOME MESSAGE

Adolescent athletes had the highest rates of upper/lower cervical fracture, dislocation, and SCIWORA. Injuries within this age-group were significant predictors of concurrent TBI likely due to higher level of competition.

	Children (Age 4-9)	Pre-Adolescent (Age 10-13)	Adolescent (Age 14-17)	P Value
Demographics				
Total Sports Injuries (N)	7,737	10,989	19,813	
Mean Age (years)	8.71	11.86	15.62	
Sex (%F)	34.4%	21.1%	18.0%	*<0.001
Race (%)				
White	52.5%	60.6%	62.5%	1.000
Black	11.9%	14.0%	14.9%	1.000
Hispanic	25.7%	17.1%	15.4%	1.000
Asian/Pacific Islander	3.6%	2.2%	2.3%	1.000
Other	6.3%	5.1%	5.0%	1.000
Year				
2003 (N=10,908)	1,276 (11.7%)	3,482 (31.9%)	6,150 (56.4%)	*<0.001
2009 (N=9109)	1,487 (16.3%)	2,554 (28.0%)	5,068 (55.6%)	*<0.001
2012 (N=18,522)	4,974 (26.9%)	4,953 (26.7%)	8,595 (46.4%)	*<0.001
Total Hospital Charges	$25,898.73	$24,615.16	$28,760.41	*<0.001
Comorbidities				
Skeletal Dysplasia	30	49	43	*0.001
Sickle Cell Anemia	2	2	10	0.314
Vitamin Deficiency	7	7	35	*0.017
Cervical Injury Type				
C1-4 fracture w/o SCI	18(0.23%)	22(0.20%)	144(0.73%)	*<0.001
C5-7 fracture w/o SCI	14(0.18%)	20(0.18%)	147(0.74%)	*<0.001
C1-4 fracture with SCI	4(0.05%)	1(<0.01%)	40(0.20%)	*<0.001
C5-7 fracture with SCI	4(0.05%)	8(0.07%)	46(0.23%)	*<0.001
Dislocation	12(0.16%)	11(0.10%)	66(0.30%)	*0.001
SCIWORA	18(0.23%)	101(0.92%)	296(1.49%)	*<0.001
TBI	377	873	1,477	*<0.001

Age Group	C1-4 Fracture with SCI (N)	% total	Odd Ratio	Lower CI	Upper CI	P Value
Children	4	8.89%	0.388	0.139	1.084	0.071
Pre-Adolescent	1	2.22%	0.057	0.008	0.413	*0.005
Adolescent	40	88.89%	7.374	2.989	19.196	*<0.001
Total	45	100%				

Age Group	C1-4 Fx w/o SCI (N)	% total	Odd Ratio	Lower CI	Upper CI	P Value
Children	18	9.78%	0.458	0.281	0.747	*0.002
Pre-Adolescent	22	11.96%	0.362	0.231	0.566	*<0.001
Adolescent	144	78.26%	3.181	2.233	4.531	*<0.001
Total	184	100%				

Age Group	C5-7 Fracture w/o SCI (N)	% total	Odd Ratio	Lower CI	Upper CI	P Value
Children	14	7.73%	0.333	0.193	0.574	*<0.001
Pre-Adolescent	20	11.05%	0.310	0.195	0.494	*<0.001
Adolescent	147	81.22%	4.109	2.829	5.970	*<0.001
Total	181	100%				

Age Group	C5-7 Fracture with SCI (N)	% total	Odd Ratio	Lower CI	Upper CI	P Value
Children	4	6.90%	0.295	0.107	0.813	*0.018
Pre-Adolescent	8	13.79%	0.401	0.190	0.845	*0.016
Adolescent	46	79.31%	3.629	1.922	6.853	*<0.001
Total	58	100%				

Age Group	Cervical Dislocation (N)	% total	Odd Ratio	Lower CI	Upper CI	P Value
Children	12	14.5%	0.657	0.362	1.19	0.168
Pre-Adolescent	11	13.3%	0.380	0.210	0.726	*0.003
Adolescent	60	72.3%	1.70	1.19	2.42	*0.004
Total	83	100%				

Age Group	Cervical SCIWORA (N)	% total	Odd Ratio	Lower CI	Upper CI	P Value
Children	18	4.3%	0.229	0.143	0.368	*<0.001
Pre-Adolescent	101	24.3%	1.03	0.83	1.29	0.766
Adolescent	296	71.3%	2.73	2.29	3.31	*<0.001
Total	415	100%	2.09	1.78	2.46	*<0.001

Table 1: Univariate(top) and multivariate(bottom) analyses with predictors of upper (C1-4) or lower-cervical (C5-7) fractures with/without SCI, dislocation, and SCIWORA across age groups. Statistical significance was set to $p<0.05$.

40. Pedicled Omental Flaps for Complex Wound Reconstruction for Chordoma of the Mobile Spine and Sacrum

John H Shin, MD; Joseph H. Schwab, MD, MS; Francis J. Hornicek, MD, PhD

SUMMARY

We present our series of using pedicled omental flaps for soft tissue reconstruction when treating chordoma of the mobile spine and sacrum. The technical nuances of tissue harvest and transfer are presented. This is the largest series and description of the application of omental flap reconstruction to date in spine.

HYPOTHESIS

The use of pedicled omental flaps in high risk surgical environments such as previously irradiated and operated spines allows for effective soft tissue coverage, wound healing, infection control, and cerebrospinal fluid leak obliteration.

DESIGN

Retrospective case series

INTRODUCTION

Soft tissue reconstruction following en bloc resection for chordoma of the mobile spine and sacrum is a challenge given the wide excisional nature of these operations. As a result, large anatomical cavities created from resection of surrounding muscle, soft tissue, fat, bone, nerve roots, dura, and vascular structures lead to a dead space which may promote infection, hematoma, and cerebrospinal fluid diversion.Strategies for closing these dead spaces with myocutaneous, gluteal, thigh, paraspinous, and vertical rectus abdominis flaps have been reported but the quality of these tissues may be affected by prior radiation. When local flaps or free tissue transfers are limited, the omental flap with its rich vascular supply, easy handling properties, and inherent ability to fight infections is another option to cover such defects.

METHODS

After IRB approval, we conducted a retrospective search through an institutional database of patients with chordoma who underwent tumor resection and reconstruction using a pedicled omental between 2000-2018. Demographic information, operative data, and post-operative complications were recorded.

RESULTS

27 patients underwent surgery with omental flap reconstruction. Median age was 60 years (range 32-89), and 16 patients were male. Two patients had thoracic chordoma (1 recurrent), 6 lumbar (1 recurrent), and 19 sacral (7 recurrent). All patients had previous radiation to the spine. Omental graft occurred either during the time of chordoma resection (n = 10) or staged up to 12 months after the initial surgery (n = 17). Two patients died prior to their first follow-up. Mean follow-up was 42.2 months. Four patients with surgical infections had resolution after omental transfer. 7 required further washout (3.7%). 6/27 had GI complications.

CONCLUSION

Pedicled omental transfer is a safe and effective option for soft tissue reconstruction in spine surgery.

TAKE HOME MESSAGE

Chordoma surgery is associated with high morbidity and complications due to extent of soft tissue and spinal column resection. Omentum is a valuable tissue option for healing.

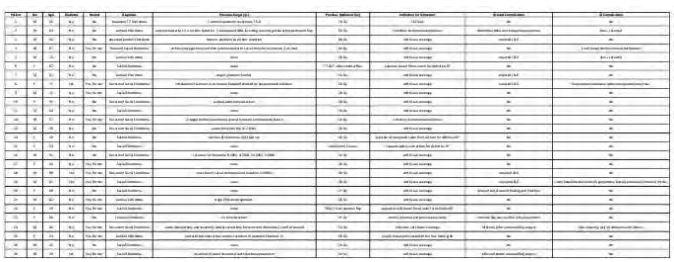


Table of patient demographics, results, and complications.

41. The Use of Autologous Free Vascularized Fibula Grafts in Reconstruction of the Mobile Spine Following Tumor Resection: Surgical Technique and Outcomes

Michiel E.R. Bongers, MD; Paul T. Ogink, MD; Katrina F. Chu, MD; Anuj Patel, MD; Brett D. Rosenthal, MD; John H. Shin, MD; Francis J. Hornicek, MD, PhD; Joseph H. Schwab, MD, MS

SUMMARY

Overview of outcomes and an illustrated description of the surgical technique using a free vascularized fibula graft for the reconstruction of the mobile spine following en bloc spondylectomy for the treatment of malignant spinal tumors.

HYPOTHESIS

Reconstruction of the mobile spine following TES using FVFG have better union rates and increased survival compared to other reconstruction techniques

DESIGN

Retrospective cohort study

INTRODUCTION

Reconstruction of the mobile spine following total en bloc spondylectomy (TES) of one or multiple vertebral bodies in patients suffering from malignant spinal tumors is a challenging procedure with high failure rates. Using a free vascularized fibula graft (FVFG) is a promising reconstruction technique, especially in areas exposed to radiation. We present a series of patients with malignant tumor resection in the mobile spine to review our institution's experience and an illustrated description of the surgical technique.

METHODS

Thirty-six patients treated at our tertiary care institution between 2010 and 2017 for a diagnosis of malignant tumor in the mobile spine with the use of FVFG following TES were reviewed. Postoperative union was reviewed with union defined as external bridging callus at the proximal and distal ends of the graft, or absence of osteotomy lines. Presence of proximal and distal union was stated separately. Also, complications, neurological outcome, reoperations, and survival were reported. The mean follow-up was 45 months.

RESULTS

The cohort consisted of 25 males and 11 females, with a median age of 57 years. Chordoma was the tumor that occurred most often (69%) and tumors occurred most often in the lumbar spine (42%). Bilateral, both proximal and distal, union was seen in 22 patients (73%). The overall complication rate was 56%, instrumentation failure was the most common complication with 25% of patients affected. In 14 patients (38%) one or more reoperations were needed, 46 percent of the reoperations were performed to solve instrumentation failure. The overall 1, 3, and 5-year survival rate was 92%, 89%, and 83%, respectively.

CONCLUSION

The FVFG is an adequate reconstruction technique of the mobile spine following TES for malignant tumors. Even though we see higher union rates and comparable complication rates compared to other techniques, the rate of instrumentation failure was high.

42. Bridging the Pay Gap: An Assessment of Medicare Procedure Volume and Reimbursement Among Spine Surgeons

Marine Coste, BA; George A. Beyer, MS; Sarah Stroud, AB; Harleen Kaur, BA; Qurratul-Ain Dar, BS; Nicole R. Vingan, BS; Lana Kass-Gergi, MS; Joanne Dekis, MD; *Neil V. Shah, MD, MS;* Bassel G. Diebo, MD; Virginie Lafage, PhD; Carl B. Paulino, MD

SUMMARY

When analyzing the gender gap in physician salary for spinal fusion procedures, male and female spine surgeons performed the same mean total of all fusion procedures in 2016. Although the difference in mean total number of claims between male and female surgeons was not significant, male surgeons submitted a higher number of total claims than female surgeons, and total reimbursements were significantly greater for male surgeons; however, reimbursements for specific procedures did not vary significantly between male and female surgeons.

HYPOTHESIS

This study sought to: 1) calculate the number of female and male surgeons who performed fusion procedures, 2) assess the number of claims submitted per surgeon for these procedures, and 3) evaluate how subsequent reimbursements varied between cohorts.

DESIGN

Retrospective analysis

INTRODUCTION

Few studies have compared the salary and procedure volume of male and female orthopaedic spine surgeons in the United States. Particularly, the gender gap in physician salary has not been analyzed for spinal fusion procedures.

METHODS

Surgeons who performed spinal fusion procedures in 2016 were identified from the Medicare Provider Utilization and Payment Public Use File database and divided into male and female cohorts. For each cohort, the mean number of total fusion procedures, as well as the mean numbers of anterior lower spinal column fusions, anterior upper spinal fusions, and posterior/posterolateral fusions were obtained. Levels were not specified. Total claims (hospital stay, office visits, etc.), total surgical claims, and reimbursements for each procedure were calculated. Cohorts were compared using two-tailed student's t-tests.

RESULTS

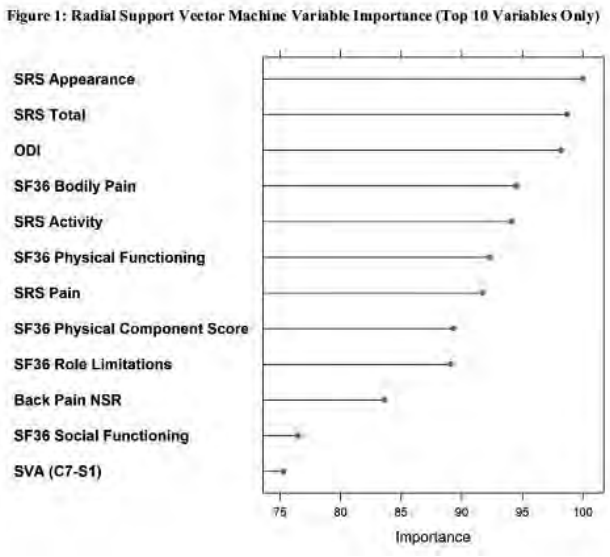
2,035 total spine surgeons were identified, 23 of whom were females (1.1%). Both male and female surgeons performed similar mean anterior lower (23 vs. 14) and posterior/posterolateral fusions (23 vs. 21), all $p>0.05$. However, male surgeons performed fewer anterior upper fusions (18 vs. 27; $p=0.03$). Overall male and female surgeons performed a similar number of total fusions per surgeon in 2016 (55.9 vs. 49.0). Male and female surgeons submitted comparable numbers of claims per surgeon, all $p>0.05$. Male surgeons received significantly higher total claim reimbursements ($87,779 vs. $50,439; $p=0.04$), but total surgical reimbursements ($77,052 vs. $54,240) as well as reimbursement rates for any fusion at any site did not vary significantly between male and female surgeons, all $p>0.05$.

CONCLUSION

Male and female spinal surgeons performed similar numbers of fusion procedures in 2016. Male surgeons submitted slightly higher total claims than females surgeons, and total reimbursements were significantly greater for male surgeons.

TAKE HOME MESSAGE

Male surgeons submitted more total claims than female surgeons, and total reimbursements were significantly greater for males; however, reimbursements for specific procedures did not differ between male and female surgeons.



43. Machine Learning Models to Predict Operative versus Non-operative Management of Adult Spinal Deformity Patients

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

SUMMARY

This study utilized a variety of modern machine learning techniques to predict operative vs. non-operative management of adult spinal deformity surgery patients. The best models exhibited excellent discrimination (AUC>0.9), and HRQoL metrics were particularly instrumental in making predictions. Future investigations may evaluate the implementation of such models for decision support in the clinical setting.

HYPOTHESIS

We sought to develop models capable of accurately discriminating between patients receiving operative vs. non-operative treatment based only on baseline radiographic and clinical data at enrollment.

DESIGN

Retrospective analysis of a multi-center, prospectively-defined, consecutive cohort of ASD patients.

INTRODUCTION

ASD patients exhibit complex and highly variable pathology. The decision to manage patients operatively is subjective and varies based on training and experience. Machine learning algorithms have shown promise in supporting clinical decision making.

METHODS

1,503 patients were included in this study, divided in a 70:30 split for training and testing. Patients receiving operative treatment were defined as those undergoing surgery up to 1 year after their baseline visit. Potential predictors included available demographics, past medical history, HRQoL, and pre-measured radiographic parameters from AP and lateral films. Variables with >10% missing data were discarded, and the remainder underwent median imputation. In total 321 potential predictors were included. Random forest, elastic net regression, and support vector machines (SVMs) with radial and linear kernels were trained. Model performance was evaluated by AUC.

RESULTS

69.0% (n=727) and 69.1% (n=311) of patients in the training and testing sets received operative management, respectively. Upon evaluation with the testing dataset, performance for SVM linear (AUC=0.910), elastic net (0.913), and SVM radial (0.914) models was excellent, and the random forest model performed very well (0.830). In our SVM radial model, HRQoL metrics were particularly important for making predictions; the top 3 most important variables were SRS appearance, SRS total, and ODI. (Figure 1)

CONCLUSION

This study developed models exhibiting excellent discrimination between patients receiving operative vs. non-operative management, based solely on baseline enrollment values. HRQoL metrics were strongest in making these predictions. Future investigations may evaluate the implementation of such models in the clinical setting.

TAKE HOME MESSAGE

This study utilized a variety of modern machine learning techniques to predict operative vs. non-operative management of adult spinal deformity surgery patients • The best models exhibited excellent discrimination (AUC>0.9)

44. Prospective Enumeration of Opioid Consumption Patterns after Lumbar Decompression or Microdiscectomy Using a Novel Text Messaging System

Francis C. Lovecchio, MD; Ajay Premkumar, MD, MPH; Jeffrey G. Stepan, MD, MS; Dianna L. Mejia, BS; Dan Stein, BS; Dil Patel, BS; Benjamin Khechen, BS; Sravisht Iyer, MD; Darren R. Lebl, MD; Sheeraz Qureshi, MD; Virginie Lafage, PhD; Russel C. Huang, MD; Kern Singh, MD; Todd J. Albert, MD

SUMMARY

Prospective dual-institution collection of daily opioid use and pain scores after lumbar decompression or microdiscectomy (MD) through an automated SMS survey. Most patients ceased opioid use by one week. Half of the sample consumed 32 pills or fewer, and 75% consumed fewer than 57. The data may be used to establish benchmarks in patient recovery, identify patients at the higher end of the opioid use spectrum, and formulate evidence-based opioid prescription guidelines.

HYPOTHESIS

Observational study

DESIGN

Dual institutional prospective observational study

INTRODUCTION

The standardization of opioid prescribing practices can decrease the risk of misuse and lower the number of pills available for diversion in this high-risk patient population. There is a paucity of quantitative data on the minimum necessary amount of opioid appropriate for post-discharge prescriptions.

METHODS

At two institutions from 8/2017-8/2018, we prospectively enrolled 85 consecutive adult patients who underwent one-level lumbar decompression or MD. Patients with a history of opioid dependence were excluded. Daily opioid consumption and NRS pain scores were collected using an automated text-messaging based platform for six weeks or until consumption ceased. Patients were asked for the number of pills left over and the method of disposal. Results were reported as oral morphine equivalents (OME) and as "pills" (oxycodone 5 mg equivalents) in order to facilitate clinical applications. Risk factors were compared between patients in the top and bottom half of opioid consumption, and a multivariate logistic regression model was used to identify independent predictors of opioid use.

RESULTS

Average age was 50.6 years, 67% underwent MD and 33% decompression. Total opioid consumption ranged from 0-118 pills, with a median consumption of 32 pills (236.3 OME). Only 22.4% completed their prescription, and only 9.4% requested a refill. Mean NRS pain scores always fell in the mild-moderate range, and declined steadily over the first two weeks. By POD7 half of the study population had ceased taking opioids altogether. No factor, including BMI, inpatient stay, psychiatric history, history of intermittent opioid use, or type of opioid prescription was associated with increased use ($p<0.05$).

CONCLUSION

Our data may be used to formulate evidence-based opioid prescription guidelines, establish benchmarks, and identify patients at the higher end of the opioid use spectrum. Furthermore, most patients who completed their prescriptions did not obtain a refill , thus, lower prescription amounts should decrease leftover pills and overall consumption.

TAKE HOME MESSAGE

The majority of patients take relatively few opioids after single-level decompression or microdiscectomy and finish within the first week.

	N	% or range
Age*	50.5±14.6	19-86
BMI*	28±5.5	18.5-47.6
Gender		
Male	58	68.24%
Female	27	31.76%
Surgery		
Microdiscectomy	57	67.06%
Decompression	28	32.94%
Level		0.00%
L2-3	4	4.71%
L3-4	9	10.59%
L4-5	43	50.59%
L5-S1	29	34.12%
Inpatient stay (days)	20	23.53%
History of psychiatric disorder†	11	12.94%
History of intermittent opioid use‡	27	31.76%
Type of opioid prescribed		
Tramadol	29	34.12%
Oxycodone	34	40.00%
Hydrocodone	18	21.18%
Dilaudid	3	3.53%
Codeine	1	1.18%
Average OME prescribed*‡	384.8±203.2	40-900
Patients completing initial prescription	19	22.35%
Opioid refills within 6 weeks of surgery	8	9.41%
Average number of days before refill*	15.4±11.8	3-33
Average OME consumed*	277.4±207.3	0-885
Average OME left over*	100.6±159.1	0-550
Method of disposal		
Destroy/throw away	14	16.47%
Keep	18	21.18%
Return to pharmacy or authorities	4	4.71%
Unsure	49	57.65%
Total opioid use (oxycodone 5 mg pill equivalents)		Cumulative percent
0-10	11	15%
10-20	15	34%
20-30	10	47%
30-40	15	67%
40-50	2	70%
50-60	9	82%
60-70	6	90%
70-80	4	95%
80-90	1	96%
90-100	0	–
100+	3	100%

*Reported as mean, standard deviation, and range. †Defined as medically diagnosed psychiatric disorder either self-reported or in patient's medical record. ‡Defined as non-daily use of opioids in the 6 months preceding surgery. OME, oral morphine

Table 1. Demographics, surgical factors, and opioid use/prescription characteristics

45. Patient-controlled Analgesia Following Lumbar Spinal Fusion Surgery is Associated with Increased Opioid Consumption and Opioid-related Adverse Events

Corey T. Walker, MD; Arpan A. Patel, BS; Virginia Prendergast, PhD, NP-C; Jakub Godzik, MD; Udaya K. Kakarla, MD; Juan S. Uribe, MD; Jay D. Turner, MD, PhD

SUMMARY

We performed a retrospective evaluation of posterior lumbar spinal fusion patients being treated post-operatively with patient-controlled analgesia (PCA) and compared their pain related outcomes to nurse-controlled analgesia (NCA). PCA utilization was independently associated with increased opioid prescription in the post-operative period. After controlling for pre-operative opioid use, we found that opioid naive patients have worse pain control with PCA than NCA, and patients with very high opioid consumption (>90 MME/day) had greater rates of opioid-related adverse events with PCA.

HYPOTHESIS

Patient-controlled analgesia (PCA) and nurse-controlled analgesia (NCA) would result in different levels of post-operative pain control, opioid consumption and adverse events after spinal fusion with variability related to pre-operative opioid consumption.

DESIGN

Retrospective Clinical Study

INTRODUCTION

Optimal post-operative pain control is critical after spinal fusion surgery. There remains significant variability in the use of post-operative intravenous opioid patient-controlled analgesia (PCA) and very little data evaluating its utility compared to nurse-controlled analgesia (NCA) in lumbar fusion patients.

METHODS

A retrospective review from a single institution was conducted in consecutive patients treated with posterior lumbar spinal fusion for degenerative pathology. Patients were divided into two cohorts: those treated post-operatively with PCA or NCA. Post-operative numerical rating scale (NRS) pain scores, length of stay, and total opioid consumption were collected. Patients were stratified according to pre-operative opioid consumption as naïve, low (<60 morphine milligram equivalents (MME) daily), high (61-90 MME) or very high (>90 MME).

RESULTS

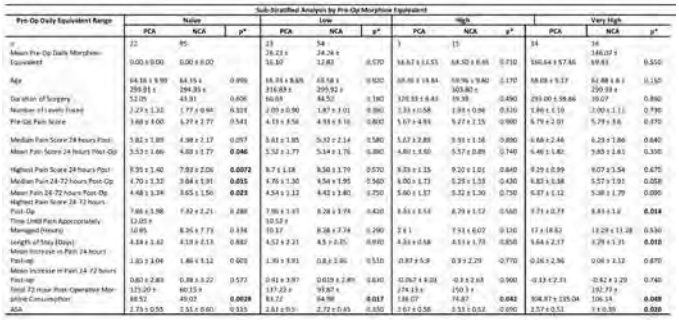
240 patients were identified: 62 and 178 patients in PCA and NCA groups, respectively. PCA patients had higher mean pre-operative opioid consumption compared to the NCA group (49.2 vs 24.3 MME, p=0.009). PCA patients had higher mean opioid consumption in first 72 hours in all preoperative opioid consumption categories. Pain control and adverse event rates were similar between PCA and traditional opioid therapy in the low to high pre-operative opioid consumption groups (>0 to 90 MME daily). Opioid naive patients had worse mean and highest NRS pain scores in the first 72 hours (all p<0.05) despite higher opioid consumption. Patients with very high opioid consumption (>90 MME daily) had a greater rate of opioid-related adverse events (95% versus 70%, p<0.001).

CONCLUSION

Postoperative PCA utilization is associated with significantly more opioid consumption and equal or worse post-operative pain scores compared to NCA after lumbar spinal fusion surgery.

TAKE HOME MESSAGE

PCA utilization results in greater opioid consumption after lumbar fusion surgery with equal or worse pain control. Opioid naive patients appear to do better with NCA.



Perioperative factors between patients receiving PCA therapy and NCA therapy sub-stratified by pre-operative daily MME consumption

46. Initiation of a Standardized Escalation Pain Protocol after 1-2 Level Lumbar Fusion Reduces In-hospital Opioid Consumption

Portia A. Steele, MS; Jeffrey L. Gum, MD; Morgan Brown, MS; Christy L. Daniels, MS; Mladen Djurasovic, MD; Charles H. Crawford III, MD; Steven D. Glassman, MD; Leah Yacat Carreon, MD, MS

SUMMARY

We compared patients undergoing 1-2 level navigated or robotic-assisted, midline posterior lumbar fusions before and after initiation of a Standard Escalation Pain Protocol. Standardization of prescribing patterns decreased in-hospital opioid consumption by 54% and shortened length of stay.

HYPOTHESIS

Use of a Standard Escalation Pain Protocol (SEPP) will decrease in-hospital opioid consumption.

DESIGN

Retrospective review

INTRODUCTION

Our previous study showed that prescribing patterns, more than surgery invasiveness or patient factors affect post-operative opioid consumption. Since then we have instituted a SEPP: patients receive 0-60 Morphine Milligram Equivalents (MME) above their baseline pre-op MME after surgery. The purpose of this study is to evaluate how prescribing patterns affect immediate postoperative opioid consumption in patients undergoing 1- to 2-level posterior lumbar interbody fusion with a navigated or robotic-assisted, midline exposure (MIDLIF).

METHODS

Patients with degenerative lumbar pathology who had a MIDLIF from 2017 to 2018 were identified and divided into two cohorts: patients who had surgery before the institution of SEPP (PreSEPP) and those who had surgery after (PostSEPP). Length of stay and daily opioid consumption were extracted by EMR data analysts unaware of the purpose of the study.

RESULTS

The PreSEPP (N=34) and PostSEPP (N=27) patients were similar at baseline in age, sex distribution, ASA grade, BMI and smoking status. Pre-Op (2.2 vs 3.6, p=0.630) and Post-op Day-0 (POD-0, 52.5 vs 38.8, p=0.192) MME consumption was similar between the two groups. At POD-1, cumulative MME consumption was higher in the Pre-SEPP (131.7) compared to the PostSEPP group (76.0, p=0.004) and this was maintained up to discharge (54% total MME reduction). Length of stay was also longer in the PreSEPP (1.97 days) compared to the PostSEPP group (1.37 days, p=0.004).

	PreSEPP	SEPP	
N	34	27	
Female	24	16	0.422
ASA			0.515
1	2	1	
2	8	10	
3	21	14	
Current Smoker	16	13	0.992
Age	49.74	59.04	0.004
BMI	33.06	30.54	0.114
LOS	1.97	1.37	0.030
Pre-Op_MME	2.19	3.57	0.630
POD_0_MME	52.55	38.81	0.192
Cumulative POD_1_MME	131.70	75.95	0.004
Cumulative POD_2_MME	164.11	80.00	0.001
Cumulative POD_3_MME	172.55	80.48	0.001
Cumulative POD_4_MME	175.83	80.48	0.001

CONCLUSION

The use of a standard escalation pain protocol decreases in-hospital opioid consumption by 54% and shortens length of stay after 1-2 level lumbar spinal fusion. Similar to our previous study, prescribing pattern is an important factor affecting post-op opioid consumption.

TAKE HOME MESSAGE

In-hospital opioid consumption can drastically be reduced utilizing a standardized escalation pain protocol.

47. A Predictive Model for Early Reoperations and Readmissions in Adult Spinal Deformity

Nathan J. Lee, MD; Meghan Cerpa, BS, MPH; Joseph M. Lombardi, MD; Alex Ha, MD; Paul J. Park, MD; Eric Leung, BA; Zeeshan M. Sardar, MD, MS, FRCS(C); Lawrence G. Lenke, MD; Ronald A. Lehman Jr., MD

SUMMARY

Reducing unnecessary reoperation and readmission rates are important in improving the quality of care and reducing costs in patients undergoing adult deformity surgery (ASD). Currently, there is a paucity of data examining the modifiable risk factors for these metrics in this population. Using institutional data, risk stratification models were developed and found to reliably predict 90-day readmission and reoperations.

HYPOTHESIS

Using single-institution perioperative data, a risk stratification model can be accurate and reliable in predicting 90-day readmission and reoperation rates.

DESIGN

Single-Institution cohort study

INTRODUCTION

With the continued evolution of bundled payment plans, there has been a greater focus within orthopedic surgery on quality metrics up to 90 days of care. This includes the readmission and reoperation rates, which may be markers for substandard care during the index admission. Therefore, it is important to understand the drivers for unplanned readmission and reoperations to improve the quality of care and reduce costs

METHODS

250 adult (age≥18) patients undergoing at least 6 levels of spine fusion for adult spinal deformity at a single institution were reviewed. Demographics, operative conditions, medical complications, and surgical outcomes were assessed. Chi-square and t-tests were used for descriptive analyses. A step-wise multivariate logistic regression was used to identify independent risk factors for 90-day readmissions and 90-day reoperations.

RESULTS

90-day readmission and 90-day reoperation rates were 7.6% and 3.6%, respectively. The median time for readmission and

reoperations were 27 days (range: 6-76) and 34 days (7-67). The final model for 90-day readmission included age, operative duration, depression, history of DVT/PE, and history of cancer. (C-statistic = 0.806, hosmer-lemeshow = 0.290). History of DVT/PE and history of cancer increased risk for 90day readmission by 7.5 and 4-fold. The final model for 90-day reoperation included operative duration, female gender, depression, hypothyroidism, and age (C-statistic= 0.925, HL=0.793). Depression and hypothyroidism increased risk for early reoperation by 23.2 and 8.5-fold.

CONCLUSION

Several patient and operative factors were found to independently predict unplanned readmissions and reoperations. History of DVT/PE and history of cancer notably increased risk for readmission. Interestingly, a history of depression and hypothyroidism substantially increased risk for reoperation.

TAKE HOME MESSAGE

Risk factors for readmission and reoperations for ASD are different yet include potentially modifiable patient and operative factors. Both models were found to accurately predict unplanned readmissions and reoperations.

48. Propionibacterium Acnes Biofilm in Human Lumbar Discectomy Material Supports the Existence of Low-grade Infection over Sample Contamination

Manu Capoor, MD; Filip Ruzicka, PhD; Garth James, PhD; Tana Machakova, MS; Radim Jancalek, MD, PhD; Fahad Ahmed, BS; Todd Alamin, MD; Neel Anand, MD; Nitin N. Bhatia, MD; Robert K. Eastlack, MD; Steven R. Garfin, MD; Ziya L. Gokaslan, MD; Calvin C. Kuo, MD; Konstantinos Mavromattis, PhD; Assaf Raz, PhD; Jiri Sana, PhD; Philip S. Stewart, PhD; Jeffrey C. Wang, MD; Timothy F. Witham, MD; Michael F. Coscia, MD; *Christof Birkenmaier, MD;* Vincent A. Fischetti, PhD; Ondrej Slaby, PhD

SUMMARY

P. acnes biofilm was demonstrated by means of CSLM and FISH as evidence of a definite, pre-existing infection of intervertebral disc nucleus material amongst a high rate of positive microbiological cultures (detected by MALDI-TOF). While perioperative and in-process contamination remains a challenge with lesser diagnostic efforts, our data demonstrate beyond a reasonable doubt that low-grade P. acnes infections of human intervertebral discs are for real.

HYPOTHESIS

the presence of Propionibacterium acnes (P. acnes) in intervertebral discs may represent true infection and not contamination

DESIGN

experimental study seeking to validate P. acnes prevalence in cultures from resected intervertebral disc material

INTRODUCTION

P. acnes has been found in cultures from microdiscectomy specimens in 25% of cases, suggesting a possible link between low-grade bacterial infection and disc degeneration. Since P. acnes also is a skin commensal, there has been difficulty in excluding the possibility of perioperative contamination rather than true infection.

METHODS

Nucleus material from 368 patients undergoing microdiscectomy were divided into several portions, one being homogenized, subjected to quantitative anaerobic culture. A second fragment was frozen for additional analyses. Bacterial colonies were identified by means of MALDI-TOF mass spectrometry and P. acnes phylotyping was conducted using multiplex PCR. For a sub-set of specimens, bacteria localization within the disc was assessed utilizing confocal laser scanning microscopy (CLSM) and fluorescent in situ hybridization (FISH).

RESULTS

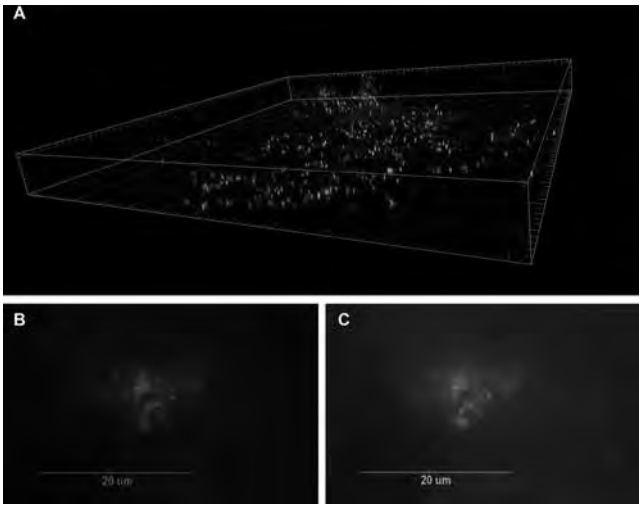
Positive cultures were obtained from 162 discs (44%), including 119 cases (32.3%) with P. acnes. In 89 cases, P. acnes was the only bacterium cultured; in 30 cases, it was isolated in combination with other bacteria. Among positive specimens, the median P. acnes bacterial burden was 350 CFU/g (12 - ~20,000 CFU/g). 38 P. acnes isolates were subjected to molecular sub-typing, identifying 4 of 6 defined phylogroups: IA1, IB, IC, and II. 8 culture-positive specimens were evaluated by fluorescence microscopy and revealed P. acnes biofilm within the disc matrix.

CONCLUSION

This study confirms that P. acnes is highly prevalent in herniated disc tissue. It also provides the first visual evidence of P. acnes biofilms within such specimens. This demonstrates beyond a reasonable doubt, that a true infection exists. These findings open the door to speculation whether P. acnes may play a role as a promotor of degenerative disc disease and whether such an infection correlates to a degenerative disc becoming symptomatic.

TAKE HOME MESSAGE

We must consider the possibility that P. acnes plays a role in symptomatic degenerative disc disease. This points to a need for more appropriate diagnostics and possibly also treatments.



A. Three dimensional reconstructed CSLM image of biofilm bacteria stained with a DNA stain (SYTO9, green) in a disc tissue sample. B-C. The presence of P. acnes biofilms in this sample verified using FISH. Epifluorescence micrographs of a biofilm cluster

49. Fat Infiltration and Spine Flexibility are Risk Factors for Proximal Junctional Kyphosis

Jonathan Charles Elysée, BS; Renaud Lafage, MS; Mathieu Bannwarth, MD; Alex Liu Huang; Bryan Ang, BS; Katherine E. Pierce,

BS; Jessica Andres-Bergos, PhD; Peter G. Passias, MD; Han Jo Kim, MD; Frank J. Schwab, MD; *Virginie Lafage, PhD*

SUMMARY

Thoracic flexibility plays a critical role in sagittal realignment. Flattening of the thoracic spine between standing and supine was significantly greater for patients with Proximal Junctional Kyphosis(PJK). Multilinear analysis demonstrated pre-operative PJK angle and thoracic kyphosis(TK) flexibility as independent predictors of post-op PJK angle, regardless of UIV. Sub-analysis on patients with available data on fat infiltration demonstrated an increase fat infiltration for PJK patients. Multivariate analysis demonstrated flattening of TK and fat infiltration as independent predictors of radiographic PJK

HYPOTHESIS

Thoracic Flexibility is associated with PJK

DESIGN

Retrospective

INTRODUCTION

Previous studies have reported the significant role that spine flexibility plays in PJK but have been limited to the unfused portion of the thoracic spine

METHODS

Standing-to-supine and pre-to-post analysis were conducted using repeated measure analysis. Thoracic flexibility(standing TK-supine TK) stratified into 3 groups: Kyphotic change(increased TK), Lordotic change(decreased TK), No Change. Exact Fisher test assessed rate of PJK between flexibility groups. Evaluation of TK flexibility between PJK and noPJK pts used overall TK and the fused portion of thoracic spine. Subanalysis assessed pts with available data on fat infiltration of the posterior muscles. Multilinear stepwise logistic regression investigated independent predictors of PJK

RESULTS

101 ASD pts(63yr, 83.3%F, 27.4kg/m², 52% revision) included. Pre-op SRS-Schwab ASD classification showed moderate to severe deformity (PT: 27.7% ++; PI-LL: 44.6% ++; SVA: 42.6% ++) corrected post-op(all p<0.001). Repeated measure showed reduction of the spinopelvic mismatch between standing, supine and post-op(19.8° vs 10.3° vs -1.4°, all p<0.001) and a significant reduction of TK between standing and supine, and an increase post-op(T2-T12: -39.4° vs -31.9° vs -50°, TKfused: -25.3° v -19.6° v -29.9° all p<0.001). Rate of radiographic PJK:23.8%, regardless of UIV position(UT:27% v LT:20.4% p=0.442). Comparison between PJK and noPJK demonstrated larger flexibility in PJK pts. There was significant difference in PJK rate between flexibility groups(Kyphotic:0.0% v No change:18.4% v Lordotic:35.0% p=0.049). Sub-analysis(43.6% cohort) demonstrated overall fat infiltration of 48.3%. PJK patients demonstrated higher infiltration than noPJK(44% vs 61.1% p=0.006). Multivariate logistical regression revealed thoracic flexibility(p=0.024) and fat infiltration(p=0.006) as independent predictors of PJK.

CONCLUSION

PJK is associated with flexibility and fat infiltration of posterior muscles. Extra precaution should be taken when the patient is in the supine position during surgery, as a reduction of TK is a PJK risk factor in patients with high fat infiltration

TAKE HOME MESSAGE

TK flexibility and pre-operative PJK angle are predictors of PJK magnitude independently of the UIV position. Both TK flattening and fat infiltration are independent predictor of radiographic PJK

	NoPJK	PJK	p
TK Flexibility	5.5°±10.8	12.3±8.6	0.038
Kyphotic change > 5°	100.00%	0.00%	
No Change (<5°)	81.60%	18.40%	0.049
Lordotic change >5°	65.00%	35.00%	
TK Fused Flexibility	4.2°±9.0	10.5°±12.7	0.034
Fat percent. Maximum	44.0%±18.1	61.1%±13.1	0.005
Fat percent. UIV area	32.8%±19.7	49.5%±8.5	0.006

50. Relaxed Sitting-standing Lumbopelvic Mechanics in the Setting of Lumbar Spinal Pathology and Fusion

Edem J. Abotsi, BA; Ran Schwarzkopf, MD; Joseph Zuckerman, MD; Roy Davidovitch, MD; Dennis Vasquez-Montes, MS; Erik Wang, BA; Jordan Manning, BA; Christopher G. Varlotta, BS; Ethan W. Ayres, MPH; Dainn Woo, BS; Max Egers, BS; Jonathan Vigdorchik, MD; Constance Maglaras, PhD; *Aaron J. Buckland, MBBS, FRACS*

SUMMARY

Lumbar and pelvic alignment alters when transitioning from relaxed standing to relaxed sitting posture. Lumbar fusion & lumbar flatback have been implicated in the pathogenesis of the hip-spine syndrome and instability following Total Hip Arthroplasty (THA). A spectrum of disease occurs from normal to degenerative to flatback and lumbar fusion with progressive reduction in lumbar lordosis, and/or increased lumbopelvic stiffness. Despite preconceived beliefs, this study demonstrates that flatback deformity cause similar lumbopelvic stiffness to multilevel lumbar fusion.

HYPOTHESIS

Lumbar degeneration, flatback and fusion are a spectrum of diseases resulting in progressive increase in lumbopelvic stiffness when transitioning from relaxed standing to relaxed sitting.

DESIGN

Single-center retrospective radiographic review of patients undergoing THA.

INTRODUCTION

ASD and lumbar fusion have been implicated as risk factors for THA dislocation and hip-spine syndrome. This is thought to be secondary to effects on postural pelvic tilt change and femoracetabular impingement.

METHODS

Patients >18 yrs with full body standing-sitting radiographs at a single institution were included. Exclusion criteria included ankylosing spondylitis, post-THA, and transitional lumbosacral anatomy. Lumbar spines were classified as normal (N), fusion (F), degenerative (D) (at least 1 level disc height loss >50%, facet arthropathy, or spondylolisthesis), or lumbar flatback (LF) (D criteria + Pelvic Incidence-Lumbar Lordosis (PI-LL) mismatch>10°). Radiographic assessment of lumbar lordosis (LL), thoracic kyphosis (TK), thoracolumbar kyphosis (TLK), pelvic incidence (PI), pelvic tilt (PT), PI-LL mismatch, and T1 pelvic angle (TPA) was performed. Differences between groups were assessed by a one-way ANOVA & Tukey post-hoc test; significance p<0.05.

RESULTS

1,344 patients (62±14yrs, 59%F, avg. hip OA grade 1.90±1.3), consisting of 606 N, 429 D, 274 LF, and 31 F patients (mean 5.84 levels fused). Significant changes were noted between standing and sitting for all spinopelvic parameters ($p<0.001$) (Fig 1). In standing analysis, there was a stepwise increase in PT, PI-LL, and TPA from N to D to LF to F, though post-hoc analyses revealed no significant differences between lumbar flatback and fusion groups. When transitioning from the relaxed standing to sitting, smaller changes in PT, PI-LL, and TPA were observed along the spectrum from N to D to LF to F, with no significant changes between flatback deformity and fusion.

CONCLUSION

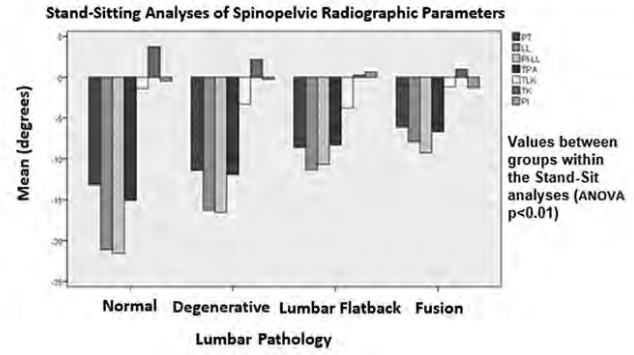
Lumbar flatback patients exhibited similar changes in PT and PI-LL to multilevel lumbar fusion patients in a stand to sit transition, likely implicated in the increased risk of THA dislocation in the flatback population.

TAKE HOME MESSAGE

Multi-level lumbar fusion causes equivalent restricted lumbopelvic motion as lumbar flatback when changing from standing-sitting posture. This supports the etiology of lumbar flatback deformity and lumbar fusion in THA instability.

Fig 1: Comparison of Relaxed Standing, Relaxed Sitting and Postural Change in Spinopelvic Alignment

	Relaxed Standing				
	Normal (n=606)	Degenerative (n= 429)	Lumbar Flatback (n=274)	Fusions (n=31)	ANOVA P-Value Standing
PT	13.9 ± 8.6	14.4 ± 7.1	25.1 ± 6.8	23.3 ± 12.2	0.000
PI	52 ± 10.9	52 ± 11.4	61 ± 14.2	57.1 ± 15.4	0.000
PHL	-3.8 ± 7.4	-2.3 ± 7.2	18.4 ± 7.8	11.3 ± 19.6	0.000
LL	-55.8 ± 10.8	-54.3 ± 11.9	-42.6 ± 15.4	-45.8 ± 22.2	0.000
TPA	10.2 ± 6.4	12.4 ± 6.5	23.9 ± 7	22.4 ± 13	0.000
TLK	1.4 ± 9.5	2.1 ± 10.8	-2.2 ± 12.3	5.1 ± 16.3	0.000
TK	39.1 ± 11.2	41.6 ± 12.4	30 ± 11.5	36.3 ± 17.5	0.000
	Relaxed Sitting				
	Normal (n=606)	Degenerative (n= 429)	Lumbar Flatback (n=274)	Fusions (n=31)	ANOVA P-Value Sitting
PT	27.1 ± 13	25.8 ± 13.2	33.7 ± 12.7	30.5 ± 12.2	0.000
PI	25.4 ± 12.7	26.5 ± 11.9	26.6 ± 12.6	28 ± 14.7	0.000
PHL	17.8 ± 16.1	14.3 ± 14.8	29.1 ± 13.5	21.1 ± 16.3	0.000
LL	-34.7 ± 16.5	-38 ± 16.4	-31.2 ± 15.8	-31.5 ± 21.1	0.000
TPA	25.3 ± 11.6	24.3 ± 11.8	32.2 ± 11.5	28.9 ± 12.6	0.000
TLK	2.7 ± 10.9	5.4 ± 11.6	1.5 ± 12.4	6.2 ± 12.7	0.000
TK	35.4 ± 13.5	39.4 ± 15.1	29.8 ± 12.7	35.3 ± 15.6	0.000
	Stand-Sit				
	Normal (n=606)	Degenerative (n= 429)	Lumbar Flatback (n=274)	Fusions (n=31)	ANOVA P-Value Difference
PT	-13.2 ± 13.7	-11.4 ± 13.8	-8.6 ± 12.9	-7.2 ± 12.4	0.000
PI	12.7 ± 12.8	11.1 ± 12.6	9.3 ± 10.1	5.7 ± 11.6	0.000
PHL	-21.6 ± 15.4	-16.5 ± 14.1	-10.7 ± 13	-9.7 ± 11.3	0.000
LL	-21.1 ± 14.9	-16.3 ± 13.6	-11.9 ± 11.2	-8.3 ± 9	0.000
TPA	-15.1 ± 11.4	-11.9 ± 11.3	-8.3 ± 10.8	-6.7 ± 7.3	0.000
TLK	-1.4 ± 6.8	-3.3 ± 6.1	-3.8 ± 6.1	-1.2 ± 8	0.000
TK	3.7 ± 6.3	2.2 ± 7.9	0.5 ± 6.7	1 ± 6.4	0.000



51. Does Matching Roussouly Spinal Shape and Improvement in SRS-Schwab Modifier Contribute to Improved Patient-reported Outcomes?

Peter G. Passias, MD; Katherine E. Pierce, BS; Cole Bortz, BA; Haddy Alas, BS; Avery Brown, BS; Dennis Vasquez-Montes, MS; Ethan W. Ayres, MPH; Erik Wang, BA; Jordan Manning, BA; Christopher G. Varlotta, BS; Dainn Woo, BS; Edem J. Abotsi, BA; Max Egers, BS; Constance Maglaras, PhD; Bassel G. Diebo, MD; Tina Raman, MD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; Michael C. Gerling, MD

SUMMARY

The Roussouly Classification system of sagittal spinal shape and the SRS-Schwab adult spinal deformity(ASD) classification system have become important indicators of spinal deformity. No prior studies have examined the outcomes of matching both Roussouly type(RT) and improving in Schwab modifiers postoperatively. This analysis of operative ASD patients found that matching Roussouly type and improvements in SRS-Schwab modifiers were associated with clinically significant improvements in health-related quality-of-life(HRQL) improvements.

HYPOTHESIS

Operative ASD patients with SRS-Schwab improvements and matched Roussouly type had superior self-reported outcomes. Therefore, both classification systems should be utilized in surgical decision making.

DESIGN

Single institution retrospective review

INTRODUCTION

The Roussouly and SRS-Schwab classifications are studies as applicable to ASD. No studies have examined the postop outcomes of matching both RT and improving in Schwab modifiers.

METHODS

Surgical ASD patients(SVA≥5cm, PT≥25° or TK≥60°, >3 levels fused) with radiographic data at baseline(BL) and 1-year(1Y) were grouped by "theoretical" Roussouly type (Type 1:PI<45°, LL apex below L4; Type 2:PI<45°, LL apex above L4-L5 space; Type 3:45°<PI<60°; Type 4:PI>60°); and "actual"(1:SS<35°, LL apex below L4; 2:PI<35°, LL apex above L4-L5 space; 3:35°<PI<45°; 4:PI>45°). 1Y matched-RT: preop mismatch between actual and theoretical that matched at 1Y. Schwab modifiers at BL 0, +, and ++(severe) were assessed. Schwab improvement: decrease in modifier by 1Y.

RESULTS

103 ASD patients(62yrs 63%F). Surgical approach: 90% posterior, 11% combined, 3% anterior. Avg 4.6 levels fused. BL actual RT: 28% Type 1, 25% Type 2, 32% Type 3, 15% Type 4. BL RT mismatch 65%. BL Schwab modifiers: PT(0:9%, +:42%, ++:50%), SVA(0:30%, +:20%, ++: 50%), PI-LL (0:28%, +:25%, ++:47%). At 1Y, 19% matched RT target type, while 13% improved in SVA, 43% in PI-LL, 46% in PT according to Schwab modifier. Patients that met RT and improved in Schwab modifiers: 9 PT(9%), 8 PI-LL(8%), 2 SVA(2%). 2% met their RT and improved in Schwab modifiers. 1Y matched-RT patients improved more for all HRQLs vs. mismatched RT, but not significantly($p>.05$). Matched RT and Schwab-PT improvement met MCID for EQ5D more(33% vs 11%, $p=.05$). Matched RT and Schwab-PI-LL had more patients meet MCID for all HRQLs, yet none significant($p>.05$). Matched RT and Schwab-SVA improvement met MCID for ODI more ($p=.024$).

CONCLUSION

Patients who both matched Roussouly sagittal spinal type and improved in SRS-Schwab had superior 1Y HRQL. Using both classification systems in surgical decision making can optimize patient outcomes.

TAKE HOME MESSAGE

Operative ASD patients with SRS-Schwab improvements and matched Roussouly type had superior self-reported outcomes.

Therefore, both classification systems should be utilized in surgical decision making.

		Immature (Risser 0-1, Sanders ≤ 4)
Number of patients (curves)		28 (39)
Age in years (mean, range)		12.63 ± 0.78
Follow-up		32.3 months (± 6.4)
Pre-op curve (°) (avg., range)	Thoracic	55.44 ± 10.2 (35 - 70)
	Lumbar	49 ± 12.3 (36 - 70)
Disc release (not fusion)	Thoracic only in 34/65 (52%) curves	11/28 pts
Most recent curve (°) (avg., range)	Thoracic	15.81 ± 10.62 (-3 - 34)
	Lumbar	13 ± 9.2 (-5 - 28)
Success rate percentage (≤ 30° at 2-year follow-up)	Patients	93% (26/28)
	Total curves treated	95% (37/39)
	Thoracic curves	92% (25/27)
	Lumbar curves	100% (12/12)
Number (%) anticipated revision	3 overcorrections 1 limited correction (needed 2nd planned stage)	3/28 (11%) 1/28 (4%)
Number (%) unanticipated revision	1 for adding on (instrumented too short) and broken cord	1/28 (4%)

52. Treatment of Immature Idiopathic Scoliosis Patients with a Non-fusion Anterior Scoliosis Correction (ASC) Technique

William Paul Bassett, MD; M. Darryl Antonacci, MD; Laury A. Cuddihy, MD; Janet L. Cerrone, PA-C; Allison R. Haas, RN, BSN, CNOR, RNFA; Randal R. Betz, MD

SUMMARY

The results of non-fusion Anterior Scoliosis Correction (ASC), which is a cord/screw correction performed through a muscle-sparing mini-anterior thoracic or thoracolumbar approach, showed that 26/28 patients (93%) and in 37/39 curves (95%) met the definition of clinical success with curves ≤30° at most recent follow-up. There was only 1 unanticipated revision (4%). Anticipated cord lengthening procedures for overcorrection were noted in 3 patients (11%) who were all Sanders 2 or 3 (not 4).

HYPOTHESIS

ASC will demonstrate better results compared to anterior VBT and is applicable to both thoracic and lumbar scoliosis.

DESIGN

Retrospective IRB-approved analysis

INTRODUCTION

Anterior vertebral body tethering (VBT) has been reported as an alternative to metal rod fusion for thoracic idiopathic scoliosis, with 57% success (Miyanji et al SRS 2018). We report the results of non-fusion ASC, a cord/screw correction performed through a muscle-sparing mini-anterior approach which allows for better derotation and enables disc release (not fusion) if needed as well as sparing of segmental vessels.

METHODS

Inclusion: patients with AIS , curves 40-70°, Sanders ≤ 4, Risser 0-1, minimum 2 year follow-up. 28 patients met the criteria. 16 patients had thoracic curves only, 1 had a lumber curve only, and 11 had double curves instrumented totaling 39 curves for analysis.

RESULTS

All 28 patients (100%) were available for review. Mean follow-up was 32.3 months with 23/28 (82%) having reached skeletal maturity. Age at surgery was avg. 12.6 yrs. Clinical success (curves ≤ 30°) was achieved in 26/28 patients (93%) and in 37/39 curves (95%) at recent follow-up. The 2 patients who did not achieve clinical success each had a 34°residual thoracic curve. Lengthening procedures for overcorrection occurred in 3/28 (11%) and, of those, 3/18 (17%) were Sanders 2/3 vs. 0/10 (0%) Sanders 4. Anticipated second stage surgery for initial limited correction occurred in 1/28 patients (4%), and 1/28 patients (4%) had unanticipated non-fusion revision surgery for adding on and a broken cord. Medical complications: 1 chylothorax and 1 C. difficile.

CONCLUSION

Non-fusion ASC for the treatment of 28 immature patients (Sanders ≤ 4) with idiopathic scoliosis was corrected to ≤30° in 26/28 (93%). There were 3 (11%) anticipated revisions for overcorrection and 1 (4%) for limited correction. There was 1 (4%) unanticipated revision also for a large, stiff pre-op curve. No fusion surgeries were performed. Anticipated cord lengthening procedures for overcorrection were seen only in patients who were Sanders 2 or 3 (not 4).

TAKE HOME MESSAGE

Non-fusion anterior scoliosis correction (ASC) showed 93% clinical success with curves ≤ 30° at most recent follow-up. Anticipated cord lengthening procedures for overcorrection were noted in 3 patients (11%).

53. Clinical Judgment of Initial Correction Need and Follow-up Curve Behavior after VBT According to Sanders Classification & Comparison to Fusion in a Matched Cohort

Ahmet Alanay, MD; Altug Yucekul, MD; Kadir Abul, MD; Gokhan Ergene, MD; Sahin Senay, MD; Binnaz Ay, MD; Barbaros Omer Cebeci; Ömer Orhun; Barkın Erdogan; Murat Pekmezci, MD; Suna Lahut, MSc, PhD; Tais Zulemyan, MSc; Yasemin Yavuz, PhD; Caglar Yilgor, MD

SUMMARY

Reporting on the results of initial curve correction and follow-up curve behaviors in 25 consecutive Lenke 1 patients, this study points out the differences in outcomes after thoracoscopic anterior vertebral body tethering (VBT) for patients with different Sanders skeletal maturity staging groups. Anticipating the findings of UIV-LIV follow-up vertical height gain and follow-up curve correction rates together with the patient's Sanders stage, the authors recommend a patient selection and surgical planning scheme.

HYPOTHESIS

Initial curve correction need and follow-up curve behavior for VBT can clinically be judged preoperatively.

DESIGN

Retrospective analysis of prospectively collected data

INTRODUCTION

VBT is a growth modulation technique that allows gradual spontaneous f-up curve correction as the patient grows. There is a

lack of evidence regarding appropriate patient selection and timing of implantation.

METHODS

For Sanders 1, 2, 3, 4-5 and 6-7 groups, data were collected preoperatively, before discharge, and at each follow-up. Demographic, perioperative, clinical, radiographic and complication data were compared using Fisher-Freeman-Halton tests for categorical and Kruskal Wallis tests for the continuous variables. Pulmonary function test and SRS-22r questionnaire results were compared using Wilcoxon signed ranks test.

RESULTS

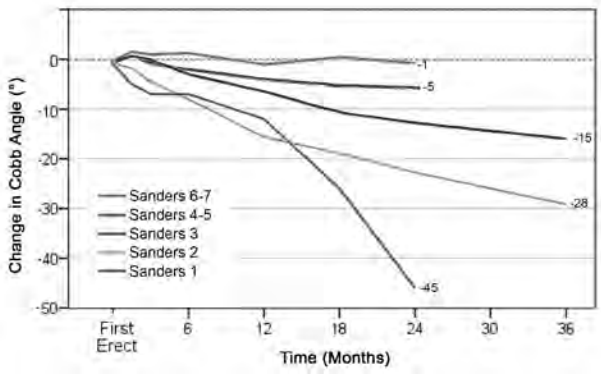
25 Lenke 1 pts (23F, 2M, 12.3±1.2 years) with a mean f-up of 22.1 (12-54) months were included. The mean preoperative main thoracic curve was 46.4°±7°. For all curves, preoperative and first erect curve magnitudes, bending flexibility and operative correction percentages were similar between groups ($p>0.05$). The median height gained during the course of the f-up was different between groups ($p<0.001$), which was reflected into median f-up curve correction rates. The mean preoperative forced vital capacity significantly increased at 1 year f-up ($p<0.000$). 3 (12%) patients had pulmonary and 6 (24%) had mechanical complications. 1 (4%) patient required readmission and 2 (8%) required reoperation. Occurrence of pulmonary complications was similar in Sanders groups ($p=0.804$), while mechanical complications were significantly higher in Sanders 2 patients ($p=0.022$).

CONCLUSION

Clinical judgment of surgical correction need and estimation of f-up curve behavior after thoracoscopic VBT can be done using Sanders staging. Sanders ≤2 patients are candidates for overcorrection, thus surgery should be delayed if possible. Sanders 3-5 patients possess a lesser risk of mechanical complications. VBT resulted in improved pulmonary functions and patients reported outcomes.

TAKE HOME MESSAGE

Ideal candidates for VBT are Sanders 3-5 patients. VBT should be delayed by conservative measures for Sanders ≤2 patients. Sanders classification may help decide on the amount of surgical correction.



54. Non-fusion Anterior Scoliosis Correction (ASC): Comparison of Outcomes in Skeletally Immature vs. Skeletally Mature Patients with Adolescent Idiopathic Scoliosis

William Paul Bassett, MD; M. Darryl Antonacci, MD; Laury A. Cuddihy, MD; Janet L. Cerrone, PA-C; Allison R. Haas, RN, BSN, CNOR, RNFA; Randal R. Betz, MD

SUMMARY

Non-fusion Anterior Scoliosis Correction (ASC) showed comparable clinical success with residual curves ≤ 30° at 2 years or later in 93% of immature patients, 81% of maturing patients, and 86% of mature patients with AIS. There was 1 case each of unanticipated reoperation in each of the immature and maturing groups, and 1 is pending in the mature group.

HYPOTHESIS

No difference in outcomes between maturity groups

DESIGN

Retrospective IRB-approved review

INTRODUCTION

Anterior vertebral body tethering (VBT) in skeletally immature AIS patients has been reported with success in approximately 60%. Non-fusion Anterior Scoliosis Correction (ASC) allows more curve correction and derotation at surgery even when patients are skeletally mature. The purpose of this review is to compare outcomes of a cohort of skeletally immature patients to cohorts of skeletally maturing and mature patients.

METHODS

Inclusion criteria: curves 40-70°, age ≤ 21 years, min. 2-year follow-up or failure before. 79 patients met the criteria, and 71 (90%) had 2-year radiographic follow-up for analysis. 59/71 (83%) were female. Of the 71 patients, 28 were immature (Risser 0-1, Sanders ≤ 4), 36 patients were maturing (Risser 2-4, Sanders 5-7), and 7 patients were mature (Risser > 4, Sanders ≥ 8). 34/71 patients (48%) had both thoracic and lumbar curves instrumented leaving 105 curves for analysis.

RESULTS

Age of the patients at time of surgery was avg. 12.6 years for the immature, avg. 14.5 years for the maturing, and avg. 17.9 years for the mature patients. Average follow-up and clinical success (final curve ≤ 30°) were similar across all 3 groups (NS, p values > 0.10). In the immature group, expected (anticipated) revision occurred in 3/28 (11%) for overcorrection and in 1/28 (4%) for a large, stiff curve, and there was only 1/28 (4%) unanticipated revision for adding on (instrumented too short) with cord failure. There was 1/36 (3%) unanticipated revision in maturing group, and 1/7 (14%) pending revision in the mature group.

CONCLUSION

Early 2-year results of non-fusion ASC showed clinical success with residual curves ≤ 30° in 93% of immature patients, 81% of maturing, and 86% of mature patients. There was a 14% incidence of expected anticipated reoperations in the immature group. The unanticipated reoperation rate was 1 patient (4%) in the immature, 1 patient (3%) in the maturing, and 1 patient (14%) pending in the mature group.

TAKE HOME MESSAGE

Non-fusion Anterior Scoliosis Correction (ASC) showed very good clinical success when comparing residual curves ≤ 30° in immature, maturing, and mature patients with AIS.

		Immature (Risser 0-1, Sanders ≤ 4)	Maturing (Risser 2-4, Sanders 5-7)	Mature (Risser > 4, Sanders ≥ 8)
Number of patients (curves)		28 (39)	36 (55)	7 (11)
Age in years (mean, range)		12.63 ± 0.78	14.52 ± 1.3	17.86 ± 2.43
Follow-up (months)		32.3 ± 6.4	29.8 ± 5.96	26.2 ± 6.9
Pre-op curve (°) (average, range)	Thoracic	55.44 ± 10.2 (35 - 70)	53.09 ± 10.45 (34 - 70)	50 ± 5.98 (41 - 59)
	Lumbar	49 ± 12.3 (36 - 70)	45.13 ± 7.65 (34 - 62)	54 ± 8.21 (44 - 64)
Disc release (not fusion)	Thoracic only in 34/65 (52%) curves	11/28 pts	19/36 pts	4/7 pts
Most recent curve (°) (average, range)	Thoracic	15.81 ± 10.62 (-3 - 34)	22.28 ± 9.85 (3 - 40)	21.29 ± 8.9 (10 - 34)
	Lumbar	13 ± 9.2 (-5 - 28)	17.61 ± 7.68 (5 - 29)	27.25 ± 17.03 (10 - 50)
Success rate percentage (< 30° at 2-year follow-up)	Patients	93% (26/28)	81% (29/36)	86% (6/7)
	Total curves treated	95% (37/39)	87% (48/55)	82% (9/11)
Number (%) anticipated revision		4/28 (14%)	0/36 (0%)	0/7 (0%)
Number (%) unanticipated revision		1/28 (4%)	1/36 (3%)	1/7 (14%) [pending]

55. Vertebral Body Tethering in Lumbar Curves. Minimum 2 Year Follow-up

Darren F. Lui, MBBS, FRCS; Shahnawaz Haleem, MBBS, MSc (Tr&Orth), MRCSEd, MRCSI, FRCS(Tr&Orth); Cristina Lupu, PA-C; *Tim Bishop, MBBS, FRCS;* Jason Bernard, MD, FRCS

SUMMARY

Posterior fusion into the lumbar spine for scoliosis surgery is often avoided to prevent morbidity and loss of movement. Vertebral body tethering in lumbar curves has not previously been described. We describe 7 cases of AIS with 3 cases of two stage double major curves and 4 single lumbar curves corrected by VBT. to be safe and effective with good radiogrpahic and clinical outcomes at minimum 2 year follow up.

HYPOTHESIS

Vertebral body tethering can be utilised in lumbar curves

DESIGN

Retrospective review of case series with prospectively collected data

INTRODUCTION

Vertebral body tethering (VBT) is still a relatively new technique with a paucity of data. Fusion surgery has been the gold standard and the envisaged benefits of VBT are that the spine is not fused. Scoliosis surgeons have traditionally avoided fusing the lumbar spine and the more distal the fusion the worse the future degeneration and back pain. In fact many patients with well balanced double major curves deliberately avoid surgery to avoid the complications of a long fusion. VBT, non fusion technique, in the lumbar spine offers a viable alternative.

METHODS

Retrospective review of 17 consecutive patients between 2014 and 2016 were studied for lumbar curve VBT. Demographics, radiology and patient related outcome measures were recorded prospectively and analysed.

RESULTS

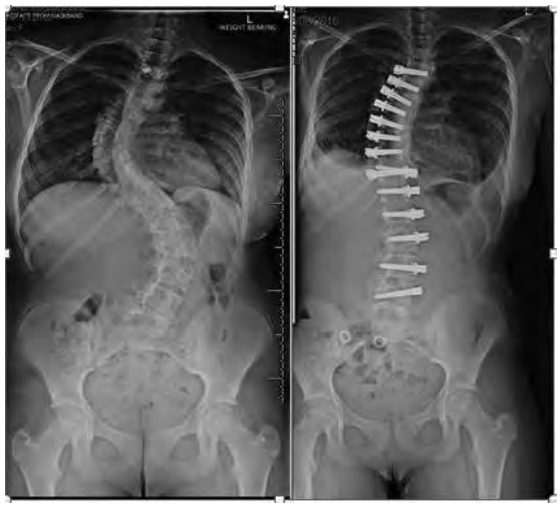
Female 100% n=7. Risser mean 2.7 (2-4). Age 14.09y. Harrington Stable Vertebra (HSV) 4.57 Single Lumbar Curves n=2 (Lenke 5) Mean Cobb = 43 deg. Bending 3 deg. Flexibility 93% Double Major Curve n=5. Lenke 6 (n=2), Lenke 3C (n=1), Lenke 1C (n=2). Average MT Cobb 59.4 (39-87) Average TL/L Cobb = 55.5, Bending Film TL/L – 35.2 deg). Flexibility 36%. 3 patients (Lenke 1C, 3C) had 2 stage procedures with both MT +TL/L curves tethered, 4 patients (Lenke 5,6) had VBT of only lumbar curve. 2 patients (Lenke 6) Indirect thoracic curve correction in: Avg preop MT Cobb 40.5 deg became Avg Post op MT Cobb 27.5. Correction Rate Mean 69.1%. SRS30 preop=2.7; Postop=3.80. Mean Hospital Length of Stay (HLOS)=6.7 Complications: No unplanned or planned return to surgery at 2 year f/u.

CONCLUSION

Lumbar VBT is a safe and effective option to avoid a long fusion into the lumbar spine. Traditional guidance eg. HSV, often dictate long fusions. Two stage double major curves are possible. Single lumbar VBT for double major and single curves are effective. Correction is also satisfactory in indirect derotation of the MT curve. This is the first report of Lumbar VBT with a minimum 2 year follow up for PROMS and Radiographic data.

TAKE HOME MESSAGE

VBT is possible in the lumbar spine for single and double major curves. It is safe and effective at 2 years. It may help avoid long fusions and maintain flexibility.



Double Major Lenke 3C - Preop MT (95) and TL/L (81deg). Post op Double Curve VBT: MT (24deg) and TL/L (12 deg) at 2 years

56. Minimally Invasive Surgery Versus Open Posterior Approach for Adolescent Idiopathic Scoliosis: A Multi-center, Retrospective, Cohort Study

Gao Si, MD; Tong Li , MD; *Miao Yu, MD*

SUMMARY

Minimally invasive spine surgery is common for the treatment of multilevel pathology in adults. Although MIS approaches have potential advantages in small incision, soft-tissue trauma and intraoperative blood loss, the application of MIS approaches in AIS is still limited for many technical challenges. Therefore, the safety and efficacy of MIS approaches in AIS remained unknown. We are going to compare the safety and efficacy of minimally invasive surgery (MIS) to open posterior approach (OPA) for adolescent idiopathic scoliosis (AIS).

HYPOTHESIS

MIS and OPA have their own advantages for adolescent idiopathic scoliosis.

PODIUM PRESENTATION ABSTRACTS

DESIGN

A multi-center, retrospective study.

INTRODUCTION

To compare the safety and efficacy of minimally invasive surgery (MIS) to open posterior approach (OPA) for adolescent idiopathic scoliosis (AIS).

METHODS

The authors searched a multi-center database for all patients with AIS who had been treated with either MIS or OPA without osteotomy between March 2007 and January 2017. All patients were followed at least 2 years. Levels of fusion, operation time, estimated blood loss and other clinical characteristics were recorded. Coronal and sagittal parameters were evaluated before surgery, immediately after surgery, and at the last follow-up. Data were compared using standard t-test for continuous variables and Fisher exact tests for categorical variables

RESULTS

The authors reviewed the records of 112 patients with AIS, 64 who underwent three-incision minimally invasive surgery and 48 underwent open posterior spine fusion. The MIS and OPA groups were similar for all preoperative clinical characteristics (P>0.05). The average Cobb angle was 50.7±5.3° with MIS and 48±14.8° with OPA. Comparison of radiographic parameters had no significant difference between 2 groups immediately after surgery. However, there was obvious difference in operation time (P<0.001) and estimated blood loss (P<0.001). In this study, MIS had more fusion segments than OPA (P<0.001). Both groups showed high accuracy in pedicle placement in postoperative CT. No deep wound infection, neurological damage and implant failure were recorded in both groups during at the last follow-up.

CONCLUSION

Minimally invasive surgery is a safe and effective alternative to standard open posterior approach with AIS. The short-term outcome showed no obvious difference between two groups. MIS have advantages in less blood loss, shorter operation time and mild pain, but it still need a challenging learning curve and limited indications. Surprisingly, MIS performed as well as OPA in long segments fusion. Overall, long-term data is needed before MIS can be considered as a routine alternative for AIS.

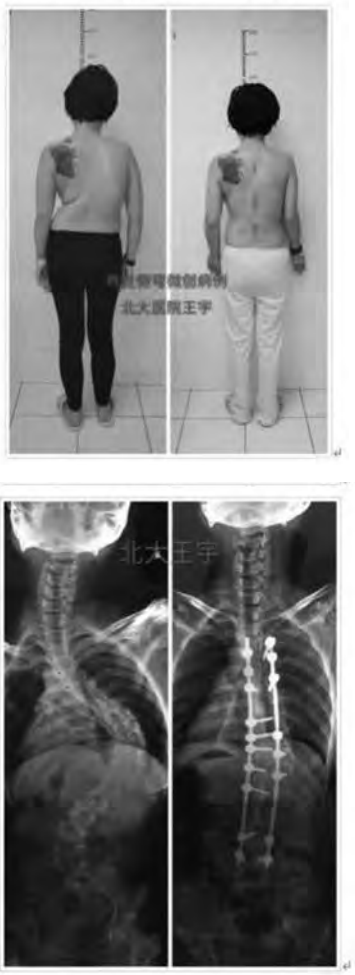
Table 1. Comparison of radiographic parameters between MIS and OPA

Variable	MIS	OPA	P
patients	64	48	
Cobb of main angle (°)			
preop	50.7±5.3	48±14.8	0.361
postop	16.9±10.2	18.2±10.5	0.805
Correction rate of main curve (%)			
postop	78.4±14.2	58±13.4	0.813
AVT (mm)			
preop	52.9±26.1	49.2±25.8	0.616
postop	13.2±10.4	15.3±10.2	0.116
TK (°)			
preop	29.2±9.4	28.7±7.1	0.911
postop	17.9±8.1	18.1±13.2	0.815
LL (°)			
preop	53.6±11.7	52.7±14.9	0.786
postop	46.9±9.4	45.6±5.9	0.704

Table 2. Comparison of surgical data between MIS and OPA

Variable	MIS	OPA	P
patients	64	48	
Operation time (mins)	366±94	274±43	< 0.001
Blood loss (ml)	502±217	808±325	< 0.001
Level of fusion	8.4±2.3	6.2±2.6	< 0.001
SRS-22			
Functional/activity	4.0±0.4	4.2±0.7	0.253
Pain	3.2±0.8	4.0±0.3	0.043
Mental status	3.9±0.3	4.1±0.4	0.571
Self-image/appearance	4.4±0.6	3.9±0.3	0.063
Satisfaction	4.5±0.3	4.2±0.4	0.386

Fig 1. One patient from MIS group



57. Minimally Invasive Surgery in AIS has Better Functional Outcomes, Decreased Costs, and Similar Radiographic Correction

Vishal Sarwahi, MD; Jesse Galina, BS; *Rachel Gecelter, BS;* Sayyida Hasan, BS; Stephen F. Wendolowski, BS; Yungtai Lo, PhD; Terry D. Amaral, MD; Aaron M. Atlas, BS

SUMMARY

SRS 30, validated sports activity questionnaire (SAQ) outcomes, and OR costs were analyzed in AIS patients undergoing PSF utilizing MIS approach compared to standard PSF surgery in a case controlled manner. MIS patients have significantly lower transfusion risk, OR costs, and fewer pedicle screws. However, the length of surgery tends to be higher compared to the PSF approach.

HYPOTHESIS

Minimally invasive surgery in AIS patients yields similar radiographic correction, better perioperative outcomes while decreasing patient cost

DESIGN

Retrospective case-controlled matched studies

INTRODUCTION

MIS in patients with idiopathic scoliosis is an innovative technique comparable to the standard open posterior approach. We seek to compare the two different approaches in case-control matched manner in the AIS population.

METHODS

21 MIS patients were matched with 21 PSF controls based on age, Cobb angle, BMI, and levels fused. Charts and XRs were reviewed for intra-op, post op and radiographic measurements. Outcomes were analyzed on SRS 30 and a statistically validated sports activity questionnaire. OR costs (implant cost, equipment, blood products, etc.) were calculated for each surgery. Wilcoxon signed-rank tests and McNemar's tests were utilized.

RESULTS

MIS patients had significantly fewer fixation points (17 vs 20, $p<0.001$), but a longer median anesthesia time (10 vs 7.1 hrs, $p=0.005$). There was no significant difference between EBL (400 vs 500cc, $p=0.131$), however transfusion rate was lower in MIS (1 vs 6, $p=0.025$). % Cobb correction, VAS score, length of stay and complications were not significant ($p=0.987$, $p=0.187$, $p=0.479$, $p=0.317$). SRS 30 and SAQ were not significantly different ($p=0.902$, $p>0.05$). OR costs in MIS were significantly lower and on average $4,200 less than the control ($p<0.001$).

CONCLUSION

Minimally invasive scoliosis surgery has similar radiographic, functional, and athletic return outcomes to the standard PSF approach, but significantly fewer transfusions and fixation points, and cost savings. These results suggest MIS may have economic and patient safety benefits, which need to be greatly considered.

TAKE HOME MESSAGE

Our case-controlled study shows the importance of minimally invasive surgery in reducing the need for blood transfusions, number of fixation points, and OR costs while maintaining radiographic outcomes

58. Are Postoperative Standing Radiographs Relevant Before Hospital Discharge in Adolescent Idiopathic Scoliosis?

Audrey Angelliaume, MD, MD Sc; Anne Laure Simon, MD, MS; Christophe J. Vidal, MD; *Brice Ilharreborde, MD, PhD*

SUMMARY

Early postoperative full spine radiograph is usually performed before hospital discharge after AIS posterior fusion. Results of the current study reported a significant difference between early radiograph and recall at 4 months regarding parameters analysing coronal and sagittal spinal balance. Four implants misplacement were reported, none led to a surgical revision. Thus, these radiographs do not reflect the final spinal alignment and do not affect surgical decisions.

HYPOTHESIS

Standing radiographs are not relevant during the first postoperative week in Adolescent Idiopathic Scoliosis (AIS), because patients have not recovered yet their physiological alignment. In addition, the analysis of implants position and instrumented levels rarely leads to surgical revision.

DESIGN

Monocentric prospective radiological study.

INTRODUCTION

Standing radiographs are often performed before hospital discharge (first week postoperative) after posterior fusion for AIS. However, patients are usually still painful and have not recovered yet their physiological balance. The aim of this study was to evaluate the relevance of such early radiographs, and more specifically investigate if postoperative alignment could be analyzed, and if the verification of implants locations affected surgical decisions.

METHODS

All consecutive AIS patients operated between January 2015 and January 2016 were included. All patients underwent biplanar stereoradiographs before discharge, at 4 months postoperative and at last follow-up (minimum 2-year). 15 parameters (8 coronal and 7 sagittal), reflecting correction and spinal alignment were measured and compared. The incidence of implants misplacement and the incidence of revision were recorded.

RESULTS

87 AIS patients were included. A significant difference was found for 13 out of the 15 evaluated parameters between the first erect radiograph and the 4-month follow-up visit, including the central sacral vertical line and the sagittal vertical axis, which are commonly used to assess global postoperative alignment. Both clavicle and last instrumented vertebra frontal tilts were also significantly different at 4 month. In opposition, no significant change occurred for the main parameters between the 4-month visit and latest follow-up. In 4 cases, 1 pedicle screw was considered misplaced on the first radiograph, but all patients remained asymptomatic and no revision surgery was performed.

CONCLUSION

Standing radiographs do not reflect final alignment during the first week postoperative in AIS, and patients readjust during the first 4-months after surgery.

TAKE HOME MESSAGE

Standing radiographs do not reflect final alignment during the first week postoperative in AIS, such early radiographs are not necessary if intraoperative control has already been performed.

59. Removal of Urinary Catheter Prior to Epidural Analgesia Discontinuation is Associated with Increased Risk of Post-operative Urinary Retention in Patients Undergoing Correction of Adolescent Idiopathic Scoliosis

Assem A. Sultan, MD; Ryan J. Berger, MD; William A. Cantrell, BS; Linsen T. Samuel, MD, MBA; Erin Ohliger, MD; Joshua L. Golubovsky, BS; Salam Bachour, BS; Selena Pasadyn, BA; Jaret M. Karnuta, BS; Jacob M. Rabin; Phuc Le, PhD, MPH; Thomas Kuivila, MD; David P. Gurd, MD; *Ryan C. Goodwin, MD*

SUMMARY

In patients who had posterior segmental instrumented fusion (PSIF) for adolescent idiopathic scoliosis (AIS), removal of a urinary catheter before discontinuation of epidural analgesia (EA) is an independent risk factor for post-operative urinary retention (UR) requiring re-catheterization and may be associated with incurred cost.

HYPOTHESIS

Timing of Foley catheter removal relative to discontinuation of EA may be related to UR development.

DESIGN

Retrospective cohort study

INTRODUCTION

EA is widely utilized for post-operative pain control in AIS patients after PSIF. In these patients, removing the indwelling Foley catheter, is indicated in the early post-operative period. It is controversial however whether the Foley catheter should be removed before or after EA discontinuation. Early removal may decrease incidence of urinary tract infections, while removal after EA discontinuation may avoid urinary retention (UR) and re-catheterization. The purpose of this study was to determine 1) if there a difference in UR rate among patients with early vs. late removal of indwelling Foley catheters, 2) if early vs. late catheter removal carries an independent risk for UR and recatheterization, and 3) if this is associated with an incurred cost.

METHODS

A total of 297 AIS patients who underwent PSIF were included in the final analysis. All patients received hydromorphone EA delivered by epidural catheter inserted during surgery. Patient characteristics and the order and timing of removing the urinary and epidural catheters were collected. Rates of UR were statistically compared in patients who had early vs. late urinary catheter removal. A univariate and multivariate regression analysis was conducted to identify independent risk factors for UR development

RESULTS

Patients with early (n=66, 22%) vs. late (n=231,78%) catheter removal had a significantly higher incidence of UR requiring re-catheterization (15 vs. 64.7%, p= 0.007). Patient with early removal were almost 4 times more likely to develop UR requiring re-catheterization (odds ratio (OR)= 3.8, 95% CI, (CI)= 1.5 – 9.7, p=0.005. UR incurred additional costs averaging $15,000/patient (P=0.204).

CONCLUSION

In patients who had PSIF for AIS, removal of a urinary catheter before discontinuation of EA is an independent risk factor for post-operative UR requiring re-catheterization and may be associated with incurred cost.

TAKE HOME MESSAGE

In AIS patients receiving EA, removing the urinary catheter before discontinuation of EA should be avoided to prevent the the risk of re-catherization, associated morbidity, and additional cost

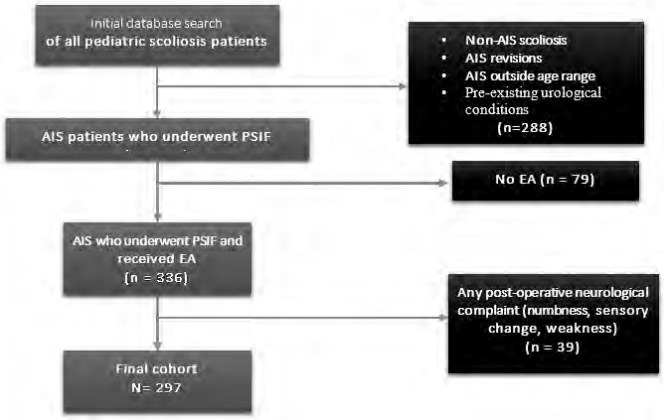


Figure 1: Flow chart showing patient selection (AIS; adolescent idiopathic scoliosis, PSIF; posterior segmental instrumented fusion, EA; epidural analgesia)

60. One-stage Posterior Multiple Level Asymmetrical Ponte Osteotomies vs. Single Level Posterior Vertebral Column Resection for Severe and Rigid Adult Idiopathic Scoliosis: A Minimum 2-year Follow-up Comparative Study

Yangpu Zhang, MD; Yong Hai, MD, PhD; *Aixing Pan, MD, PhD*

SUMMARY

Both Multiple Level Asymmetrical Ponte Osteotomies (MAPO) and VCR can achieve satisfactory spinal deformity correction of severe and rigid AIS with no significant difference. The considerable amount of flexibility established over the entire curve after MAPO permitted corrective maneuvers to become more effective, which may result in the comparative correction effect produced by VCR. Compared to VCR, risks of complication after MAPO are relatively low as well as operation time and blood loss.

HYPOTHESIS

We hypothesis that MAPO and VCR can achieve satisfactory spinal deformity correction of severe and rigid AIS with no significant difference. MAPO group has relatively low rate of complication as well as operation time and blood loss.

DESIGN

Retrospective comparative study

INTRODUCTION

The surgical treatment of severe and rigid AIS is a demanding and difficult challenge due to its complicated characteristics. Spine surgeons have often pursued advanced correction techniques for such patients such as VCR, which reported to present excellent correction outcomes. But this attractive procedure brought the greatest risk to both surgeons and patients.

METHODS

A total of thirty-eight patients who underwent MAPO or VCR and fusion surgery with minimum 2-year follow-up between February 2009 and November 2015 were enrolled. Twenty-six patients were included in MAPO group and 12 patients in VCR group with an average age of 26.65±8.40 years and 27.92±7.50 years. The average follow-up was 30.24±10.55 months. The surgical details and complications were recorded. The radiological parameters and clinical outcome including Oswestry Disability Index (ODI) and Scoliosis Research Society-22 (SRS-22) questionnaire scores was collected and analyzed.

RESULTS

The main curve in MAPO and VCR group were corrected from an average of 98.52±16.50° to 44.11±17.72° and 108.91±16.56° to 56.49±18.82° with no significant difference. The postoperative coronal and sagittal parameters of two groups were all improved and it showed no significant differences between the two groups. The incidence of complications in MAPO group was 3.85%, which was significantly lower than that of VCR group. All the clinical scores were significantly improved at final follow up, with no significant difference.

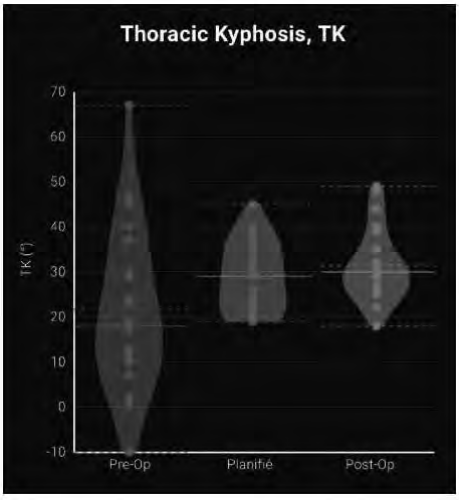
CONCLUSION

The surgical procedure of multiple asymmetrical Ponte osteotomy is a safe, easy-to-operate and effective technique that can correct scoliosis and restore the sagittal alignment and gain similar correction outcome to VCR, offering the advantages of reduced complications.

TAKE HOME MESSAGE

MAPO can achieve similar satisfactory spinal deformity correction of severe and rigid AIS compared to VCR, with lower complication rate.

A 36-year-old female patient of severe and rigid idiopathic scoliosis with a rigid main curve of 91.1° underwent 6 levels of asymmetric Ponte osteotomy surgery, which achieved a correction rate of 49.29%.



61. Patient Specific Designed and Manufactured Rods for AIS Surgical Correction: Applying The Principles Of The New AIS Sagittal Classification

Pierre Grobost, MD; Stephane Verdun, PhD; *Kariman Abelin-Genevois, MD, PhD*

SUMMARY

The new AIS sagittal classification has been designed to refine all the pathological shapes occurring in AIS, in order to guide the surgical strategy of sagittal correction. Strict application of the guidelines given by this classification using patient specific rods lead to adequate and predictible restoration of sagittal alignement in a prospective study of 49 patients especially in terms of length and magnitude of thoracic kyphosis. All cases with pathological shapes had restoration of an adequate sagittal alignement.

HYPOTHESIS

Guidelines given by the new AIS sagittal classification using patient-specific rods leads to predictible restoration of sagittal alignement.

DESIGN

Prospective monocentric study on AIS patients candidate to surgery to test the applicability of sagittal AIS classification guidelines in terms for pre operative 3D planification and rod contouring in order to optimize sagittal correction.

INTRODUCTION

AIS surgical treatment aims at improving spinal alignement while improving trunk cosmesis. In order to prevent mechanical complication and early degenerative changes, sagittal realignment according to spino pelvic parameters and TK restoration have been shown to be essential.

METHODS

Corrections applied through the simulation mode in order to approach a normalized spine : TK > 20° (ideally 34°), neutral TL junction (T10L2 < 10°, ideally 0 +/- 5°), to adapt inflexion point. A computerized simulation of sagittal correction was performed by surgeon, before guidelines were transmitted to the rod manufacturer with surgical details (diameter and material of the rod, levels of fusion, estimated correction rate) and AP and lateral calibrated X-rays.

RESULTS

A total of 49 AIS patients were prospectively included. All rods were implanted without modifications. Mean Cobb 54 +/- 10 degrees corrected average 21 +/- 8 degrees (62%). No changes occurred in terms fo PI, while PT initially increased similarly to planification as some cases presented with an anteverted pelvis. However PT was comparable to preoperative values at 6 months FU. All patients maintained in their Roussouly shape. TK and LL increased from preoperative to last FU. L4S1 ratio initially decreased but was again comparable between preoperative and last FU (66%). T10L2 angle distribution has been refined from 0,9 +/- 13,3 to 0,06 +/- 8,9 degrees. Improvement of TK was strictly identical to preoperative planning from 19,9 +/- 13 preoperatively to 29,6 +/- 8,3 at last FU (simulation TK value : 30,7 +/- 10,1), p<001.

CONCLUSION

All patients with a pathological sagittal alignement were changed into a sagittal type 1 by restoring proper length and magnitude of thoracic kyphosis.

TAKE HOME MESSAGE

Guidelines given by the new AIS sagittal classification using patient-specific rods lead to adequate and predictible restoration of sagittal alignement, achieving good correction in both frontal and sagittal plane.

62. Progressive Correction Following Anterior Vertebral Body Growth Modulation of the Spine for Idiopathic Scoliosis: Prospective Evaluation of 50 Patients with Minimum 2-Year Follow-up

Marjolaine Roy-Beaudry, MSc; Abdulmajeed Alzakri, MD, MS; Isabelle Turgeon, BS; Olivier Turcot, BS; *Stefan Parent, MD, PhD*

SUMMARY

Preoperative and 2 years postoperative clinical and radiological data of anterior vertebral body growth modulation (AVBGM) was evaluated. AVBGM is a safe technique that offers a significant correction in the coronal and transverse planes. Cobb Angle will continue to correct and consequently improving the rib hump.

HYPOTHESIS

AVBGM continue to correct after immediate post-op.

DESIGN

Prospective developmental study

INTRODUCTION

Anterior Vertebral Body Growth Modulation (AVBGM) aims to gradually correct scoliosis, using the patient's growth, while preserving spine motion.

METHODS

We reviewed the clinical, perioperative and radiological prospectively collected data of the first 97 patients who received the AVBGMT at our institution. The preoperative, 1st erect visit (FE), 1 year and 2 years post-operative data were analyzed. Means, standard deviation and paired t-test of specific parameters were calculated on 50 patients that reached 2 years follow-up. Patients with more than 1°/month correction and patient with less than 1°/month were compared with ANOVA.

RESULTS

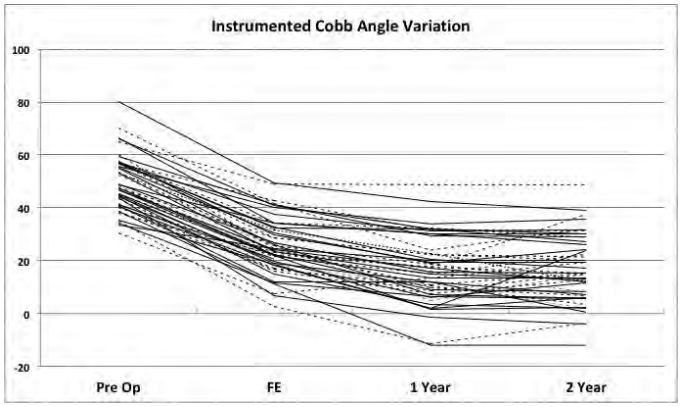
All 50 patients were skeletally immature (mean age 11.9 yo). Mean operative time was 167 min with an EBL of 206.4 ml. AVBGM was performed thoracoscopically on an average of 7.3 vertebral levels. Instrumented Cobb angle was 49.4°±10.3° preoperatively and 16.7°±12.5° at the 2-year PO visit (p=0.00)(Fig.1 curve correction). In the sagittal plane, kyphosis was modified from 18.5°±11.2° preoperatively to 16.4°±11.1° at the 2-year PO visit (p=0.00). Also, rib hump significantly improved after 2 years (13.5°±5.9° preoperatively and 9.0°±6.5°, p=0.00). AVBGM reduces curvature by 50% immediately after surgery with progressive correction reaching 67% at 2 years. Between FE and 1st year, instrumented curvature improved at a rate of 0.52°/month decreasing thereafter to a rate of 0.011°/month. Patients that show higher rate of correction per month have a higher pre-op Cobb Angle (51.2°±10.2°) compared to patients that show less correction (44.7°±9.5°) (p=0.043).

CONCLUSION

AVBGM offers a significant correction in the coronal and transverse planes post-op with gradual correction occurring during the first-year post-op improving by at least 5° during the first-year post-op. As the Cobb angle improves, Rib humps also improves. The rate of correction diminishes after the first-year post-op probably related to diminishing vertebral growth but also to cable breakage.

TAKE HOME MESSAGE

AVBGM is a safe technique that offers significant correction over time with the potential advantage of retaining spine mobility. Most of the correction occurs during the first year post-operatively.



Individual curve correction over time

63. Image Registration of 3D Ultrasound (3DUS) Vertebral Surfaces onto CT Vertebrae for Pedicle Screw Navigation in Adolescent Idiopathic Scoliosis (AIS) Surgery

Andrew Y. Chan, MD; Edmond H. Lou, PhD; Eric C. Parent, PhD

SUMMARY

Pedicle screw insertion for AIS surgery requires high accuracy to prevent neurologic injury. Usage of 3D ultrasound to provide surgical navigation may offer improved accuracy while minimizing ionizing radiation and disruptions to surgical flow. A custom 3D ultrasound and image registration system was developed to localize and determine orientation of spinal vertebrae during surgery. With an accuracy of 1.6±1.2o and 0.3±0.2mm and processing time of 32.6±4.1s, the current system is promising for use in the operating room.

HYPOTHESIS

Image registration of vertebrae from CT scans onto 3D ultrasound can be used for pedicle screw insertion to within adequate accuracy and time constraints.

DESIGN

Ultrasound Phantom Registration Experiment

INTRODUCTION

Surgery for severe AIS involves inserting screws into narrow thoracic pedicles, risking neurologic injury. Although CT navigation can aid screw placement and reduce pedicle breaches, the added radiation and surgical times preclude its widespread usage. Navigation using 3D Ultrasound (3DUS) is proposed as an alternative solution. Ultrasound-imaged 3D vertebral surfaces can be registered to pre-op 3D spinal imaging to be displayed for navigation purposes. This study evaluates a custom image registration program for 3DUS vertebral surfaces on CT vertebrae for speed (<1min) and accuracy (<1mm and 5degrees) to be used in spine surgery.

METHODS

A 3D medical ultrasound integrating a medical ultrasound machine with a 6.7MHz, 38mm transducer with four motion capture cameras formed a novel surgical navigation system. Software was developed to register individual vertebrae from the CT scan to the 3DUS vertebral surface image. The CT scan of a phantom T4-T9 vertebral segment was 3D printed and imaged in a water bath with scans taking 15s to perform and process. Each vertebra from T5-T8 was imaged 27 times at nine different orientations. Each registration was timed and accuracy was evaluated by manually transforming volumes to determine if a more optimal registration could be achieved.

RESULTS

Automated registration of ultrasound scans required 32.6±4.1s on a quad-core 3.6 GHz processor with 16GB RAM and a 4GB video card. All 108 registrations were successful to accuracies within 5o and 1mm, with an average accuracy of 1.6±1.2degrees and 0.3±0.2mm.

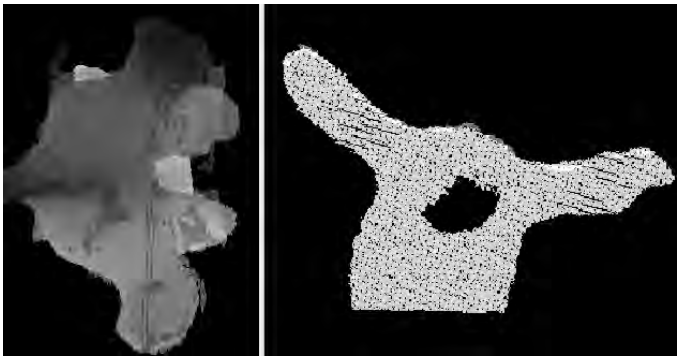
CONCLUSION

Image registration of individual vertebrae 3D ultrasound images with CT scans are able to achieve adequate registration accuracy while requiring a reasonable amount of time to use in the operating

room. Further investigation into soft tissue effects on registration will be completed next.

TAKE HOME MESSAGE

Image registration of vertebrae for AIS surgery from 3D ultrasound to CT scans can be completed within 1 minute and met the 1mm and 5 degree screw accuracy requirements



Top-view (left) and cross-sectional view (right) of 3DUS phantom vertebral surface (purple) registered on CT phantom vertebra (green)

64. Single-position Adult Spinal Deformity Surgery with Minimally Invasive Lateral Lumbar Interbody Fusion and Lateral Segmental Screw-rod Fixation

Joseph L. Laratta, MD; Karishma Gupta, BS, MPH; William Smith, MD

SUMMARY

The minimally invasive lateral approach for lumbar interbody fusion is being increasingly indicated for more complex pathologies. This novel technique involves multi-level LLIF in conjunction with a lateral, transpsoas screw-rod construct; however, the efficacy of this technique has yet to be fully evaluated in an adult spinal deformity population. The purpose of current study was to assess the radiographic and patient-reported, clinical outcomes of ASD patients treated with single position, minimally invasive LLIF and lateral segmental screw-rod fixation.

HYPOTHESIS

Single-position surgery with multi-level LLIF and lateral segmental screw-rod fixation is safe and effective in ASD treatment.

DESIGN

Single center prospective

INTRODUCTION

The minimally invasive lateral approach for lumbar interbody fusion (LLIF) is being increasingly indicated for more complex pathologies. This technique involves multi-level LLIF in conjunction with a lateral, transpsoas screw-rod construct; however, the efficacy of this technique has yet to be fully evaluated in an adult spinal deformity (ASD) population.

METHODS

Thirty-two adult degenerative scoliosis patients with significant sagittal malalignment treated with multi-level LLIF and lateral rod fixation were included. All patients underwent single position surgery. Radiographs were evaluated at pre-op, post-op, and at >6 months postoperatively. All patients underwent postoperative CT scan at 24 months to evaluate fusion. Patient-reported outcomes were assessed by VAS and ODI scores.

RESULTS

Average patient age was 62.8 years. Complete anterior longitudinal ligament (ALL) release was performed in 67% of cases. Clinical follow-up averaged 34.8 months. Intraoperative OR time, estimated blood loss and length of stay averaged 205 minutes, 182 mL, and 3.0 days, respectively. Preoperative lumbar lordosis, pelvic incidence and pelvic tilt -28.1°, 57.2°, and 32.0°, respectively. At final radiographic follow-up, LL and PT improved to -46.1° and 19.1°, respectively. The PI-LL mismatch improved from 29.1° to 11.1°. Visual analog scale for low back pain (VAS-BP) declined from 8.4 preoperatively to 3.5 at final follow-up. Oswestry Disability Index (ODI) decreased from 61 to 28 at two-year follow-up. Additionally, there were no clinical or radiographic pseudarthroses as evaluated by CT scans, and no evidence of proximal junctional kyphosis.

CONCLUSION

Single-position surgery with multi-level LLIF and lateral segmental screw-rod fixation is safe and effective in the treatment of ASD. This relatively novel approach allows for significant improvements in patient reported outcomes that are not inferior to other minimally invasive and open ASD surgical techniques.

TAKE HOME MESSAGE

Single-position surgery with multi-level LLIF and lateral segmental screw-rod fixation is safe and effective in the treatment of ASD.

65. Surgical Result of Adult Spinal Deformity Patients Treated with Lateral Interbody Fusion Combined with Posterior Fusion: Comparison with Propensity-score Matched Patients Treated with Posterior-only Approach

Naobumi Hosogane, MD, PhD; Mitsuru Yagi, MD, PhD; Hitoshi Kono, MD; Nobuyuki Fujita, MD, PhD; Shoichi Ichimura, MD; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD, PhD; Kota Watanabe, MD, PhD

SUMMARY

To assess the relevancy of LIF in ASD surgery, 31 ASD patients treated with LIF combined with posterior open surgery were compared with propensity-score matched 31 ASD patients treated with conventional open posterior-only surgery with multilevel PLIF/TLIFs. Similar or slightly better correction in lumbar Cobb and LL were obtained in LIF group with significantly less utilization of PSO in primary ASD patients.

HYPOTHESIS

LIF combined with posterior fusion is equally effective as conventional posterior only approach for ASD.

DESIGN

Retrospective study of propensity-score matched cohorts.

INTRODUCTION

Lateral interbody fusion (LIF) is used to correct sagittal/coronal deformity in adult spinal deformity patients (ASD). To reveal the validity of LIF, ASD patients without previous fusion treated with LIF combined with open posterior fusion were compared with

propensity-score matched ASD patients treated with posterior-only approach with multiple PLIF/TLIFs.

METHODS

Among 112 operative ASD patients, 31 ASD patients treated with LIF combined with open posterior fusion (LIFPF; mean 65.9y, 97% women, 8.9 levels fused) with minimum 2y follow-up were propensity-score matched for age, gender, SRS-Schwab classification, baseline lumbar Cobb angle and PI-LL with 31 primary ASD patients treated with conventional posterior-only approach with multilevel PLIF/TLIFs (CON; mean 65.9y, 87% women, 9.3 levels fused). Radiographical parameters were compared at baseline (BL), immediate after surgery (PO) and at the final follow-up (FU).

RESULTS

Lumbar curve were equivalent (all CON/LIFPF, BL 38.8/36.6°, PO 15.0/11.7°, FU 15.4/11.6°), however correction rate at PO was significantly better in LIFPF (61.3/70.0%, p=0.04). In sagittal plane, LL was similar at BL (9.0/7.4°) and PO (39.3/42.2°), and significantly better at FU in LIFPF (35.9/42.2°, P=0.04). No significant differences were observed in PI-LL (BL 41.9/44.5°, PO 10.3/7.2°, FU 16.1/10.3°) or SVA (BL 91.6/103.4, PO 35.4/22.5, FU 54.0/44.8mm). Although mean total surgical time was significantly longer in LIFPF (286/439min, p<0.01), total EBL was similar in both groups (1036/855 g). PSO was conducted in 3.2% of LIFPF which was significantly less than CON (19.4%, p=0.04).

CONCLUSION

Our results revealed the relevancy of LIF in correction surgery for ASD as slightly better correction were obtained in LIFPF. Our results also suggest more invasive surgery such as PSO could be avoided with using LIF.

TAKE HOME MESSAGE

Slightly better deformity correction was obtained with LIF combined with posterior fusion compared with posterior-only approach in ASD. These equivalent corrections were obtained with less PSO utilization in LIF group.

66. Intraoperative Neuromonitoring for Lateral Lumbar Interbody Fusion: An Intra-operative Protocol to Avoid Postoperative Neurologic Deficit

Nicole Record, DO; Robert K. Eastlack, MD; Stacie Tran, MPH; Daniel J. Thibaudeau, MD; Alissa Carnelian, AuD; Kristina C. Brady, Au.D; Behrooz A. Akbarnia, MD; *Gregory M. Mundis Jr., MD*

SUMMARY

Neuromonitoring is used to decrease risk of potential neurologic damage. We aimed to assess intra-operative NM events and postoperative deficits and how an intraoperative protocol could be implemented to decrease postoperative deficits. 14 patients had NM alerts which prompted surgeon response and only 1 POD (92.9% of patients averted potential harm). 6 patients had POD without NM alert (8.1 false negative rate). No association was found for: level of LLIF, number of LLIF, number of alerts, or dilator EMG.

HYPOTHESIS

The use of an intraoperative protocol for neuromonitoring alerts will trigger a response by the surgeon resulting in avoidance of post-operative deficits.

DESIGN

Single institution retrospective review of consecutive prospectively enrolled LLIF patients

INTRODUCTION

Transpsoas lateral lumbar interbody fusion (LLIF) is associated with known approach related neurologic risk. Directional EMG and neuromonitoring (NM; SSEP and MEP) is frequently used. We aim to investigate the use of NM in LLIF and the utility of the IOP (figure 1) to avoid POD.

METHODS

An intraoperative protocol (IOP) was developed to mitigate post-operative deficits (POD). POD was defined as a motor (M) or sensory (S) deficit associated with approach level. NM alerts were defined as sustained EMG or 50% change in baseline SSEP or MEP.

RESULTS

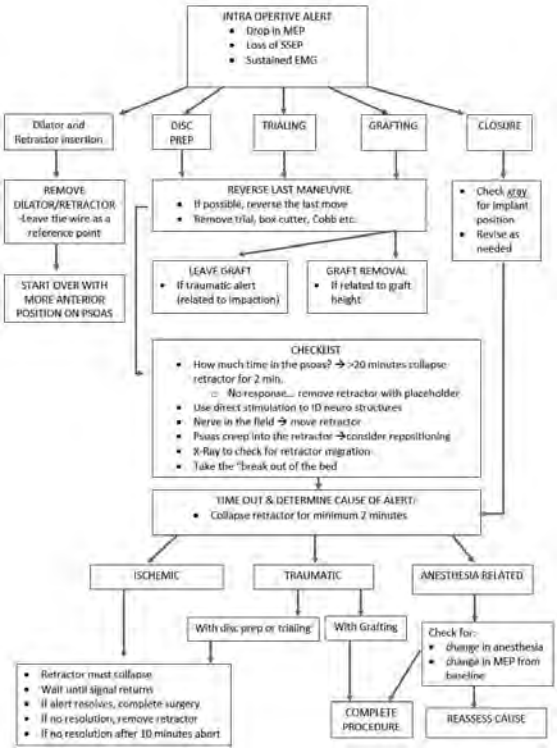
76 pts (103 levels) were included (33F, 43M), 46 degen and 30 deformity. Average posterior fusion was 2.3 levels with total EBL 193cc. 7 (9.2%) pts had a total of 8 POD (3 sensory; 3 motor; 1 both) with no difference between deformity (n=5, 16.7%) or degenerative (n=2, 4.3%; p>0.05). 14 (18.4%) had a total of 20 NM alerts (3 SSEP, 6 MEP, and 11 EMG) triggering the IOP, 1 (7.1%) awoke with a POD (motor and sensory). 62 (81.6%) had no NM alert, and 6 (9.7%) developed POD (3 sensory; 3 motor). 12 (15.8%) had psoas weakness, 10 resolved by 1 mo, 1 remained at 3 mo. All POD recovered by 25 mo. No association was found for: level of LLIF, number of LLIF, number of alerts, or dilator EMG. L3-L4 had significantly higher NM alerts (10, 41.7%, p=.002). ROC curve was used to obtain critical retractor time (RT) of 24.5 min (sensitivity 0.67, specificity 0.62, AUC=0.741). RT >24.5min was associated with higher sensory but not motor POD (p=0.034).

CONCLUSION

An IOP was triggered among 14 pts with only 1 developing a POD, suggesting that POD was potentially averted in 13 (92.9%). NM had an 8.1% false negative rate. Patients with deformity had a substantially higher POD. The IOP is useful in the setting of NM alerts, however, further investigation is needed to understand the occurrence of POD in the absence of NM alerts.

TAKE HOME MESSAGE

Neuromonitoring is important to alert physicians of potential nerve damage. An intraoperative protocol provides a plan for surgeons to avoid nerve injury and safely complete the LLIF surgery.



67. Does Patient Frailty Status Influence Recovery Following Spinal Fusion for Adult Spinal Deformity?

Katherine E. Pierce, BS; *Peter G. Passias, MD;* Renaud Lafage, MS; Virginie Lafage, PhD; Christopher P. Ames, MD; Douglas C. Burton, MD; Robert A. Hart, MD; D. Kojo Hamilton, MD; Michael P. Kelly, MD, MS; Richard Hostin, MD; Shay Bess, MD; Eric O. Klineberg, MD; Breton G. Line, BS; Christopher I. Shaffrey, MD; Praveen V. Mummaneni, MD; Justin S. Smith, MD, PhD; Frank J. Schwab, MD; International Spine Study Group

SUMMARY

Frailty severity may be an important determinant for impaired recovery after adult spinal deformity (ASD) corrective surgery. No prior studies have examined the associations between increasingly frail states and the trajectory of recovery. Utilizing a novel area-under-the-curve (AUC) normalization methodology, our analysis establishes objective recovery benchmarks for 1Y and 3Y follow-up timepoints for frailty status. Across frailty scores, patients exhibited postoperatively improved health related quality of life (HRQL) scores. Severely frail patients exhibited significantly better improvement.

HYPOTHESIS

Frailty states have unique recovery profiles

DESIGN

Retrospective review

INTRODUCTION

The profiles of recovery across frailty status is poorly understood.

METHODS

Included: ASD patients with HRQLs at BL, 1Y, and 3Y. Patients stratified by frailty by ASD-FI scale 0-1(no frailty:<0.3[NF], mild:0.3-0.5[MF], severe:>0.5[SF]). Demographics, alignment, and SRS-Schwab modifiers were assessed with chi-squared/paired t-tests to compare HRQLs. AUC method generated normalized HRQL scores at BL and f/u intervals(1Y, 3Y). AUC was calculated for each f/u, and total area was divided by cumulative f/u length, generating one number describing overall recovery(Integrated Health State-IHS).

RESULTS

191 patients included(59yrs, 80%F). By frailty group: 43.6%NF, 40.8%MF, 15.6%SF. SF patients were older(P=0.003), >BMI(P=0.002). MF and SF were significantly(P<0.001) more malaligned at BL: PT(NF:21.6°; MF:27.3°; SF:22.1°), PI-LL(7.4°, 21.2°, 19.7°), SVA(31mm, 87mm, 82mm). By SRS-Schwab modifiers, NF were mostly Minor(40%), MF and SF Markedly deformed(64%, 57%). SF had a greater CCI, EBL, and LOS(P<0.050). Frailty groups exhibited BL to 3Y improvement in SRS-22, ODI, NRS Back/Leg Pain(P<0.001). After HRQL normalization, SF had improvement in SRS-22 at Y1 and Y3(P<0.001), and NRS Back Pain at 1Y. 3Y IHS showed a significant difference in SRS-22(NF:1.2 vs MF:1.32 vs SF:1.69, P<0.001) [Figure 1] and NRS Back Pain(NF:0.52, MF:0.66, SF:0.6, p=0.025) between frailty groups. No significant differences were found for IHS NRS Leg Pain and ODI between frailty groups. SF had more postop complications(79%). SF/Marked deformity had a larger invasiveness score(112) compared to MF/Moderate deformity(86.2). Controlling for baseline deformity and invasiveness, SF showed more improvement in SRS-22 IHS(NF:1.21, MF:1.32, SF:1.66, p<0.001).

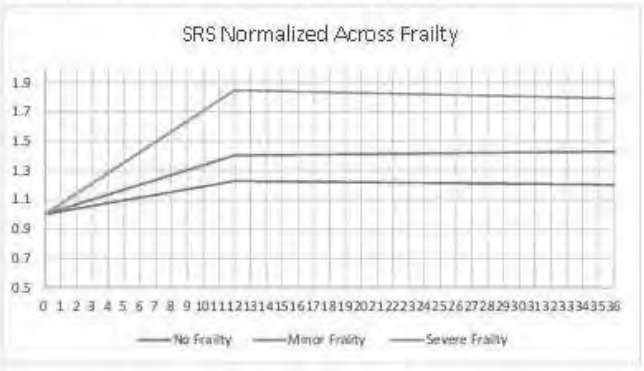
CONCLUSION

SF patients recovered better in SRS-22 and NRS Back Pain, despite more complications and larger invasiveness scores, signifying with an increase frailty severity, patients have room for greater recovery due to low baseline quality of life.

TAKE HOME MESSAGE

Frailty status contributes to a patient's unique recovery profile. While all frailty groups exhibited improved postop disability/pain scores, the severely frail had better patient-reported outcomes.

Table 1. SRS Scores Normalized and plotted by follow-up time point.



68. Efficacy of Multi-rod Constructs: Comparison of Two Different 4-Rod and 3-Rod Configurations in Adult Spinal Deformity Patients with Long Fusions to the Sacrum

Mostafa H. El Dafrawy, MD; Owoicho Adogwa, MD; Maksim A. Shlykov, MD, MS; Michael P. Kelly, MD, MS; Keith H. Bridwell, MD; Munish C. Gupta, MD

SUMMARY

Rod configurations in 110 ASD pts. with long PSF to the sacrum with multi-rod constructs were classified using a new classification system. 4 and 3 rod constructs were divided into two groups: accessory rod group or satellite rod groups. We compared rod failure rate (RF) between the two different 4-rod and 3-rod configurations. In 4-rod constructs, there was no difference in RF between Satellite and Accessory rods. However, in 3-rod constructs the Accessory group had more RF.

HYPOTHESIS

There is no difference in RF between accessory and satellite rod configurations for 3-rod and 4-rod constructs in ASD pts fused to sacrum

DESIGN

Retrospective cohort study

INTRODUCTION

Multi-rod constructs in long PSF can be modular with variable Rod configurations (RC). The high rate of RF in ASD lead to the adoption of multi-rod constructs. The effect of RC on the RF rate in multi-rod constructs is unknown as there is no classification system to define and compare the different multi-rod construct

METHODS

Database of 526 ASD pts fused to sacrum reviewed, 110 pts with multi-rod constructs identified and divided into 4-rod or 3-rod constructs then classified according to the RC into group A with additional accessory rods or group S with additional satellite rods. Majoriy of the Satellite rods were midline rod with hooks. Accessory and satellite rod configurations for 4-rod and 3-rod constructs were compared for RF

RESULTS

4-rod constructs included 15 satellite and 18 accessory RC. Avg. BMI and % primary to revision surgeries in both groups was not different p=0.38. Rod diameter (5.5 vs 6.35) in both groups was not different p=0.28. Median levels fused S-group 15[13-17] vs A-group 12[10-15], p=0.11. Interbody fusion was not different S-group 12(80%), A- 15(83%), p=0.81. RF in S-group occurred in 2(13.3%) vs 4(22.2%) A-group, p=0.47. Duration of time from surgery to RF was 27 mos. in S-group vs 14.5 in A-group. 3-rod constructs included 42 satellite and 29 accessory RC. Avg. BMI was not different(p=0.83), S-group had more revision cases 38(90.5%) vs 17(58.6%) A-group p=0.03. In S-group 14(33.33) were 5.5 rods, 27(64.3) 6.35 rods vs A-group: 26(89.6) 5.5 rods and 3(10.34) 6.35 rods, p=0.01. Median levels fused was not different, but A-group had more interbody fusions performed 12(41.4) vs 4(9.52%) p=0.03. RF in S-group were 7(16.66%) vs 15(51.72%) A-group, p=0.01. Duration of time from surgery to RF in Satellite group: 41 mos. vs accessory group 31 mos.

CONCLUSION

In 4-rod constructs there was no difference in RF between Satellite and Accessory rod groups, in 3-rod constructs the Accessory group had more RFs

TAKE HOME MESSAGE

Multi-rod constructs with different rod configurations were compared using a new classification, 4-rod constructs showed no difference in RF, in 3-rod constructs Accessory RC had more RFs compared to Satellite

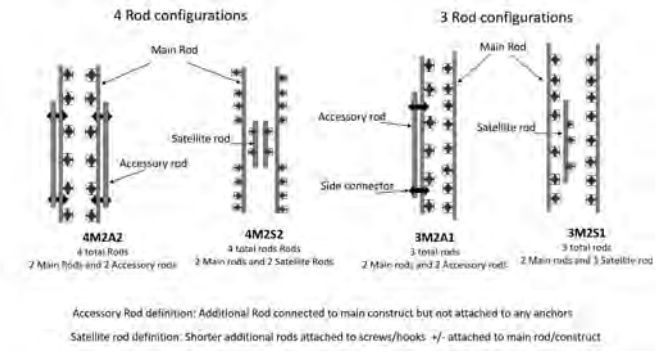


Diagram showing the two different within the 4-rod and 3-rod constructs with definition of Satellite rods and Accessory rods

69. The Approach to Pseudarthrosis after Adult Spinal Deformity Surgery: Is a Multiple-rod Construct Necessary?

Tina Raman, MD; Khaled M. Kebaish, MD, FRCS(C); Thomas J. Errico, MD; Peter G. Passias, MD

SUMMARY

A common approach in revision adult spinal deformity (ASD) surgery for pseudarthrosis is the use of multiple rods spanning the level of pseudarthrosis, to theoretically provide greater stability of fixation to promote bony fusion. We found that there was no significant difference in 2-year fusion grades, rod fracture, interbody device failure, operative time, blood loss, or complication rate between a 2-rod and multi-rod construct for revision ASD surgery for pseudarthrosis.

HYPOTHESIS

There is no difference in the rate of rod fracture, rate of pseudarthrosis, and complications between a 2-rod and multi-rod construct in revision ASD surgery for pseudarthrosis.

DESIGN

Retrospective review of prospectively collected single center database.

INTRODUCTION

The revision approach for pseudarthrosis can entail the use of multiple rods spanning the level of nonunion, but to date, no studies have demonstrated the efficacy of this technique compared to a 2-rod technique, in achieving a solid union.

METHODS

47 patients who underwent revision ASD surgery for pseudarthrosis were identified. A 2-rod construct was used in 24 patients, and a multi-rod construct (18 satellite rod constructs, 5 kickstand rod constructs) in 23 patients, spanning the pseudarthrosis level. 2-year fusion grading, and rates of pseudarthrosis and implant failure, were calculated.

RESULTS

There were no differences in patient or surgical characteristics: (2-rod: Age 60 ± 14, Levels 10 ± 5, 3CO:17%; multi-rod: Age: 62 ± 11, Levels 9 ± 4, 3CO:30%). Patients in the multi-rod construct were transfused a greater volume of pRBCs intraoperatively (2.6 ± 2.9 U vs. 1.1 ± 1.5 U, p<0.0001). At 2 years, there was no difference in fusion grades at the previous level of pseudarthrosis, the rate

of rod fracture or pseudarthrosis between the two groups, or rate of reoperation for pseudarthrosis, rod fracture, wound infection, instrumentation prominence, or PJK/PJF.

CONCLUSION

Our data demonstrate no difference in fusion grade, or rates of rod fracture, pseudarthrosis, or revision surgery at 2 years, after utilizing a 2-rod versus multi-rod construct in revision ASD surgery for pseudarthrosis. The low complication rates seen in this series warrant further investigation of the optimal instrumentation configuration.

TAKE HOME MESSAGE

At 2 years, there was no difference in fusion grade, and rates of pseudarthrosis, rod fracture, and reoperation between 2-rod and multi-rod constructs for revision ASD surgery for pseudarthrosis.

	2-rod construct (n=24)	Multi-rod construct (n=23)	P
BMP (n, [%])	4 [17]	15 [64]	0.002
Interbody (n, [%])	14 [58]	14 [61]	0.86
Fusion grade	1.39 ± .84	1.33 ± .66	0.80
Rod fracture (n, [%])	6 [25]	3 [12.5]	0.298
Wound infection (n, [%])	1 [4.2]	0 [0]	0.33
Hardware prominence (n, [%])	0 [0]	0 [0]	0.35
PJK/PJF (n, [%])	0 [0]	2 [8.7]	0.13
Reoperation for pseudarthrosis	5 [21]	4 [17.4]	0.76

2-rod versus Multi-rod construct for Revision Surgery for Pseudarthrosis

70. Interbody Use Provides No Added Benefit Over 3-Rod Constructs in Adult Spinal Deformity Surgery

Philip J. York, MD; Michael E. Steinhaus, MD; Renaud Lafage, MS; Alex Liu Huang; Bryan Ang, BS; Jonathan Charles Elysée, BS; Frank J. Schwab, MD; Virginie Lafage, PhD; Han Jo Kim, MD

SUMMARY

Theoretical advantages of interbody fusion (IBF) in Adult Spinal Deformity (ASD) exist, however, no consensus exists regarding its indications in ASD. This study compared constructs for ASD including two rods with and without IBF and three rods without IBF. There was no difference in rod failure although differences were observed in degree of correction seen in three-rod patients. These findings raise the question of whether or not IBF is of benefit when 3 rod constructs are utilized in ASD

HYPOTHESIS

Three rod constructs without interbody perform equivalently to 2 rod-constructs + interbody fusion (IBF) in ASD surgery

DESIGN

Retrospective cohort

INTRODUCTION

IBF at L5-S1 may increase fusion rates and protect S1 screws. However, modern iliac fixation has been shown to provide greater protection due to its placement being more anterior to the center of rotational axis. When appropriate iliac fixation is used, can it obviate the need for IBF?

METHODS

ASD patients with a minimum follow up of 12 months and LIV S1/Ilium with >5 levels of fusion were reviewed. Exclusion criteria included patients with 3 column osteotomy, prior fusion spanning from L4-S1, trauma, or diagnosis of neuromuscular, inflammatory arthritis or skeletal dysplasia. Patients were grouped by construct types: 2 rods w/ (IBF) and w/o IBF (2R) and >3 rods (spanning at least L4-S1) w/o IBF (3R). Demographics, perioperative data, and evidence of rod fracture were collected. ANOVA, chi-square and Fisher exact test were used to compare surgical information and alignment between construct types

RESULTS

71 patients met inclusion: 2R=18, IBF=15, and 3R=38. There were no significant differences in OR time, EBL, # of levels fused, UIV position or rod failures (2R, IBF, 3R) (5.6%, 20.0% and 7.9%; p = 0.42). Significantly greater SPOs were used in 3R group (55.6%, 46.7%, 78.9%; p = 0.04). While there was no significant difference in the % of patients receiving BMP (88.9%, 80.0%, 89.5%) there was a significant variation in the dose (23.2±8.7, 17.1±11.0, 12.6±9.2; p<0.01). There were no significant differences in pre or post alignment, however, significant differences were seen in the corrections in thoracolumbar cobb (-2.2, -3.1, 13.4; p=0.04), SVA (-31.5, -24.0, -71.5; p=0.01), and thoracolumbar junction angle (-1.0, 1.9, 12.0; p <0.01).

CONCLUSION

The addition of IBF demonstrated no benefit in terms of avoiding rod failure or correction in our cohort. Our findings suggest that the addition of a third rod when utilizing bilateral iliac fixation in ASD is an acceptable construct to avoid rod failures at 12 months follow up without sacrificing corrections when compared to constructs with IBF

TAKE HOME MESSAGE

Interbody fusion in ASD provides no benefit compared to posterior only, 3-rod constructs in terms of risk for rod fracture or ability to obtain deformity correction

71. Does Interbody Support at L5-S1 Matter in Long Fusions to the Pelvis? A 5 Year Analysis

Nina J. Lara, MD; Donovan Lockwood, BS; Andrew Chung, DO; Jan Revella, RN; Dennis G. Crandall, MD; *Michael S. Chang, MD*

SUMMARY

Current literature has not definitively shown that the use of interbody support is better than posterior correction alone in deformity surgery. This study compared the 5yr clinical and radiographic outcomes between PSF alone and interbody support. This study demonstrates that compared to posterior spinal fusion alone, interbody fusion at L5-S1 results in superior short-term sagittal alignment and lower rates of revision for proximal junctional failure in adult deformity patients undergoing long fusions to the pelvis.

HYPOTHESIS

When compared to PSF alone, interbody support at L5-S1 is not associated with superior clinical or radiographic outcomes at 5yr follow-up.

DESIGN

Retrospective cohort study of prospectively collected data from a single surgical spine practice.

INTRODUCTION

Biomechanical studies have suggested that an interbody fusion at L5-S1 is beneficial in long fusion constructs with sacropelvic fixation. However, there is limited data reflecting the actual clinical benefit of interbody use to assist with deformity correction relative to PSF. This study will compare the 5yr clinical and radiographic outcomes and complications between long fusion constructs with L5-S1 interbody support vs. PSF alone.

METHODS

88 consecutive adults with spinal deformity who underwent at minimum T10-pelvis PSF and had 5yr follow-up were included. Two cohorts were created based on technique used at the lumbosacral junction (L5-S1): 1) No interbody (PSF; n=23) or 2) ALIF or TLIF (I; n=65). Radiographic measurements and clinical outcome measures (VAS,ODI) were compared preop, postop and at 5 years. Complications were recorded.

RESULTS

There were no differences in baseline patient characteristics between cohorts. Initial postop sagittal alignment (SVA) was better in the interbody group (PSF: 6.46cm, I:2.48cm, p=0.007). At 5yr follow-up there was no significant difference in coronal balance or SVA (PSF: 6.53cm, I:5.86, p=0.753). One nonunion occurred at L5-S1 in the PSF group (p=0.091). No significant differences in proximal junctional kyphosis (PJK) (PSF:7/23, I:9/65, p=0.076). However, proximal junctional failure requiring revision surgery (PJF) was more frequent in the PSF only group (PSF:6/23, I:6/65, p=0.043). No significant differences in complications including: rod fracture (PSF:5, I: 8, p=0.201), infection (PSF:1, I:2, p=0.714), or overall revision surgery (PSF:10, I:29, p=0.810). At final follow-up there were no significant differences in VAS or ODI between cohorts; all cohorts had improvement from baseline scores.

CONCLUSION

Compared to PSF alone, interbody fusion at L5-S1 results in superior short-term sagittal alignment and lower rates of revision for PJF in adult deformity patients undergoing long PSF.

TAKE HOME MESSAGE

Benefits of interbody support in long posterior spinal fusion constructs include short-term sagittal alignment correction and lower rates of revision for proximal junctional failure in adult spinal deformity patients.

72. Supplemental Rods are Needed to Maximally Reduce Rod Strain Across the Lumbosacral Junction with TLIF but not ALIF in Long Constructs

Jakub Godzik, MD; Randall J. Hlubek, MD; Anna Newcomb, MS; Jennifer N. Lehrman, MS; Bernardo de Andrada, MD; S. Harrison Farber, MD; Lawrence G. Lenke, MD; Brian P. Kelly, PhD; Jay D. Turner, MD, PhD

SUMMARY

This study investigated the effect of supplemental rod (4R) fixation on lumbosacral stability and strain in long segment constructs with either ALIF or TLIF at L5-S1. We found that 4R did not significantly change lumbosacral stability (ROM) or sacral screw strain (SS) in ALIF or TLIF compared to traditional rods. ALIF provided significant reduction in rod strain (RS) compared to TLIF, however addition of 4R resulted in equivalent stability and strain reduction between ALIF and TLIF

HYPOTHESIS

4R fixation across the lumbosacral junction will provide greater stability, reduce RS, and reduce SS in both ALIF and TLIF conditions.

DESIGN

Human biomechanical cadaveric study (n=14)

INTRODUCTION

Rod fractures at the lumbosacral junction remain challenging in long-segment fusion and likely stem from increased lumbosacral strain. Reduction of LS instrumentation strain may help reduce fracture rates.

METHODS

Standard nondestructive flexibility tests (7.5 Nm) were performed on 14 cadaveric specimens (L1-ilium) to assess range of motion stability (ROM), rod strain (RS), and sacral screw strain (SS) of four-rod condition (+4R) versus two-rod condition (+2R) (Fig 1); specimens were equally divided into either an L5-S1 ALIF or L5-S1 TLIF group. 5 conditions were tested: 1) noLIF+2R, 2) ALIF+2R and 3) ALIF+4R, or 4) TLIF+2R and 5) TLIF+4R. Data were analyzed using RM-ANOVA or ANOVA ($p<0.05$).

RESULTS

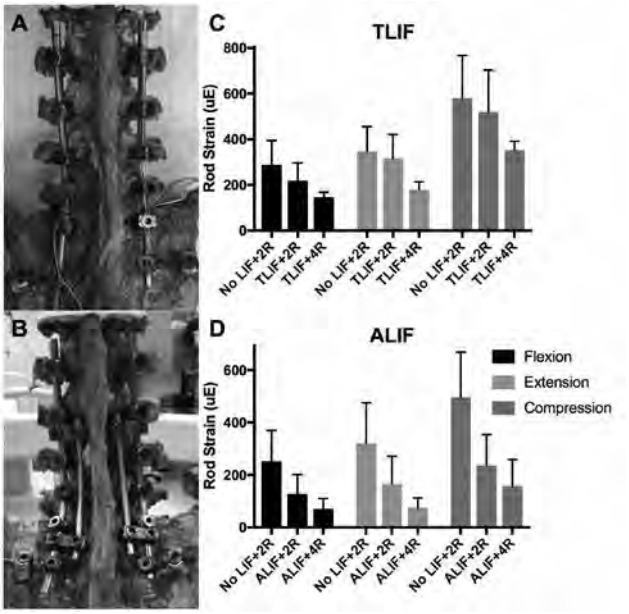
No differences were observed between groups 1 and 2 for age, sex, bone mineral density, or baseline ROM ($p>0.09$). Overall, TLIF+2R demonstrated greater ROM than ALIF+4R in extension ($p=0.03$), with greater rod strain in flexion, extension, and compression ($p<0.001$), and greater SS in compression and AR ($p<0.04$). Compared to TLIF+2R, TLIF+4R resulted in reduced rod strain in flexion, extension, compression, and LB ($p<0.04$), as well as SS in AR ($p<0.001$); TLIF+4R improved the biomechanics compared to ALIF+2R, only SS in flexion, extension, compression, and AR remained elevated ($p<0.01$). ALIF+4R did not significantly improve ROM, rod strain, or SS ($p>0.11$).

CONCLUSION

The use of ALIF and adding accessory rods with TLIF significantly reduced lumbosacral rod strain in a long-segment cadaveric model with iliac fixation. Reducing strain could decrease the risk of failure associated with long-segment fixation.

TAKE HOME MESSAGE

Using extra rods in a long segment construct with TLIF at L5/S1 leads to significantly reduced rod strain that may translate to reduced fracture rates



Rod Strain (RS) in Two- and Four-Rod Configurations with either TLIF or ALIF

73. Effect of Supine Alignment on Post-operative Sagittal Alignment Following ASD Surgery

Jonathan Charles Elysée, BS; *Renaud Lafage, MS;* Mathieu Bannwarth, MD; Bryan Ang, BS; Alex Liu Huang; Haddy Alas, BS; Jessica Andres-Bergos, PhD; Peter G. Passias, MD; Han Jo Kim, MD; Frank J. Schwab, MD; Virginie Lafage, PhD

SUMMARY

Prediction of post-operative alignment following ASD surgery is a complex exercise. Pre-operative alignment in supine position demonstrated significant association with post-op fused alignment. Correlation analysis also demonstrated a stronger association between LL Supine and Post-op LL on patients who underwent a complete fusion of LL. Similar results were found for TK. Multilinear analysis demonstrated that LL Supine and PI are the only predictor of LL-post while LL Supine, TK Supine and patient age are the only predictor of post-op TK

HYPOTHESIS

Post-operative LL and TK are affected by pre-operative supine alignment

DESIGN

Retrospective review of single center database of ASD patient with minimum 1 year follow-up

INTRODUCTION

Post-operative alignment may be highly affected by pre-operative data, such as demographics or spinal flexibility. Pre-op supine radiographs allow for early visualization of patient alignment in the intra-op position. Our objective was to determine the greatest predictors of post-op alignment among PI, age and supine alignment

METHODS

Pre-to-post analysis was conducted using paired t-tests. Patients were stratified by location of fusion: complete lumbar fusion (from L1 to S1) and/or complete thoracic fusion (from T4 to T12). Pearson's correlations were conducted between post-op curvatures (LL and TK) and pre-op alignment in standing and supine positions. Correlation analysis was repeated for LL in patients with complete lumbar fusion and for TK in patients with complete thoracic fusion. Multilinear stepwise regression was conducted to identify predictors of LL or TK post-op

RESULTS

99 pts were included (63.2yo, 83.1%F, 27.3kg/m2, FU 21mo±.9.8). Pre-op alignment demonstrated moderate to severe sagittal and/or coronal deformity, significantly corrected post-op (all p<0.001). 73 pts (73.7%) underwent complete lumbar fusion and 50 (50.5%) underwent complete thoracic fusion. 20.6% underwent a 3CO with no significant difference in post-op alignment between pts with/without 3CO (PI-LL:-2.6°vs1.8°, p=0.175). Correlation analysis demonstrated significant associations between pre and post-op LL alignment as well as pre and post-op TK alignment. Correlations were stronger depending on fusion location (Table). Multilinear regression demonstrated that only LL supine and PI were significant predictors of post-op LL with an r^2 0.568. Similarly LL Supine, TK supine and patient age were the only predictors of post-op TK (r^2 0.490)

CONCLUSION

Pre-op supine alignment is one of the best predictors of post-op alignment at 1 year. When controlling for fusion location, results show an even greater importance of supine alignment, especially concerning thoracic alignment

TAKE HOME MESSAGE

Pre-operative supine alignment is the strongest predictor of 1 year post-operative alignment. Multivariate analysis emphasized such findings for both TK and LL within a general cohort and by fusion location

	L1-S1 Post-op				T4-T12 Post-op			
	all patient		lumbar fused		all patient		Thoracic fused	
L1-S1 pre-op Supine	0.668	p < 0.001	0.716	p < 0.001	-0.320	p = 0.001	-0.313	p = 0.027
L1-S1 pre-op Standing	0.608	p < 0.001	0.691	p < 0.001	-0.287	p = 0.004	*n.s.*	p =0.389
T4-T12 pre-op Supine	-0.208	p < 0.001	*n.s.*	p = 0.154	0.488	p < 0.001	0.530	p < 0.001
T4-T12 pre-op Standing	-0.225	p < 0.001	*n.s.*	p = 0.122	0.549	p < 0.001	0.454	p = 0.001
Pelvic Incidence	0.577	p < 0.001	0.553	p < 0.001	*n.s.*	p = 0.148	*n.s.*	p = 0.065
Patient Age	*n.s.*	p = 0.545	*n.s.*	p = 0.169	-0.280	p = 0.005	-0.468	p = 0.001

74. Gait Improvements in Adult Degenerative Scoliosis Patients at Three and Twelve Month Following Surgical Realignment

Damon Mar, PhD; *Isador H. Lieberman, MD, FRCS(C);* Ram Haddas, PhD, MS, MEng

SUMMARY

Surgical realignment of ADS has been shown to improve patient gait performance, however it is unknown over what period of follow-up it may be sustained. Functional gait evaluations of ADS were performed at one week before and at 3 and 12 months after realignment surgery. Patients show significantly improved gait at both 3 and 12 months following surgery and a greater number of improvements at 12 months. Findings were reflected in improved pain and functional patient reported outcomes.

HYPOTHESIS

Surgical treatment of adult degenerative scoliosis (ADS) will significantly improve patient gait function at 3 and 12 month follow-up evaluations.

DESIGN

Non-Randomized, prospective, concurrent-cohort study of 16 symptomatic ADS patients.

INTRODUCTION

ADS patients often show reduced walking efficiency and range of motion (RoM) of the spine and lower extremities. There has been growing interest in the use of gait analysis to provide new quantitative measures to supplement and improve the reliability of patient-reported outcomes. It is unclear if surgical realignment of ADS results in short and long term improvements in gait and if such improvements are reflected in patient-reported outcomes.

METHODS

Gait evaluations were performed one week pre (Pre), 3 months post (Post3), and 12 months post (Post12) realignment surgery. Evaluations included over-ground gait trails at a self-selected speed. 3-Dimensional motion capture and three force plates were used to collect spatiotemporal and RoM data. Patients completed back and leg visual analog scales (VAS), Oswestry Disability Index (ODI), and Scoliosis Research Society (SRS22) questionnaires.

RESULTS

From Pre to Post3, significant improvements were seen for cadence ($p=0.036$), walking speed (right $p=0.047$), and step time (left $p=0.043$). From Post3 to Post12, significant improvements were again seen for cadence ($p=0.018$), and step time (both $p<0.01$), but additionally stride time (right $p=0.007$) and single-support (both $p<0.050$). From Pre to Post12, significant improvements were seen for cadence ($p=0.008$), walking speed (both $p<0.05$), stride time (right $p=0.002$), step time (right $p=0.015$), and single-support (both $p<0.01$). Significant improvements were found for VAS low back and leg scores (both $p<0.05$) and SRS22 function, self-image, satisfaction, and total scores (all $p<0.05$).

CONCLUSION

ADS patients showed faster and more efficient gait and improved self-reported outcomes at both Post3 and Post12 follow-ups. The number of improvements increased fromPost3 to Post12. This study shows that realignment surgery can result in both short-term and long-term improvements in functional gait of ADS patients.

TAKE HOME MESSAGE

The ADS patients evaluated in this study showed continual improvements in gait and self reported outcomes at both the Post3 and Post12 time points.

75. First Application of the Dubousset Functional Test in Patients with Spinal Pathologies: The Future of Objective Clinical Outcomes is Now

Bassel G. Diebo, MD; Neil V. Shah, MD, MS; David Kim, BS; Oscar Krol; David J. Kim, BS; Michael G. Dubner, BA; Neil Patel, BS, BA; Rachel Axman; Harleen Kaur, BA; Adam J. Wolfert, BA; Barthelemy Liabaud, MD; Renaud Lafage, MS; Carl B. Paulino, MD; Peter G. Passias, MD; Vincent Challier, MD; Frank J. Schwab, MD; Virginie Lafage, PhD

SUMMARY

The Dubousset Functional Test (DFT) is a four-component, novel, multi-domain physical function and balance assessment test proposed by Dr. Jean Dubousset. This study revealed significant correlations between times spent performing DFT components and ODI, NDI, and SF-12 PCS. The DFT Dual Tasking test correlated with patients' reported cognitive scores, which is encouraging toward revealing the relationship between alignment, balance and coordination when adding the radiographic alignment to the equation in future studies.

HYPOTHESIS

Performance of functional tests via the DFT will correlate with pt-reported outcomes.

DESIGN

Prospective Single-Center

INTRODUCTION

Our understanding of pts' function is lacking a more objective and quantified mechanism of assessment. Therefore, we sought employ the recently proposed DFT to identify correlations between pt-reported outcome measures (PROs) and objective functional performance metrics.

METHODS

Prospective study w/ consecutive primary pt enrollment of those presenting to the spine service for evaluation of spinal deformity or degenerative lumbar disease. Included were pts who completed DFT tests and PROs (ODI, NDI, SF-12), and a lifestyle/functionality survey. Montreal Cognitive Assessment (MoCA), was used to evaluate cognitive functioning. DFT is a 4-component functional test described by Dr. Jean Dubousset (Figure). Each test was timed and pt performance was scored by seconds required to finish the test. Of note, DFT reference/normative values were UWT: 14.8s, ST: 6.3s, DST: 6.0s, and DTT: 12.8s. Descriptive analysis evaluated global performance of DFT in our population. Correlation analyses investigated the DFT vs PROs relationship.

RESULTS

Included: 35 pts, mean age: 47.7±16.6y; 68% Female, mean BMI 28.7±5.9kg/m2). Mean DFT test durations: UWT, 31.2±23.5s; DTT, 25.2±16.8s; DST, 11.7±7.9s (7 pts unable to complete); and ST, 11.1±6.1s (3 pts unable to complete). Significant correlations were observed between DFT components and PROs, including UWT vs. ODI ($r=0.675$), DTT vs. SF12 MCS ($r=0.307$), DST vs. ODI ($r=0.614$), DST vs. SF12 PCS ($r=-0.445$), ST vs. ODI ($r=0.675$). The DTT significantly correlated with MoCA scores of cognitive ability ($r=-0.309$), all $p<0.05$.

CONCLUSION

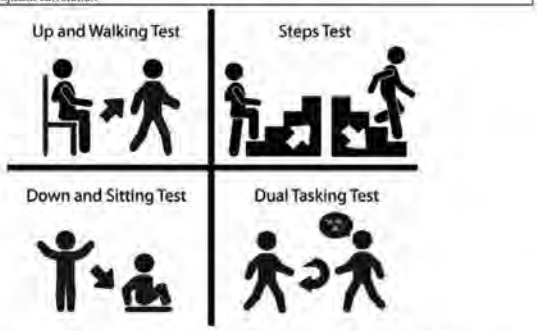
We propose the DFT as a simple method to assess functionality of spinal pathology pts. Time spent performing DFT tests correlated with established PROs utilized in the spine literature. Correlation between the Dual Tasking test and cognitive functionality is may reveal the relationship between alignment, balance and coordination when adding radiographic alignment to the equation.

TAKE HOME MESSAGE

Dubousset Functional Test is a four-component, novel, multi-domain function and balance assessment test. This study revealed significant correlations between times spent performing DFT and ODI, NDI, SF-12 and Cognitive scores.

	Dubousset Functional Test Component			
	Up and Walking	**Dual Tasking**	**Down and Sitting**	**Steps**
ODI	0.676	0.485	0.614	0.675
NDI	-	-	0.409	0.227
SF 12 PCS	-0.355	-0.310	-0.445	-0.474
SF12 MCS	-	0.307	0.312	0.465

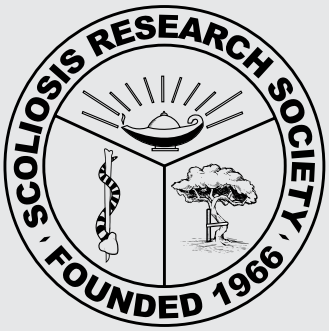
Correlation coefficients (r) between DFT components and Patient's Reported Outcomes, all p<0.05
"-" Denotes insignificant correlation



The **Dubousset Functional Test** consists of the following four components: (1) **UWT (Up-and-Walking Test)**: unassisted sit-to-stand, walk forward/backward 5m (no turn), unassisted sit; (2) **ST (Steps Test)**: ascend 3 steps, turn, descend 3 steps; **(3) DST (Down-and-Sitting Test)**: stand-to-ground, sit-to-stand, assistance as needed; **(4) DTT (Dual-Tasking Test)**: walk 5m forth and back while counting down from 50 by 2.

NOTES

E-POSTER ABSTRACTS



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

E-POSTER ABSTRACTS

100. A Hierarchical Classification of Right Thoracic Adolescent Idiopathic Scoliosis

Saba Pasha, PhD

SUMMARY

Classification of adolescent idiopathic scoliosis aims to guide surgical decision making. Two-dimensional classification of AIS presented some limitation to identify subtle. 3D classification were not accessible to a majority of clinics. We developed a hierarchical classification of 103 right thoracic AIS based on the 3D spinal curve patterns. Five subtypes with significantly different curve patterns were determined. The pairs of frontal and sagittal curves in these subtypes were characterized for a 3D classification using 2D pairs of X-ray images.

HYPOTHESIS

Statistically different 3D curve patterns exists within a right thoracic AIS patients group. These differences can be characterized by pairs of frontal and sagittal spinal curves.

DESIGN

retrospective cohort study

INTRODUCTION

The pre-operative shape of the spinal curve is an important factor in surgical decision-making. The application of the two-dimensional (2D) X-ray images for AIS diagnosis and classification has limited the characterization of the spinal curvature to 2D projections of the 3D spinal curvatures on the orthogonal planes. Methods for 3D classifications of the spinal curve in AIS have been explored, however, complicated and time consuming post-processing techniques associated with these classifications has hampered the dissemination of these classifications as readily applicable tools in clinical setups.

METHODS

103 right thoracic AIS were included. 3D spinal curve was calculated by interpolating the center of vertebrae. A hierarchical classification of the normalized 3D spinal curves was developed to group the patients based on the similarity of their 3D spinal curve. The spinal curves in the three anatomical planes were compared between the scoliotic subtypes.

RESULTS

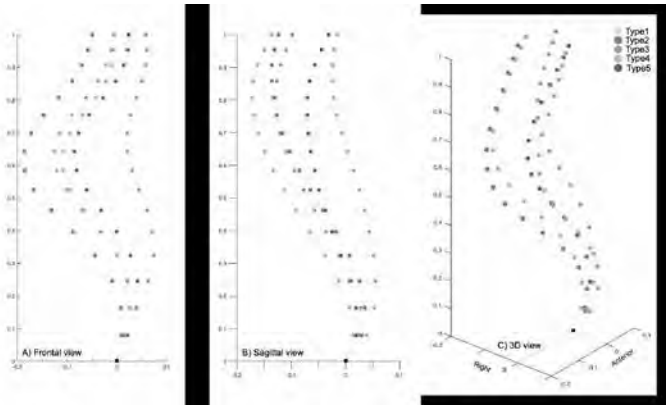
A total of 5 subgroups in a cohort of right thoracic AIS patients were identified (Fig.1): Type 1: Normal sagittal profile and S shape axial view. T1 level or tilted to the right in the posterior view. Type 2: Hypokyphotic (both T5-T10 and T10-L2) and a V shape axial view. T1 tilt to the left in the posterior view. Type 3: L Hypokyphotic (only T5-T10) and frontal imbalance, S shape axial view. T1 level or tilted to the right, and 3 frontal curves. Type 4: Flat sagittal profile (T1-L2) and slight frontal imbalance with a V shape axial view, T1 tilted to the left. Type 5: Hypokyphotic and forward trunk shift with a proximal kyphosis and S shape axial, T1 level or tilted to the right.

CONCLUSION

The differentiating features between the right thoracic subtypes can be identified from the pairs of frontal and sagittal spinal curves in right thoracic AIS patients allowing for a 3D classification of the spine using two-view X-rays without the need for image post-processing.

TAKE HOME MESSAGE

A 3D classification of right thoracic AIS that can be identified based on pairs of 2 view X-rays was developed. This classification can improve identifying AIS subtypes.



101. Posterior Spinal Fusion Improves Functional Movement and Balance in Patients with Adolescent Idiopathic Scoliosis

Robert K. Lark, MD, MS; Camille Ratliff Guzel, MD; Abigail Carpenter Schmitt, MS; Timothy Sell, PhD; Benjamin A. Alman, MD; Robert D. Fitch, MD

SUMMARY

Contrary to our popular belief that PSF limits motion, patients with AIS show significant improvements based on functional movement screen scores and dynamic balance after undergoing PSF.

HYPOTHESIS

Patients with AIS who undergo posterior spinal fusion will have decreased functional movement and dynamic balance compared to their pre-operative scores.

DESIGN

Prospective Case Series (Pilot Study)

INTRODUCTION

Patients with Adolescent Idiopathic Scoliosis (AIS) have been shown to have limited spinal motion and balance deficits. There is a paucity of data on when these patients can return sport after surgery. To our knowledge, no one has tested functional movement or dynamic balance in this population.

METHODS

We recruited 10 female subjects ages 12-18 with AIS scheduled for posterior spinal fusion. Baseline measures were taken via questionnaire (Marx, Tegner, SRS-22r, and EQ-5D). Additionally, measures of balance and movement were recorded through the Lower Quarter Y-Balance Test (LQYBT) and Functional Movement Screen (FMS) that have been validated for other orthopaedic conditions (ie ACL reconstruction, total joint arthroplasty) at our Human Performance Research Laboratory.

RESULTS

Typical static measurements such as forward bend, lateral bend, etc. showed significant declines 6 weeks post-operatively (Table 1). FMS and LQYBT showed no significant difference at 6 weeks post-operatively. Trunk rotation showed no significant change from

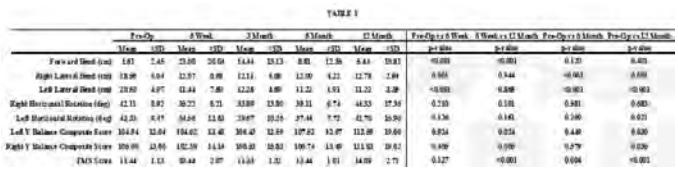
pre to any time point post-operatively. Starting at 3 months post-operatively the FMS and LQYBT scores began to improve and were back to baseline levels. At 6, the FMS scores were significantly better than pre-operative scores and by 12 months post-operative, both FMS and LQYBT scores were significantly improved from pre-operative scores.

CONCLUSION

Patients with severe AIS show significant deficits in static measures but not functional motion scores and dynamic balance 6 weeks post-operatively. Surprisingly, they improved their FMS and LQYBT scores to baseline by 3 months and had significant improvements in scores at 6 and 12 months post-operatively.

TAKE HOME MESSAGE

Contrary to our popular belief that PSF limits motion, patients with AIS show significant improvements based on functional movement screen scores and dynamic balance after undergoing PSF.



Motion scores at pre-operative and all subsequent post-operative visits

102. Association Between Three-dimensional Measurements and Preoperative SRS-22 Scores in Major Thoracic Adolescent Idiopathic Scoliosis

Masayuki Ohashi, MD, PhD; Madeline Cross, MPH; Tracey P. Bastrom, MA; Burt Yaszay, MD; Vidyadhar V. Upasani, MD; Peter O. Newton, MD

SUMMARY

Within surgical range of adolescent idiopathic scoliosis (AIS), poor associations between 2-dimensional (2D) measurements and preoperative SRS-22 scores have been reported. However, as no studies have analyzed 3D measurements, we evaluated the effect of major thoracic AIS on preoperative SRS-22 scores using 3D methods of deformity quantification. We found small statistically significant effects of 3D measurements on preoperative function, mental health, and total scores. These effects were primarily associated with deformity in the 3D sagittal plane.

HYPOTHESIS

3D measurements of spinal deformity could reflect preoperative SRS-22 scores.

DESIGN

Prospective multicenter study

INTRODUCTION

Previous studies reported 2D measurements were not or only weakly correlated with preoperative SRS-22 scores, while no studies have analyzed with 3D method.

METHODS

A multicenter prospective registry of patients undergoing surgery for AIS was queried for patients with right major thoracic AIS (Lenke type 1-4). Patients preoperatively underwent biplanar radiography, and 3D measurements were performed using custom software. We utilized two reference frames: global (gravity-based frame) and local (vertebra-based frame). '3D global' measured the angle between levels when projected into the specific global plane. '3D local' summed each segmental angle, measured in the local reference frames between the levels of interest. Patients were divided into two groups for each SRS-22 domain according to scores: low (L, <4) and high (H, ≥4) score groups. Group differences and correlations with SRS-22 domain scores were analyzed using t-test and Pearson's correlation coefficients (r), respectively, with $p < 0.01$ as the threshold for significance.

RESULTS

405 patients [83.5%female, mean age of 14.4 years] met inclusion criteria. Lenke curve types were type 1 in 180 patients, type 2 in 128, type 3 in 60, and type 4 in 37. Mean thoracic Cobb angle was 59° (45°-115°). The only significant correlations of 3D measurements with SRS-22 scores occurred in the Function, Mental Health domains and the Total score. There were no coronal and axial measures that correlated with SRS-22. All of the significant correlations in SRS-22 outcomes were with sagittal plane measures. Global and local thoracic kyphosis (TK) and TK/LL ratio demonstrated significant, but weak, correlations with function and total scores ($|r| < 0.2$, $p < 0.01$).

CONCLUSION

SRS-22 scores have weak associations between 3D measurements of thoracic scoliosis preoperatively. Interestingly the sagittal plane was the principle 3D plane in which the correlations existed.

TAKE HOME MESSAGE

For surgical range AIS, there are weak correlations between several 3D measures of thoracic scoliosis (primarily sagittal plane) and SRS-22 outcome scores (function, mental health, total) preoperatively.

	L group	H group	L vs. H group		Correlation with SRS-22 scores	
			MD	P	r	P
Function						
Global TK/LL ratio	-0.4 ± 0.3	-0.3 ± 0.3	-0.01	0.036	0.147	0.003*
Local TK (°)	4.7 ± 14.3	0.9 ± 13.7	3.7	0.016	-0.131	0.009*
Local TK/LL ratio	-0.06 ± 0.25	0.01 ± 0.24	-0.07	0.012	0.141	0.004*
Mental health						
Local LL (°)	-62.0 ± 13.8	-58.6 ± 11.8	-3.4	0.008*	0.043	0.385
Total						
Global TK (°)	21.2 ± 15.4	18.0 ± 14.9	3.2	0.038	-0.166	<0.001*

TK, thoracic kyphosis; LL, lumbar lordosis; MD, mean difference.
*p <0.01 was considered to be significant.

3-D measurements with statistical significance in comparisons between low (L; <4) and high (H; ≥4) SRS-22 score groups or in correlation analyses with SRS-22 scores

103. 3D Analysis of Spinal Deformity Correction Using Posteromedial Translation vs. Differential Rod Contouring

Vidyadhar V. Upasani, MD; Brice Ilharreborde, MD, PhD; Madeline Cross, MPH; Carrie E. Bartley, MA; Megan Jeffords, MS; Tracey P. Bastrom, MA; Keyvan Mazda, MD, MS; Burt Yaszay, MD; Peter O. Newton, MD

SUMMARY

3D assessment of post-operative deformity correction is important to guide surgical techniques in spinal deformity surgery. Differential rod contouring and pedicle screw fixation compared to posteromedial translation using thoracic sublaminar bands resulted in improved coronal and sagittal plane correction with similar axial plane correction.

HYPOTHESIS

Similar 3D deformity correction can be obtained with posteromedial translation using thoracic sublaminar bands and differential rod contouring using thoracic pedicle screws in patients with AIS.

DESIGN

Retrospective comparative study of AIS patients from two institutions

INTRODUCTION

Biplanar radiography allows for better understanding of 3D deformity in AIS. Comparison of 3D postop deformity correction has not been widely performed and no studies compare pedicle screw fixation and differential rod contouring versus sublaminar band fixation and posteromedial translation of the spine.

METHODS

AIS patients with thoracic major (Lenke 1- 2) curves who underwent spinal deformity correction and instrumented fusion with one of two techniques were reviewed. Site 1 performed posteromedial translation using thoracic sublaminar bands and cobalt chromium (5.5mm) rods. Site 2 performed spine derotation using differential rod contouring, thoracic pedicle screws and ultra-high strength stainless steel (5.5mm) rods. 3D spinal reconstructions were created using sterEOS software and imported into custom MATLAB software. Patients were matched 1:1 between sites for Lenke type (95% Lenke 1, p=0.99) and mean follow-up time.

RESULTS

82 patients were included, split evenly between the two sites with average 1 year follow-up. Mean preop thoracic Cobb was not different (Table), however postop differences were observed with a significantly greater percent correction at Site 2 ($p<0.001$). Mean pre and postop 3D T5-T12 kyphosis was different between sites, with significantly greater kyphosis restoration at site 2 ($p<0.001$). 2D post-op T4-T12 kyphosis was also significantly greater at Site 2 ($p=0.001$). Mean preop and postop apical thoracic vertebral rotation was different between sites with no significant difference in apical rotation change between sites. Fusion levels were significantly different between sites with a longer fusion performed at Site 1.

CONCLUSION

This study assessed short-term 3D spinal deformity correction using two different techniques and demonstrates significant variations in UIV and LIV level selection, rod type, and deformity correction.

TAKE HOME MESSAGE

Significantly greater 3D correction of the coronal and sagittal plane were observed when pedicle screws were utilized with differential rod contouring.

		Site 1	Site 2	p-values: Site 1 vs 2 Preop	p-values: Site 1vs 2 Postop	p-values: Site 1 vs 2 Change from Pre to Post
Radiographic Measurements						
3D Thoracic Cobb (°)	Preop	55±12	52±10	0.3	**<0.001**	**0.013**
	Postop	21±9	12±6			
Thoracic Cobb Correction (%)		61±14	76±12	n/a	**<0.001**	n/a
3D T5-T12 Kyphosis (°)	Preop	2±14	7±12	**0.05**	**<0.001**	**0.002**
	Postop	14±8	27±5			
2D T1-T12 Kyphosis (°)	Preop	26±13	31±13	0.16	0.92	0.10
	Postop	38±11	38±8			
2D T4-T12 Kyphosis (°)	Preop	19±13	22±14	0.55	**0.001**	0.26
	Postop	22±9	29±5			
2D L1-S1 Lordosis (°)	Preop	56±8	57±11	0.89	0.17	0.18
	Postop	56±8	60±10			
Apical Vertebral Rotation (°)	Preop	-19 ± 7	-14±8	**0.006**	**0.002**	0.9
	Postop	-10±7	-6±5			
Surgical Data						
Rod Material (%)						
Cobalt Chrome		100	7.3		**<0.001**	
Stainless Steel		0	92.7			
UIV						
T1		7.3	0			
T2		46.3	12.2		**<0.001**	
T3		46.3	56.1			
T4		0	31.7			
LIV						
T11		0	2.4			
T12		0	31.7			
L1		0	26.8		**<0.001**	
L2		39	22			
L3		58.5	14.6			
L4		2.4	2.4			

Table. Comparison of outcomes between Sites 1 (bands/ posteromedial translation) and 2 (pedicle screws/differential rod contouring)

104. Comparison of Operative Implications Between Adolescent and Early Adult Idiopathic Scoliosis Patients from Scoliosis Research Society Mortality and Morbidity Database

Swamy Kurra, MBBS; *William F. Lavelle, MD;* Prisco J. DeMercurio, BS

SUMMARY

Surgical treatment of IS is delayed to early adulthood for many reasons. We compared operative variables between adolescent idiopathic scoliosis and young adult idiopathic scoliosis patients from SRS M&M database. Delaying surgical treatment into adulthood can result in complex surgical procedures and more operative associated complications.

HYPOTHESIS

There will be more complex surgical procedures and operative associated complications with young adult idiopathic scoliosis patients.

DESIGN

Retrospective study queried SRS M&M database for AIS(10-18) and YAdIS(19-30) cases enrolled between 2009-2015.

INTRODUCTION

Parents or patients often delay surgery surgical treatment of idiopathic scoliosis (IS) into early adulthood due to academic, personal, psychological or other reasons.

METHODS

Groups categorized based on type of IS. Demographic and surgical parameters (gender, approach type, osteotomy type, estimated blood loss(EBL), levels of fusion, preoperative curve magnitude, and ASA scores evaluated and compared between groups. Chi-square and ANOVA tests used.

RESULTS

N=690: AIS(n=607) and YAdIS(n=83). Lenke curve classification distributions in AIS and YAdIS were: main thoracic, 48% vs. 40%; double thoracic, 7% vs. 6%; double major, 26% vs. 18%; triple major, 2.4% vs. 6%; thoracolumbar, 14% vs. 20%; and lumbar, 1.7% vs. 7%, respectively. Patients with coronal curve > 90° were significantly greater in YAdIS(n=14) vs. AIS(n=48), p=0.008. (Table 1) Combined and anterior surgery rates were significantly higher in YAdIS, p = 0.02. 2-staged surgeries were significantly higher for YAdIS(n=19) vs. AIS(n=23), p= 0.01. Osteotomy rate was similar between YAdIS(n=29) and AIS(n=188), p = 0.42, but proportion of 3-column osteotomies significantly higher for YAdIS, p<0.001. ASA (severe systemic disease and some functional limitation) score 3 patients' rate higher in YAdIS p=0.01. EBL was significantly higher in YAdIS, p =0.001. Average number of levels of fusions was similar, p=0.87.

CONCLUSION

Delaying surgical treatment of idiopathic scoliosis into adulthood can result in complex surgical procedures and more operative associated complications.

TAKE HOME MESSAGE

Delaying surgical treatment of idiopathic scoliosis into adulthood can result in complex surgical procedures and more operative associated complications.

Table 1: Comparison of Adolescent and Young Adult Idiopathic Scoliosis Patients

		AIS	YAdIS	P value
n		607	83	
Type of Surgery	Posterior only	81% (494)	78%(65)	<0.028
	Anterior only	1.9% (12)	4.8%(4)	
	Combined	3.9% (24)	9.6%(8)	
Osteotomy		31% (188)	35% (29)	0.42
	PSO*/three column	10.6% (20/188)	38% (11/29)	<0.001
Two-Staged Surgery		3.7% (23)	11% (19)	0.01
ASA Scores	1	80% (489)	77%(64)	0.01
	2	15% (94)	12% (10)	
	3	1.4%(9)	6% (5)	
Curve Magnitude	40°-90°	87% (530)	75% (63)	0.008
	>90°	8% (48)	16% (14)	
Estimated Blood Loss		835 ml	1197 ml	<0.001
Levels Fused		11.7	11.6	0.87

PSO= pedicle subtraction osteotomy

105. Reproducibility of a Low-dose Radiation Protocol for Whole Spine Radiography Using Heavy Metal Filters

Satoru Demura, MD; Hideki Murakami, MD, PhD; Takeshi Sasagawa, MD; Satoshi Kato, MD; Hiroyuki Tsuchiya, MD, PhD

SUMMARY

The radiation dose and image quality for whole spine radiography using new processing parameters employing heavy metal filters were investigated in AIS patients. Utilizing this protocol allowed for radiographs to be obtained using a reduced radiation dose without degradation in image quality.

HYPOTHESIS

The radiation dose used in obtaining whole spine radiographs in AIS patients can be reduced without sacrificing image quality by employing a new protocol.

DESIGN

Prospective case-control study

INTRODUCTION

Conventional plain radiograph should be further explored to reduce the radiation dose in pediatric patients. To improve the image quality of existing radiographic equipment, using a variety of heavy metal filters, new radiographic processing protocol has been investigated to reduce radiation dose.

METHODS

Study 1: Whole spine radiographs using a new processing protocol were obtained using a human body phantom. The radiation dose with or without 0.2 mm copper filters were compared. Study 2: 19 patients who underwent posterior fusion were evaluated. At consecutive X-ray follow-ups, the new processing protocol with or without the use of copper filters were alternately selected. Image quality was evaluated using 6 points in the frontal views and 7 points in the lateral views. The image quality was assessed and graded by 3 spine surgeons using a three-point grading system.

RESULTS

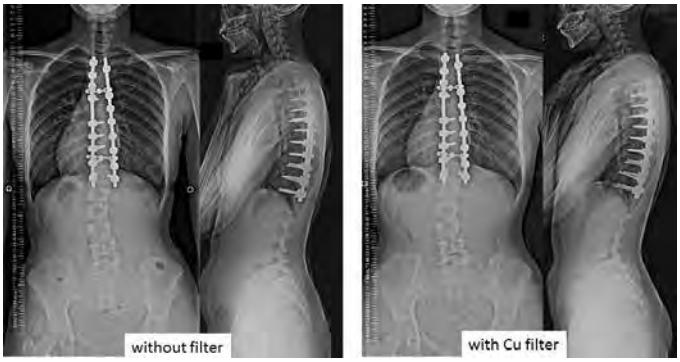
Result 1: In the frontal view, the surface dose were 0.31 (w/o filter) and 0.11 mGy (w/ filter). In the lateral view, those were 1.37 (w/o filter) and 0.53 mGy (w/ filter). Result 2: In the frontal view, there were no significant differences of grade 3 (all of the endplates were identifiable) between the groups. In the lateral view, a grade of 3 was assigned significantly less often at T2 and T12 with a filter. However, the percentage of grade 1 (none of the endplates were identifiable) was less than 5% in both groups. Inter- and intra-observer reliability was moderate to substantial (κ = 0.59, and 0.61, respectively).

CONCLUSION

Greater than 95% of the endplates were identifiable using this new processing protocol with existing equipment. Used in routine postoperative X-ray follow-ups, this protocol using copper filters is clinically effective in reducing the radiation dose to the patient without compromising image quality.

TAKE HOME MESSAGE

A protocol using 0.2mm copper filters is clinically effective in reducing the radiation dose to the patient without compromising image quality.



106. Comparison Between Different Radiographic Methods for Assessment of the Curve Flexibility in AIS (more than 70° Curves)

Selhan Karadereler, MD; Huseyin Ozturk, MD; Sinan Kahraman, MD; Yunus Emre Akman, MD; Tunay Sanli, MA; *Meric Enercan, MD;* Azmi Hamzaoglu, MD

SUMMARY

Traction x-ray under general anesthesia (TRUGA) shows better flexibility for main thoracic (MT) curves more than 70°. TRUGA and bending x-rays shows better flexibility for thoracolumbar/lumbar (TL/L) curves more than 70°. TRUGA also shows a better correlation with postoperative radiologic results.

HYPOTHESIS

TRUGA offers better flexibility and predicts postop radiologic results than other radiographic methods.

DESIGN

Retrospective

INTRODUCTION

In this study we aimed to compare the corrective ability and predictability of TRUGA with Bending(BXR), Fulcrum(F) and Traditional traction(TTr) x-rays in AIS pts

METHODS

126(105F,21M) surgically treated AIS pts who had more than 70° MT or TL/L curves were studied. Preop radiologic evaluation included standing AP/LAT, BXR, F, TTr and TRUGA. TRUGA was performed just before surgery. All curves were measured and the flexibility ratio was determined on each radiograph. The amount of correction obtained by all radiographic methods was compared with the amount of surgical correction by evaluating the differences from surgery as absolute values. Mean absolute differences from surgery were used to determine the confidence intervals. Statistical differences were calculated with Friedman and Wilcoxon signed rank test

RESULTS

MT curve was more than 70° in 69 pts (54,8%), TL/L curve was more than 70° in 38 pts (30,2%) and both curves were more than 70° in 19 pts (15%). Av. preop Cobb angle for MT 76° (70 -114) and TL/L curves were 72° (70-77). For both MT and TL/L curve more than 70° group preop Cobb angles were 95° (70-130) and 77° (70-94) respectively. For MT curves, TRUGA provided better flexibility compared to BXR, F and TTr x-rays and gives most close value to postop x-ray($p<0.05$). TRUGA and BXR predicts better flexibility for TL/L curves and correlation with post op correction than the other x-rays ($p<0.05$). But there is no statistically significance for TL/L curve flexibility between TRUGA and BXR($p>0.05$)

CONCLUSION

TRUGA demonstrated highest flexibility rate for MT more than 70° and gives better prediction with postop radiologic results. TRUGA and BXR showed similar flexibility for TL/L curves. TRUGA, taken in addition to the standing x-ray, gives more detailed information in the determination of flexibility and estimation of postop correction. This study showed us that standing x-ray and TRUGA is enough for curve flexibility assessment of MT curves. For TL/L curves, flexibility can be assessed with BXR and TRUGA.

TAKE HOME MESSAGE

TRUGA shows better flexibility for MT curves, TRUGA and bending x-rays shows better flexibility for TL/L curves more than 70°. TRUGA also shows a better correlation with postoperative radiologic results.

107. Biomechanical Study Comparing Stiffness of Constrained Versus Unconstrained Concave Rod for Adolescent Idiopathic Scoliosis Treatment

Corey Burke, MD; Joshua N. Speirs, MD; Serkan Inceoglu, PhD; Scott C. Nelson, MD

SUMMARY

Restoring kyphosis in patients with adolescent idiopathic scoliosis (AIS) remains challenging using many reduction techniques employed today. We have developed a new technique of initially locking an overcontoured concave rod proximally and distally, which has seen us gain an average of 27° of kyphosis in hypokyphotic patients in a separate clinical study. This biomechanical study demonstrates the significant increase in sagittal bending stiffness in our concave rod when constrained, allowing maintenance of the kyphotic bend of the rod.

HYPOTHESIS

Using a constrained rod on the concavity of the curve will significantly increase the sagittal bending stiffness.

DESIGN

Comparative in vitro, biomechanical study.

INTRODUCTION

Posterior instrumented fusion for AIS has traditionally resulted in failure to restore hypokyphosis. We have developed a technique of initially locking an overcontoured concave rod both proximally and distally. Constraining the rod in this way has allowed us to achieve an average increase of 27° of kyphosis in hypokyphotic patients in a separate clinical study. We believe the clinical success is in part due to the increased rod sagittal bending stiffness. This biomechanical study evaluates the stiffness of our construct using a constrained versus an unconstrained rod.

METHODS

6.0 mm polyaxial screws were inserted into custom designed blocks fabricated with a 3D printer. 1 block was completely immobilized while the other was placed onto an X-Y table with negligible friction. 6.0 mm titanium circular rods (25 cm in length, contoured with 75° bend) were locked in both screws. The rods

were split into 4 groups with n=5 in each group. Group 1 was unconstrained, group 2 was semi-constrained with 1 spring (spring constant = 26.4 N/mm) between the 2 blocks, group 3 was semi-constrained with 2 parallel springs (equal to spring constant of 52.8 N/mm), and group 4 was fully constrained so that the second block was also completely immobilized. A probe attached to the load cell was used to load the rods at the apex until 1 cm of displacement. Stiffness was calculated as the slope of the load-displacement curve between initial and peak points and was compared between groups using an ANOVA test.

RESULTS

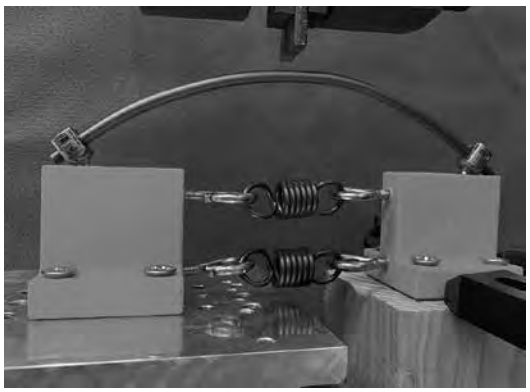
Groups 1-4 had mean stiffness values (±SD) of 56.2 (±2.4) N/mm, 81.1 (±5.6) N/mm, 88.4 (±7.1) N/mm, and 170.1 (±7.0) N/mm, respectively. Group 4 (the fully constrained group) had a significantly higher stiffness compared to each group ($p<0.00001$).

CONCLUSION

Constraining a rod by first locking it proximally and distally significantly increases the sagittal bending stiffness. Any flattening of the rod that does occur has the benefit of distracting the concavity of the curve.

TAKE HOME MESSAGE

Constraining the concave rod significantly increases the sagittal bending stiffness, which clinically allows restoration of kyphosis by increased maintenance of the shape of the overcontoured concave rod.



Testing set-up for a semi-constrained rod construct

108. Restoration of Anatomic Thoracic Kyphosis in AIS Utilizing Predictive Algorithm to Generate Patient Specific Rod Contours

Comron Saifi, MD; Christopher J. DeWald, MD

SUMMARY

Deformity correction in adolescent idiopathic scoliosis (AIS) patients with posterior spinal instrumentation has been successful in addressing coronal deformity, however restoration of anatomic thoracic kyphosis has been more challenging. Axial plane correction maneuvers have exacerbated this problem. In the current study a predictive algorithm was developed to preoperatively determine patient specific rod contours to predictably restore anatomic kyphosis.

HYPOTHESIS

A validated predictive equation, correction algorithm, and sagittal measures can be used to preoperatively contour patient-specific rods to generate a predictive postoperative thoracic kyphosis.

DESIGN

Prospectively enrolled pilot study. Level IIb

INTRODUCTION

While excellent deformity correction has been achieved in the coronal plane for AIS patients, anatomic correction of thoracic kyphosis has been limited. Direct vertebral derotation and similar maneuvers have resulted in further loss of thoracic kyphosis in a population who is typically hypokyphotic preoperatively. Using a predictive algorithm and preoperative radiographs, we developed a system to calculate the appropriate patient-specific rod bend needed to restore anatomic kyphosis without sacrificing correction in either the coronal or axial planes.

METHODS

Thirty patients with a diagnosis of AIS undergoing operative treatment were prospectively enrolled in this study. Coronal and sagittal parameters were measured from standing preoperative radiographs. Preoperatively the concave rod was contoured based on predictive equations which estimated the appropriate preoperative contour for ideal postoperative regional and global sagittal alignment. A standardized convex rod bend was uniformly used on all patients. After placement of posterior instrumentation, a dual-rod correction was utilized with prebent rods molded with differential contours.

RESULTS

Based on the Lenke classification, there were 12 type I, 11 type II, 4 type III, and 3 type IV patients. The main thoracic curve was reduced 74% from a mean of 57.3° to 15.1°. The mean thoracic kyphosis was increased 13.2°±6. The mean postoperative thoracic kyphosis was within 4.7° of the predicted endpoint. 21 out of 30 patients met 3 out of 3 sagittal balance measures, 29 out of 30 patients met 2 out of 3 sagittal balance parameters. There were no reoperations, hardware complications, or radiographic adjacent segment pathology.

CONCLUSION

Preoperative predictive rod contouring contributes to proper sagittal alignment, and in particular thoracic kyphosis while also achieving excellent coronal correction.

TAKE HOME MESSAGE

Preoperative predictive rod contouring contributes to proper sagittal alignment, and in particular thoracic kyphosis while also achieving excellent coronal correction.

109. Does the True Anterior-posterior Radiograph for Scoliosis Differ From Convention? Lessons From 3D Imaging

Woojin Cho, MD, PhD; Brittany A. Oster, BS; Nicole L. Levine, BA; Sina Rashidi Kikanloo, BS; Sandip P. Tarpada, MD; Richard J. Sekerak, BS; Dongyoung Kim, BS

SUMMARY

Using rotationally compensated 3D CT image (RC-3DCT), we find that measurements made on traditional radiographs may be

inaccurate due to unaccounted vertebral rotation (VR). In 42% of patients, VR compensation altered end vertebral designation by at least 1 level. Axial rotation of a patient 19° per Nash–Moe grade with respect to the anterior-posterior (AP) plane may adequately compensate for VR.

HYPOTHESIS

Cobb angles obtained from the compensated images differ from those on traditional AP radiograph.

DESIGN

Retrospective matched cohort study

INTRODUCTION

Scoliosis has long been measured in the 2D AP plane, which does not account for axial vertebral rotation (VR). In the past, the Stagnara lateral has been used in attempt to correct for VR. To date, no similar view has been described for the AP plane.

METHODS

AP, lateral, and bending radiographs of 66 patients age 10-19 with adolescent idiopathic scoliosis (AIS) were obtained. Using multi-planar 3D CT, the coronal plane was reconstructed within the plane of the vertebral axis to form a rotationally compensated 3D CT image (RC-3DCT). The following measurements were made on both imaging modalities: proximal thoracic (PT), main thoracic (MT), thoracolumbar/lumbar (TL/L) curve, coronal balance, thoracic/lumbar apical vertebral translation (T/L-AVT), thoracic/lumbar apical vertebral rotation (T/L-AVR), thoracic kyphosis, and sagittal balance.

RESULTS

Mean MT curve was found to be 40.56° on AP radiograph vs. 35.39° on RC-3DCT (n=63, P=0.00039). The mean TL curve obtained on radiograph, was significantly larger than that of RC-3DCT (n=62; 35.34° vs. 30.98° ; P=0.0046). AP films overstated coronal balance by over 50% when compared to RC-3DCT Mean T-AVT was measured to be 25.28mm on conventional films and 19.46mm on RC-3DCT (n=62; P=0.00033). RC-3DCT L-AVT was significantly smaller than that of standard films (P=0.0094). Mean T-AVT on standing film was 26.2 ±31.0 °. The mean proximal thoracic kyphosis did not differ between the two modalities: 20.66°on radiograph vs. 21.062° on RC-3DCT (P=0.41).

CONCLUSION

In 42% of patients, VR compensation altered end vertebral designation by at least 1 level. Axial rotation of a patient 19° per Nash–Moe grade with respect to the coronal plane may adequately compensate for the rotational component of deformity.

TAKE HOME MESSAGE

Using rotationally compensated 3D CT image (RC-3DCT), we find that measurements made on traditional radiographs may be inaccurate due to unaccounted vertebral rotation

110. Surgical Outcomes in Subtypes of Right Thoracic Adolescent Idiopathic Scoliosis

Saba Pasha, PhD; Keith Baldwin, MD

SUMMARY

Classification of AIS aims to guide surgical decision-making. We tested the utility of a previously developed 3D classification of the right thoracic AIS patients as it relates to the two-year rate of curve correction and percent of suboptimal outcomes in each of the subtypes of right thoracic patients. Our postoperative analysis of the spinal curve in each subtype showed our pre-operative classification can stratify the patients by the risk of suboptimal radiographic outcomes at two year follow-up.

HYPOTHESIS

the rate of suboptimal outcomes is different in 3D subtypes of right thoracic AIS and is further determined by the upper and lower fusion levels in each subtypes.

DESIGN

retrospective cohort

INTRODUCTION

We had previously developed a classification for right thoracic AIS patients derived from a true 3D classification of the spinal curves that uses the pairs of the frontal and sagittal spinal curves to identify 5 subgroups of right thoracic AIS patients with different axial characteristics. We aim to determine the variation between the surgical decision-making and surgical outcomes in each subtype of right thoracic AIS patients according to our classification.

METHODS

A total number of 76 right thoracic left lumbar AIS patients with two-year follow-up were included. We used a previously developed 3D classification of AIS to cluster the pre-operative patients based on the sagittal, frontal, and axial characteristics into 5 groups. The Upper and lower fusion levels and the radiographic surgical outcomes at two-year (frontal balance (FB), proximal junctional kyphosis (PJK), and adding on) were compared between the five types.

RESULTS

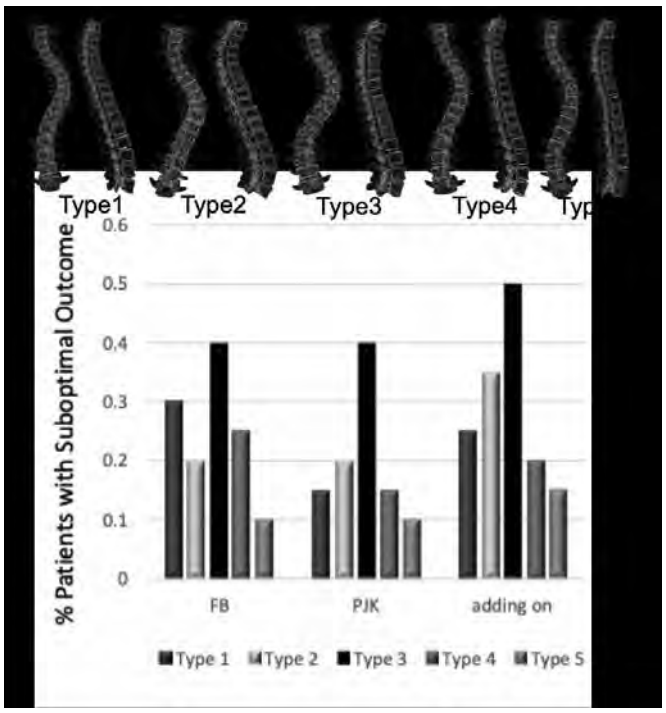
Type 1 patients (n=15) showed better frontal balance at two-year when fusion stopped at T12 compared to L1. In Type 2 (n=17), optimal frontal balance was achieved in 90% at two-year and 72% were fused to L1. Type 3 (n=6) had the shortest fusion length and the highest rate of FB exceeding 1cm and developing PJK exceeding 10° at two-year. Type 4 (n=21) had the longest fusion and suboptimal FB was observed in 42% of the patients. Type 5 (n=18) patients had the lowest rate of unsatisfactory outcomes at two-year with no correlation with the lower fusion level (T12-L2).

CONCLUSION

We used a 3D classification of the spinal curve in right thoracic AIS patients and identified the risk of suboptimal radiographic outcomes in each subgroup. Our analysis showed the risk of suboptimal outcomes in each of the 3D subtypes changes as a function of the fusion level. Surgical outcomes are related to the pre-operative 3D classification of the right thoracic patients.

TAKE HOME MESSAGE

Stratifying patients based on the 3D pre-operative spinal curve is an important factor for determining the rate of suboptimal outcomes.



Rate of suboptimal outcomes in three categories (Frontal balance, PJK, adding on) in the five right thoracic subtypes

111. Two and Three Year Outcomes of Minimally Invasive and Hybrid Correction of Adult Spinal Deformity

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

SUMMARY

Previous research has demonstrated short term benefit using minimally invasive (cMIS) and Hybrid techniques to correct adult spinal deformity (ASD). It is not known if these benefits are maintained over longer periods of time. Comparing baseline data to 2 year data, cMIS patients had greater improvement of back pain ($p < 0.002$) and ODI ($p < .023$) improvements than Hybrid patients.

HYPOTHESIS

CMIS and Hybrid Correction of ASD maintain their beneficial outcomes at least to 3 years post-operatively.

DESIGN

Multicenter retrospective review of adult spinal deformity database.

INTRODUCTION

Short term benefit has been demonstrated in outcomes with fewer complications using minimally invasive (cMIS) and Hybrid techniques to correct adult spinal deformity (ASD). It is not known if these benefits are maintained over longer periods of time. This study evaluated pain scores, Oswestry Disability Index (ODI) and complications 2 and 3 years following cMIS and Hybrid correction of ASD.

METHODS

A multicenter database of ASD patients was reviewed. Adjusting for age and pre-op Cobb angle, radiographic, clinical outcomes, and complications were assessed at 2 and 3 years post-operatively. Inclusion criteria were age ≥18 years, and one of the following: coronal cobb>20, SVA>5cm, PT>20, PI-LL >10.

RESULTS

197 (99%) patients were evaluated at 2 years and 96 (49%) patients had 3 year data. CMIS corrected the Cobb angle greater than Hybrid technique (18.3 v 15.2, $p<.029$). At 2 years post-operatively cMIS improved back pain (3.8 v 2.7, $p<.002$) and ODI (35.6 v 25.5, $p<.002$) more than Hybrid technique. CMIS had greater overall change in back pain from baseline (3.8 v 2.7 $p<.023$) and as a percentage of baseline (58% v 35%, $p<.01$). These were no longer significant at 3 years. Consistent with this, between the 2 and 3 year data points, cMIS had greater loss of improvement in overall ODI score ($p<.017$) and as a percentage ($p<.028$). cMIS technique had significantly fewer complications than Hybrid technique in overall complications, major and minor complications, infections, neurologic and cardiopulmonary categories.

CONCLUSION

Both techniques significantly improved radiographic parameters, and this was maintained through 2 and 3 years. When controlling for age and pre-operative Cobb angle, cMIS improved Cobb angle slightly more than Hybrid technique. Although back pain and ODI were significantly more improved using cMIS technique at 2 years, this difference was no longer significant by 3 years. Complications were significantly less frequent using cMIS than Hybrid technique.

TAKE HOME MESSAGE

Back pain and ODI were significantly more improved using cMIS technique at 2 years, but not at 3 years. Complications were significantly less with cMIS than Hybrid.

112. Psychological Implications of Pain in Pre-surgical AIS Patients

Brandon A. Ramo, MD; Teresa L. Collins-Jones, PhD; Kiley Frazier Poppino, BS; Shelby P. Cerza, MA; *Lori A. Karol, MD*

SUMMARY

Adolescent Idiopathic Scoliosis (AIS) patients often report having chronic back pain, however, there is limited research on psychological factors associated with this chronic pain. Pain catastrophizing describes a pattern of negative thoughts and feelings about pain. This study aimed to report the level of pain catastrophizing in a surgical AIS population and assess its relationship to quality of life and pain levels. 11.75% had clinically elevated PCS scores: these patients are at risk for chronic pain and mental health concerns.

HYPOTHESIS

Some preoperative AIS patients have pain catastrophizing characteristics placing them at risk for chronic pain.

DESIGN

Prospective

INTRODUCTION

Adolescent Idiopathic Scoliosis (AIS) patients often report having chronic back pain, however, there is limited research

on psychological factors associated with this chronic pain. Pain catastrophizing describes a pattern of negative thoughts/feelings about pain. Greater levels of pain catastrophizing are associated with pain intensity, muscle/joint tenderness, and poorer response to pain intervention. The purpose of this study was to report pain catastrophizing in the AIS population and assess its relationship to quality of life and pain levels.

METHODS

From 2015-2018, prospective data was collected on patients who underwent a PSF for AIS. Patients with clinically significant pain catastrophizing levels, defined as a PCS (Pain Catastrophizing Scale) total score of 30 or higher, were compared against patients with scores within normal limits. Preoperative SRS-30 and NPRS (Numeric Pain Rating Scale) scores were correlated.

RESULTS

332 AIS patients (239F; 54M), underwent PSF from 2015-2018. A total of 39 (11.75%) patients (28F; 11M) had clinically elevated PCS scores. There was no difference in age (14.4 v 14.2 years; p=0.398); BMI (21.5 v 22.4; p=0.758), or major Cobb angle (62.7° v 63.0°; p=0.250). Elevated PCS patients had significantly lower preoperative SRS scores in the domains of Pain (3.05 v 3.62; p<0.001); Appearance (3.07 v 3.39; p<0.001); Activity (3.61 v 3.97; p<0.001); Mental health (3.37 v 4; p<0.001); and Total score (3.29 v 3.78; p<0.001). In comparison to the NPRS, patients who catastrophized also endorsed moderate to severe levels of pain including: typical level of pain (89%), worst level of pain the week of surgery (92%), and current pain level (61%). Of these patients, 70% (n=27) did not receive preoperative psychological referral.

CONCLUSION

Patients who experience clinically significant pre-operative PCS scores are at risk for chronic pain and mental health concerns. Surgeons failed to identify and refer 70% of these patients indicating a need for appropriate psychological pain assessment and screening tools prior to AIS surgery.

TAKE HOME MESSAGE

11.75% of AIS patients are at risk for long term pain of pain catastrophizing and unaddressed mental health symptoms. Preoperative screening protocols/psychological interventions are warranted to aid in treatment planning.

113. Improvement of Static and Dynamic Pulmonary Function after Surgery in Patients with Adolescent Idiopathic Scoliosis

Youxi Lin, MD; Haining Tan, MD; Tianhua Rong, MD; Yang Jiao, MBBS; Chong Chen, MD; Jianxiong Shen, MD; Shufen Liu, MD; Hui Cong, MS; Wangshu Yuan

SUMMARY

Surgical correction changes the height and shape of the rib cage in AIS patients, but it is not clear how it affects pulmonary function. We compare static and dynamic pulmonary function before and after surgery and investigate the correlation with radiographic changes. Both static pulmonary and dynamic function increased significantly. Correction in proximal thoracic spine was correlated with changes of static pulmonary function, and in exercise testing, correction in major thoracic spine correlated with a better respiratory response and pattern.

HYPOTHESIS

Static and dynamic pulmonary function improves after correction surgery in AIS patients.

DESIGN

Retrospective study of prospectively collected data.

INTRODUCTION

Up to now, there is no consensus on how pulmonary funciton and breathing pattern are affected in AIS patients after correction surgery. Our study aims to analyze the changes of static and dynamic pulmonary function and the correlation with radiographic improvement.

METHODS

Patients with AIS and underwent surgical correction were included. Radiographic parameters of the spine were measured, and results of pulmonary function testing(PFT) and cardiopulmonary exercise testing(CPET) before and at last follow-up was collected. Pared-samples T test and Pearson correlation test was used.

RESULTS

Fifteen patients(11F, 4M) were included, with an average age of 14.5(12-17) years at the time of surgery and average follow-up time 20.4(12-31) months. The Lenke type distribution of patients in Type 1,2,3,4,6 were 2,9,2,1,1, respectively. The number of curve fused in proximal thoracic(PT), thoracic and lumbar region were 12, 15 and 4, with overall correction of 20.9(51.9%), 41.0(74.6%) and 32.9(76.3%) degrees. T1-T12 height increased from 23.5cm to 26.3cm. The actual value of FEV1(2.5±0.6 vs 2.7±0.6) and FVC(3.0±0.8 vs 3.2±0.7) increased (P<0.05), without significant difference in the percentile value. The maximal tidal volume(Vt) in exercise increased significantly from 1.15±0.31L to 1.27±0.31L(P=0.006). The increase of FEV1 and FVC was positively correlated with correction in PT(r=0.064, P<0.06), but not in thoracic or lumbar spine. In exercise test, patients with larger major thoracic curve correction had more increase in minute ventilation(VE) and Vt, both in actual value and percentile value(r 0.562 to 0.725, P<0.05), and the response of VE, Vt and ventilatory reserve to exercise was also positively correlated with thoracic correction(r 0.631 to 0.674, P<0.05), indicating better respiratory pattern.

CONCLUSION

In AIS patients, correction in proximal thoracic spine improves static pulmonary function, and correction in major thoracic spine leads to a better respiratory response and pattern in exercise.

TAKE HOME MESSAGE

Correction surgery improves both static and dynamic pulmonary function in AIS patients. In exercise testing, correction in major thoracic spine correlated with a better respiratory response and pattern.

114. The Screw-Aorta Dilemma: Changing Patient Position in CT Scan is Critical in Documenting Aortic Mobility

Vishal Sarwahi, MD; Jesse Galina, BS; Sayyida Hasan, BS; *Beverly Thornhill, MD;* Yungtai Lo, PhD; Terry D. Amaral, MD; Aaron M. Atlas, BS

SUMMARY

Pedicle screw (PS) aortic misplacements are asymptomatic but are a treatment dilemma. A CT scan in both supine and prone position better delineates aorta- screw relationship.

HYPOTHESIS

Prone CT helps delineate aorta-screw relationships

DESIGN

Retrospective chart review

INTRODUCTION

PS misplacement rate is reported between 6-15%. Studies looking at misplacements on a per patient basis show up to 14% of patients have screws at risk (impinging vital structures). A screw abutting the aorta is a management challenge and often requires vascular surgery intervention. However, CT scans routinely done in supine position may overestimate screw-aorta relationship. Change in patient position may allow the aorta to roll away and, in most cases, reveal an uncompromised aorta. This will allow safe removal of pedicle screws without any vascular intervention.

METHODS

111 patients with post-op CT, who underwent PSF for spinal deformity, from 2004-2009, were evaluated. Patients with concerning screw-aorta relationship underwent a prone CT scan. Mobility of the aorta was determined as described in Figure 1. This was to document general mobility of the aorta. Distance (D) was compared using prone and supine CT scans. Pair t-test and signed rank tests were utilized.

RESULTS

2,295 screws were reviewed, 45 screws in 27 patients were in proximity to the aorta. 36 of these were in close proximity, but not impinging (>1cm aorta-screw distance). 14 screws (7 patients) were impinging (<1cm). On prone CT, 13 out of the 14 instances the aorta moved away from the screw (median 2.6mm). The mean distance above the level of the misplaced screw was 2.97mm (p=0.17), and 3.8mm (p=0.001) below. In one instance the relationship was unchanged on prone CT. No screw was noted to violate the lumen or distort the aorta.

CONCLUSION

Supine CT-scan alone is not entirely accurate in determining screw-aorta relationship. Prone-CT scan provides additional information for better delineation. This additional diagnostic step can change the treatment option by limiting the need for vascular intervention. When in doubt, the additional use of an arteriogram can allow for improved visualization.

TAKE HOME MESSAGE

Prone CT in conjunction with supine CT can help diagnose possible pedicle screw impingement on the aorta.

Distance (D) was calculated by measuring the distance between line drawn from posterior margin of aorta (B) perpendicular to the long axis of screw (A) and a parallel line to A passing through the anterior margin of the body of vertebra (C) in mm

115. A Novel Superelastic Shape-Memory Rod Provides More Options for Optimal AIS Correction: Biomechanical Analysis of A Clinical Trial with 5-year Follow-up

Xiaoyu Wang, PhD; Kelvin Yeung, PhD; Jason Pui Yin Cheung, MBBS, FRCS, MS; Johnson Y.N. Lau, MD, MBBS, FRCP; Weichen Qi, MS; Kenneth MC Cheung, MD; Carl-Eric Aubin, PhD, ScD (h.c.), P.Eng

SUMMARY

Superelastic Nickel-titanium shape memory (SNT) rod enables maximally utilizing the viscoelastic properties of the spine and fundamentally different correction process for optimal AIS correction. We conducted a biomechanical analysis of AIS instrumentations complementary to a clinical trial with 5-year follow-up using SNT vs. conventional rigid rods. The SNT rods allowed equivalent correction in a unique progressive way with lower forces at bone-implant interface, providing advantages of spreading corrective forces over all anchor points and post-instrumentation correction from tissue relaxation.

HYPOTHESIS

SNT rod can maximize AIS correction as conventional rod but with less stress at bone-implant interface and allow greater correction from tissue relaxation.

DESIGN

Computer simulation and analysis of AIS instrumentation with SNT rods.

INTRODUCTION

Rigid rods are believed to result in superior deformity correction, but there is a risk of screw pull-out and plastic rod deformation (yielding to the spine), when the spine is stiff. The SNT rod enable gradual intraoperative correction and relatively constant corrective forces leading to further postoperative correction as the tissues relax. A clinical trial using SNT rod with 5-year follow-up for AIS documented comparable efficacy to conventional rod. This study aimed to compare the biomechanics of the SNT vs. conventional rods.

METHODS

A validated computer model was used to simulate intraoperative correction of 12 AIS cases from the clinical trial and alternative instrumentations using SNT, Titanium (Ti) and Cobalt-chrome (Co-Cr) rods (5.5 or 6 mm; 30°, 50° or 60° sagittal contouring angles; 0°, 25° or 50° coronal over-contouring angles). Correction after 30% postoperative stress relaxation was also simulated.

RESULTS

Without over-contouring, main thoracic Cobb (MT) and thoracic kyphosis (TK) using the SNT rods were 4° to 7° to the Ti and Co-Cr rods with bone-implant forces 26% and 39% lower. Increasing the coronal over-contouring to 50°, SNT rods allowed up to 15° MT correction improvement within the bone-implant fixation strength; Ti and Co-Cr rods of 50° coronal over-contouring resulted in forces nearly 200% higher than the fixation strength. The MT and TK corrections with the SNT rods in tissue relaxation were 4°–8° greater than the Ti and Co-Cr. Increasing the SNT rod contouring angles enabled greater corrections from tissue relaxation (Fig. 1).

CONCLUSION

This study concurs with clinical observations that the SNT rods are easier to insert and can result in similar correction to the conventional rods. The SNT rods allow significantly lower bone-implant force and have the ability to take advantage of post-instrumentation correction as tissues relax.

TAKE HOME MESSAGE

SNT rods allow easier insertion, progressive in situ correction after having been attached at all anchor points, better load sharing among implants, predictable corrective forces, and correction from tissue relaxation.

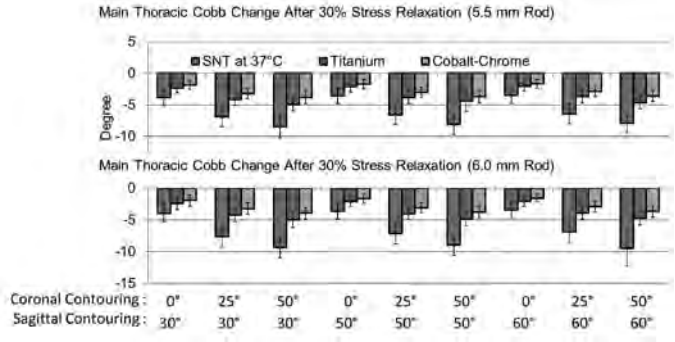


Fig. 1 – Thoracic Curve Correction in 30% Stress Relaxation in the Spine

116. When is the Peak Growth Velocity of Pelvic Incidence During Adolescence? A Longitudinal Study

Hongda Bao, MD, PhD; Yuancheng Zhang, MS; Zezhang Zhu, MD; Yong Qiu, MD

SUMMARY

Pelvic incidence is an important parameters and PI is not a stable parameter during adolescence because of the growing pelvis. A longitudinal study was designed and results showed PI reaches the peak growth velocity in Risser 1 and remains growth potential in Risser 5. The change of PI correlates with pelvic height, femoral head-sacrum distance, pelvic width and sacral width during adolescence.

HYPOTHESIS

PI may have the peak growth velocity at the peak height velocity and it is correlated with growing pelvis.

DESIGN

A retrospective longitudinal study

INTRODUCTION

Duval-Beaupère et al showed a parameter that described the anatomical structure of pelvis termed "pelvic incidence. PI is not a stable parameter during adolescence because of the growing pelvis. The relationship between the velocity of changing PI and the maturity status still lacks of report.

METHODS

The inclusion criteria were AIS patients age between 9 and 18 years with full spine images and with at least 3 follow-ups. The anatomical parameters were measured in each follow-up. Subjects were divided into 3 groups: Low Risser Group (Risser 0-1), Moderate Risser Group (Risser 1-3) and High Risser group (Risser 3-5). The ΔParameters were defined as Parameters(n) minus Parameters(n-1). Growth velocity was defined as ΔParameters divided by the time interval. Intra- and inter-group comparisons of parameters were performed by means of independent-samples t test. The Pearson coefficients of correlation were calculated to assess the relationships between PI and age, ΔPI and ΔParameters.

RESULTS

318 AIS patients were included in our study with a mean age of 13.1 years at first visit. PI reached the peak growth velocity at Risser 1 (female 1.5°/year and male 1.6°/year), followed by the Risser 0 with closed triradiate cartilage (female 1.2°/year and male 1.5°/year) and Risser 2 (female 1.1°/year and male 1.4°/year). Significant correlations were found between PI and age in all three subgroups ($p<0.05$) and the correlation was stronger in Low Risser group and Moderate Risser group than that in High Risser group. Significant correlations were also observed between the anatomical parameters (PW, SW, FH-S, S-C length) and PI (all $p<0.05$).

CONCLUSION

Pelvic incidence reaches the peak growth velocity in Risser 1 and remains growth potential in Risser 5. The change of PI correlates with pelvic height, femoral head-sacrum distance, pelvic width and sacral width during adolescence.

TAKE HOME MESSAGE

PI is not a stable parameter during adolescence because of the growing pelvis. Pelvic incidence reaches the peak growth velocity in Risser 1 and remains growth potential in Risser 5.

117. Does Intraoperative Traction X-ray Under General Anesthesia (TRUGA) Change the Surgeon's Preoperative Decision for Selection of Fusion Levels in AIS?

Selhan Karadereler, MD; Huseyin Ozturk, MD; Yunus Emre Akman, MD; Sinan Kahraman, MD; Tunay Sanli, MA; *Meric Enercan, MD;* Azmi Hamzaoglu, MD

SUMMARY

40 AIS pts were analyzed by 5 senior deformity surgeons.First, reviewers reported their decisions for UIV and LIV based on preop standing and bending x-rays.At the second stage TRUGA was added to previous x-rays and changes in the selected levels were reviewed.TRUGA changed the decision for UIV and LIV in patients with Lenke type3(27%), type4(25%) and type6(22%) curves more than the other types.TRUGA changed authors' decision for LIV to save at least one more mobile segment in53% of the patients.

HYPOTHESIS

TRUGA is helpful in decision making for the selection of the fusion levels in AIS.

DESIGN

Analytic study.

INTRODUCTION

The purpose of this study was to evaluate the effect of traction x-ray under general anesthesia (TRUGA) on decision making for the selection of UIV and LIV in AIS.

METHODS

We evaluated 5 senior spine surgeons' UIV and LIV decisions using preop standing and bending x-rays vs x-rays with TRUGA in 40 AIS pts. All reviewers had more than 20 years of experience in spine deformity. At first stage, reviewers selected the UIV and LIV levels upon standing full spine x-rays and bending x-rays. At the second stage reviewers were asked again to evaluate the same patients for UIV and LIV, but this time TRUGA was added to standing and bending x-rays. In the second stage the reviewers were informed about their first stage decisions for each patient to avoid intra-observer variability. Changes in decisions were compared for each author before and after TRUGA with Mc Nemar Bowker test.

RESULTS

TRUGA reviewers changed their decisions 11.5% (0-25) for UIV and 20% (15-25) for LIV. There was moderate consistence between authors' level decisions for the first stage (κ:0.48). TRUGA changed the decision for UIV and LIV in patients with Lenke type 3 (27%), type 4 (25%) and type 6 (22%) curves more than the other types. Almost all authors selected UIV as T2 at first stage and did not change it after TRUGA for structural proximal thoracic curves. For non-structural proximal thoracic curves; TRUGA changed the UIV in 10.2% of the cases. TRUGA changed the selection of LIV from L4 to L3 in 53% (46-63) patients with structural lumbar curves. There was consistence between all authors in terms of changing LIV from L4 to L3 (κ=0.76).

CONCLUSION

TRUGA reviewers changed their decisions 11.5% of cases for UIV and 20% of cases for LIV. TRUGA changed the decision for UIV and LIV in patients with Lenke type 3, 4 and 6 curves more than the other types. TRUGA changed the decision of LIV in 53% of the cases to save at least one more mobile segment in structural lumbar curves (Lenke type 3,4 and 6) in contrast to standing and bending x-rays.

TAKE HOME MESSAGE

TRUGA is helpful in decision making for the selection of the fusion levels in AIS and changed the decision of LIV in structural lumbar curves (Lenke type 3,4&6) (53%).

118. Avoiding Challenging and Potentially Dangerous Pedicle Screws: Leaving out the Proximal Thoracic Concave Apical Screw(s) in Adolescent Idiopathic Scoliosis (AIS)

Joseph A. Osorio, MD, PhD; James D. Lin, MD, MS; Richard P. Menger, MD, MPA; Meghan Cerpa, BS, MPH; Griffin R. Baum, MD, MS; Simon Morr, MD, MPH; Lawrence G. Lenke, MD

SUMMARY

PT concave apical screws in AIS patients are often challenging to place due to pedicle morphology, wound depth, concavity trajectory and spinal cord location directly adjacent to the medial pedicle wall. We evaluated 40 patients with Lenke Type 1 and 2 AIS curves. 63% had PT concave apical screw(s) purposely left out. The most common levels left out were T5 (30%) and T6 (53%). There was no difference in correction of PT (p=0.44) and main thoracic (p=0.93) curves between groups.

HYPOTHESIS

The proximal thoracic (PT) concave apical screw(s) in AIS patients carries high risk with little to no benefit, thus these screws can be left out without compromising correction.

DESIGN

Retrospective Analysis

INTRODUCTION

In AIS patients, pedicle screw fixation is paramount to achieving surgical correction. Frequently, the concave PT pedicles are smallest, often slit-like, and rotated making access/fixation challenging. The spinal cord is also draped along the pedicle-vertebral body junction thus rendering even a slight medial trajectory/breach a potential neurologic catastrophe. Additionally, PT curve correction occurs with distraction distributed away from the apex, making the apical screw unnecessary for correction. Thus, we sought to evaluate whether leaving these concave apical PT screw(s) out made any difference in overall curve correction.

METHODS

40 consecutive AIS patients with Lenke Type 1 and 2 curves with UIV of T4 or cephalad were identified. Mean age was 15.3 yrs. (11-17). 27 pts. (68%) had Type 1 curves, and 13 (33%) had Type 2. UIV was T1 in 1 (3%), T2 in 11 (28%), T3 in 14 (35%), and T4 in 14 (35%) pts. The levels where PT apical screws were left out were analyzed using Cobb angles for PT and main thoracic (MT) curves (pre- and postop standing radiographs). Two sample t-test was used for statistical analysis.

RESULTS

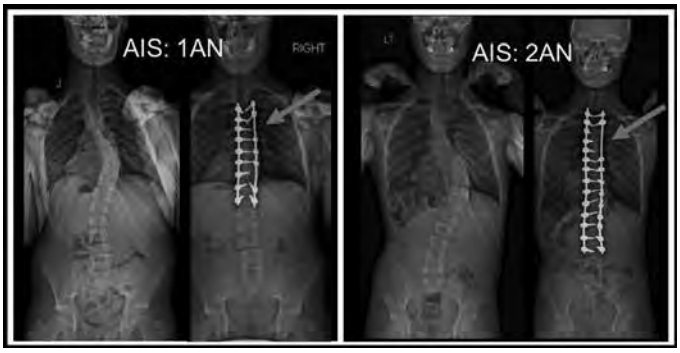
25 of 40 (63%) pts. had PT concave apical screw(s) left out (59% of Type 1, 69% of Type 2 curves; Fig 1). 15% of screws left out were at T4, 30% at T5, 53% at T6, and 3% at T7. Cobb angles of cases with screws left out: preop PT 29 deg. (13-52) and MT 58 deg. (45-82); and Cobb angles of cases where all screws were placed: preop PT 28 deg. (16-44) and MT 58 deg. (18-84). There was no difference for screws left out vs. all screws placed in postop PT correction (10 deg. (2-26) vs. 9 deg. (3-23), p=0.44), and postop MT correction (10 deg. (1-31) vs. 10 deg. (1-18), p=0.93).

CONCLUSION

Leaving out the proximal thoracic concave apical pedicle screw(s) in Lenke Type 1 and 2 AIS patients avoids challenging and high-risk screw placement without sacrificing coronal correction.

TAKE HOME MESSAGE

Leaving out the PT concave apical pedicle screw(s) in Type 1/2 AIS patients has no effect on coronal correction while avoiding unnecessary risks of these challenging and neurologically risky screws.



Patient examples of AIS Type 1 and Type 2 curves with apical PT screws left out.

119. What Happens to Unfused Upper Thoracic Curves in Adolescent Idiopathic Scoliosis?

Steven W. Hwang, MD; Patrick J. Cahill, MD; Joshua M. Pahys, MD; Tracey P. Bastrom, MA; Peter O. Newton, MD; *Amer F. Samdani, MD*; Harms Study Group

SUMMARY

25-41% of unfused upper thoracic (UT) curves have been reported to improve post-op. We retrospectively reviewed a cohort of 450 Lenke 1-4 AIS patients with unfused UT curves to better predict curve outcomes. 86% of unfused UT curves improved by 6 months with a mean improvement of 49%. Greater correction of the main thoracic curve and larger pre-op main thoracic curve magnitude were associated with greater likelihood of improvement of the unfused UT curve.

HYPOTHESIS

Unfused upper thoracic curves will improve over time, and increased flexibility predicts better improvement.

DESIGN

Retrospective review of a multicenter prospectively collected cohort

INTRODUCTION

Historically, 25-41% of unfused upper thoracic (UT) curves improve over time. However, few criteria have been reported to help anticipate which UT curves are more likely to improve. We sought to investigate what happens to unfused UT curves and risk factors associated with lack of improvement.

METHODS

A multicenter prospectively collected cohort of AIS patients was retrospectively queried for all patients with Lenke 1-4 curve patterns whose UT curves were not instrumented. . Patients were then subdivided into 2 cohorts: 1) those with no improvement, and 2) those who showed improvement at 2 year follow-up. Univariate and multivariate analyses were used to compare both cohorts with a p value < 0.05 considered significant.

RESULTS

385/450 patients (86%) had improvement of the UT curve by a mean of 49% ($24.7 \pm 6.5° > 12.6 \pm 5.9°$). The remaining 65 (14%) did not Improve ($20.3 \pm 5.8° > 18.5 \pm 5.7°$), but no patients worsened. All patients who improved had done so by 6 months post-op. Preoperatively, the unimproved cohort had smaller UT and main thoracic (MT) curves which bent to smaller curves as well. Flexibility of UT or MT curves were not associated with improvement. At 2 years post-op, significant variables included UT and MT curve magnitude, T2-5 kyphosis, and UT and MT correction. Age, Lenke type, magnitude of lumbar curves, translation, instrumentation type, shoulder height, SRS scores and skeletal maturity were not significant. In multivariate analysis, MT curve size pre-op and MT curve correction remained significant predictors of UT curve improvement. Greater correction of the MT curve and larger initial MT curve size were associated with a greater likelihood of UT curve improvement.

CONCLUSION

Surgeons should be aware that the majority of unfused UT curves (86% in this study) improve by 6 months post-op and that greater correction of the main thoracic curve increases the likelihood of UT curve improvement.

TAKE HOME MESSAGE

86% of unfused upper thoracic curves will improve by 50%. Larger pre-op size and greater correction of main thoracic curves correlated with greatest improvement of the unfused upper thoracic curve.

	Improved UT Curve	Unimproved UT Curve	P
Age (years)	14.6 ± 2.1	14.8 ± 1.9	0.31
Gender (% female)	82	83	0.85
Lenke type	1: 72%, 2: 6%, 3: 17%, 4: 4%	1: 82%, 2: 2%, 3: 14%, 4: 2%	0.44
PRE-OP MEASURES			
UT curve (°)	24.7 ± 6.5	20.3 ± 5.8	<0.001 *
Main thoracic curve (°)	54.5 ± 10.8	49.4 ± 7.6	<0.001 *
UT bend (°)	16.2 ±7.4	13.8 ± 6.9	0.02 *
UT flexibility (%)	35 ± 26	34 ± 28	0.74
Main thoracic bend (°)	34.6 ± 14.6	29.2 ± 11.8	0.01 *
MT flexibility (%)	37 ± 21	41 ± 21	0.15
C7-CSVL translation (mm)	-0.6 ± 2.2	-0.4 ± 2.5	0.42
Apex-CSVL translation (mm)	4.0 ± 2.7	3.5 ± 3.7	0.23
T2-5 kyphosis (°)	20.6 ± 13.6	20.8 ± 12.2	0.94
Radiographic shoulder height (mm)	1.4 ± 1.1	1.4 ± 1.1	0.92
SRS total score	3.97 ± 0.47	3.90 ± 0.46	0.30
SRS self-image	3.40 ± 0.68	4.07 ± 0.78	0.25
2 YEARS POST-OP			
UT curve (°)	12.6 ± 5.9	18.5 ± 5.7	<0.001 *
Main thoracic curve (°)	20.3 ± 8.0	22.5 ± 6.4	0.03 *
C7-CSVL translation (mm)	-0.6 ± 1.4	-0.8 ± 1.6	0.42
Apex-CSVL translation (mm)	1.0 ± 1.5	0.8 ± 1.5	0.31
T2-5 kyphosis (°)	10.9 ± 6.7	12.7 ± 7.0	0.046
Radiographic shoulder height (mm)	0.89 ± 0.76	0.90 ± 0.79	0.92
Main thoracic correction (%)	62 ± 14	54 ± 12	<0.001 *
SRS total score	4.39 ± 0.51	4.48 ± 0.48	0.20
SRS self-image	4.40 ± 0.62	4.50 ± 0.57	0.21

* Statistically significant

121. Parents Can Reliably and Accurately Screen for Scoliosis Using an Inclinometer Smartphone APP

Marie Beausejour, PhD; Carole Fortin, PhD; Mathilde Carignan, BS; Delphine Aubin; Marjolaine Roy-Beaudry, MSc; Nathalie Bourassa; Nathalie Jourdain, MA; Philippe Labelle; Hubert Labelle, MD, FRCS(C)

SUMMARY

An inclinometer smartphone APP to measure the angle of trunk inclination (ATI) was tested for reliability and validity in the hands of lay persons in comparison to the expert surgeon. Excellent reliability and good validity were obtained in potential and confirmed cases

of Adolescent Idiopathic Scoliosis. This study suggests that parents, provided with web-based video instructions and a convenient and low-cost device, are able to adequately screen for significant ATI in their child.

HYPOTHESIS

After viewing a short instructional video, lay persons can reliably and accurately measure the angle of trunk inclination (ATI) in young adolescents using an inclinometer smartphone APP

DESIGN

Validation of screening device protocol with two-factor crossed design generalizability study

INTRODUCTION

An inclinometer smartphone APP enables the measure of ATI as a convenient means to screen for back surface asymmetry. The objective was to determine its reliability and validity in the hands of lay persons.

METHODS

Three lay observers and a surgeon measured maximum ATI twice in 69 consecutive patients seen in the spine clinics to rule out scoliosis or regular follow-up (boys & girls, 10-18 y.o., Cobb [0o-59o]). Observers were parents working at the hospital center not familiar with scoliosis screening nor use of an inclinometer. They watched an instructional video describing the forward bending test, how to move the device down the back using both thumbs as underneath support, and performing the measurement of maximum ATI. Assessments where blinded to other observers and order of measurement was randomly assigned. Intra an inter-observer reliability were determined using the generalizability theory and validity was assessed from the agreement with expert on ATI measures and identification of a threshold for consultation (>=6o ATI).

RESULTS

The generalisability analysis led to a very good dependability coefficient $\Phi = 0.83$. Intra and inter-observer reliability coefficients were excellent $\Phi = 0.92$. Standard error of measurement SEM=1.5o, so that a parent may detect a change of 3.5o between examinations 90% of the time. Comparison of measures between lay persons and expert displayed ICC varying from 0.83 [0.73-0.89] to 0.86 [0.79-0.91] and revealed no systematic bias and very low proportional bias. Agreement between lay observers and expert on the decision to consult occurred in 83 to 90% of cases.

CONCLUSION

The inclinometer smartphone APP displayed excellent reliability, sufficiently low SEM and good validity in the hands of lay persons. The device and the instructional video are adequate means to allow screening and regular examination of back surface asymmetry by parent.

TAKE HOME MESSAGE

A low-cost inclinometer smartphone APP supported by a web-based instructional video is a reliable and accurate means for parents to detect scoliosis and seek for medical advice for their children.

122. Exploration of Coronal-sagittal Coupling of Spine on Patients with Adolescence Idiopathic Scoliosis Using 3D Ultrasound

Timothy Tin Yan Lee, MS; Kelly Ka-Lee Lai, BS; Yi-Shun Wong, BSc (Hons); Jack C.Y. Cheng, MD; René M. Castelein, MD, PhD; Tsz-Ping Lam, MBBS; Yong Ping Zheng, PhD

SUMMARY

Three-dimensional (3D) ultrasound could provide a non-ionizing and reliable evaluation of spine features and curvature. In the previous studies, our 3D ultrasound system has been demonstrated to deliver reliable and repeatable measurement of coronal and sagittal spinal curvature of patients with adolescent idiopathic scoliosis (AIS). In this study 3D ultrasound was capable to detect a coronal-sagittal coupling relationship, a phenomenon which was also detected using traditional radiographs, in patients with AIS.

HYPOTHESIS

3D ultrasound could detect coronal-sagittal coupling relationship, provided such relationship could be demonstrated by traditional X-ray, in patients with AIS based on Cobb angle classification.

DESIGN

A cross-sectional study

INTRODUCTION

Cobb angle is the gold standard for assessing coronal and sagittal spinal curvature, yet X-ray is ionizing. Our non-ionizing 3D ultrasound system had been demonstrated to be feasible in evaluating coronal and sagittal spinal curvatures of patients with AIS. Various studies had observed coronal-sagittal coupling relationship on patients with AIS. The objective of the study is to investigate whether 3D ultrasound could be able to detect such a phenomenon.

METHODS

Patient with AIS underwent bi-planar X-ray and ultrasound scanning, and those with Cobb $< 40°$ were included. Thoracic kyphosis and lumbar lordosis of 115 patients with AIS (88F and 27M; Age: 15.6 ± 3.5 years) were evaluated using laminae angle and Cobb angle obtained from sagittal ultrasound images and X-ray images respectively (Figure 1). Sagittal ultrasound and X-ray values between patients with Cobb $\leq 20°$ and $20° <$ Cobb $\leq 40°$ in the main thoracic and (thoraco)lumbar region were compared using independent t-tests.

RESULTS

Mean and standard deviation of thoracic kyphosis and lumbar lordosis were: $34.2 \pm 10.7°$ and $27.4 \pm 12.3°$ (ultrasound) and $25.6 \pm 11.6°$ and $44.6 \pm 10.6°$ (X-ray) respectively. Thoracic kyphosis of patients with larger main thoracic Cobb angle was significantly smaller than those with smaller main thoracic Cobb angle, based on the sagittal results obtained from ultrasound ($p = 0.003$) and X-ray ($p = 0.007$). However, there is no significant difference between different Cobb groups for lumbar lordosis.

CONCLUSION

Thoracic kyphosis value was smaller in patients with AIS with larger main thoracic Cobb compared to those with smaller Cobb using bi-planar X-ray, and such a phenomenon could be demonstrated using 3D ultrasound. Further study will be needed to investigate

the coronal-sagittal coupling using 3D ultrasound alone and the coupling effect on curve progression.

TAKE HOME MESSAGE

Relative hypokyphosis was observed in patients with AIS with a larger coronal deformity in the main thoracic region using bi-planar X-ray, and such phenomenon could be demonstrated using 3D ultrasound

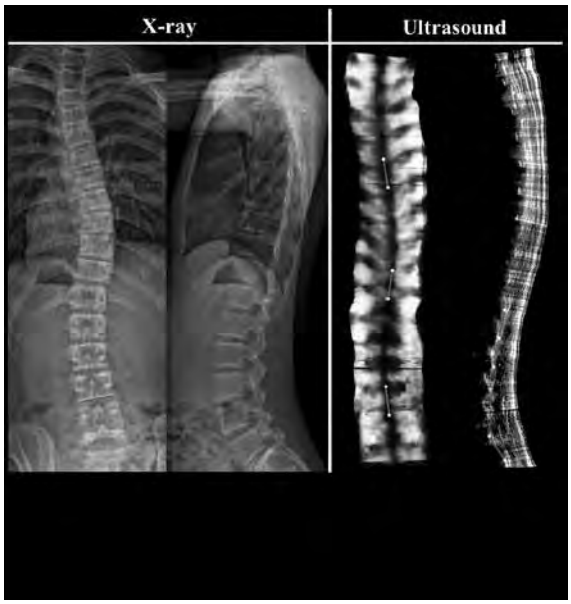


Diagram illustrating the measurements made on coronal and sagittal X-ray images [(a) and (b)] and ultrasound images [(c) and (d)] respectively

124. The Effect of Ponte Osteotomies (PCOs) on the Sagittal Shape of the Rods and Spine Derotation in Adolescent Idiopathic Scoliosis (AIS)

ElAmir Bachar Harfouch, MD; Mona A. Al Faraidy, MD, MBBS

SUMMARY

Adding PCOs to the correction technique of AIS surgeries has profoundly affected the entire sagittal shape of the rod. PCOs increased the Thoracic kyphosis measured by the concave rod ends angle, rod apex angle, and deflection. In contrast no-PCOs tend to have lordotic rods at the apices, less kyphosis at the ends, and less deflection. In addition, concave and convex rods are more superposed at the apex in patient with PCOs.

HYPOTHESIS

PCOs are an effective procedure to correct thoracic hypokyphosis in patients with AIS.

DESIGN

Retrospective comparative study of AIS patients operated at a single academic center.

INTRODUCTION

Patients with AIS have thoracic hypokyphosis or even lordosis. PCOs help correcting the sagittal deformity. We study the effect of PCOs on the shape of thoracic part of the rods in sagittal plan.

METHODS

A retrospective review of 40 AIS patients, half of them had PCOs (Schwab Type 2 ostoeotmy). T5-T12 Kyphosis was measured. All cases were done by one surgeon in posterior approach only. In all Patients CoCr 5.5 mm rods and titanium screws were used. Rod was over bent on the concave side and under bent on the convex side. On lateral radiograph, the rod end angle (A) was calculated by intersection of tangents to the rod proximal end point and inflection point between kyphosis and lordosis countours of the rod distally. Rod maximal deflection was obtained (D). In addition, two points were selected 1cm on both sides of rod apex; Intersection of tangents to these 2 points forms the rod apex angle (B). Distance between the edges of concave and convex rod at the apex was measured. Statistical analysis was performed using the SPSS version 25.

RESULTS

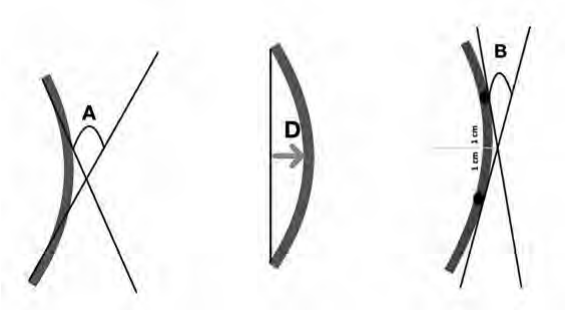
No significance differences of age (p=0.13), curve pattern subtypes (p=0.6), and thoracic kyphosis (p=0.4) of the two groups. No difference between groups in Lenke curve subtypes and 95 % of cases had Major Thoracic curves. Concave rods tend to be straight or even lordotic at the apex in no-PCOS group (-0.9deg) vs. (+5.9deg) for PCOS group (p=0.000). Rod end angle and deflection were significantly less in no-PCOS group (15.2deg; 7.1mm) vs. (26.3deg; 17.8mm) for the PCOS group (p= 0.000 and 0.000). Convex rods are less kyphotic in the no-PCOS group with an end angle and deflection (27.6deg; 16mm) vs. (33.4deg; 23.8mm) in PCOS group (p=0.03 and 0.000). No significant difference for the convex rod apex angle between groups (p=0.8). Rod Apices are more superposed in the PCOS group (2.9mm) vs. (9.3mm) in the no-PCOS group (p=0.000)

CONCLUSION

PCOs increase sagittal kyphosis and improve 3D derotation of spine

TAKE HOME MESSAGE

PCOs should be a routine in AIS for kyphosis correction and Spine derotation



A: Rod end angle B: Rod apex angle D: Rod deflection

125. One and Done Surgical Fusion for Skeletally Immature Idiopathic Scoliosis: Leads to Equivalent PROs at 5-years Despite High Rates of Adding-on

Nathan Boes, MD; Brandon A. Ramo, MD; Dong-Phuong Tran, MS; David C. Thornberg, BS; *Lori A. Karol, MD*

SUMMARY

A review of 37 skeletally immature patients with open TRC, age>8 years, and had 5-year follow-up. While adding-on rates were

reported in 54% of patients, only 6 patients (16%) required surgical revision specifically for adding-on. The majority of adding-on patients, (70%), did not need to undergo additional surgeries for correction. The only significant difference at 5-years was a larger residual Cobb angle, 38° vs 24°, in the adding-on group. Adding-on was not an indicator for worse PROs.

HYPOTHESIS

Definitively fused skeletally immature patients who develop adding-on have worse radiographic and reported outcomes at 5-yr follow-up.

DESIGN

Single institution, retrospective review of prospectively collected data

INTRODUCTION

Idiopathic scoliosis patients who develop surgical magnitude deformities while still skeletally immature (Risser 0, open triradiate cartilage(TRC)) present a unique surgical decision: utilize growing rods which subject the child to multiple procedures vs. primary fusion which risks adding-on due to remaining growth. We seek to describe outcomes following definitive spine fusion in skeletally immature patients with 5-yr follow-up.

METHODS

Review of skeletally immature IS patients over 8 yo who underwent definitive spinal fusion with 5-yr follow-up. Demographics, surgical data, reoperation rates, radiographs, and SRS outcomes were analyzed. Adding-on is defined as main Cobb angle or last-instrumented vertebra (LIV) tilt angle >5° progression. Comparisons were made between groups 1) no postop adding-on vs 2) those who experienced adding-on, with/without surgical revision.

RESULTS

37 patients underwent primary spinal fusion(8 anterior, 11 anterior/posterior, 18 posterior) with mean follow-up of 5 years(3.9-6.7). 11 (30%) required revision surgery at mean 1.7 years postop. 20 (54%) experienced adding on. 6 (16%) underwent revision surgery at mean 2.8 years postop specifically due to adding-on whereas the majority of patients with adding-on (14/20) did not undergo revision. There were no significant differences in preoperative SRS scores, and there was no difference in any domains or total SRS scores at 5-years between the groups, mean total 4.22(3.39-4.88) vs. 4.04(3.09-4.57), p=0.181. Patients with adding-on had larger residual Cobb angles (38° vs 24°, p=0.006) and slightly worse sagittal balance, but did not have significant differences in any other outcomes.

CONCLUSION

Definitive fusion surgery for skeletally immature IS resulted in a reoperation rate of 30% (11/37). Adding-on was noted in 54% (20/37), with only 6 patients requiring surgery. There were no differences between groups in PROs at 5-yr.

TAKE HOME MESSAGE

"One and done" spinal fusion for skeletally immature patients is a valid treatment to avoid repetitive surgeries due to growing rods while achieving similar outcomes at 5 years.

126. Severe Adolescent Idiopathic Scoliosis: Which Approach to Choose?

Peter O. Newton, MD; Lawrence G. Lenke, MD; Oheneba Boachie-Adjei, MD; Sumeet Garg, MD; Paul D. Sponseller, MD, MBA; Suken A. Shah, MD; Mark A. Erickson, MD; Daniel J. Sucato, MD, MS; Amer F. Samdani, MD; Burt Yaszay, MD; Joshua M. Pahys, MD; Patrick J. Cahill, MD; David L. Skaggs, MD, MMM; David W. Polly Jr., MD; Peter F. Sturm, MD, MBA; Brenda A. Sides, MS; Michael P. Kelly, MD, MS; Munish C. Gupta, MD

SUMMARY

In AIS cases with an average curve size of 116±17° a posterior approach with only posterior column osteotomies was performed in 67% of the cases. Vertebral column resection (VCR) or anterior release were utilized in the remainder. Correction rates, blood loss, operative time, and neurologic risk varied by approach. An anterior release increased the % correction compared to posterior alone.

HYPOTHESIS

Severe primary AIS is rarely indicated for a vertebral body resection (VCR).

DESIGN

Analysis of severe AIS deformity cases prospectively enrolled in a multicenter registry.

INTRODUCTION

Severe AIS with curves > 90-100° create a decision-making challenge with options of adding an anterior release or a VCR.

METHODS

Primary surgical cases from 12 centers with a diagnosis of severe AIS and 2 years of follow-up were reviewed. Pre-op and 2yr post-op radiographic and SRS-22 outcomes were compared between 3 groups: Posterior with VCR (PVCR), Posterior with posterior column osteotomies (PPCO), Posterior with anterior release (A+P). Neuromonitoring (NM) alerts and new post-op neurologic deficits were recorded.

RESULTS

A total of 45 patients were included: 7 (15%) PVCR, 30 (67%) PPCO and 8 (18%) A+P. Average age was 14.2±2.1 years and 73% were female. Primary curve magnitude (p=0.4) and % flexibility (p=0.8) were not different for the 3 groups pre-op (Table). An average of 13±1 levels were fused in each group. EBL ranged from 450-3000 ml and total operative time was lowest for PPCO group (p<0.05). Two year post-op primary curve was reduced in all, with % correction significantly greater in A+P compared to PPCO (p<0.05). Intra-op NM alerts were common, but rates were not statistically different between groups (p=0.5). There were 2 (4%) incomplete spinal cord deficits that resolved 1-1.5 years post-op (1 PVCR, 1 PPCO). SRS-22 scores improved in all domains with total score increasing from 3.6±0.5 pre-op to 4.3±0.4 at 2 years.

CONCLUSION

A VCR (15%) and the addition of an anterior approach (18%) were rarely used in these AIS cases with curves ranging from 90-159°. There was a bias for approach within centers, with 9 of 12 using only 1 of the 3 approaches for all cases. This information may help inform decision making in these rare but difficult AIS cases with substantial neurologic risk.

TAKE HOME MESSAGE

VCR was rarely indicated in severe cases of primary AIS surgery. 67% of cases were managed posteriorly without VCR, although adding an anterior release resulted in a greater correction rate.

	Posterior + VCR	Posterior with PCO	Anterior + Posterior	Total	p-value
N	7	30	8	45	---
Age (yrs)	14.4 ± 2.4 (12.3-19.3)	14.4 ± 2.1 (10.6-19.6)	13.3 ± 1.8 (10.5-19.3)	14.2 ± 2.1 (10.5-19.6)	0.43
Sex	3F, 4M	24F, 6M	6F, 2M	33F, 12M	0.13
Preop Primary Curve (°) (range)	124 ± 15 (110-155)	115 ± 16 (90-150)	113 ± 24 (97-159)	116 ± 17 (90-159)	p=0.4
Primary Curve Flexibility (%) range)	23 ± 13 (4-45)	24 ± 14 (4-54)	21 ± 12 (0-41)	23 ± 13 (0-54)	p=0.8
# (%) staged procedure	**4 (57%)**	**6 (20%)**	**5 (63%)**	**15 (33%)**	**0.03**
# levels fused (range)	13 ± 1 (10-14)	13 ± 1 (11-15)	13 ± 1 (12-14)	13 ± 1 (10-15)	0.4
EBL for all stages combined (ml)	1107 ± 279 (750-1550)	1549 ± 697 (450-3000)	1778 ± 938 (450-2800)	1521 ± 715 (450-3000)	p=0.2
Op Time for all stages combined (min)	**616 ± 223 (313-910)**	**396 ± 158 (115-960)**	**684 ± 237 (410-1074)**	481 ± 218 (115-1074)	**p<0.001**
# (%) Patients with IONM Changes	3 (43%)	15 (50%)	2 (25%)	20 (44%)	p=0.5
2yr Primary Curve (°)	**44 ± 10 (26-58)**	**50 ± 20 (15-83)**	**28 ± 14 (10-50)**	**45 ± 19 (10-83)**	**p=0.01**
% Correction of Primary Curve	**64 ± 7 (58-79)**	**57 ± 14 (31-87)**	**76 ± 8 (66-90)**	62 ± 14 (31-90)	**p=0.002**

127. A Decade of Adolescent Idiopathic Scoliosis Care Adhering to SRS Guidelines in an Underserved Population: A Single-surgeon Registry

Bassel G. Diebo, MD; Neil V. Shah, MD, MS; Harleen Kaur, BA; Adam J. Wolfert, BA; Alfonso Caetta, BS; Nathan S. Kim, BA; Daniel E. Suarez; George A. Beyer, MS; Saad Tarabichi, BS; Suriya Baskar, BA; Dan Monessa, BS; Sirish Khanal, BS; Steven J. Morrin, BS; Renaud Lafage, MS; Peter G. Passias, MD; Virginie Lafage, PhD; Frank J. Schwab, MD; Carl B. Paulino, MD

SUMMARY

The SRS has established guidelines to manage AIS. We evaluated a single spine surgeon's experience treating primary AIS treatment over >10 years in an underserved community. Data revealed that adherence to SRS guidelines led to low rates of curve progression, with only 0.7-1.5% progresses into worse SRS categories between 1Y and 2Y FU. Moreover, over the years, Risser grades of presenting patients were lower for the same curves indicating improved community awareness toward scoliosis and early detection in adolescence

HYPOTHESIS

Adherence to SRS treatment guidelines will yield favorable treatment outcomes regardless of skeletal maturity or socioeconomic status.

DESIGN

Retrospective review

INTRODUCTION

This study sought to evaluate single-surgeon AIS management via the SRS guidelines over a decade of practice in a medically and economically underserved population.

METHODS

Primary pts presenting to a single spine surgeon's for evaluation of scoliosis from 2006-2018 were retrospectively reviewed. Inclusion criteria: 10-25 y/o, available clinical and radiographic (36-inch full-spine xrays). Risser grade and full coronal and sagittal radiographic analysis were obtained. Pts were categorized and treated via known SRS guidelines: (SRS-O)bservation, (SRS-B)racing and (SRS-S) urgical candidates). Pts with 2 data points of 1Y and 2Y FU were sub-analyzed to investigate disease progression.

RESULTS

Included: 552 pts, mean age 14.3±2.6 and 67% Female. Risser grades were: R0, n=85 (15.4%), R1, n=32 (5.8%), R2, n=85 (15.4%), R3, n=147 (24.8%), R4, n=122 (22.1%), R5; n=87 (15.8%). At BL, SRS-0 (n=326, 59.1%, 21.9°), SRS-B (n=128, 23.2%, 33.5°), SRS-S (n=98, 17.8%, 59°). 325 (58.8%) met SRS criteria for AIS. Curve breakdown was: Lumbar (n=52, 16%), Main thoracic (n=196, 60.3%) and thoracolumbar (n=77, 23.7%). Analyzing pts with 2Y FU revealed that among patients with BL curves (<25°), only 10.8% progressed into [25-45°] at 1Y, and 11.5% total progressed at 2Y FU. Among pts with 25-45° BL curves, 22% corrected into [<25°], and 3.8% progressed into [>45°] at 1Y and 5.2% progressed at 2Y. Evaluating Risser grade distribution across years, pts presenting with Risser (0-2) significantly increased from 8.5% in 2008 to 25% in 2018 despite comparable mean annual curve magnitude (33.9 to 30.3°). Conversely, % pts presenting with Risser 5 decreased from 49.2% to 26.8% from 2008-18.

CONCLUSION

Adherence to SRS management guidelines and pt education over a decade of practice led to a low rate of curves progression and improvement of our underserved community education regarding the disease.

TAKE HOME MESSAGE

Adherence to SRS management guidelines and pt education over a decade of practice led to a low rate of curves progression and improvement of our underserved community education regarding scoliosis.

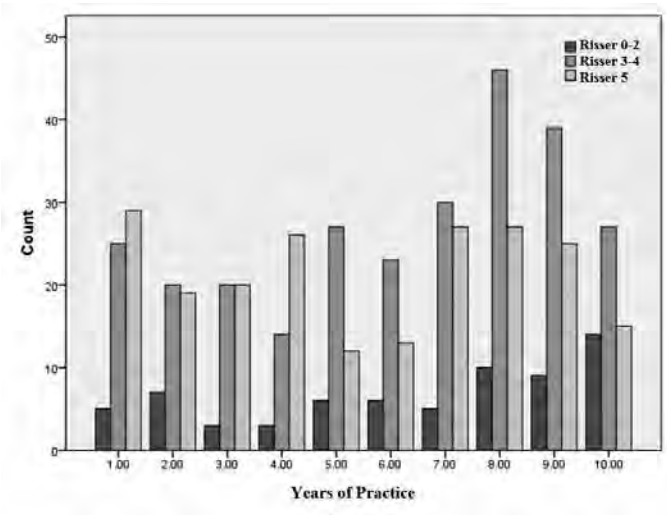


Figure. Number of patients in each Risser Grade group (Risser 0-2, Risser 3-4, and Risser 5) across 10 individual years of a single scoliosis surgeon's practice in treating primary patients with AIS (2008 to 2018).

128. Early Postoperative Complication Rates for AIS at a Global Outreach Site are Comparable to Developed Countries

Kenneth J. Paonessa, MD; Mark C. Lee, MD

SUMMARY

Global outreach (GO) efforts for surgical management of AIS raise concerns about overall safety of these interventions for patients in resource poor environments. Evaluation of 30 day perioperative adverse events for AIS surgical patients from a single site demonstrated higher transfusion rates and average blood loss but comparable neurologic injury and infection rates compared to developed countries. The study offers unique evidence that GO campaigns have early postoperative complication rates that are comparable to that of developed

HYPOTHESIS

A single AIS GO site has early postoperative complication rates comparable to that reported for developed countries.

DESIGN

Retrospective evaluation of a prospectively collected database.

INTRODUCTION

GO for AIS involves the provision of complex surgical care to patients in resource poor countries. A concern with such efforts is a possible increased perioperative complication rate, given the complexity of the surgery and the limited medical capacity of the host institution. The study examines the early postoperative complication rates in the surgical management of AIS at a single GO site.

METHODS

A retrospective chart and radiographic evaluation was performed with a prospectively collected patient database from a single GO site. AIS patients operated on between 2012, the founding of the site, to 2018 were included. Intraoperative neuromonitoring changes, transfusion rates and complications within 30 days of surgery were recorded. A complication was defined as any peri-operative event that resulted in a change in patient management.

RESULTS

100 surgical patients with AIS (74 female, 26 male) were identified with an average age of 16.5 +/- 3.0 yrs. Patients underwent posterior spinal fusion with either all pedicle screw or hybrid constructs, spanning an average of 11.1 +/- 1.8 levels. Average OR time was 250 +/- 70 minutes. Average blood loss was 1.1 +/- 1.0 L, with 39% of patients requiring transfusion. 2 transient intraoperative neuromonitoring changes were noted. 30 day complications of significance included 1 infection and 1 radiographic screw pullout. (Figure 1)

CONCLUSION

Surgery for AIS at a single GO site yields higher transfusion rates but comparable overall complication rates to that reported in developed countries. The development of a GO site with an interested host, a mechanism for continuity of care and a consistent surgical team can yield early post-operative outcomes similar to that observed in developed nations. However, long-term patient outcomes and the ability of the site to manage major complications requires additional study.

TAKE HOME MESSAGE

A well-organized global outreach site may have early complication rates similar to that of developed countries.

Figure 1

Incidence of Major Perioperative Events for Idiopathic Scoliosis[1,2,3,4]

	Global Outreach Site	Developed Countries
Pulmonary (not PE)* (%)	0	0.96–5.53
Acute deep wound infection (%)	1	0.1–2.7
Implant related (%)	1	0.64–4.6
Paresis/paralysis (%)	0	0.29–0.32
Death (%)	0	0.01–0.05
Intraoperative Blood Loss (mL)	1100 +/- 1000	389 ± 345
Tranfusion Rates (%)	39	26

*Includes pleural effusion, hemothorax, pneumothorax, pneumonia, pulmonary edema, and pulmonary hemorrhage.

1. Bartley et al. J Bone Joint Surg Am 2017;99:1206-12.
2. Burton et al. Spine Deform 2016;4:338-43.
3. Coe et al. Spine (Phila Pa 1976) 2006;31:345-9.
4. NSQIP Database 2012-2016

130. A Prone Thoracoscopic Anterior Release and Fusion As Part of A Combined Anterior/ Posterior Surgery: Is There a Role in 2019 and How Does it Compare to Open

Daniel J. Sucato, MD, MS; Ian Corcoran-Schwartz, MD; Kiley Frazier Poppino, BS; Chelsea Karacz, MS

SUMMARY

In a group of idiopathic scoliosis patients undergoing an anterior release and fusion followed by a posterior spinal fusion/ instrumentation, the thoracoscopic approach has comparable results to performing an open approach with similar correction of the coronal and sagittal planes. This technique provides excellent access without the detrimental effects on pulmonary function and cosmesis provided by the open approach.

HYPOTHESIS

A thoracoscopic anterior release/fusion for severe deformity is an effective and safe technique to and improved deformity correction and obtain fusion.

DESIGN

Retrospective

INTRODUCTION

An anterior procedure to increase flexibility and/or achieve anterior column fusion is relatively rare today in when managing idiopathic scoliosis, however, when it is utilized two approaches are possible: the open thoracotcomy and thoracoscopic approach. The purpose of this study is to compare the two techniques.

METHODS

A consecutive series of severe AIS were included who had a thoracoscopic (T group) or open release (O group) prior to posterior fusion. Anterior fusion was graded using a previous classification (1-100%, 2: >50% 3: <50% 4: no fusion). Curve correction was determined and compared between groups.

RESULTS

There were 65 patients who underwent a combined anterior/ posterior surgery for idiopathic scoliosis who had a minimum of 2 year followup. There were 58 in the T group and 7 in the O group. There were no differences between the T and O groups in age (12.8 vs 11.1 years), preop Cobb (80.9 vs 80.1°), T5-T12 kyphosis (31.2 vs 28.4°), Risser stage, chest tube duration (2.3 vs 2.6 days), or hospital stay (6.2 vs 6.1 days)(p>0.05). The 2 year corrections were

the same between the T and O groups for coronal Cobb (64 vs 71%, p>0.05) and final thoracic kyphosis (28.2 vs 26.0°, p>0.05). The number of anterior levels fused was the same (5.0 vs 5.4) but disc space fusion was less in the T group (average 1.8 vs 1.2, p<0.001) with less levels graded as 1 or 2 (81.1 vs 97.4%, p<0.001). There were no pseudoarthroses in either group and there were no neurologic complications.

CONCLUSION

A thoracoscopic anterior release/fusion is an effective procedure to improve the flexibility of the spine with the same amount of correction as open techniques for patients with idiopathic scoliosis and avoids the large thoracotomy incision and the decreased pulmonary function. Despite less radiographic union of the anterior levels patients in the thoracoscopic group did not have revision surgery for pseudoarthrosis.

TAKE HOME MESSAGE

Thoracoscopic anterior release and fusion provides excellent flexibility to the spine and assists in achieving an excellent fusion when a posterior fusion/instrumentation is performed.

131. Adolescent Idiopathic Scoliosis in Adults: A Comparison of Health-related Quality of Life (HRQOL) Scores to Normative Data

Jace Erwin, BS; Brandon B. Carlson, MD, MPH; Joshua Bunch, MD; Robert Sean Jackson, MD; Marc Asher, MD; Douglas C. Burton, MD

SUMMARY

Most patients diagnosed with AIS function well in adulthood, though some have increased disability. A retrospective study was performed comparing SRS HRQOL scores in adults with AIS to age-gender normative data. Adults with AIS have SRS scores that differ significantly from age and gender matched norms. Despite this difference, surgical rate remains low (14%). Increased understanding of self-reported quality of life measures serves to improve decision making concerning treatment in adolescent and adult spinal deformity.

HYPOTHESIS

Adults with AIS have similar HRQOL scores as persons who are unaffected.

DESIGN

Retrospective study

INTRODUCTION

Long-term studies of AIS in adulthood have shown most patients function well, though some have increased disability. Little is known about the symptomatology of patients actively seeking care for their scoliosis. Our purpose is to analyze and compare SRS HRQOL scores in adults with AIS to those without to better understand and add to what is known concerning the natural history of AIS.

METHODS

All unoperated adult (≥20 years of age) patients with AIS who presented to a tertiary deformity clinic from 2008-2018 were reviewed. Demographics, curve size [thoracic (T) and thoracolumbar (TL)], comorbidities, ODI, and SRS-22r, were recorded for each patient. SRS-22r categories were calculated and recorded including: function, pain, self-image, mental health, and total score. Mean scores were analyzed across 3 age groups: 20-39 (G1), 40-59 (G2), and 60+ (G3). Each group was further subcategorized by gender. One sample t-tests were used to compare means between our data and normative data.

RESULTS

249 consecutive AIS patients were seen by the senior author over the 10-year study period. 200 patients had an SRS-22r score and are the subject of this study. When analyzing across age groups, G1 reported higher scores in function (p=0.006) and pain (p=0.033). G3 had lower self-image scores (p=0.044). In comparison to normative data, our patients had significantly worsened scores in the pain, self-image, and mental-health. Function was significantly different for women except for G1 (p<.0001). There was no significant difference for function in males. 16/249 patients in this study ultimately required adult deformity surgery.

CONCLUSION

Adults with AIS have SRS scores that differ significantly from age and gender matched norms.

TAKE HOME MESSAGE

Adults with AIS have SRS scores that differ significantly from age and gender matched norms. Despite this difference, surgical rate remains low (14%).

Table 1: Outcome Data

	Collected Data					
	Age 20-39		Age 40-59		Age 60+	
	F (n=84)	M (n=25)	F (n=47)	M (n=5)	F (n=36)	M (n=4)
Function						
Mean	4.16	4.32	3.91	3.92	3.63	4.05
Stand. Dev.	0.638	0.628	0.8	1.4	0.818	0.412
Avg (F & M)	4.2		3.91		3.68	
Pain						
Mean	3.18	3.91	3.07	2.96	2.89	2.48
Stand. Dev.	0.864	0.859	0.933	1.15	0.822	0.899
Avg (F & M)	3.35		3.06		2.85	
Self-Image						
Mean	3.25	3.55	3.04	3.08	2.93	3.25
Stand. Dev.	0.74	0.855	0.786	1.2	0.647	0.436
Avg (F & M)	3.32		3.05		2.96	
Mental Health						
Mean	3.74	3.82	3.64	3.84	3.94	3.43
Stand. Dev.	0.788	0.875	0.762	1.27	0.686	0.532
Avg (F & M)	3.76		3.66		3.89	
Total						
Mean	3.51	3.79	3.35	3.34	3.3	3.23
Stand. Dev.	0.602	0.678	0.67	1.15	0.582	0.236
Avg (F & M)	3.57		3.35		3.29	
	Normative Data					
Function						
Mean	4.3	4.44	4.3	4.29	4.11	4.18
Stand. Dev.	0.42	0.31	0.42	0.48	0.6	0.53
Pain						
Mean	4.4	4.57	4.33	4.4	4.23	4.4
Stand. Dev.	0.59	0.46	0.63	0.65	0.79	0.66
Self-Image						
Mean	4.22	4.46	4.16	4.25	4.16	4.27
Stand. Dev.	0.53	0.46	0.59	0.56	0.65	0.53
Mental Health						
Mean	4.06	4.33	4.08	4.22	4.09	4.28
Stand. Dev.	0.47	0.46	0.55	0.5	0.57	0.5
Total						

132. Determining Lowest Instrumental Vertebrae (LIV) on Prone X-Ray Can Save Fusion Levels with Good Correction and Balance in AIS Patients Compared to Traditional Methods

Vishal Sarwahi, MD; Sayyida Hasan, BS; Jesse Galina, BS; Terry D. Amaral, MD; Aaron M. Atlas, BS

SUMMARY

Touched Vertebra (TV) on prone XR is a superior way to determine the lowest instrumented vertebra. At 2-year follow up, this study did not find coronal decompensation.

HYPOTHESIS

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

DESIGN

Ambispective cohort study

INTRODUCTION

Minimizing the fusion levels in PSF for AIS is important. Previously, good results using TV as the LIV were seen. TV is the 'touched' vertebra determined by central sacral vertical line on standing AP XRs (TVS). We found that TV moves proximally on supine/prone XRs. Thus utilizing TV on prone XRs (TVP) in LIV may shorten fusions.

METHODS

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

RESULTS

The control group had 132 patients with a median (IQR) Cobb of 20°, age of 16, coronal balance 1.4, disc wedging of 4°, and LIV tilt of 10°. In Group I, median preoperative Cobb was 53.8° and coronal balance was 1.8. Final Cobb was 12.4° and coronal balance was 0.9. Compared to controls, Group I patients had significantly less coronal imbalance ($p = 0.023$), lower disc wedging ($p > 0.001$) and LIV tilt ($p < 0.001$). In Group II, preoperative Cobb was 53.5° and coronal balance was 2. Final Cobb was 20° and coronal balance was 0.7. Group II patients could have saved an average 2.24 levels, if fused to TVP. Preoperative Cobb angle, coronal balance, LIV tilt, disc angle, final coronal balance and LIV translation were similar between Group I and Group II. Final Cobb angle ($p < 0.001$), disc angle ($p < 0.001$), and LIV translation ($p = 0.002$) were all significantly smaller for Group I. Group II fused significantly fewer levels ($p = 0.005$), and had significantly more patients with final disc angle > 5° ($p < 0.001$).

CONCLUSION

In AIS, using TVP to determine LIV allows for shorter fusion, without comprising LIV tilt or disc wedging, emphasizing its efficacy.

TAKE HOME MESSAGE

TVP is a more effective way to determine the lowest instrumented vertebra in AIS. Using this method may allow for shorter fusions without compromising other key disc measurements.

133. 3D Spinal Alignment, Thoracic Volume and Pulmonary Function in Surgical Correction of AIS: A 5 Year Follow-up Study

Aaron J. Buckland, MBBS, FRACS; Burt Yaszay, MD; Dainn Woo, BS; Amer F. Samdani, MD; Dennis Vasquez-Montes, MS; Michelle Claire Marks, MS, PT; Amit Jain, MD; Thomas J. Errico, MD; Randal R. Betz, MD; Baron S. Lonner, MD; Peter O. Newton, MD

SUMMARY

Sagittal and 3D spinal alignment has become an increased focus in Adolescent Idiopathic Scoliosis (AIS) correction, aiming to maximize thoracic volume and improve pulmonary function, spinal balance, and self-appearance. This study demonstrates that although there is significant perioperative improvement in all 3D alignment parameters, this does not result in increased thoracic volumes. Thoracic volumes increase immediately postop until 5Y follow-up, with improvement in pulmonary function tests (PFTs), however patients still remain below their age- and height- predicted PFT.

HYPOTHESIS

Increased thoracic kyphosis (TK) restoration in AIS type 1- and 2-curves will provide increased 5Y thoracic volume (TV) and PFTs.

DESIGN

Retrospective review of prospective multicenter database.

INTRODUCTION

Surgical correction of AIS, and in particular, restoration of TK aims to prevent progressive deformity and pain, improve thoracic volume, restore sagittal balance and improve PFT and self-appearance.

METHODS

Patients with posterior spinal fusion for Type 1- and 2- AIS curves with preop, 1st erect and 5Y radiographs and PFTs. 3D radiographic analysis assessed spine alignment and chest wall dimensions at each visit. Variables were analyzed between visits with ANOVA, and between variables with linear regression.

RESULTS

39 patients were included (37F, age 14.4+/-2.2). 3D analysis showed reduction preop to 1st erect in upper(41.3 to 11.6 degrees) and mid(48.6 to 9.55 deg) thoracic & lumbar Cobb angles(19.7 to 8.9 deg), apical vertebral rotation(9.5 to 2.1 deg), increased TK:T2-12(20.0 to 39.8 deg) and TK:T5-12(9.8 to 28.2 deg)(all $p < 0.001$). 3D spinal alignment was stable 1st erect to 5Y visit($p > 0.05$). From preop to 1st erect, there was a reduction in max ribcage depth(144 to 138mm), width(235 to 232mm), and increased thoracic height (220 to 230mm, all $p < 0.01$), but no change in thoracic volume (5136 to 5202 L $p = 0.184$). Peri-op spinal alignment change and ribcage volume change did not correlate. From 1st erect to 5Y visit, there was an increase in max depth (138 to 144mm), max width(232 to 242mm), height(230 to 233mm) and Thoracic volume (5202 to 5912L,all $p < 0.001$). Preop to 5Y FEV1(2.73 to 2.98L,$p = 0.003$) and FVC(3.22 to 3.46L,$p = 0.006$) increased, but not TLC(4.54 to 4.59L,$p = 0.517$). %predicted TLC decreased(BL:101.3% to 5Y:89.1%, $p < 0.001$); %predicted FEV and FVC did not(89% to 86.4%,$p = 0.227$ and 92.5% to 87.7%,$p = 0.1$). 5Y PFTs correlated best with 5Y ribcage volume(FEV $r = 0.643$, FVC $r = 0.8$, TLC $r = 0.73$,$p < 0.001$).

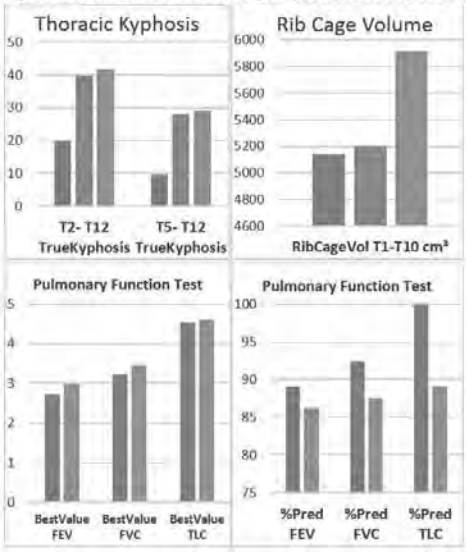
CONCLUSION

3D changes in spinal alignment from preop to 1st erect do not directly influence chest wall volume. Thoracic volume increases from 1st erect to 5Y due to continued growth, corresponding with improved 5Y PFTs.

TAKE HOME MESSAGE

Thoracic volume doesn't change perioperatively, and isn't associated with TK restoration, but subsequently increases to 5Y, contributing to improved PFTs. Alas, AIS patients have lower than predicted 5-year PFTs.

Figure 1. Baseline, 1st erect, and 5-year postoperative spinal, rib cage and pulmonary tests.



Baseline, 1st erect, and 5 year postoperative spinal, rib cage and pulmonary tests.

134. Utility of the Lumbosacral Takeoff Angle (LSTOA) to Predict Post-operative Lumbar Cobb Angle following Selective Thoracic Fusions in Adolescent Scoliosis

Keith Bachmann, MD; Edwin Lu, BS; Wendy M. Novicoff, PhD; Peter O. Newton, MD; Mark F. Abel, MD

SUMMARY

This study validates an equation to predict the residual lumbar Cobb after selective fusion using the LSTOA. There is not significant change in the LSTOA with a selective thoracic fusion and less improvement to midline of the coronal balance. The LSTOA can be used to help predict the residual Cobb angle to help in discussions with the family or in determining correction goals for ultimate coronal and sagittal balance.

HYPOTHESIS

The LSTOA can be used to predict post-operative lumbar Cobb angle after selective fusion

DESIGN

Retrospective review of a prospective database

INTRODUCTION

Selective fusion of double curves in scoliosis is considered to spare fusion levels. In 2011, we studied the LSTOA defined as the angle between CSVL and a line through the centrum of S1, L5 and L4. The LSTOA was shown to strongly correlate with the lumbar Cobb and a predictive equation was developed to predict the lumbar Cobb after selective fusions. This study validates that equation in a separate cohort and assesses differences in outcomes from selective (S) vs non-selective (NS) fusion.

METHODS

Patients with Lenke 1 or 3 (B and C) curve patterns undergoing fusion (both S and NS) with pedicle screw constructs and a minimum of 2-year follow up were included. S fusion was defined as a distal level of fixation proximal to the apex of the lumbar curve. To validate the previously derived equation, we used this dataset and ANOVA to check for differences between the actual and the calculated post-op lumbar Cobb angles. Pearson correlations, multiple linear regression, and t-tests were used to explore relationships and differences between groups (S vs NS).

RESULTS

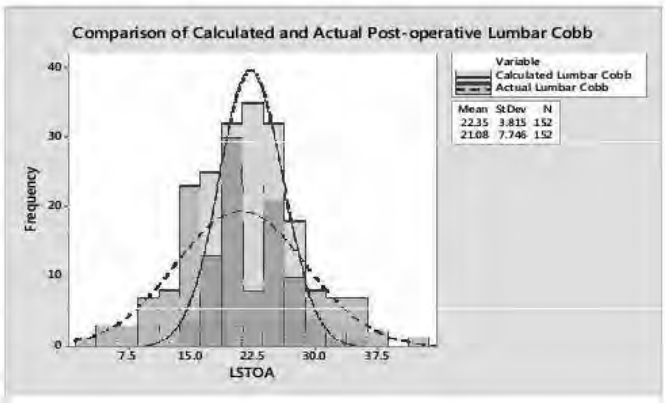
The mean calculated post-op lumbar Cobb angle (22.4°, SD=3.81) was not significantly different from the actual post-op lumbar Cobb angle (21.1°, SD=7.75) with an average model error of -1.268° (95% CI=-2.649-0.112). Pre-operative lumbar Cobb angle was larger (50.2° versus 38.9°, p=0.002) in deformities chosen for NS fusions. Performing S fusion resulted in a 3.5 degree (p=0.0001) correction of the LSTOA while NS fusion resulted in a 9.3 degree (p=0.0001) correction. NS fusion generated 10 degrees of lordosis at the thoracolumbar junction and improved coronal balance 1cm to midline. There was no change in either variable in the S group.

CONCLUSION

Change in LSTOA following S fusion is small and LSTOA may be used to predict residual lumbar Cobb. Surgeons tended to employ NS fusions for double curves with a larger lumbar deformity. Improvement in LSTOA and coronal balance is greater with a NS fusion.

TAKE HOME MESSAGE

The LSTOA can be used to predict residual lumbar Cobb angle and may be used by surgeons to aid in the decision between selective and non-selective fusion.



Calculated vs. Measured Lumbar Cobb

135. Can We Stop Distally at STV-1 for Adolescent Idiopathic Scoliosis with Lenke 1A/2A Curves?

Zezhang Zhu, MD; Xiaodong Qin, PhD; Zhen Liu, MD; Yong Qiu, MD

SUMMARY

Selecting one level proximal to substantially touching vertebra (STV-1) as lowest instrumented vertebra (LIV) could yield good outcomes in nearly 30% adolescent idiopathic scoliosis (AIS) with Lenke 1A and 2A curves. However, for skeletally immature patients with long thoracic curve, large rotation and deviation of STV-1, distal fusion level should extends to substantially touching vertebra (STV) to avoid distal adding-on.

HYPOTHESIS

In some cases, selecting STV-1 as LIV could achieve similar outcomes to STV.

DESIGN

Retrospective study

INTRODUCTION

Selective thoracic fusion to save more lumbar mobile segments has become the mainstay of operative treatment for adolescent idiopathic scoliosis (AIS) with Lenke 1A and 2A curves. Although previous studies have recommended selecting the substantially touching vertebra (STV) as lowest instrumented vertebra (LIV), good outcomes could still be achieved in some cases when STV-1 was selected as LIV. The purpose of the study is to determine in which case STV-1 could be a valid LIV, in which case distal fusion should extend to STV, and to identify risk factors for distal adding-on.

METHODS

Seventy-four patients were included in the study with a minimum of 2-year follow-up after selective posterior thoracic instrumentation, in which STV-1 was selected as LIV. Patients were identified with distal adding-on between first erect radiographs and 2-year follow-up based on previously defined parameters. Factors associated with the incidence of adding-on were analyzed.

RESULTS

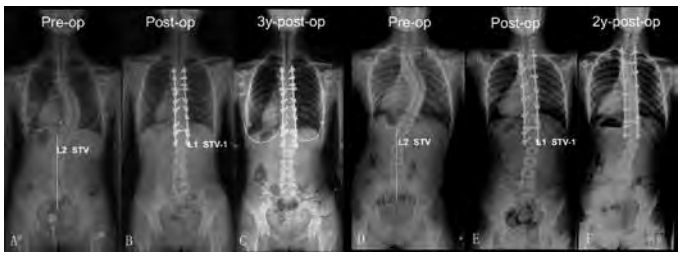
The mean follow-up duration was 33.8±17.4 months. Twenty patients (27.1%) with STV-1 selected as LIV achieved good outcomes at the last follow-up. Several preoperative risk factors significantly associated with distal adding-on were identified, including lower Risser (p=0.034), longer thoracic curve length (p=0.013), larger rotation and deviation of STV-1 (p=0.022 and p=0.002).

CONCLUSION

Skeletally immature patients with long thoracic curve, large rotation and deviation of STV-1 are at increased risk of distal adding-on when selecting STV-1 as LIV. Under this condition, distal fusion level should extend to STV; While in other case, STV-1 could be a valid LIV.

TAKE HOME MESSAGE

For skeletally immature patients with long thoracic curve, large rotation and deviation of STV-1, distal fusion level should extends to STV; In other case, STV-1 could be a valid LIV.



(A-C) A 18-year-old female (Risser=5) with L1 (STV-1) selected as LIV, and no distal adding-on occurred at the last follow-up. (D-F) A 10-year-old female (Risser=0) with L1 (STV-1) selected as LIV, and distal adding-on occurred at the last follow-up.

136. Longitudinal Magnetic Resonance Imaging Evaluation on Uninstrumented Lumbar Intervertebral Disc after Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis

Satoshi Suzuki, MD, PhD; Eijiro Okada, MD, PhD; Osahiko Tsuji, MD, PhD; Narihito Nagoshi, MD; Nobuyuki Fujita, MD, PhD; Mitsuru Yagi, MD, PhD; Takashi Tsuji, MD, PhD; Masaya Nakamura, MD, PhD; Morio Matsumoto, MD, PhD; Kota Watanabe, MD, PhD

SUMMARY

We conducted longitudinal MRI analysis of 106 unfused lumbar discs in patients with adolescent idiopathic scoliosis treated when the age was over twenty, and found that deteriorated intervertebral disc degeneration was observed in 13 discs (12.2%). Correction rate of apical translation of the main curvature was significantly lower in patients with degenerated lumbar discs than those without, suggesting that residual apical translation of the main curvature could be the risk factor for lumbar disc degeneration.

HYPOTHESIS

Successful correction surgery for adolescent idiopathic scoliosis (AIS) was associated with reduced progression of the caudal unfused intervertebral disc degeneration (IVDD) in adulthood.

DESIGN

Longitudinal radiographic analysis with evidence level IV

INTRODUCTION

Long fusion constructs after surgery for AIS have been reported to accelerate caudal uninstrumented IVDD, however, longitudinal magnetic resonance imaging (MRI) analysis of the unfused spinal segments is not fully elucidated.

METHODS

Twenty-nine AIS patients (6 male, 23 female, mean age 31.8 years) who underwent posterior collection surgery when the age was over twenty and were followed more than 5 years were included. We evaluated lumbar MRI and standing X-ray at preoperatively and 5 years postoperatively. Unfused lumbar disc was assessed by one radiologist and one spine surgeon using modified Pfirrmann classification. We divided the patients into two groups depends on MRI, that is degenerated group (group D) consisted of patients with deteriorated IVDD and non-degenerated group (group ND) consisted of those without.

RESULTS

A total of 106 discs were evaluated. Of nine patients in group D, deteriorated IVDD was observed in 13 discs (12.2%) consisting of

at L2-3 in 1 disc, L3-4 in two discs, L4-5 in five, and L5-S1 in five. There were no significant differences between the groups in age, sex, BMI (P=0.71, 0.65, 0.09, respectively). In radiographic analysis, no significances were observed in curve type (P=0.80), Cobb angle of the main curve (P=0.29), apical translation (P=0.65), number of fusion (P=0.16), correction rate of the main curvature (P=0.38), level of lowest instrumented vertebra (LIV) (P=0.08), LIV tilt (P=0.71), LIV inclination (P=0.83). The correction rate of the apical translation of the main curvature was significantly lower in group D than that in group ND (51±17% vs 70±18%, P=0.02).

CONCLUSION

The results of the study indicated that residual apical translation of the main curvature after posterior fusion surgery in patients with AIS could be the risk factor for IVDD in the caudal unfused intervertebral discs in adulthood.

TAKE HOME MESSAGE

Maximum correction of apical translation could minimize the influence of long fusion on unfused lumbar disc in patients with AIS in adulthood.

137. Residual Thoracolumbar/Lumbar Curve Is Related to Self-image after Selective Thoracic Fusion of Lenke 1 and 2 Curves for Adolescent Idiopathic Scoliosis

Tetsuhiko Mimura, MD; Jun Takahashi, MD, PhD; Shota Ikegami, MD, PhD; Hiroki Oba, MD; Masashi Uehara, MD, PhD; Shugo Kuraishi, MD; Takashi Takizawa, MD, PhD; Ryo Munakata, MD; Terue Hatakenaka; Michihiko Koseki, PhD; Hiroyuki Kato, MD, PhD

SUMMARY

Apical vertebral translation (AVT) of the main thoracic (MT) curve appears to be more strongly related to self-image than does Cobb angle. Two years after surgery for adolescent idiopathic scoliosis Lenke 1 and 2 curves, persistent curvature of the thoracolumbar/lumbar region, AVT of the MT curve, and high Risser grade may contribute to diminished gains in self-image.

HYPOTHESIS

Specific patient characteristics and radiographic factors are related to self-image in adolescent idiopathic scoliosis (AIS).

DESIGN

Analysis of single-center, prospectively collected data

INTRODUCTION

Although it is well known that major curve severity in AIS is related to self-image, surgeons often encounter patients who complain of low self-image with preoperatively mild curves or postoperatively well-corrected main curves, suggesting the presence of other factors.

METHODS

A total of 69 consecutive patients who underwent selective thoracic fusion for Lenke 1 or 2 curve AIS and were followed for a minimum of 2 years afterwards were included in this study of Scoliosis Research Society (SRS)-22r survey self-image scores. We considered sex, body mass index, Risser grade, age, angle of trunk rotation, Cobb angle of the main thoracic (MT) curve, Cobb angle of the thoracolumbar/lumbar (TL/L) curve, apical vertebral translation (AVT), T5-12 kyphotic angle, and clavicular angle. Univariate and multivariate general linear models were adopted to identify factors affecting self-image before and 2 years after surgery.

RESULTS

Preoperatively, we observed no remarkable correlation between MT curve Cobb angle and SRS-22 self-image score (p=0.32), although higher AVT of the MT curve was associated with a significantly worse self-image (p = 0.01) in univariate analysis. At 2 years after surgery, preoperatively larger Cobb angle of the TL/L curve (p=0.01) and higher Risser grade (p=0.02) were significantly related to a lower self-image score. AVT of the MT curve remained significant (p=0.009) in multivariate analysis of preoperative data. Multivariate analysis of data of 2 years after surgery revealed higher TL/L curve (p<0.01), higher Risser grade (p=0.02), and higher AVT of the MT curve (p=0.02) as having a significant impact on diminished self-image.

CONCLUSION

In patients with AIS, AVT of the MT curve appears to be more strongly related to self-image than does Cobb angle preoperatively. Two years after surgery, persistent curvature of the TL/L region and high Risser grade may additionally contribute to self-image worsening.

TAKE HOME MESSAGE

Two years after adolescent idiopathic scoliosis surgery, persistent curvature of the thoracolumbar/lumbar region, apical vertebral translation of the main thoracic curve, and high Risser grade diminished gains in self-image.

138. Concussive Injury to the Spinal Cord During Pediatric Spinal Surgery for Adolescent Idiopathic Scoliosis: A Rare Complication That Recovers Quickly

Robert H. Cho, MD; Martin Morrison, MD; Martin J. Herman, MD; David Lazarus, MD; Selina C. Poon, MD

SUMMARY

We describe 5 cases of direct concussive impact to the spinal cord during posterior spinal fusion with instrumentation (PSIF) that lead to rapid loss of TcMEP signals. Patients were closed and had some motor deficit with variable sensory deficits of which function returned completely or near complete prior to return to the operating room in 7-10 days. Patients had no residual neurologic deficit within 6 weeks of the index operation, and most were neurologically intact upon discharge.

HYPOTHESIS

Motor and sensory deficits caused by spinal cord concussion during PSIF will resolve itself after cessation of surgery.

DESIGN

Case series

INTRODUCTION

Iatrogenic injury to the spinal cord during posterior spinal fusion with instrumentation is rare, but is usually associated with screw misposition or secondary to the corrective maneuver used and the resultant spinal cord stretch. Direct concussive injury to the spinal cord is rare and has not been described in previous literature.

METHODS

Five PSIF cases from 4 institutions were reviewed. Patients had experienced direct concussive injury to the spinal cord secondary to an instrument used during surgery (gearshift pedicle probe, ball-tipped feeler probe, Frazier suction tip). Within 1-15 minutes, a decrease in TcMEP was noted in all patients. Four patients experienced a subsequent decrease in SSEP. Surgery was aborted in all cases after appropriate management of signal loss (blood pressure increase, warming spinal cord, removal of implants) and each patient was closed.

RESULTS

Initial postoperative neurologic deficit was noted in all 5 patients, ranging from weakness of entire lower extremity with sensory changes to loss of a particular muscle group with no sensory changes. Within 4-7 days, all patients had complete or near complete return of neurologic function. Patients were taken back to the operating room between 7-10 days for completion of the index procedure. No patients had TcMEP changes during the second procedure. Four patients were within preoperative neurologic baseline at the completion of the procedure, with 1 patient regaining sensory function by 6 weeks after surgery.

CONCLUSION

Concussive injury to the spinal cord during PSIF for adolescent idiopathic scoliosis is a rare complication that results in immediate TcMEP changes with subsequent SSEP changes. These patients should be closed after appropriate spinal cord management for signal loss. Postoperative neurologic injury recovers completely or nearly completely within 4-7 days and it is safe to proceed with index procedure after 7-10 days.

TAKE HOME MESSAGE

Neurologic deficit caused by spinal cord concussion during PSIF will resolve itself with appropriate management, allowing for completion of index procedure 7-10 days later.

139. The Validation of a New Sagittal Classification System in Adolescent Idiopathic Scoliosis

Sidsel Fruergaard, MD; Mohit J. Jain, MD; Casper Dragsted, MD; John Heydemann, MD; Soren Ohrt-Nissen, MD, PhD; Martin Gehrchen, MD, PhD; Benny T. Dahl, MD, PhD, DMSci

SUMMARY

The implications of sagittal malalignment are well documented in the adult population but less is known about the consequences in AIS. A new spinal sagittal classification has been proposed for surgical guidance. We validated the new classification system and found different distribution of the 4 proposed Genevois-Abelin sagittal types.

HYPOTHESIS

An external validation of a newly proposed sagittal classification system for adolescent idiopathic scoliosis (AIS).

DESIGN

Retrospective clinical study

INTRODUCTION

The overall objective of AIS corrective surgery is to achieve a balanced spine both in the coronal and sagittal plane. The implications of sagittal malalignment are well documented in the adult population but less is known about the consequences in AIS. Recently, a new spinal sagittal classification has been proposed by Genevois-Abelin et al to provide guidelines for the surgical strategy. The purpose of the present study was to validate this classification.

METHODS

We retrospectively included 105 consecutive AIS patients who underwent posterior spinal fusion. Preoperative long standing EOS radiographs and bending films were available on all patients. Patients were classified according to the recently suggested four sagittal patterns; type 1, 2a, 2b or 3. Furthermore, several predetermined sagittal parameters were compared between the four groups.

RESULTS

The mean preoperative Cobb angle was 63.8 ±11.5 and 73 % of the patients were women. Of 105 patients, 51 were type 1, 14 were type 2a, one was type 2b and 39 were type 3. The distribution of the four sagittal patterns was significantly different compared with the original publication ($p<0.05$). The four sagittal groups differed significantly in terms of thoracic kyphosis, length of thoracic and lumbar curves, lumbar lordosis, thoracic slope, C7 slope, pelvic incidence, and sacral slope ($p<0.05$). We found no difference between the groups in terms of cervical lordosis or upper and lower cervical angle.

CONCLUSION

The distribution of the four sagittal patterns varies between AIS cohorts and requires further validation.

TAKE HOME MESSAGE

The newly proposed sagittal classification system for AIS requires further validation.

140. Biomechanical Strength Comparison of Pedicle Screw Augmentation Using Poly-dicalcium Phosphate Dihydrate and Polymethylmethacrylate

Alberto J. Criado, MD; Sanar S. Yokhana, MD; *Tahsin M. Rahman, BS;* Scott McCarty, MD; Christopher J. Andrecovich, MS; Wei-Ping Ren, MD, PhD; Walid K. Yassir, MD

SUMMARY

Our study compared the pullout strength and torque resistance of pedicle screws augmented with polymethylmethacrylate (PMMA) and a novel cement, poly-dicalcium phosphate dihydrate (P-DCPD). An instron machine was used to measure the various loads and showed that P-DCPD is comparable to PMMA in pullout resistance. As such, P-DCPD has the potential to serve as an alternative to PMMA given other attractive qualities of P-DCPD, such as antibiotic integration and non-exothermic reactivity.

HYPOTHESIS

The hypothesis for our study is that the pullout strength and torque load for the PMMA and P-DCPD augmented pedicle screws would show no difference.

DESIGN

Prospective testing of pullout and torque resistance of PMMA and P-DCPD augmented CPS screws using standardized open cell rigid

foam blocks 5.5 PCF to mimic osteoporotic spinal bone and Instron machine to apply loads.

INTRODUCTION

The purpose of our study was to compare the pullout strength and torque resistance of conventional pedicle screws (CPS) augmented with either polymethylmethacrylate (PMMA) or Poly-dicalcium phosphate dihydrate (P-DCPD) cement in polyurethane foam blocks mimicking osteoporotic bone.

METHODS

Standardized low-density polyurethane open cell foam blocks were instrumented with conventional pedicle screws and were categorized into three groups of six each. Group 1 was the control group and no cement was used. Groups 2 and 3 were augmented with PMMA and P-DCPD respectively. An instron machine was used to apply an axial load to failure at a rate of 2 mm/min for three minutes and a torsional load to failure at a rate of 1 degree/second. Failure was defined by an evident drop in the load after maximum value.

RESULTS

Table 1 demonstrates the pullout load to failure for the groups described above. The PMMA and P-DCPD were significantly greater than control ($p < 0.0001$). Interestingly, there was no significant difference in the pullout load to failure for the PMMA and P-DCPD groups (Table 1). Table 2 demonstrates the torque load to failure for the groups. Analysis showed significant difference between PMMA and P-DCPD, with PMMA having greater torque resistance ($p = 0.00436$)

CONCLUSION

No difference was observed between PMMA and the biologically active P-DCPD in axial pullout load to failure conducted in standardized low-density open cell rigid foam blocks. While a significant difference did exist in our torque analysis, clinical significance of such a load on a native spine is questionable. Further investigation is warranted for this promising compound that seems to be comparable in pullout resistance to PMMA and offers attractive safety features.

TAKE HOME MESSAGE

Poly-Dicalcium Phosphate Dihydrate may be biomechanically comparable to polymethylmethacrylate and therefore serve as an attractive alternative for conventional pedicle screw cementing.

Table 1: Pullout Load Comparison

	Block 1 Pullout Load (N)	Block 2 Pullout Load (N)	Block 3 Pullout Load (N)	Block 4 Pullout Load (N)	Block 5 Pullout Load (N)	Block 6 Pullout Load (N)	Average Pullout Load (N)
PMMA	165.29	162.69	126.7	111.15	111.33	119.91	132.8 ± 24.8
P-DCPD	191.99	164.5	131.88	130.03	109.54	177.75	150.9 ± 31.9
Control	22.56	15.38	24.56	23.59	32.58	23.47	23.69 ± 5.5

Table 2: Torque Load Comparison

	Block 1 Torque Load (N*m)	Block 2 Torque Load (N*m)	Block 3 Torque Load (N*m)	Block 4 Torque Load (N*m)	Block 5 Torque Load (N*m)	Block 6 Torque Load (N*m)	Average Torque Load (N*m)
PMMA	0.754	0.416	1.81	3.48	2.03	2.58	1.85 ± 1.14
P-DCPD	0.363	0.358	0.201	0.351	0.392	0.326	0.331 ± 0.0675
Control	0.111	0.0754	0.086	0.0592	0.048	0.054	0.0722 ± 0.0236

Maximal Pullout and Torque Loads in PMMA Versus P-DCPD

141. Surgical Overcorrection Relative to Patient-specific Ideal Spinopelvic Alignment Reduces Pelvic Non-response for Severely Mal-aligned Adult Spinal Deformity Patients

Peter G. Passias, MD; Cole Bortz, BA; Haddy Alas, BS; Avery Brown, BS; Katherine E. Pierce, BS; Christopher G. Varlotta, BS; Jordan Manning, BA; Ethan W. Ayres, MPH; Edem J. Abotsi, BA; Erik Wang, BA; Dainn Woo, BS; Dennis Vasquez-Montes, MS; Mohamed A. Moawad, MPH; Constance Maglaras, PhD; Bassel G. Diebo, MD; Tina Raman, MD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; Michael C. Gerling, MD; Frank J. Schwab, MD; Renaud Lafage, MS; Virginie Lafage, PhD

SUMMARY

Persistent lumbopelvic malalignment following ASD-corrective surgery may impair quality-of-life and result in persistent pathologic compensation in the lower extremities. Patient-specific age- and BMI-adjusted alignment targets have been proposed to improve alignment outcomes; however, it is unclear whether reaching these postop targets reduces rates of pelvic non-response following surgery. This study shows greater persistent lower-extremity compensation for pelvic non-responders. Additionally, for severely malaligned patients, overcorrection relative to ideal age- and BMI adjusted targets was associated with lower rates of pelvic non-response.

HYPOTHESIS

For severely deformed patients, matching ideal postop alignment does not lower rates of pelvic non-response.

DESIGN

Retrospective review

INTRODUCTION

It's unclear whether reaching ideal postop alignment reduces rates of pelvic non-response.

METHODS

ASD patients from a single center with pre- and postop(<1Y) full-body stereoradiographs were grouped: no postop improvement in SRS-Schwab PT modifier (pelvic non-responders, PNR), and improvment (pelvic responders, PR). Groups were propensity score matched for preop PT, and assessed for differences in spinal and lower-extremity (LE) alignment. Persistent postop LE compensation (no improvement in LE alignment) was compared between groups. Subanalysis assessed the relationship between reaching postop age- and BMI specific alignment targets and rates of pelvic non-response.

RESULTS

Following propensity score matching, PNR(N=29) and PR(N=29) patients did not differ in demographics, preop alignment, or levels fused(all $p>0.05$); however, PNR patients has less preop knee flexion (9° vs 14°, $p=0.043$). PNR patients had inferior postop lumbopelvic alignment in PT (30° vs 17°), PI-LL (17° vs 3°), and globally (TPA 27° vs 15°, all $p<0.001$). Table 1 shows the greater LE compensation for PNR patients. Groups did not differ in rates of reaching age- and BMI specific ideal postop alignment (PT, SVA, TPA, PI-LL, all $p>0.05$). For patients with severe preop SVA deformity, overcorrection relative to ideal postop PT was associated with lower rates of pelvic non-response (under: 12%, match: 18%, over: 71%, $p<0.001$). Lower rates of non-response were observed

for patients with severe preop PT deformity overcorrected relative to ideal postop PI-LL (under: 0%, match: 30%, over: 70%, p=0.016).

CONCLUSION

Pelvic non-responders following ASD-corrective surgery had higher rates of persistent lower extremity compensation. Patients with severe preop PT deformity that were surgically overcorrected with respect to ideal PI-LL had lower rates of postop pelvic non-response, indicating that for such patients, existing alignment targets may need to be adjusted to optimize alignment outcomes.

TAKE HOME MESSAGE

For patients with severe preop PT, overcorrection relative to ideal postop PI-LL alignment was associated with lower rates of pelvic non-response, indicating existing alignment targets warrant adjustment to optimize outcomes.

	Patient Group		p-value
	Pelvic Non-Responders (PNR) (N=29)	Pelvic Responders (PR) (N=29)	
Postoperative Lower Extremity Alignment			
Pelvic shift (mm)	52.6± 30.4	31.2± 36.0	***0.021**
Pre- to Postoperative Change in Lower Extremity Alignment			
Sacfofemoral angle (°)	2.1± 5.8	-5.3± 7.0	***<0.001**
Pelvic Shift (mm)	-24.1± 37.3	-63.7± 42.5	***0.001**
Pelvic femoral angle (°)	-1.4±2.2	-3.8±3.0	***0.002**
Global sagittal angle (°)	-3.5± 4.8	-8.8±4.4	***<0.001**
Rates of persistent postoperative lower extremity compensation			
Sacfofemoral angle	68%	25%	***0.003**
Ankle flexion	64%	33%	***0.032**
Pelvic shift	28%	4%	***0.049**

142. Time-dependent Interpretation of Mechanical Complications Using Cox Regression and Survival Analysis

Caglar Yilgor, MD; Altug Yucekul, MD; Can Berk Asaroglu; Duhan Kilickan; Tais Zulemyan, MSc; Duru Karasoy, PhD; Yasemin Yavuz, PhD; Sleiman Haddad, MD, PhD, FRCS; Ibrahim Obeid, MD, MS; Frank S. Kleinstueck, MD; Francisco Javier Sanchez Perez-Grueso, MD; Emre R. Acaroglu, MD; Ferran Pellisé, MD, PhD; Ahmet Alanay, MD; European Spine Study Group

SUMMARY

Using data from an adult spinal deformity (ASD) database, including 697 patients with a mean of 29.5 months follow-up after surgery, and a 36% complication rate, risk of mechanical complications were assessed in a time-dependent manner. The postoperative GAP Score, sacroiliac fixation, age, postoperative T10-L2 Sagittal angle, the number of levels fused and the number of rods were found to be independent factors affecting the occurrence and timing of mechanical complications. Survival graphs for the most important features were depicted.

HYPOTHESIS

Risk assessment for mechanical complications should be time-dependent

DESIGN

Retrospective analysis of prospectively collected data

INTRODUCTION

Risk factors associated with mechanical complications after ASD surgery are multifactorial and plentiful (>60 have been suggested). Duration of follow-up emerges to be one of the most important determinants. Thus, factors affecting the occurrence and timing of mechanical complications should be assessed together in multifactorial Cox regression and survival models.

METHODS

Inclusion: ≥4-level fusion. Univariate tests included 66 factors derived from preoperative (25 history, demographic, radiographic), operative (32 technique and implant-related data), and postoperative (9 radiographic) data. To avoid multicollinearity, correlations were assessed guided by clinical expertise. Multivariate Cox proportional hazards models were created to estimate survival time probabilities and predict independent factors affecting the occurrence and timing of mechanical complications.

RESULTS

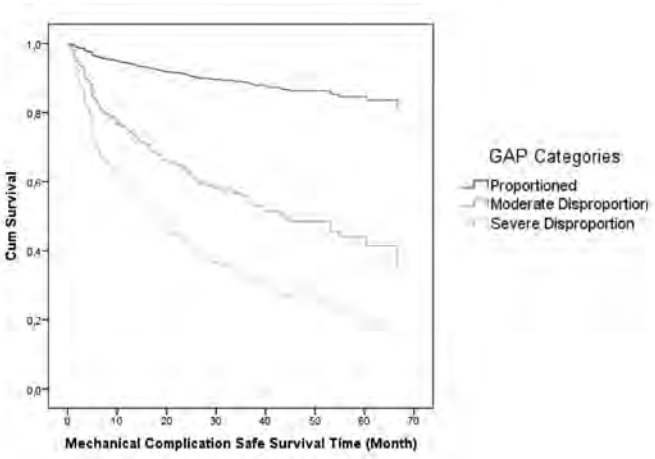
697 pts (551F, 146M, 53±19 yrs) with a mean f-up of 29.5 (1.5-94) months were included. 29 factors were identified as significant and near significant (p<0.25), and was included in multivariate analysis. Sagittal plane reconstruction quantified by the postoperative GAP Score, sacroiliac fixation, age, postop T10-L2 Sagittal angle, the number of levels fused and the number of rods were most important factors. Moderately and severely disproportioned states displayed 4.9 (95% CI 3.1-7.8) and 8.7(95% CI 5.4-14), times higher Hazards Ratios, respectively (p<0.001). Patient with sacroiliac fixation experienced 1.8 greater odds of incurring a mechanical complication compared to thoracolumbar fusions (p=0.01). Rates of mechanical complications increased as age (p=0.004), the number of levels fused(p=0.002) and postoperative T10-L2 Sagittal angle (p=0.009) increases. Using double-rod constructs decreased the likelihood of incurring a mechanical complication (p=0.029).

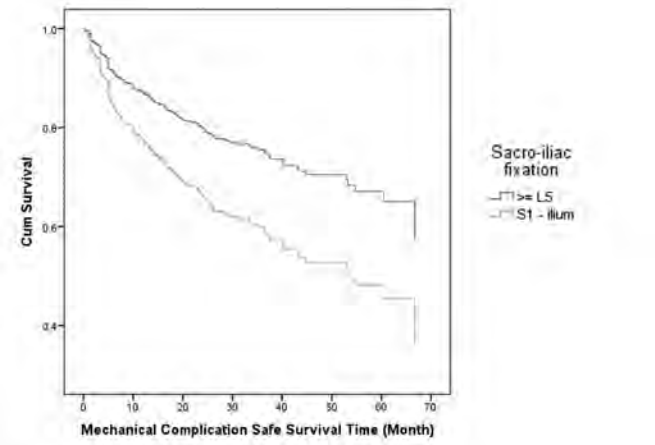
CONCLUSION

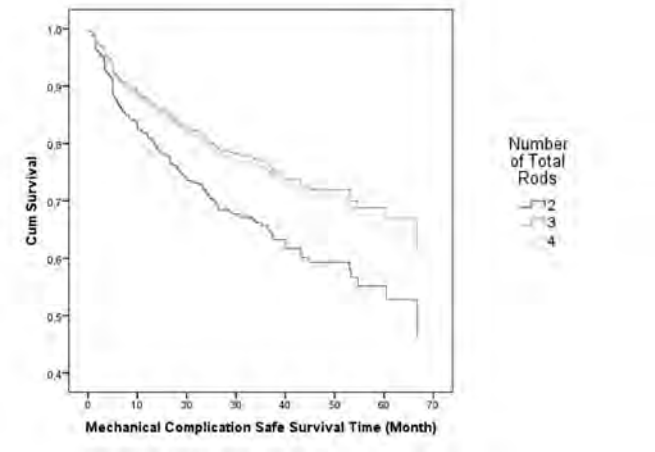
A total of 6 factors regarding demographics, technical details and sagittal radiographic measurements were identified affecting the occurrence and timing of mechanical complications.

TAKE HOME MESSAGE

The postoperative GAP Score, sacroiliac fixation, age, postoperative T10-L2 Sagittal angle, the number of levels fused and the number of rods were the most important factors affecting mechanical complication rates.







143. Equilibrating SRS Sagittal Deformity Grades with the PROMIS Physical Health Domain in Adult Spinal Deformity

Peter G. Passias, MD; Haddy Alas, BS; Avery Brown, BS; Cole Bortz, BA; Katherine E. Pierce, BS; Dennis Vasquez-Montes, MS; Erik Wang, BA; Ethan W. Ayres, MPH; Edem J. Abotsi, BA; Jordan Manning, BA; Christopher G. Varlotta, BS; Bassel G. Diebo, MD; Tina Raman, MD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; Michael C. Gerling, MD

SUMMARY

The Patient-Reported Outcomes Measurement Information System (PROMIS) is a comprehensive self-report measurement tool with patient functions, symptoms, behaviors, and mental health outcomes. Little work has been done correlating PROMIS physical health domain metrics with established adult spinal deformity (ASD) classifications such as SRS-Schwab deformity. We correlated baseline sagittal malalignment grades via the SRS-Schwab classification with Pain Intensity(PI), Physical Function(PF), and Pain Interference(Inter), establishing threshold scores in PROMIS predictive of severe sagittal deformity grades in a cohort of operative ASD patients.

HYPOTHESIS

PROMIS physical health domain scores correlate to grades of SRS sagittal deformity

DESIGN

Retrospective review

INTRODUCTION

The PROMIS is a powerful self-assessment metric with broad applicability across spine pathologies.

METHODS

Surgical ASD patients(SVA≥5cm, PT≥25°, TK ≥60°) ≥18 years old with available baseline(BL) radiographic and PROMIS data were isolated in the single-center comprehensive Spine Quality Database (Quality). Patients were classified according to SRS-Schwab deformity modifiers(0,+,++) for SVA, PI-LL, and PT. Descriptives and univariate analyses compared population-weighted PROMIS scores for PI, PF, and Interference across ASD deformity modifiers. Conditional Tree Analysis(CTA) with logistic regression sampling established cut-off points for PROMIS scores predicting severe malalignment (++) at BL compared to mild or moderate (0,+).

RESULTS

41 pts (58.95yrs,75.6%F,29.1kg/m2) met inclusion criteria. BL SRS modifiers were as follows: SVA 51.2%, 2.4%, 46.3% (0,+,++); PI-LL 27.3%, 12.1%, 60.6%(0,+,++); PT 18.2%, 36.4%, 45.5% (0,+,++). Mean cohort PI score was 94.2±6.0, mean PF score 8.95±10.1, mean Inter score 57.84±5.46. PF and Interference differed significantly across low and high SVA groups, with low SVA having significantly higher PF(13.50 vs 3.68,p<0.001) and lower Inter (59.62 vs 56.30, p=0.05). PI did not differ across SVA groups(p>0.05). Low PI-LL pts had significantly higher PF than pts with ++PI-LL(19.3 vs 4.15,p=0.001), and trended lower PI and Inter without significance. No significant differences in PI, PF, or Inter were found across PT groups(all p>0.05). CTA found a PI score>98 or PF score <6 were independent predictors of Severe(++)SVA as opposed to Mild/Moderate SVA(Table1). For example, a PF score<6 increased odds of ++SVA by at least 2.7x compared to 0/+SVA. Similar significant thresholds in PI and PF scores were found for ++PI-LL, but not ++PT.

CONCLUSION

Inferior PROMIS scores of Pain Intensity and Physical Function predicted increasingly severe SRS sagittal modifiers at baseline, specifically severe sagittal vertical axis and lumbopelvic mismatch.

TAKE HOME MESSAGE

Inferior PROMIS scores of Pain Intensity and Physical Function predicted increasingly severe sagittal modifiers at baseline, specifically severe sagittal vertical axis and lumbopelvic mismatch.

			PROMIS Metric											
			Pain Intensity				Physical Function				Pain Interference			
			Threshold Defined?	OR	Lower Interval	Upper Interval	p	Threshold Defined?	OR	Lower Interval	Upper Interval	p	Threshold Defined?	OR	Lower Interval	Upper Interval	p
Severe SRS-Schwab Modifier	SVA(++)		>98	7.04	1.55	31.9	**0.012**	≤6	14.88	2.71	81.7	**0.002**	>56	3.69	0.83	16.51	0.087
	PI-LL(++)		>98	11.61	2.12	63.74	**0.005**	≤8	12.00	2.20	65.52	**0.004**	>54	2.83	0.62	13.04	0.181
	PT(++)		No	na	na	na	na	≤9	2.93	0.66	12.93	0.156	>59	2.92	0.75	11.41	0.124

Table 1: Global alignment parameters (SVA, PI-LL, PT) across PROMIS physical health metrics (Pain Intensity, Physical Function, and Pain Interference). Thresholds were defined using Conditional Tree Analysis, with significant p-values bolded at p<0.05.

144. Spinal Alignment and Lumbar Fusion: Implications on Spinopelvic Alignment in Dynamic Hyperextended and Flexed Postures

Edem J. Abotsi, BA; Ethan W. Ayres, MPH; Laviel Fernandez, MD; Jonathan Vigdorchik, MD; Andrew J. Shimmin, MBBS, FRCS;

Jonathan Baré, MBBS, FRACS; Constance Maglaras, PhD; *Aaron J. Buckland, MBBS, FRACS*

SUMMARY

Hip-spine literature largely focused on relaxed standing and sitting radiographs for analysis, however lumbopelvic alignment in dynamic hyperextension and flexion postures has not previously been studied. This study investigates the effect of PI-LL mismatch and lumbar fusion on the relative contributions of the lumbar-spine and pelvis in dynamic hyperextended and flexed-postures. We demonstrate that lumbar flatback and fusion patients predominanatly alter pelvic tilt moving from extremes of flexion and extension, contrary to hyperlordotic patients who primarily recruit lumbar spinal motion.

HYPOTHESIS

Lumbar flatback (LF) or Fusion patients will recruit more pelvic tilt (PT) change and less lumbar lordosis (LL) change than normal or hyperlordotic (HL) lumbar spines between hyperextension step-up (STEP) and flexed sitting (FLEX) postures.

DESIGN

Retrospective analysis of a prospective, multicenter database.

INTRODUCTION

Hip-spine literature has largely focused on relaxed standing and sitting radiographs for analysis, however lumbopelvic alignment in dynamic hyperextension and flexion postures has not previously been studied.

METHODS

A multi-center database of patients undergoing Total Hip Arthroplasty was queried to analyze sagittal lumbar spinal and pelvic alignment on dynamic radiographs of patients in the standing, STEP and FLEX postures. Single leg step-up (STEP) images were taken to simulate maximal extension of the lumbar spine and pelvic retroversion, and flex-seated (FLEX) radiographs simulated the position of maximal lumbar spinal flexion and pelvic anteversion. Patients were grouped by lumbar pathology and classified according to PI-LL (<-10°, -10° to 10°, >10°). Lumbar flatback (LF) deformity was defined as PI-LL>10° (mild = PI-LL >10°; severe = PI-LL>20°), hyperlordosis (HL) as PI-LL<-10° (mild = PI-LL <-10° and severe = PI-LL<-20°), normal (PI-LL = -10° to 10°), and lumbar fusions. Changes in PT and LL between postures across PI-LL groups compared using a one-way ANOVA.

RESULTS

1,374 patients (64±10yrs, 50%M) were analyzed. PI-LL groups consisted of severe HL (n=81), mild HL (n =256), normal (n=811), mild LF (n=152), severe FL (n=56), and fusion (n=14, 2.64 levels fused). There was no difference between STEP and standing alignment. LF patients had higher mean PT and lower LL in all postures, ($p<0.05$) than normal and HL patients (Fig1). When transitioning from STEP to FLEX, HL groups had significantly less change in PT and more change in LL ($p<0.05$). Fusion patients had similar PT change as severe LF patients from STEP to FLEX postures.

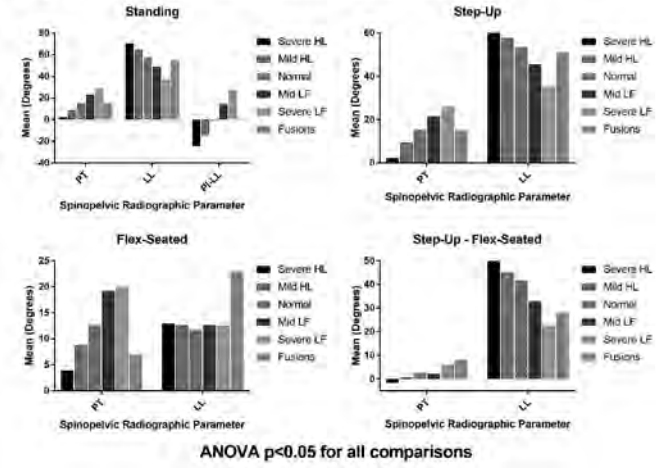
CONCLUSION

LF and Fusion patients address limited lumbar mobility via recruitment of PT, distinct from HL patients who recruit more LL and less PT from hyperextension to flexed postures.

TAKE HOME MESSAGE

Lumbar flatback and fusion patients compensate lumbar stiffness by increasing pelvic tilt change from maximal flexion to extension, while hyperlordotic patients apply lumbar spinal motion but less pelvic tilt change.

Fig. 1: Variance in mean values of parameters.



145. Neural Network Utilization for the Automated Extraction of Schwab Modifiers from Plain Radiographs in Adult Spinal Deformity Patients

Wesley M. Durand, BS; Alan H. Daniels, MD; Maria I. Restrepo, PhD; Paul Stey, PhD; Indra N. Sarkar, PhD; D. Kojo Hamilton, MD; Peter G. Passias, MD; Themistocles S. Protopsaltis, MD; Virginie Lafage, PhD; Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Munish C. Gupta, MD; Eric O. Klineberg, MD; Robert A. Hart, MD; Frank J. Schwab, MD; Douglas C. Burton, MD; Shay Bess, MD; Christopher P. Ames, MD; International Spine Study Group

SUMMARY

This study utilized a neural network with a modified DenseNet architecture to automatically extract binary Schwab modifiers from lateral plain radiographs of adult spinal deformity patients. The predictive accuracy and AUC for SVA were very good, while PT and PI-LL predictions were less impressive. These results represent an evolving technique with room for further refinement, particularly with regard to perception of non-global alignment metrics.

HYPOTHESIS

Models can be developed to extract Schwab modifiers from lateral radiographs of ASD patients.

DESIGN

Retrospective analysis of a multi-center, prospectively-defined database of a consecutive cohort of ASD patients.

INTRODUCTION

The measurement of sagittal alignment is a key component of patient assessment and operative planning in adult spinal deformity surgery. Machine learning techniques, such as artificial neural networks (ANNs), have shown promise in medical image analysis. We sought to evaluate the potential for ANNs to automate extraction of Schwab modifiers from lateral plain radiographs of adult spinal deformity patients.

METHODS

From 1,506 patients, lateral plain radiographs were randomized to training and testing datasets in an 80:20 ratio. Outcome measures were Schwab modifiers for SVA, PT, and PI-LL, analyzed as binary (0 vs. +/++). Pre- and post-operative radiographs were abstracted as available up to 2-year follow-up. Image preparation and analysis was done using the Julia programming language and a modified DenseNet architecture.

RESULTS

Among Schwab modifier outcomes, AUCs for prediction of 0 vs. +/++ rating were 0.95 for SVA, 0.85 for PI-LL, and 0.78 for PT. The corresponding prediction accuracies and false positive/negative rates (FPR/FNR) for SVA, PI-LL, and PT were 87% (FPR 11%, FNR 16%), 79% (FPR 11%, FNR 35%), and 71% (FPR 28%, FNR 30%), respectively.

CONCLUSION

This study demonstrates the potential for ANNs to automate extraction of binary SVA, PI-LL, and PT from pre- and post-operative lateral plain radiographs of ASD patients. The predictive accuracy and AUC for SVA showed the most promise. The results suggest the potential of ANNs, identify areas for refinement, particularly with regard to perception of non-global alignment metrics.

TAKE HOME MESSAGE

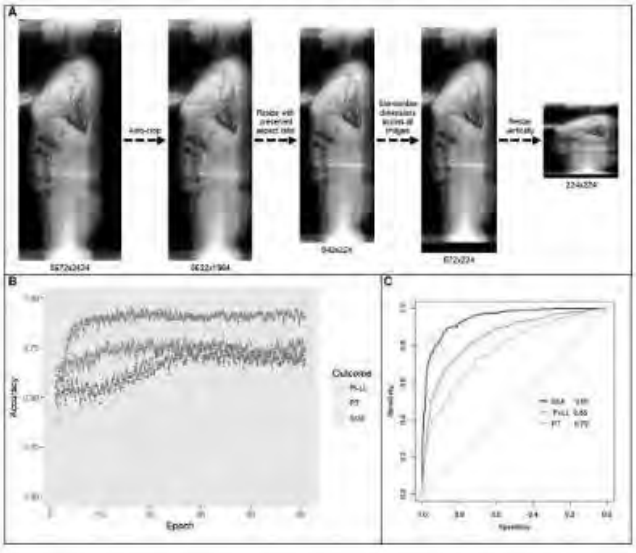
This study utilized a neural network with a modified DenseNet architecture to automatically extract binary Schwab modifiers from lateral plain radiographs of adult spinal deformity patients

Figure 1:

A: Example of Image Pre-Processing

B: Model Validation by Schwab Modifier

C: Receiver Operating Characteristic Curve Analysis by Schwab Modifier



146. SRS-22r Question 11 is a Valid Screen for Opioid Use in Adult Spinal Deformity

Travis S. CreveCoeur, BS; Shay Bess, MD; Robert Owen, MD; Jeffrey L. Gum, MD; Breton G. Line, BS; Lawrence G. Lenke, MD; *Michael P. Kelly, MD, MS*

SUMMARY

Question 11 (Q11) from the SRS-22r outcomes questionnaire is sensitive and specific for the use of opioids before and after ASD surgery. Patients reporting "Daily narcotic" use consume nearly three times the morphine-equivalent dose of "Weekly or less" users. Q11 exhibits almost perfect agreement with an independent prospective questionnaire designed to assess opioid consumption and may serve as an appropriate surrogate for monitoring opioid use.

HYPOTHESIS

The Scoliosis Research Society-22 (SRS-22) question 11 (Q11) response is a valid measure to capture opioid use in adult spinal deformity (ASD) patients.

DESIGN

Prospective observational cohort

INTRODUCTION

The United States is facing an opioid crisis. Opioids are an ineffective treatment for low back pain and their effectiveness in ASD surgery is unknown. The Question 11 (Q11) explicitly asks about pain medication use. No study has validated Q11 responses as a method of assessing preoperative and postoperative opioid use in ASD.

METHODS

A prospective, observational cohort study of adults undergoing surgery for ASD was queried for Q11 responses and case report morphine equivalent dosing (MED) consumption data. Data were collected at enrollment and 2-year followup. Responses to question 11 (Q11) from SRS-22r were collected and compared with responses to the opioid consumption CRF, including morphine equivalent dosage (MED). Cohen's kappa measured agreement between the CRF and Q11. Mean daily MED consumption for Q11 responses were calculated. Sensitivity and specificity for the Q11 (+) responses were calculated using MED reports as the gold standard.

RESULTS

116 Patients completed minimum 2-year followup. Mean daily MED consumption for patients reporting "Daily Narcotic" use was 62.0 (SD: 87.5)mg; for patients reporting "Narcotics weekly or less" mean daily MED consumption was 21.6 (29)mg. The positive Q11 responses 96% sensitive and 92% specific for opioid users. Cohen's kappa indicated almost perfect agreement between the MED CRF and Q11 ($k=0.878$, $p<0.001$).

CONCLUSION

SRS-22r Q11 exhibits almost perfect agreement with an independent questionnaire designed to assess opioid consumption in an ASD cohort. Patients reporting "Daily narcotic" use report nearly 3x the mean, daily MED versus "Weekly or less" users (62.0 ± 87.5mg vs 21.6 ± 29mg). Q11 exhibited excellent sensitivity and specificity for determining opioid users and nonusers. Given the need for opioid research in ASD, Q11 may serve as an appropriate surrogate for dedicated questionnaires regarding opioid use.

TAKE HOME MESSAGE

Surgeons can reliably use the self-reported opioid consumption on the SRS-22 Q11 as a qualitative marker of prescribed opioid consumption, which can be applied to future outcome studies.

147. Revision Surgery in Pan Lumbar Arthrodesis for Adult Spinal Deformity– Incidence; Risk Factors and Impact

Tatsuya Yasuda, MD; Sleiman Haddad, MD, PhD, FRCS; Alba Vila-Casademunt, MS; Ahmet Alanay, MD; Caglar Yilgor, MD; Emre R. Acaroglu, MD; Frank S. Kleinstueck, MD; Ibrahim Obeid, MD, MS; Francisco Javier Sanchez Perez-Grueso, MD; Tomohiko Hasegawa, MD, PhD; Yu Yamato, MD, PhD; Daisuke Togawa, MD, PhD; Go Yoshida, MD, PhD; Tomohiro Banno, MD, PhD; Hideyuki Arima, MD, PhD; Shin Oe, MD; Ferran Pellisé, MD, PhD; Yukihiro Matsuyama, MD, PhD; European Spine Study Group

SUMMARY

Pan Lumbar Arthrodesis (PLA) is often required for correction of adult spinal deformity. Revision Surgery (RS) rate after PLA was 28% in data collected from an institutional and multicenter datasets, 80% of all revisions were due to mechanical failures. RS negatively impacted patients' general health at 2-years. Univariate analysis identified demographical (BMI, Diagnosis) and postoperative sagittal variables (GT and RPV) associated with RS. Multivariate analysis could identify nerve system disorder comorbidity and BMI as sole independent risk factors.

HYPOTHESIS

Revision surgery (RS) in Pan Lumbar Arthrodesis (PLA) for adult spinal deformity (ASD) are common and have negative impact on clinical outcome.

DESIGN

Retrospective multicenter review of prospectively collected ASD data from 7 hospitals covering Europe and Japan.

INTRODUCTION

Very few papers have investigated complications and outcomes in the subset of patients with less compensatory capacity associating pelvic fixation and PLA. The aim of this study was to assess RS rate after PLA for ASD, its risk factors and impact on clinical outcomes.

METHODS

ASD patients from two prospective databases having a posterior instrumented fusion spanning the whole lumbar region (UIV ≥ T12; LIV≤S1) with more than 2 years of follow-up were reviewed. Demographic, surgical, deformity and Health Related Quality of Life (HRQoL) parameters were included in the analysis. Univariate and multivariate regression models analyzed risk factors for RS.

RESULTS

Out of the 1359 ASD patients included in the database 589 (43%) had a PLA. Of these 357 reached the 2-years follow-up and were analyzed. Average age was 67 and 82% were females. 100 Patients (28.1%) needed a RS and 80% were due to mechanical failures. 16 patients needed more than 1 RS. Infection rate was 2.8%. Revised patients were more likely to have nerve system disorder comorbidity, higher BMI and worst immediate postoperative alignment (Global Tilt and Relative Pelvic Version). Deformity and HRQoL parameters were comparable at baseline and non-revised patients had significantly better clinical outcomes at 2 years (SRS 22 scores, ODI, Back pain). Multivariate analysis could identify nerve system disorder comorbidity (OR 4.8; p =0.001) & BMI (OR 1.1; p =0.004) as independent risk factor for RS .

CONCLUSION

RS due to mechanical failures is relatively common after PLA leading to worse clinical outcomes. Prevention strategies should focus on individualized restoration of sagittal alignment and better weight control to decrease stress on these rigid construct in non-compliant spines. Nerve system disorder comorbidities also increase RS risk in PLA.

TAKE HOME MESSAGE

PLA have worse tolerance to deviations from individualized sagittal ideals and increased mechanical loads (high BMI, nerve system disorder), due to limited compensation capacity.

		No-Revision		Revision		
N		257	(%, SD)	100	(%, SD)	P value
Demographical Variables						
Age		67.3	69.06	65.69	11.09	0.146
Gender(%)	F	214	83.3	80	80	0.536
	M	43	16.7	20	20	
ASA classification		1.98	0.46	2.2	0.53	0.444
BMI		***24.23***	***4.31***	***25.97***	***4.82***	***0.001***
Diabetes		29	11.3	10	10	0.851
Liver Disease		8	3.1	4	4	0.745
Nerve system Disorder		***8***	***3.1***	***13***	***13***	***0.001***
Osteoporosis		73	28.4	32	32	0.519
Renal Disease		15	5.8	4	4	0.606
Tobacco Consumption		30	11.7	19	19	0.086
Surgical Variables						
Total Blood Loss		1816.88	1212.05	2017.4	1266.2	0.167
Total Surgical Time		143.89	220.74	190.57	199.31	0.067
Number of fusion segment		9.79	2.82	9.6	3.12	0.691
Combined Anterior/Posterior Approaches		42	16.3	11	11	0.247
3-Columns Osteotomy		82	31.9	31	31	0.9
First Standing X-Ray Parameters						
Cobb Angle		12.81	11.67	13.44	15.58	0.686
Global Tilt		***20.41***	***10.59***	***23.48***	***11.59***	***0.02***
PI-LL		5.49	13.47	8.19	13.56	0.099
PT		20.89	9.27	21.69	8.82	0.471
SVA		35.98	44.43	40.62	47.4	0.407
Relative Lumbar Lordosis		-13.91	11.51	-15.79	13.13	0.194
Relative Pelvic Version		***-7.92***	***7.52***	***-9.83***	***7.97***	***0.04***
Lumber Distribution Index		64.97	18.66	67.78	19.39	0.348
Relative Spinopelvic Alignment		10.76	8.77	13.46	10.53	0.072
2 Years HRQoL Parameters						
Back Pain VAS		**3.69**	**2.8**	**4.45**	**3.15**	**0.031**
Leg Pain VAS		3.49	2.89	3.62	3.04	0.708
ODI Score		**31.09**	**19**	**40.7**	**21.16**	**<0.001**
SRS-22 Function		**3.2**	**0.79**	**2.91**	**0.85**	**0.003**
SRS-22 Mental		**3.34**	**0.78**	**3.07**	**0.85**	**0.005**
SRS-22 Pain		**3.67**	**0.96**	**3.26**	**1**	**<0.001**
SRS-22 Satisfaction		**3.8**	**0.98**	**3.59**	**1**	**0.075**
SRS-22 Self Image		**3.37**	**0.85**	**3.05**	**0.89**	**0.002**
SRS-22 Total Score		**3.43**	**0.7**	**3.12**	**0.74**	**<0.001**
ΔODI		**16.18**	**18.72**	**9.7**	**-17.86**	**0.003**

148. The Natural Evolution of Pelvic Incidence in Degenerative Scoliosis Patients: A Longitudinal Study with a Minimum Follow-up of Two Years

ChangChun Tseng, MD; Zhen Liu, MD; Jie Li, MS; Yong Qiu, MD; Zezhang Zhu, MD

SUMMARY

Previous studies suggested that pelvic incidence man increased due to lumbosacral stress and age. The purpose of this study is to verify whether PI would change in degenerative scoliosis (DS) patients during the natural evolution and identify possible factors associated with the change in PI.

HYPOTHESIS

1

DESIGN

Retrospective cohort

INTRODUCTION

The purpose of this study is to verify whether PI would change in degenerative scoliosis (DS) patients during the natural evolution and identify possible factors associated with the change in PI.

METHODS

Patients over age 50 who came to our clinic between January 2010 and January 2018 were retrospectively reviewed. Inclusion criteria include: Patients (1) who were diagnosed as degenerative scoliosis at last follow-up, (2) Follow-up period longer than two years. Patients with a prior history of spinal or pelvic surgery and nonambulatory patients were excluded from the study. A total of 13 DS patients with follow-up more than two years were included in this study. The following sagittal radiographic parameters were measured: PI, pelvic tilt (PT), sacral slope (SS), sagittal vertical axis (SVA), Lumbar lordosis (LL), T1 pelvic angle, PI-LL, PT/PI. Meanwhile, Changes in PI, PT, SS, LL, SVA , PT/PI and PI-LL, were calculated by subtracting the initial values from the last visit values.

RESULTS

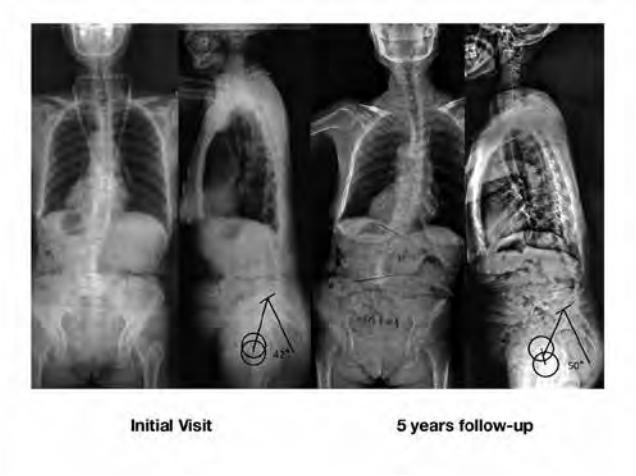
In this study, 13 DS patients (13 females; mean age, 67.25 ± 7.20 years, range 54–72 years) were ultimately included in our study with the minimum follow up of two years. Of these patients, the mean follow-up period was 38.27 ± 19.37 months, range from 24 to 96 months. PI significantly increased from 43.67° ± 5.26° initially to 52.32° ± 7.62° at last follow-up, with a mean change of 7.42° ± 2.35° ($P < 0.05$). Meanwhile, PT, SVA, TPA, PI-LL were increased significantly while LL was decreased significantly at last follow-up indicating patients at last follow-up ($P < 0.05$). In contrast, SS changed from 22.31 ± 8.22 to 23.79 ± 8.87 without statistical significance ($P = 0.103$) and PT/PI changed from 0.52 ± 0.13 to 0.55 ± 0.19 without statistical significance ($P = 0.236$). The correlation analysis showed that the change in PT ($P = 0.08$), the change in TPA ($P = 0.012$), initial PI ($P = 0.03$) and last follow-up PI ($P = 0.001$) were significantly associated with the increase in DS patient.

CONCLUSION

In conclusion, our study showed that PI significantly increased in DS patients during the natural evolution.

TAKE HOME MESSAGE

The anterior malalignment and pelvic retroversion might destabilize the sacroiliac joint which may lead to an increase in PI.



Demonstration case

150. The Minimally Invasive Interbody Selection Algorithm (MIISA) for Spinal Deformity

Praveen V. Mummaneni, MD; Christopher I. Shaffrey, MD; Robert K. Eastlack, MD; Juan S. Uribe, MD; Richard G. Fessler, MD, PhD; Paul Park, MD; Leslie C. Robinson, MD, PharmD, MBA; Joshua Rivera; Dean Chou, MD; Kai-Ming Gregory Fu, MD, PhD; Adam S. Kanter, MD; David O. Okonkwo, MD, PhD; Pierce D. Nunley, MD; *Khoi D. Than, MD;* International Spine Study Group

SUMMARY

There are several interbody approach selection options for MIS deformity surgery, and there is little existing guidance on which option to choose for which level. We developed the Minimally Invasive Interbody Selection Algorithm (MIISA) after reviewing a cohort of 223 patients in an MIS database to create a platform to guide approach selection.

HYPOTHESIS

MIS surgeons will benefit from an approach selection algorithm

DESIGN

Retrospective multicenter database review

INTRODUCTION

Multiple MIS interbody fusion options have been utilized as MIS deformity surgery has become more prevalent. However, at this time there is little guidance for approach selection for MIS deformity surgery. The minimally invasive interbody selection algorithm (MIISA) was created to provide a framework for rational decision making.

METHODS

A team of experienced spinal deformity surgeons developed the MIISA, incorporating the experience of a retrospective dataset from 223 MIS surgeries collected over a five-year period. The algorithm leads to one of 4 interbody approach options (including ALIF, ACR, LLIF, and TLIF) that allow either indirect or direct decompression of the neural elements, possibly restore disc space and foraminal height, and may restore lordosis.

RESULTS

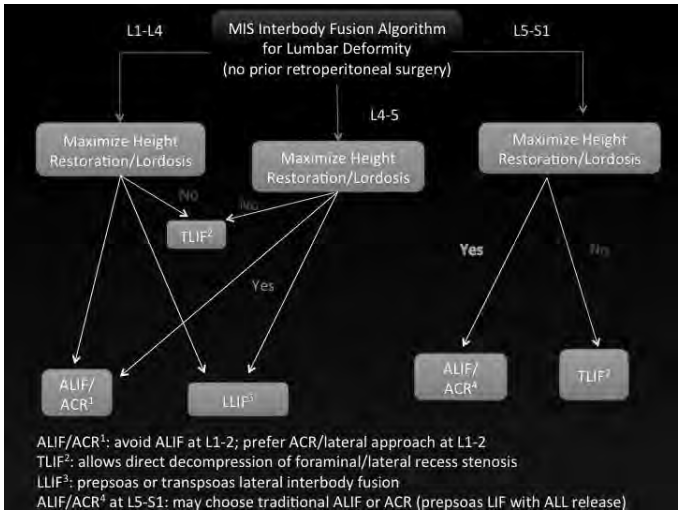
Over a five-year period, 11 surgeons completed 223 MIS deformity surgeries with 661 interbody devices. The database of these cases was reviewed and the type of interbody approach used at each level from L1-S1 was noted. The MIISA was then created with substantial agreement. The surgeons preferred lateral approaches for L1-L2 (95.6%), L2-L3 (88.0%), and L3-L4 (85.5%). They preferred lateral approaches at L4-L5 (70.7%). They preferred TLIF to ALIF at L5-S1 (63.4% vs. 36.6%). The increase in segmental lordosis at L2-L3 was significantly greater with LLIF than TLIF (4.6 vs. 1.4 degrees, $p = 0.029$). The increase in segmental lordosis at L4-L5 was significantly greater with ALIF than LLIF or TLIF (9.2 vs. 5.3 vs. 0.8 degrees, $p < 0.001$). The increase in segmental lordosis at L5-S1 was greater with ALIF than TLIF (5.3 vs. 1.9, $p = 0.011$).

CONCLUSION

The use of the MIISA provides consistent guidance to surgeons who are considering an MIS approach for the treatment of adult spinal deformity. This algorithm provides for surgeons to achieve the desired goals of surgery. When these goals consist of maximizing lordosis, one should consider LLIF at L2-L3 and ALIF at L4-L5, L5-S1; Otherwise, other interbody techniques are suitable.

TAKE HOME MESSAGE

The Minimally Invasive Interbody Selection Algorithm (MIISA) can help surgeons select appropriate interbody techniques when used in deformity.



151. Utility of Additional Interbody Devices for Fusions at the Level of the Fractional Curve

Dominic Amara, BS; Sigurd H. Berven, MD; Christopher P. Ames, MD; Bobby Tay, MD; Vedat Deviren, MD; Shane Burch, MD, MS, FRCS(C); Praveen V. Mummaneni, MD; *Dean Chou, MD*

SUMMARY

Radiculopathy from the fractional curve, from L4-S1, often prompts patients to seek surgery. 78 adult scoliosis patients from 2006-2016 with fractional curves from L4 to S1 >10° and ipsilateral radicular symptoms and who either received one, two or three interbody devices at the level of the fractional curve were studied. Use of additional interbody devices at the fractional curve levels resulted in greater reduction in their fractional curve and greater increase in lumbar lordosis without significantly increasing complications.

HYPOTHESIS

Null: no difference in fractional curve change with more interbody devices

DESIGN

Retrospective cohort

INTRODUCTION

Radiculopathy from the fractional curve, from L4-S1, often prompts patients to seek surgery. However, significant variability in techniques employed at the level of the fractional curve exists. The purpose of this paper is to evaluate the preoperative differences and outcomes in patients receiving one, two or three interbody devices at the level of the fractional curve.

METHODS

78 adult scoliosis patients from 2006-2016 with fractional curves from L4 to S1 >10° and ipsilateral radicular symptoms who received one, two or three interbody devices at the level of the fractional curve were retrospectively studied. Primary outcomes included changes in fractional curve degree, lumbar lordosis, pelvic incidence-lumbar lordosis mismatch, scoliosis major curve, as well as rates of revision surgery and post-operative complications.

RESULTS

There were no significant differences in age, gender, BMI, prior operation, fractional curve degree, pelvic tilt, pelvic incidence, pelvic incidence/lumbar lordosis mismatch, sagittal vertical axis, coronal balance, scoliosis major curve, proportion of patients receiving an osteotomy or average number of levels fused between the groups. There was a trend towards less lumbar lordosis preoperatively in patients who would go on to receive more interbody devices (p=0.055). Mean follow-up was 30.0 (range 12-101) months. Patients receiving more interbody devices (1 vs 2 vs 3 devices, respectively) had more fractional curve change (7.4 vs 12.3 vs 12.1 degrees, p=0.009), more increase in lumbar lordosis (-1.8 vs 6.2 vs 13.7 degrees, p=0.003) and more scoliosis major curve reduction (13.0 vs 13.7 vs 24.4 degrees, p=0.01). There were no significant differences between the groups in regards to post-operative complications (overall rate 44.8%, p=0.97) or need for revision surgery (overall rate 28.2%, p=0.36).

CONCLUSION

Additional interbody devices at the fractional curve is reasonable for patients desiring greater fractional curve reduction or greater increase in their lumbar lordosis without a significant increase in risk of adverse outcomes.

TAKE HOME MESSAGE

Using more interbody devices at the fractional curve can result in greater fractional curve reduction or lumbar lordosis increase without significant change in adverse outcomes.

152. The Novel "Kickstand Rod" Technique for Correction of Coronal Imbalance in Pediatric and Adult Spinal Deformity Patients

Melvin C. Makhni, MD, MBA; *Paul J. Park, MD;* Meghan Cerpa, BS, MPH; James D. Lin, MD, MS; Lawrence G. Lenke, MD

SUMMARY

In severe spinal deformity with significant coronal imbalance, use of an additional rod from a more laterally placed posterior iliac screw to the rod construct on the ipsilateral side of a trunk shift is a powerful tool to correct coronal deformity. This "kickstand rod" also adds additional structural integrity, helping to maintain this correction. Our series followed 24 patients over an average of 1.4 years with kickstand rod placement and showed significant coronal correction that was sustained throughout follow-up.

HYPOTHESIS

We describe a novel kickstand rod technique used to correct severe coronal imbalance in spinal deformity patients and to maintain correction over time

DESIGN

Single center retrospective case series

INTRODUCTION

In addition to sagittal balance, coronal imbalance (CI) is associated with poorer outcomes in spinal deformity patients. In adult patients with poor bone quality and rigid curves, CI can be especially difficult to correct. A kickstand rod from the ilium on the concavity of the

CI to the ipsilateral rod construct is a powerful and safe method to both obtain and preserve coronal alignment

METHODS

24 consecutive spinal deformity patients from July 2015-October 2017 were included. All patients underwent a thoracic to sacrum fusion with a kickstand rod. Preoperative and follow-up imaging were measured for CI, C7 sagittal vertical axis, and lumbar lordosis. Following standard deformity correction procedures, the described technique uses an additional iliac screw placed more lateral than standard iliac/S2AI screws in the posterosuperior ilium on the ipsilateral side of the trunk shift. A rod is connected from the screw to a domino connector at the thoracolumbar apex of the construct. Sequential distraction across this rod forces the trunk away from the pelvis while pushing down on the ilium while the contralateral rod is kept locked in place to avoid losing lumbar sagittal lordosis

RESULTS

The average patient age was 55 years (14-73), and average follow-up was 1.4 years. 10 patients had over two year follow-up. The average preoperative CI was 63.4mm. Average coronal correction was 46.7mm at final follow-up. Sagittal alignment preoperatively and postoperatively was 74.2mm and 30.2mm, respectively, with an average correction of 62.6mm. The ten patients with at least two years of follow-up had an average CI correction of 49.3mm. There were no complications associated with the placement nor maintenance of the kickstand rod

CONCLUSION

In this initial retrospective report, we describe the novel kickstand rod technique which can safely achieve and maintain coronal alignment in spinal deformity patients without sacrificing sagittal balance.

TAKE HOME MESSAGE

The novel kickstand rod technique described here is a safe and effective method of correcting coronal deformity with long-term maintenance without sacrificing sagittal balance

154. Disturbed Sleep is Associated with Worse Health Outcomes after Spine Surgery

Majd Marrache, MD; Andrew B. Harris, BS; Amit Jain, MD; David B. Cohen, MD, MPH; Khaled M. Kebaish, MD, FRCS(C); Brian J. Neuman, MD; Lee H. Riley III, MD; *Richard L. Skolasky Jr., Sc.D.*

SUMMARY

There is a paucity of knowledge on the association between sleep disturbance(SD) and established health related quality of life (HRQL) domains in spine surgery. Our study revealed a significant correlation between the degree of SD and HRQL measures preop in patients undergoing surgical treatment of cervical and lumbar spinal disorders. The resolution of sleep disturbance postop was a significant predictor of improvement in clinical outcomes. Postoperatively, mean improvement in HRQL scores was significantly higher for patients with no SD.

HYPOTHESIS

We hypothesize that sleep disturbance is significantly correlated with HRQL in patients undergoing surgical treatment of cervical and lumbar spinal disorders, and that patients with preoperative sleep disturbance have significant improvement in sleep postoperatively.

DESIGN

Prospective cohort study

INTRODUCTION

Sleep hygiene is an essential component of wellbeing; however, little is known regarding the association between sleep disturbance and HRQL in patients undergoing spine surgery.

METHODS

Spine surgery patients completed the Oswestry Disability Index (ODI), Short Form-12- mental (MCS) health and PROMIS sleep, fatigue, physical function, anxiety, depression and social satisfaction domains at preop and 6 week postop visit. Pearson correlation was used to assess for correlation between sleep and HRQL measures, significance was set at $p<0.01$. Comparative analysis was performed between the sleep disturbance (SD) group and the "no sleep disturbance" NSD group. SD was defined as greater than 60 points on the PROMIS sleep domain (+1 SD). Linear regression was used to determine the impact of sleep disturbance on postoperative improvement in patient clinical outcomes.

RESULTS

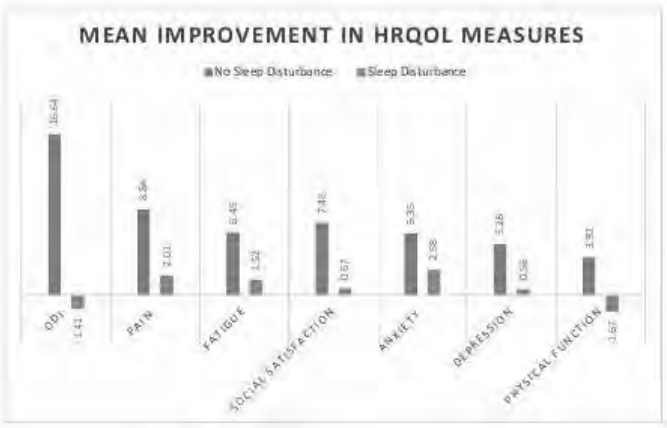
In 583 patients (mean age 60 years, 55% female) sleep disturbance was prevalent in 177 (30%) and 94 (16%) patients at preop and 6 weeks following surgery respectively. Sleep disturbance was most significantly correlated with MCS and ODI disability scores ($r=-0.485$ and 0.405 respectively), $p<0.001$. The largest difference in HRQOL domains between SD and NSD groups was seen in ODI, (53 ± 16 in SD group vs. 43 ± 16 in NSD group, $p<0.001$). 67% of patients in the SD group had resolved sleep problems at 6 weeks. At 6 weeks postop, resolved sleep disturbance was a significant predictor of improvement in pain ($p<0.001$), fatigue ($p<0.001$), depression ($p<0.001$), anxiety ($p=0.016$), physical function ($p<0.001$), social satisfaction ($p<0.001$) and ODI ($p<0.001$) scores.

CONCLUSION

Preoperative SD in patients undergoing surgical treatment of spinal disorders is significantly correlated with several established HRQL measurement instruments. Moreover, improvement in SD is also a significant predictor of improvement in other HRQL domains.

TAKE HOME MESSAGE

Sleep disturbance is a significant contributor to worse clinical outcomes in spine surgery patients and is correlated with established HRQL domains.



Mean improvement in HRQL measures at 6 weeks postop in SD and NSD. A significant difference between the two groups ($p<0.05$)

was seen with improvement in ODI, pain, fatigue, social satisfaction, anxiety, depression and physical function scores.

155. Instrumentation-related Complication-free Survival in Adult Spinal Deformity Surgery

Nikita Zaborovskii, MD, PhD; *Dmitrii Ptashnikov, MD, PhD;* Dmitrii Mikhailov, PhD; Oleg Smekalenkov, PhD; Sergei Masevnin, PhD; Anton Denisov, MD

SUMMARY

A multivariate Cox regression model analyzed variables that influence the duration of instrumentation-related complication-free survival in adult deformity surgery. Preoperative Miller frailty index, ODI score, type of osteotomy and instrumentation, overcorrection of PI - LL mismatch were associated with instrumentation-related complication-free survival.

HYPOTHESIS

We explored the factors that influence the duration of instrumentation-related complication-free (IRCF) survival in adult deformity surgery.

DESIGN

A retrospective cohort study.

INTRODUCTION

The surgical management of adult spinal deformity can provide significant improvements in pain, disability, and health-related quality of life. However, these procedures are technically demanding and are associated with a high complication rate. Complications arising from spinal surgery instrumentation present a host of challenges in prevention as well as treatment.

METHODS

One hundred ninety four patients with spinal deformity (SRS-Schwab type L, sagittal modifiers: 2 grade and more) were included, and the following parameters were studied: age, sex, body mass index (BMI), comorbidities, smoking status, neurological deficit, presence of osteoporosis, Oswestry Disability Index (ODI), Miller frailty index, previous spinal surgeries, type of osteotomy, levels of instrumentation, pelvic fixation, presence of anterior interbody fusion at L5-S1 (ALIF L5-S1), pelvic incidence (PI) and lumbar lordosis (LL) mismatch to evaluate spino-pelvic re-alignment. Instrumentation-related complications were implant instability and proximal junction disorders requiring revision. Multivariate Cox proportional hazard model analysed clinical parameters for their prognostic relevance.

RESULTS

The 12-months IRCF rate is 89%. The 24-months IRCF rate is 48%. In patients with instrumentation-related complications, multivariable analysis suggested that severe Miller frailty index (95% CI 1.19–5.87; HR 2.64), ODI less than 40 scores (95% CI 1.16–8.67; HR 3.17), 3-column osteotomy (95% CI 1.46–7.23; HR 3.25), pelvic fixation (95% CI 1.25–13.17; HR 4.21), overcorrection of PI - LL mismatch (95% CI 1.09–6.92; HR 2.74) impacted the probability of shorter IRCF survival. The model found that ALIF L5-S1 was associated with better IRCF survival (95% CI 0.14–0.79; HR 0.33).

CONCLUSION

Half of adult spinal deformity patients had instrumentation-related complications 2 year following surgery. Individual patient characteristics as well as surgical invasiveness influence the duration of IRCF survival in adult deformity surgery.

TAKE HOME MESSAGE

Preoperative Miller frailty index, ODI score, type of osteotomy and instrumentation, overcorrection of PI - LL mismatch influence the duration of IRCF survival in adult deformity surgery.

156. Racial and Ethnic Variation in Sagittal Spinopelvic Parameters in an Urban Setting

Woojin Cho, MD, PhD; Sandip P. Tarpada, MD; Dongyoung Kim, BS; Brittany A. Oster, BS; Hyun Jin Lim; Matthew T. Morris, MD

SUMMARY

Spino-pelvic (SP) parameters was investigated within isolated ethnic populations in urban setting. Here, we present an analysis of these measurements within a diverse urban population. SP measurements, such as pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS), T1-Pelvic angle (TPA), sagittal balance (SB), coronal balance (CB), lumbar lordosis (LL), and PI/LL offset, demonstrated no difference among African American, Hispanic, and Caucasian population in a heterogeneous urban setting.

HYPOTHESIS

SP parameters differ significantly among those belonging to different ethnic groups in a heterogeneous urban population

DESIGN

Retrospective review

INTRODUCTION

SP alignment is influenced by a variety of factors, including, gender, age, and ethnicity. Recent literature has reported on the influence of ethnicity on pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS), in a number of isolated populations. Here we present a retrospective chart review of SP parameters among an ethnically diverse urban population.

METHODS

110 consecutive patients (mean age 56.08 ± 14.84 years) with no evidence of thoracolumbar pathology, and no history of low back pain or previous spinal surgery were included in this study. Patient ethnicity was obtained in accordance with IRB recommendations. Among included patients, the following measurements were obtained from standing PA and Lateral films: PI, PT, SS, TPA, SB, CB, LL, and PI/LL offset. One way ANOVA was used to test for significance.

RESULTS

A total of 110 patients were included in this study, grouped into the following categories: African American (31/110), Hispanic (54/110), and Caucasian (25/110). For Black patients, mean PI, PT, SS, and TPA were 64.45. ± 10.07°, 16.29± 11.51°, 48.16 ± 10.87°, and 16.46 ± 8.60° respectively. For Hispanic patients, mean PI, PT, SS and TPA were 60.20± 14.34°, 11.14 ± 9.93°, 49.05 ± 12.80° and 15.05 ± 9.07° respectively. For Caucasian patients, mean PI, PT, and SS were 57.86±14.84°, 14,10 ± 14.79°, 43.76 ±14.51° and 16.47± 14.6° respectively. There was no significant difference between the 3 groups in PI (p=0.185), PT (p=0.126), SS (p=0.222), TPA (p=0.779), SB (p=0.470), CB (p=0.36), LL (p=0.32), and PI/LL offset (p= 0.606). Offset mean for African American was

7.45± 18.7, for Hispanic was 1.41 ± 16.3, and for Caucasian was 4.66 ± 22.38.

CONCLUSION

SP measurements taken among a diverse urban population cannot readily be distinguished on the basis of ethnicity alone. This study demonstrates that there are no difference in SP measurements among African American, Hispanic, and Caucasian population in a heterogeneous urban setting.

TAKE HOME MESSAGE

SP parameters showed no difference among African American, Hispanic, and Caucasian population in a heterogeneous urban setting

157. Minimum Clinically Important Difference (MCID) of HRQoL Scales in Adult Spinal Deformity (ASD) Vary with Age, Gender, Baseline Disability Scores and the Direction of Change Perceived by the Patient

Sinan Bahadir, MD; Selcen Yuksel, PhD; Selim Ayhan, MD; Vugar Nabiyev V.N., MD; Alba Vila-Casademunt, MS; *Ibrahim Obeid, MD, MS;* Francisco Javier Sanchez Perez-Grueso, MD; Emre R. Acaroglu, MD; European Spine Study Group

SUMMARY

To analyze the effects of age, gender and baseline scores as well as the direction of change perceived by the patient on minimum clinically important difference (MCID) values of health related quality of life scales in adult spinal deformity (ASD) population, a prospectively collected multicenter ASD database was retrospectively reviewed. The findings of the study demonstrate that MCID values change by baseline scores, direction of change (improvement/deterioration) but not by age and gender.

HYPOTHESIS

Minimum clinically important difference (MCID) values are sensitive to age, gender, baseline health related quality of life (HRQoL) scores and improvement/deterioration in adult spinal deformity (ASD) patients.

DESIGN

Retrospective analysis of data collected prospectively in an ASD multicenter database.

INTRODUCTION

MCID, an important concept to evaluate effectiveness of treatments, may not necessarily be a single magical constant for any given HRQoL scale. It shows variations based on the calculation method as well as pathology, baseline scores, comorbidities and treatment modalities.

METHODS

Patient population consisted of surgical and non-surgical patients from a multicenter ASD database who completed pretreatment and 1-year follow-up COMI, ODI, SF-36 PCS, SF-36 MCS, SRS-22R as well as an anchor question of "back health" related change over the past year. MCIDs for each HRQoL measure were calculated by an anchor-based method by using latent class analysis for the overall population as well as subpopulations based on age, gender, baseline scores (for ODI and COMI) separately for patients with positive vs negative perception of change.

RESULTS

A summary of results may be seen in Figure 1. Patients with baseline ODI score <20, 20-40 and >40 had MCID value of 2.24, 11.35 and 26.57 respectively. Similarly, patients with baseline COMI score <2.75, 2.8-5.4 and >5.4 had MCID threshold of 0.59, 1.38 and 3.67. Overall MCID thresholds for deterioration and improvement were 0.27 and 2.62 for COMI, 2.23 and 14.31 for ODI, and 0.01 and 0.71 for SRS-22R. MCID values were not affected by age or gender.

CONCLUSION

The findings of this study demonstrates that MCID values change by baseline scores, direction of change (improvement/deterioration) but not by age and gender. MCID, at its current state, should be considered as a concept. All applications in larger cohorts may be useful in defining MCID as a function rather than a fixed value.

TAKE HOME MESSAGE

Minimum clinically important difference values vary in baseline scores, and direction of change, and at its current state, it should be defined as a function rather than a fixed value.

Figure 1.MCID scores regarding age, gender, direction and baseline scores

Health Related Quality of Life Parameter	Value	MCID	
		Improvement	Deterioration
COMI	Overall	2.62	0.27
	Female	2.67	0.22
	Male	2.42	0.37
	≤36 years old	2.64	0.25
	>36 years old	2.68	0.64
	<2.8	0.59	-
	2.8-5.4	1.38	-
	>5.4	3.67	-
ODI	Overall	14.31	2.23
	Female	15.26	4.24
	Male	14.85	2.10
	≤36 years old	15.29	3.90
	>36 years old	17.00	3.09
	<20	2.24	-
	20-40	11.35	-
	>40	26.57	-
SF-36 PCS	Overall	7.33	0.13
	Female	5.99	0.83
	Male	8.66	0.96
	≤36 years old	6.51	1.08
	>36 years old	8.80	3.08
SF-36 MCS	Overall	4.37	0.24
	Female	4.13	1.49
	Male	3.08	0.91
	≤36 years old	3.50	2.53
	>36 years old	7.99	6.54
SRS-22	Overall	0.71	0.01
	Female	0.72	0.03
	Male	0.67	0.14
	≤36 years old	0.74	0.004
	>36 years old	0.75	0.24

MCID scores regarding age, gender,directionand baseline scores

158. Strategies for Prevention of Pseudarthrosis in Adult Spinal Deformity: Cobalt Chrome Rod, 4-rod Fixation, and Oblique Lumbar Interbody Fusion with Sacropelvic Fixation

Jung-Hee Lee, MD, PhD; Ki-Young Lee, MD; Won-Ju Shin, MD; Dong-Gune Chang, MD, PhD; *Sang Kyu Im, MD;* Seong Jin Cho, MD

SUMMARY

Pseudarthrosis is one of the most common complications after performing a deformity correction in adult spinal deformity. Various surgical options are reported for reducing the incidence of pseudarthrosis. Our study revealed a statistically lower incidence of pseudarthrosis by employing cobalt chrome rod, 4-rod fixation, and the oblique lumbar interbody fusion procedure with sacropelvic fixation. These methods can prove promising in reducing pseudarthrosis in the surgical treatment of adult spinal deformity.

HYPOTHESIS

Reducing the incidence of pseudarthrosis remains a challenge in adult spinal deformity surgery.

DESIGN

Retrospective study

INTRODUCTION

Restoration of the sagittal alignment in adult spinal deformity can produce excellent radiological and clinical outcomes, but pseudarthrosis is one of the most common complications. Various surgical options are reported for reducing the incidence of pseudarthrosis, but these methods are controversial and have limitations.

METHODS

A retrospective study of 186 subjects with degenerative lumbar kyphosis (average age 70.8 years) who underwent a long-segment fixation with a minimum 2-year follow up was conducted. Subjects were classified into the pseudarthrosis group (n = 39) and the non-pseudarthrosis group (n = 147). For predicting the factors of pseudarthrosis, patient factors, radiologic parameters, and surgical factors which include rod materials (Titanium vs Cobalt Chrome), the use of 4-rod fixation and sacropelvic fixation, correction methods (pedicle subtraction osteotomy vs oblique lumbar interbody fusion), and the history of the previous spine surgery were analyzed.

RESULTS

The overall pseudarthrosis rate was 21% (39/186). No significant differences in the incidence of pseudarthrosis regarding patient factors and preoperative radiological parameters were found between the two groups ($p > 0.05$). Significant differences were observed in the postoperative sagittal vertical axis and thoracic kyphosis angle ($p < 0.05$), but there were no significant differences during the last follow-up. As for surgical factors, the use of cobalt chrome rod ($p = 0.000$), 4-rod fixation ($p = 0.001$), sacropelvic fixation ($p = 0.045$), and oblique lumbar interbody fusion ($p = 0.000$) showed statistically lower incidence of pseudarthrosis than did the use of titanium rod, 2-rod fixation, non-sacropelvic fixation, and pedicle subtraction osteotomy.

CONCLUSION

Applications of cobalt chrome rod, 4-rod fixation, or oblique lumbar interbody fusion procedure with sacropelvic fixation will be promising methods for reducing pseudarthrosis in surgically treated adult spinal deformity.

TAKE HOME MESSAGE

Applications of cobalt chrome rod, 4-rod fixation, or oblique lumbar interbody fusion procedure with sacropelvic fixation are promising methods for reducing pseudarthrosis in surgically treating adult spinal deformity.

Table. Categorical Variables Comparison Between Pseud and Non-pseud group

Variables	Non-pseud group (n=147)	Pseud group (n=39)	*P*-value
Rod material			
6.35mm Titanium (n=54)	28	26	0.000*1)
6.35mm Cobalt Chrome (n=132)	119	13	
4 rod fixation			
Fixation (n=38)	38	0	0.001*1)
None (n=148)	109	39	
Sacropelvic fixation			
Fixation (n=147)	121	26	0.045*1)
None (n=39)	26	13	
Correction method			
PSO (n=105)	67	38	0.000*2)
OLIF (n=66)	65	1	
SPO (n=15)	15	0	

** Statistically significant (p-value < 0.05)*

PSO indicates pedicle subtraction osteotomy; OLIF, oblique lumbar interbody fusion; SPO, Smith-Petersen Osteotomy

1): chi-square test; 2) linear by linear association

159. Can We Predict Postoperative Sagittal Lumbar Alignment from Intraoperative Prone-Positioned Radiographs?

Joseph A. Osorio, MD, PhD; James D. Lin, MD, MS; Meghan Cerpa, BS, MPH; Simon Morr, MD, MPH; Griffin R. Baum, MD, MS; Lawrence G. Lenke, MD

SUMMARY

Intraop radiographs are important in assessing ASD correction. The outcome of the correction is determined using postop standing radiographs, although intraop decisions are entirely based on prone radiographs. We analyzed how predictive intraop prone radiographs translated to postop standing radiographs for sagittal lumbar alignment. Average intraop LL was -44 degrees (-26 to -70), while postop standing radiograph was -46 degrees (-22 to -65; p=0.76). Correlation between radiographs was strong (r=0.76; p<.0001), and demonstrated moderate predictability in regression analysis (r2=0.58; p<.0001).

HYPOTHESIS

There is minimal difference in sagittal lumbar alignment between the final intraop prone radiograph and the postop standing radiograph.

DESIGN

Retrospective Analysis

INTRODUCTION

Radiographs are important during surgery to assess correction in an adult spinal deformity (ASD) patient. Ultimately, postop

standing radiographs are used to determine the outcome of surgical correction, although surgery is performed and evaluated intraop with prone radiographs. We seek to analyze how correlative and predictive the final intraop prone radiograph translates to the postop standing radiograph when evaluating sagittal alignment.

METHODS

20 consecutive ASD patients were analyzed. 5 sagittal plane radiographs were analyzed for each patient: preop standing, preop supine, intraop pre-rod insertion, intraop post-rod insertion, and postop standing. Cobb angles were measured segmentally, as well as the total lumbar lordosis (LL) (L1-S1) and thoracic kyphosis (T5-T12). Paired t-tests, Pearson's Correlation, and linear regression were used to assess the difference in mean LL, correlation, and predictability between the intraop and postop radiographs.

RESULTS

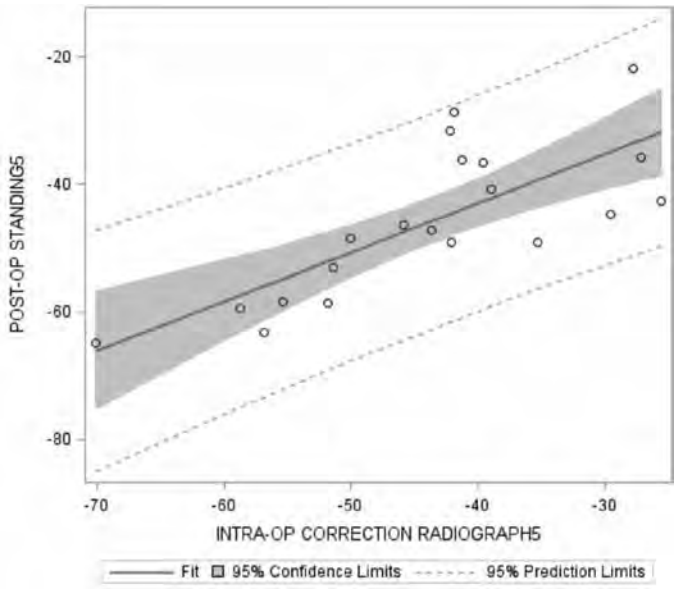
Mean sagittal LL achieved during surgery after positioning, PCO, and/or TLIFs on the intraop post-rod insertion radiograph was -44 deg. (-26 to -70) and -46 deg. (-22 to -65) on the postop standing radiographs; there was no significance difference between the two means (p=0.76). Thoracic kyphosis intraop was 23 deg. (7 to 40) and postop standing was 24 deg. (8 to 38), showing no difference: p=0.67. Furthermore, there was a significantly strong correlation between intraop and postop total LL (r=0.76; p<.0001). Ultimately, the linear model affirms a significant ability to predict the correction on postop standing radiographs from intraop radiographs (r2=0.58; p<.0001), Figure 1.

CONCLUSION

Intraop post-rod insertion radiographs have a strong correlation in predicting sagittal thoracic and lumbar alignment with the postop standing radiographs.

TAKE HOME MESSAGE

This study demonstrates that we can effectively rely on the final intraop correction radiographs to predict the postop sagittal lumbar alignment in standing radiographs for ASD patients.



Fit plot showing a strong correlation for prone positioned intraop radiographs and postop standing radiographs.

160. Adult Spinal Deformity Patients with a Decline in Certain Activities of Daily Living are Likely to Fail Nonoperative Treatment

Andrew B. Harris, BS; Brian J. Neuman, MD; Richard Hostin, MD; Alex Soroceanu, MD, FRCS(C), MPH; Themistocles S. Protopsaltis, MD; Peter G. Passias, MD; Jeffrey L. Gum, MD; Munish C. Gupta, MD; Michael P. Kelly, MD, MS; Eric O. Klineberg, MD; Virginie Lafage, PhD; Douglas C. Burton, MD; Shay Bess, MD; Khaled M. Kebaish, MD, FRCS(C); International Spine Study Group

SUMMARY

Decline in Scoliosis Research Society 22r (SRS-22r) Activity is the primary SRS-22r domain independently associated with failing nonoperative management of Adult Spinal Deformity. Within this domain, worsening physical activity, spine-related financial hardship and decreasing time with family/friends drive patients to undergo surgery, while the ability to perform household chores and attend work/school are not independently associated with failing nonoperative management.

HYPOTHESIS

Decline in specific activities of daily living (ADLs) assessed with the Scoliosis Research Society 22r (SRS-22r) can identify patients with Adult Spinal Deformity (ASD) who are likely to fail nonoperative management.

DESIGN

Prospective, observational study

INTRODUCTION

The impact of worsening ADLs such as spine-related financial difficulty and attending work/school have not been studied as potential independent predictors of failing nonoperative management.

METHODS

482 nonoperative ASD patients were identified from a multicenter database, of which 55 (11%) had eventual crossover to operative intervention. Propensity score matching (PSM) was performed to create cohorts of crossover (CX) and non-crossover (NC) patients based on age, gender, and baseline Oswestry Disability Index (ODI). Patients' change in SRS-22r and sub-domains over time was classified as increasing, decreasing or unchanged in relation to baseline. Kaplan-Meier curves were produced for time to crossover among patients by change in SRS-22r domains, and compared using log-rank test. Significant was set at 0.05.

RESULTS

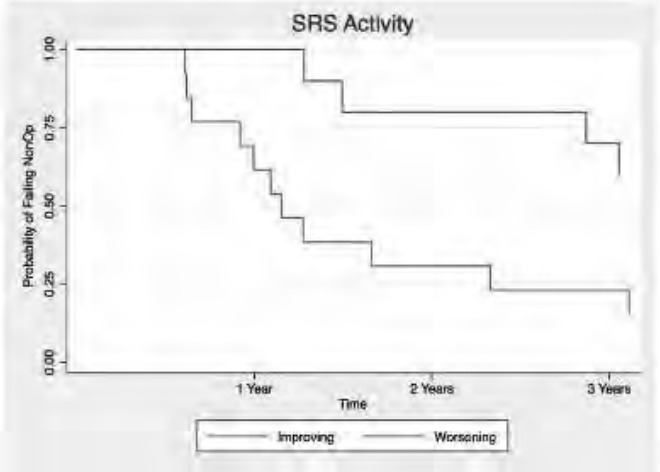
Two matched cohorts of 46 CX and 46 NC patients were analyzed following PSM. NC and CX groups were similar among age, baseline ODI, and SVA. Patients had a mean age 55 ± 15 years; ODI of 35 ± 15; SVA of 3.5 ± 5.9cm. Mean time to crossover was 1.7 ± 1.4yrs. Decline in SRS-22r Total and Activity domains were associated with increased risk of failing nonoperative management (p=0.005, p=0.006), while decline in SRS-22r Pain, Appearance and Mental Health domains were not significantly associated with failure. Analysis of specific ADLs within the Activity domain showed worsening financial hardship, level of activity and going out with friends/family to be associated with failure, while work/school activity and doing household chores were not.

CONCLUSION

Worsening SRS-22r Activity is the primary SRS-22r domain independently associated with failing nonoperative management in ASD patients. Declining physical activity, worsening spine-related financial hardship and decline in being with friends/family are the most important individual ADLs.

TAKE HOME MESSAGE

Declining physical activity, worsening spine-related financial hardship and decline in being with friends/family are the most important activity-related ADLs independently associated with failing nonoperative management of Adult Spinal Deformity.



161. Cobalt Chromium 5.5mm Spinal Rod: Material Properties Vary by Supplier

SUMMARY

Vidyadhar V. Upasani, MD; Dylan G. Kluck, MD; Christine L. Farnsworth, MS; Megan Jeffords, MS; Burt Yaszay, MD; Peter O. Newton, MD

This study assesses the mechanical properties of six different commercially available 5.5mm diameter cobalt chromium spinal rods using four-point bend testing. There was a range in material properties amongst suppliers as Young's Modulus and Rod stiffness each varied up to 19% and yield and ultimate loads varied up to 19% and 18%, respectively. Not all 5.5mm CoCr rods are therefore biomechanically equal.

HYPOTHESIS

Material properties of 5.5mm CoCr spinal rods obtained from various suppliers are similar

DESIGN

Biomechanical study

INTRODUCTION

Cobalt chromium (CoCr) alloy is a popular spinal rod choice for surgeons due to biocompatibility, lower imaging artifact than stainless steel and greater corrosion resistance. Loading in vivo tends to be primarily in bending. Therefore, this study assesses the mechanical properties of 6 different commercially available 5.5mm diameter CoCr spinal rods using four-point bending(4PBT).

METHODS

CoCr spinal rods, 5.5mm diameter, were tested in a 4PBT system fixed to a test frame (MTS858, MTS Inc, Eden Prairie, MN). In accordance with ASTM F2193, 40mm separated inner loading points and inner from outer points, simulating intervertebral instrumentation distance. For each supplier, 200mm long rods were loaded at 0.1mm/s to 20mm of deflection; load (N) and displacement (mm) were recorded continuously (FIG). Young's modulus, rod stiffness, yield load and displacement (plastic deformation at 0.2% of the test section length), and ultimate load (greatest load achieved) were calculated using customized software (MATLAB, Mathworks, Natick, MA). ANOVA (Kruskal Wallis) compared values between suppliers. Parameters with significant p values then underwent post hoc pairwise comparisons. With Bonferroni correction, significance was set at $p \leq 0.0083$.

RESULTS

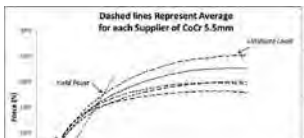
Young's Modulus and Rod stiffness varied amongst suppliers with a maximum difference of 37GPa and 62N/mm, respectively, representing 19% variation and with suppliers 1, 4 and 5 being significantly different than 3 and 6 (TABLE). Yield displacement (range 4.1 to 4.9mm) was not significantly different amongst suppliers. For yield load (range 1153 to 1367N) Supplier 3 was significantly lower than all others. Ultimate load ranged from 1882 to 2220N representing 18% variation and with Suppliers 4 and 6 being different from all others.

CONCLUSION

There is wide variation in properties of 5.5mm CoCr rods amongst suppliers with Young's Modulus and stiffness each varying up to 19%; yield and ultimate loads varied up to 19 and 18%, respectively. For example, it took 200N more force to reach plastic deformation with Supplier 6 versus Supplier 3.

TAKE HOME MESSAGE

Not all 5.5mm CoCr rods are mechanically equal, and surgeons must therefore ensure that the mechanical properties of a particular rod meet the demands of the surgical correction required.



Supplier ID	Young's Modulus (GPa)	Rod Stiffness (N/mm)	Yield Load (N)	Yield Disp. (mm)	Ultimate Load (N)
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ANOVA p-value	0.002	0.002	0.001	0.021	0.001

FIG: Load vs displacement curves. TABLE: Calculated values (mean ± standard deviation) with significantly different suppliers in parentheses below (ex: Supplier 1 Young's modulus was different than that of Suppliers 2, 3, 6). Significance set at $p<0.0083$.

163. Effects of Spinal Decompression on the Gait Efficiency and Balance of Cervical Spondylotic Myelopathy Patients: Preliminary Results

Lawal A. Labaran, BS; Emily Dooley, BS; Varun Puvanesarajah, MD; Jason A. Horowitz, BA; Shawn Russell, PhD; Francis H. Shen, MD; Xudong Joshua Li, MD, PhD; Anuj Singla, MD; Hamid Hassanzadeh, MD

SUMMARY

To characterize stability, gait, and energy expenditure following cervical decompression and/or fusion surgery in patients with cervical myelopathy, a cohort of CSM was compared to a control

patient cohort without a history of CSM, cervical spine surgery, or gait problems. Our results shows that following cervical decompression, CSM patients show improvement in stability, gait, and energy expenditure at six months.

HYPOTHESIS

Cervical decompression surgery results in improved gait parameters during the first six months of follow-up with associated improvement in energy expenditure, spatio-temporal parameters, and postural stability and balance.

DESIGN

Prospective cohort study

INTRODUCTION

Cervical spondylotic myelopathy (CSM), a progressive degenerative disease of the spine, remains one of the leading causes of spinal cord dysfunction globally (1). Although surgical treatment has been shown to mitigate the progression of myelopathic symptoms, little is known about patient's gait and functional recovery postoperatively (2).

METHODS

Prospective gait and stability biometric data was collected on 15/26 patients (5 females and 10 males, age 62.9±10.2 years) with a diagnosis of CSM at three time points: immediately prior to surgery and 3 and 6 months following cervical decompression surgery. Our study group was compared to 13/26 control patients (5 males and 8 females, age 51.4±8.7 years) who were never previously treated with spine surgery, diagnosed with CSM, nor had any gait altering pathology. Patient gait was characterized using spatiotemporal parameters including stride length, walking velocity, and time spent in double support. Total mechanical work as well as static balance parameters were calculated.

RESULTS

Pre-operatively, CSM patients take shorter steps (stride length: 0.97±0.98 v. 1.17±0.10m, $P<0.01$), walk slower (velocity: 0.81±0.25 v. 1.09±0.13m/s, $P<0.001$), take fewer steps per minute (Cadence) and spend more time in double support (% stride) compared to the control group. These patients expend more energy to initiate steps compared to control patients (3.04±0.55 v. 2.92±0.24 J/Kgm). Total body work decreased at 6 month follow-up compared to pre-operative baseline measurements. Regarding stability CSM patients had a longer path length (20.4±10.9 v. 9.8±2.6, $P=0.001$) and larger ellipse area (922±749 v. 246±96, $P<0.01$) at baseline.

CONCLUSION

Following cervical decompression, CSM patients show significant improvement in stability at six months. Other spatio-temporal parameters show improvement that is trending towards significance.

TAKE HOME MESSAGE

CSM patients make improvement in gait parameters, require less mechanical work done to initiate gait, and have improved stability postoperatively compared to their baseline.

164. Cervical Decompression Surgery Improves Dynamic Balance in Cervical Spondylotic Myelopathy Patients

Ram Haddas, PhD, MS, MEng; *Isador H. Lieberman, MD, FRCS(C);* Peter B. Derman, MD, MBA

SUMMARY

Difficulties with balance and gait are common manifestations of CSM. These patients present with altered balance and more trunk and lower extremity muscle activity when compared to healthy controls. Twenty-six cervical spondylotic myelopathy (CSM) patients undergo functional balanced and tandem gait tests. Cervical decompression surgery improved dynamic balance in CSM patients 3 months after surgical intervention.

HYPOTHESIS

Cervical decompression surgery will improve balance and posture in cervical spondylotic myelopathy (CSM) patients

DESIGN

Non-Randomized, prospective, concurrent-cohort study

INTRODUCTION

Difficulties with balance and gait are common manifestations of CSM. These patients present with altered balance and more trunk and lower extremity muscle activity when compared to healthy controls.

METHODS

Twenty-six CSM patients undergo functional balanced and tandem gait tests.

RESULTS

Surgical decompression reduced COM (Pre: 43.42 vs. Post: 30.13 cm, $p=0.033$) and head (Pre: 59.90 vs. Post: 41.36 cm, $p=0.020$) total sway and decreased muscle activity in their Erector Spinae (Pre: 23.59 vs. Post: 14.40 mV, $p=0.046$), Gluteus Maximus (Pre: 17.48 vs. Post: 10.37 mV, $p=0.044$), and Tibialis Anterior (Pre: 24.64 vs. Post: 14.49 mV, $p=0.037$) muscles in CSM patients during the Romberg's test. Furthermore, surgical decompression increased gait speed (Pre: 0.25 vs. Post: 0.41 m/s, $p=0.013$), reduced step length (Pre: 0.38 vs. Post: 0.29 m, $p=0.042$) along with reduction in trunk (Pre: 32.45 vs. Post: 19.15°, $p=0.021$) and head flexion (Pre: 50.11 vs. Post: 32.54°, $p=0.019$) angle during the tandem gait test.

CONCLUSION

Cervical decompression surgery improved dynamic balance in CSM patients. Three months after surgical intervention, CSM patients reduced their total sway. There was less muscle activity during a simple standing task and a reduction in spine and lower extremity energy expenditure. Surgical decompression improved patients balance capability and improved function in the tandem gait test. While most of the balance research in patients with spinal disorders is done based on static imaging and mostly focused on sagittal spinal alignment, this study is the first effort to evaluate global balance as a dynamic test. Quantifying and analyzing the specific balance alterations of patients with CSM not only provides a richer biomechanical understanding of normal and pathological balance, but also provides specific parameters that can be used in evaluating the severity of balance disturbance and postoperative recovery and rehabilitation.

TAKE HOME MESSAGE

Cervical decompression surgery improved dynamic balance in CSM patients three months after surgical intervention

Mean	Path Length (mm/s)	Ellipse Area (mm^2)	Stride length (m)	Velocity (m/s)	Cadence (Step/min)	Double Support (% stride)	Total Body Work (J/Kgm)
Control	9.8±2.6	246±96	1.17±0.10	1.09±0.13	111.0±0.13	26.6±3.2	2.92±0.24
Baseline	20.4±10.9	922±749	0.97± 0.23	0.81±0.25	98.6±12.9	33.2±9.1	3.04±0.55
3 months	17.4±8.3	627±447	0.98±0.20	0.82±0.21	99.9±11.3	32.1±6.9	2.85±0.41
6 months	17.6±7.3	530±311	1.03±0.20	0.89±0.21	102.6±11.7	31.3±6.1	2.83±0.52

Table. 1 Summary of Preliminary Gait and Stability Parameters

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References:

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165. Utility of Crossing the Cervicothoracic Junction During Laminectomy and Posterior Spinal Fusion Surgery for Cervical Spondylotic Myelopathy

Andrew K. Chan, MD; Ryan K. Badiee, BS; Joshua Rivera; Leslie C. Robinson, MD, PharmD, MBA; Ratnesh N. Mehra, DO; Lee A. Tan, MD; Dean Chou, MD; Praveen V. Mummaneni, MD

SUMMARY

For laminectomy and posterior spinal fusion (LPSF) surgery for cervical spondylotic myelopathy (CSM), it is unclear whether the lower instrumented vertebrae (LIV) should cross the cervicothoracic junction (CTJ). We compared 67 patients undergoing sub-axial LPSF for CSM who crossed the CTJ to 47 who did not. Crossing the CTJ was associated with greater blood loss and longer operative times, but no cases of pseudarthrosis or hardware misplacement/failure requiring reoperation. Both cohorts had similar neurological and radiological improvement.

HYPOTHESIS

Crossing the cervicothoracic junction (CTJ) for laminectomy and posterior spinal fusion (LPSF) surgery for cervical spondylotic myelopathy (CSM) may result in different (1) neurological and radiological outcomes and (2) complication profiles than surgeries that do not cross the CTJ.

DESIGN

Retrospective cohort study

INTRODUCTION

In LPSF for CSM, the evidence is unclear as to whether the lower instrumented vertebrae (LIV) should cross the CTJ. This study compares LPSF outcomes between those with and without LIV crossing the CTJ.

METHODS

Adults undergoing LPSF for CSM from 2012-2018 were identified. LPSF with sub-axial upper instrumented vertebrae and LIV between C6 and T2 were included. Clinical and radiographic outcomes were compared.

RESULTS

114 patients were included: 67 who crossed the CTJ (crossed-CTJ) and 47 who did not (not-crossed CTJ). Not-crossed CTJ had worse visual analog scale (VAS) neck pain scores at baseline (5.5vs.3.8,p=0.04), but similar Nurick scores. Postoperative VAS neck pain and Nurick change scores were similar. Crossed-CTJ had higher preoperative C2-7 sagittal vertical axis (SVA) (34.3vs.26.8mm,p=0.03), but similar preoperative cervical lordosis (CL) and T1-slope. Postoperative SVA, CL, and T1-slope did not differ significantly and change scores were similar. Crossed-CTJ was associated with increased blood loss (373.5vs.212.2 ml,p=0.001), longer operative times (217.4vs.172 min,p<0.001), but similar hospital stays (5.2vs.4.2 days,p=0.13). Reoperation rate was 4.4%. For crossed-CTJ, there was 1 reoperation (1.5%) for irrigation and debridement (I&D) and no cases of pseudarthrosis or hardware misplacement/failure requiring reoperation (0%). For not-crossed CTJ, there were 3 reoperations (6.4%) involving 2 I&Ds and a single reoperation for pseudarthrosis and hardware misplacement/failure (2.1% ; C7 screw with nerve root impingement). Mean follow-up was 13.5 months.

CONCLUSION

Crossing the CTJ demonstrated elevated blood loss and operative times, but no cases of pseudarthrosis or hardware misplacement/failure requiring reoperation. Both cohorts had similar neurological and radiological improvement.

TAKE HOME MESSAGE

In LPSF for CSM, crossing the CTJ demonstrated elevated blood loss and operative times, but no reoperations for pseudarthrosis or hardware misplacement/failure. Both cohorts had similar neurological and radiological improvement.

166. Pre-operative Narcotic Use and Impaired Ambulatory Status are Independent Risk Factors for Complications Following Posterior Cervical Spine Fusion Surgery

Ryan K. Badiee, BS; Andrew K. Chan, MD; Joshua Rivera; Annette Molinaro, PhD; Brianna R. Doherty, PhD; Dean Chou, MD; Praveen V. Mummaneni, MD; Lee A. Tan, MD

SUMMARY

This study aimed to identify risk factors associated with complications following posterior cervical fusion (PCF). Clinical data over six years at a single center was abstracted from a chart review, and demographics, radiographic data, surgical characteristics, and complication rates were analyzed using a multivariable logistic model. Loss of independent ambulation was associated with 2.5-fold greater odds of medical complication, whereas preoperative narcotic use was associated with twofold greater odds of surgical and overall complication.

HYPOTHESIS

Indicators of severe cervical pathology, such as loss of independent ambulation, as well as preoperative comorbidities, such as diabetes,

cardiovascular disease, and opioid addiction, are associated with increased risk of complications following posterior cervical fusion (PCF).

DESIGN

Retrospective cohort study

INTRODUCTION

PCF is a common procedure used to treat cervical spondylotic myelopathy (CSM). However, a contemporaneous understanding of the risk factors for developing postoperative complication is not well established.

METHODS

Adults undergoing PCF from May 2012 through July 2018 at UCSF Medical Center were identified. Demographic and radiographic data, surgical characteristics, and complication rates were compared. Preoperative medication use was defined as the presence of any active prescription at the time of surgery. Multivariate logistic regression models were developed to identify independent predictors of medical, surgical, and overall complication following surgery.

RESULTS

A total of 196 patients met the inclusion criteria and were included in the study. The medical, surgical, and overall complication rates were 10.2%, 23.0%, and 29.1% respectively. Major risk factors associated with medical complications in multivariate analysis included impaired ambulatory status (OR: 2.52, P = .03) and estimated blood loss over 500 mL (OR: 2.32, P = .03). Multivariate analysis revealed narcotic use (OR: 2.29, P = .02) and operative time (OR: 1.01, P = .005) as risk factors for surgical complication, whereas antidepressant use was a protective factor (OR: .24, P = .02). Overall complication was associated with preoperative narcotic use (OR: 2.01, P = .04) and higher intraoperative blood loss (OR: 1.001, P = .03).

CONCLUSION

Preoperative narcotic use and estimated blood loss predicted development of overall complication following PCF for CSM. Impaired ambulatory status was a significant predictor of the development of a medical complication specifically. These results may help surgeons in counseling patients who may be at increased risk of complication following surgery.

TAKE HOME MESSAGE

Narcotic use and impaired ambulatory status represent modifiable risk factors for complication following posterior cervical fusion. Opioid addiction treatment and preoperative rehabilitation programs may prevent adverse outcomes in these patients.

168. Asymptomatic ACDF Non-unions Underestimate the True Prevalence of Radiographic Pseudoarthrosis

Charles H. Crawford III, MD; Leah Yacat Carreon, MD, MS; Praveen V. Mummaneni, MD; Steven D. Glassman, MD

SUMMARY

In 345 IDE control patients (single-level ACDF with allograft and plate), 44 (13%) had radiographic non-union at 24 months. Although there was no statistically significant difference in PROs in patients with a radiographic non-union compared to those who had a solid fusion, the reoperation rate was significantly higher in the non-union group (21% vs. 7%, p=0.009)

HYPOTHESIS

Patients with radiographic nonunion after ACDF have worse Patient Reported Outcomes (PROs) compared to patients with a solid fusion.

DESIGN

Secondary analysis of subjects in the control Anterior Cervical Discectomy and Fusion (ACDF) arm of Medtronic Investigational Device Exemption (IDE) trials for cervical disc arthroplasty (CDA).

INTRODUCTION

It is unclear whether radiographic nonunion after ACDF is a relevant problem as its true prevalence is unknown. Nonunion may be under-observed, as some patients are not symptomatic enough to justify radiographic evaluation. Long-term follow-up is difficult to obtain in the ACDF population, as minimally symptomatic post-op patients are the norm.

METHODS

345 subjects enrolled in the control arm of IDE trials for CDA who had single-level ACDF with allograft and plate with 24-month data formed the study cohort. Using the 24-month post-op evaluation, subjects were divided into those who had radiographic fusion and those who did not using strict radiographic study criteria. SF-36, NDI, Neck and Arm pain NRS were collected at 6 weeks, 3, 6, 12, 24, 36, 48, 60, 72, and 84 months post-op. Last observation carried-forward method was used in the analysis for secondary surgery cases, such that the scores immediately prior to a secondary surgery were used for all future events.

RESULTS

44 (13%) patients had radiographic non-union and 301 (87%) were fused at 24 months post-op. At 24 months, NDI, Neck and Arm pain NRS were similar between the patients with radiographic non-union and those with radiographic union. Seven patients in the Nonunion group (16%) and 10 (3%) in the Fused group had additional surgery at the index level prior to the 24-month follow-up (p=0.003). Over the 84-month follow-up 9 patients in the Nonunion group (21%) and 22 (7%) in the Fused group had additional surgery at the index level (p=0.009).

CONCLUSION

While the radiographic non-union rate at 24 months was 13%, PROs show that many of these were asymptomatic. Although a majority of patients with radiographic non-union did not undergo additional surgery, index level re-operation was significantly higher (21% vs. 7%) in the radiographic non-union group.

TAKE HOME MESSAGE

While the radiographic non-union rate after single-level ACDF with allograft and plate was 13% at 24 months, PROs show that many of these were asymptomatic.

170. Restriction Monoaxial Screw(s) in Apical Vertebrae: A Modified Apex Control Technique in Children Treated with Dual Growing Rods

Yang Yang, MD; Jianguo Zhang, MD

SUMMARY
For children with large curve and apex vertebrae translation (AVT), better initial coronal correction remains challenging for dual growing rods (GRs) technique, due to loss of direct fixation on apical vertebrae. By using modified apex control technique, inserting restriction monoaxial screw(s) in apical vertebrae, good correction of coronal plane (larger main curve correction and satisfying reduce of AVT) can be achieved and maintained very well, which is helpful to reduce complications and achieve better correction in the final fusion procedure.

HYPOTHESIS
For children treated with dual GRs, modified apex control technique can improve the initial correction of coronal deformity and the correction effect can be maintained well during subsequent lengthening procedures.

DESIGN
Retrospective study

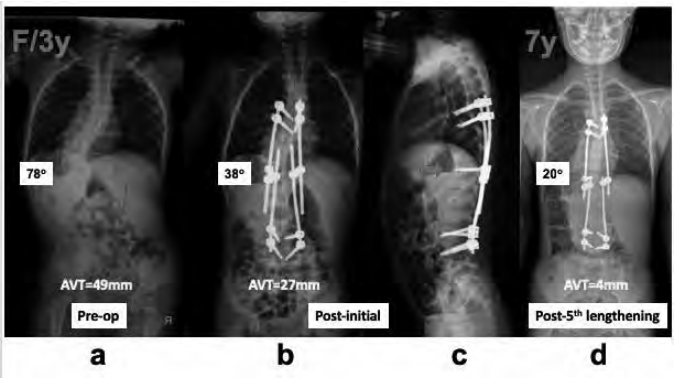
INTRODUCTION
For patients treated with dual GRs, no screws were routinely inserted in apical vertebrae in order to reduce the interference of spine growth. Thus, it may lead to insufficient correction of coronal deformity (main curve and AVT), which may increase the complication rate. Large residual coronal deformity can also increase the difficulty to achieve better correction during final fusion procedure. The purpose of this study was to evaluate the efficacy of modified apex control technique on coronal deformity correction in patients treated with dual GRs.

METHODS
From April 2010 to September 2017, 16 children (8 males, 8 females) with large AVT (> 40mm) treated with dual GRs technique, were retrospectively reviewed. Restriction monoaxial pedicle screw(s) was (were) inserted in apical vertebrae without using locking caps. Medical records of all these patients were reviewed. The parameters included age at initial surgery and the final follow-up, lengthening number, and complications. Radiographic evaluation included Cobb's angle of main curve, thoracic kyphosis, lumbar lordosis, trunk shift, and AVT.

RESULTS
The average age of these patients was 7.9±3.3 years old (range, 3-13 years). The mean follow-up was 56.4±30.8 (range, 12-92) months, with 4.0 lengthenings for each patient. The mean Cobb's angle improved from 60.1o±9.6o to 22.1o±10.0o after initial surgery and was 24.6o±11.8o at the final follow-up. AVT improved from 46.0±4.4mm to 20.0±6.5mm after initial surgery and was 19.2±11.5mm at the final follow-up. Four patients encountered implant-related complications, including rod breakage (2), pull-out of proximal screws (1), and rod dislodgement (1). One patient had proximal junctional kyphosis.

CONCLUSION
By using restriction monoaxial pedicle screw(s) in children with large coronal deformity, good correction was achieved and maintained very well during subsequent lengthening procedures.

TAKE HOME MESSAGE
Restriction monoaxial pedicle screw(s) can increase initial correction of coronal deformity , which may be helpful to reduce complications and achieve better correction in the final fusion procedure.



a, Pre-op AP film; b, Post-initial AP film; c, Post-initial lateral film; d, Post-5th extension AP film.

171. Incorporating Active Vertebral Apex Correction (APC) alongside Guided Growth Technique for Controlling Spinal Deformity in Growing Children

Aakash Agarwal, PhD; *Alaaeldin (Alaa) Azmi Ahmad, MD*

SUMMARY
Growth guidance procedure, although doesn't result in consecutive surgeries, there still remain severe complications of loss of correction through crankshafting or adding-on . The main culprit of this complication is the vertebral growth anteriorly at the apex, which mostly remains unmodulated by static fusion posteriorly. The current study presents a modified approach to Growth guidance process that could help dynamically remodulate, i.e. reverse modulate, the apex of the deformity.

HYPOTHESIS
To determine if active remodulation in the apex of the curve is possible in scoliosis and kyphoscoliosis patients, using a modified Growth Guidance; Active Vetebral Apex Correction APC technique

DESIGN
Retrospective study

INTRODUCTION
substantial percentage of patients undergoing Growth guidance technique experience loss of correction via crankshafting . In addition, the need for osteotomies on the concave side has the potential of severe complications. Therefore, any modified technique that could eliminate these is very desirable.This non-fusion Growth guidance procedure, active apex correction (APC), is performed by artificially create a compensatory pressure on the vertebral body by thus gradually allow its remodulation (reverse modulation) and reduction in the wedging over time. In contrast to the regular growth guidance approach, the addition of active apex correction could mitigate or reduce future loss of correction, and also eliminates the complications related to the need of osteotomies as a procedural byproduct.

METHODS
20 patients with either scoliosis or kyphoscoliosis underwent a modified Growth guidance approach, where an active apex correction was applied. In this modified technique, the most wedged vertebra was selected followed by insertion of pedicle screws in the convex side of the vertebrae above and below the wedged

one. Additionally, no cast or brace were used for these patients postoperatively. The patients follow up records varied between 8-97 months, with an average follow up duration of 32 months. The convex and concave heights of the wedged and control vertebrae were recorded at the time of the surgery and at follow up duration, both using CT

RESULTS

The wedged vertebra demonstrated in average a 17% (p=0.00014) increase in the proportion of concave to convex heights ratio, whereas the control vertebra didn't show any relative change in the wedged vertebra heights at the follow ups.

CONCLUSION

Active apex correction, remodulates the apex vertebra, which may in turn help mitigate loss of correction on long term due to crankshafting and adding-on

TAKE HOME MESSAGE

the study demonstrates the possibility of safely and effectively reverse modulating the wedging at the apex using a modified Growth guidance technique

173. Radiation-free Imaging of All Relevant Structures in Scoliosis Treatment Using MRI

Peter R. Seevinck, PhD; Winnie Chiu Wing Chu, MD; Rob Cornelis Brink, MD; Kwong Hang Yeung, MS, BS; Moyo C. Kruyt, MD, PhD; Jack C.Y. Cheng, MD; René M. Castelein, MD, PhD; Marijn van Stralen, PhD

SUMMARY

In scoliosis treatment planning, CT is used for 3D assessment of the osseous morphology, whereas MRI provides information on neural axis and intervertebral discs. Here we show that deep learning-based synthetic CT generation, using solely MRI data, facilitates accurate 3D visualization of the osseous structures in the spine. This demonstrates the promise of an MRI-based one-stop-shop modality for 3D imaging of all relevant spinal structures in scoliosis treatment planning, potentially reducing the number of hospital visits, radiation burden and costs.

HYPOTHESIS

MRI-based deep learning-enabled synthetic CT generation allows selective 3D visualization and characterization of the scoliotic spine.

DESIGN

prospective single center feasibility study

INTRODUCTION

In treatment of complex scoliosis cases, X-ray is used for initial assessment, CT for 3D analysis of the osseous morphology and for surgical planning, whereas MRI provides information on the neural axis and intervertebral discs (IVDs). The use of different modalities often leads to multiple hospital visits, high radiation burden and costs. Recent advances in deep learning (DL)-based image synthesis have initiated research into MRI-based radiodensity contrast mapping, known as synthetic CT (sCT) generation. This study investigates the feasibility of sCT generation of the spinal morphology in adolescent idiopathic scoliosis (AIS) patients.

METHODS

Regular high-resolution CT and 3D MRI scans were obtained in 15 AIS patients for surgical navigation purposes. No additional CT imaging was done. A dedicated, generally available multi-gradient echo MRI scan was inserted for sCT generation. Using previously validated methodology [Florkow MC et al. ISMRM, 2018], a deep learning model for sCT generation was trained based on the paired MRI and CT data. sCT images were generated using MRI data unseen during training.

RESULTS

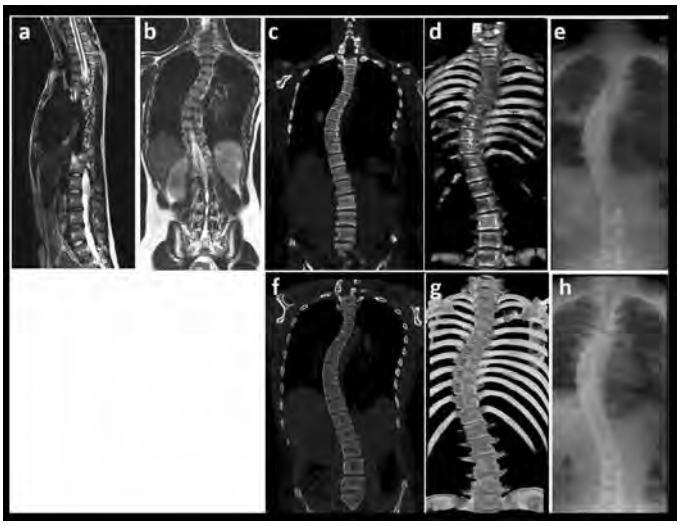
The reconstructed 3D sCT scans accurately visualized the overall 3D morphology in the spine with an image contrast similar to conventional CT (Fig. 1). Simultaneous visualization of bone and soft tissue structures highlights the previously unmatched potential of the intrinsically aligned sCT and conventional MRI images, visualizing the neural axis, IVDs and spinal morphology in a single examination. Although the MRI is performed non-standing, there is a well-known relation between the different body positions.

CONCLUSION

DL-based sCT generation enables accurate visualization of the 3D osseous structures in the scoliotic spine. This demonstrates the promise of a radiation-free MRI-based one-stop-shop modality for 3D imaging of all relevant spinal structures in scoliosis treatment management, potentially reducing the number of hospital visits, radiation burden and costs.

TAKE HOME MESSAGE

Conventional MRI in combination with deep learning-based synthetic CT generation enables 3D visualization and characterization of all crucial tissue types for scoliosis treatment management in a single radiation-free examination.



Upper row, MRI-based: Conventional sagital and coronal T2w-MRI(a-b), coronal sCT (c), 3D rendered sCT (d) and an sCT digital reconstructed radiograph (e). Lower row, CT based: coronal CT (f), 3D rendering (g) and digital reconstructed radiograph (h) .

174. Impaction Grafting of the Pedicle: A Biomechanical Analysis

Francis H. Shen, MD; Gerald M. Hayward II, BS; Jonathan A. Harris, MS; Jorge L. Gonzalez; Brandon Bucklen, PhD; Hamid Hassanzadeh, MD

SUMMARY

Pedicoplasty, a novel revision strategy that reconstitutes a failed pedicle using impaction-grafted allograft, proved to have pullout strength similar to that of larger diameter revision techniques. This technique has potential implications for preserving pedicle anatomy during revision scenarios.

HYPOTHESIS

Pedicle impaction grafting (pedicoplasty) results in mechanical fixation comparable to both pedicle screw upsizing and cement augmentation.

DESIGN

In-vitro biomechanical pullout testing

INTRODUCTION

Current options for revising screw failure are larger diameter revisions and/or injecting cement into the vertebral body for secondary screw fixation. An alternative revision method is impaction grafting (pedicoplasty) of the failed pedicle screw track. This technique utilizes impaction of allograft bone into the pedicle/vertebral body through a series of funnels to reconstitute the pedicle.

METHODS

Investigators utilized 10 vertebrae (L1–L5) free of metastatic disease. Following primary screw insertion, each screw was subjected to a pullout force applied along the screw trajectory at 5mm per minute until failure. Each specimen was instrumented with a pedicoplasty (P) revision utilizing the original screw size and on the contralateral side either a fenestrated screw with cement augmentation (CA) or a screw upsized by 1-mm (UP) in a semi-randomized fashion; these revisions were then pulled out using the previously mentioned methods.

RESULTS

There were no significant differences in initial pullout values between all groups ($p<0.05$). Primary screw pullout values for the paired UP and P were 405 ±101N and 444 ±110N, respectively (n=5). Revised pullout values for the paired UP and P were 512 ±262N and 562 ±204N, respectively ($p>0.05$). Primary pullout values for the paired CA and P were 396 ±227N and 308 ±114N, respectively (n=5). Revised pullout values for the paired CA and P were 960 ±227N and 598 ±114N, respectively ($p<0.05$).

CONCLUSION

This biomechanical investigation demonstrated no significant differences between pedicoplasty and upsized revisions. There was significantly higher pullout strength for cement-augmented revisions compared to both pedicoplasty and upsized revisions. Consideration should be given to the pedicoplasty technique when maintenance of pedicle dimensions is required or further screw diameter increases are not possible.

TAKE HOME MESSAGE

Pedicoplasty, a novel revision technique, has similar fixation strength to larger diameter screw fixation with added benefits of utilizing the same sized screw.

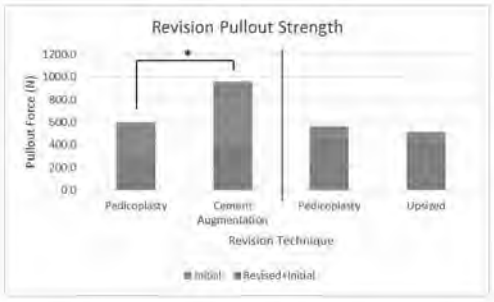


Figure 1. Revision pullout comparison between pedicoplasty, cement augmentation, and screw upsizing. *Significant Difference ($p<0.05$)

175. A Novel Fibrin Dressing Seals Durotomies and Stops CSF Leakage

Timothy Floyd, MD; Rodolfo A. Padua, PhD; Richard D. Guyer, MD; Jean-Jacques Abitbol, MD

SUMMARY

Persistent leakage of cerebrospinal fluid (CSF) remains a challenge in spinal deformity surgery, with associated increased costs, complications and length of stay. A novel fibrin dressing (NFD) stops CSF leakage in experimental durotomies. The structure of the dressing comprises electrospun nanofibers of dextran which dissolves on contact with CSF leaving a robust fibrin clot that adheres to the dura and seals the defect. The dressing does not contain any collagen, cellulose or other foreign substances.

HYPOTHESIS

We hypothesize that a version of a NFD that has been shown to seal fatal arterial injuries will be effective at sealing persistent CSF leaks from durotomies.

DESIGN

Experimental pre-clinical investigation.

INTRODUCTION

Incidental or planned durotomies are not uncommon in complex or revision surgery. Persistent leakage of cerebrospinal fluid (CSF) can lead to fistula formation, pseudomeningocoele, neurological injury, infection, systemic complications and death. CSF leaks increase operative time, costs and hospital stays. We tested a NFD that does not contain a collagen or cellulose backing in a CSF leak model. This fibrin dressing is a highly effective hemostatic device with CE Mark pending.

METHODS

The cranium of 6 adult sheep was exposed and a total of four craniotomy sites were created by connecting 2 14mm burr holes. A 12-14mm durotomy was created with a #11 scalpel and CSF leak was confirmed by direct observation. After closure with a running 5-0 silk suture a Valsalva maneuver was performed. If the durotomy continued to leak CSF the NFD was applied for 3 minutes. After 5 more minutes a repeat Valsalva maneuver was performed and observed with loupe magnification by 3 investigators. If CSF leak continued, a second dressing was applied in the same manner.

RESULTS

Suture alone controlled CSF leak in 3 of 23 (13%) durotomies (95% CI (2.78,33.6%)). The NFD controlled CSF leak in all 20 (100%) remaining durotomies (95% CI (83.2%, 100%)), demonstrating that suture + NFD is superior to suture alone ($p<0.0001$). Three injuries required 2 dressing applications. NFD stopped CSF leak even in presence of cerebral herniation.

CONCLUSION

The NFD was a useful adjunct to suture repair in this durotomy model. The NFD was able to control CSF leak even when the dura could not be approximated with suture. A separate study of lumbar durotomies in a caprine model treated with the NFD alone (no suture) showed 80% control of CSF leak with no pseudomeningocoele or histologic evidence of abnormal inflammation or fibrosis after 30 days of survival.

TAKE HOME MESSAGE

A NFD that does not contain collagen or cellulose is highly effective at controlling CSF leak in this model and may have significant clinical applications.

176. An In Vitro Comparison of Single-position Robotic-assisted Surgery Versus Conventional Minimally Invasive Surgery Following LLIF

Themistocles S. Protopsaltis, MD; Jeffrey Larson, MD; Richard Frisch, MD; Kade T. Huntsman, MD; Todd Lansford, MD; Gerald M. Hayward II, BS; Jonathan A. Harris, MS; Jorge L. Gonzalez; Brandon Bucklen, PhD

SUMMARY

Robot-assisted navigation for single-position bilateral posterior fixation following LLIF had significantly lower surgical times and radiation exposure compared to conventional minimally invasive surgery that requires patient repositioning. This posterior fixation method has potential implications of reducing surgical times and radiation exposure in clinical settings.

HYPOTHESIS

Robotic-assisted navigation reduces both surgical time and radiation exposure compared to conventional MIS methods.

DESIGN

In-vitro cadaveric time trial

INTRODUCTION

Lateral lumbar interbody fusion (LLIF) provides indirect decompression of the neural elements while minimizing potential vascular complications. Posterior fixation may be applied through various techniques, including conventional MIS (CMIS), requiring the patient to be repositioned prone to provide access to both pedicles. Conversely, robot-assisted navigation (RAN) of pedicle screws can be utilized from a single position. RAN is theorized to reduce patient surgical time and radiation due to positioning and workflow effects.

METHODS

Ten unembalmed human torsos were implanted with 2 level static LLIF cages, followed by posterior bilateral pedicle screw fixation using either CMIS (n=5) or RAN (n=5). Preoperative computed tomography (CT) RAN workflow utilized CT scans of the specimen taken off-site. Screw planning was performed preoperatively using these CT scans which were merged with intraoperative fluoroscopy. Surgical times and radiation exposure were measured in minutes and rads. Patient flip time from a consecutive patient series was included.

RESULTS

Significant differences in surgical time and radiation exposure were found between groups ($p<0.05$). Surgical times for RAN and CMIS were 63.8±4.2 and 123.6±15.9 min, respectively. Times per screw for RAN and CMIS workflows were 2.8±0.6 and 4.0±1.2 min, respectively. Both radiation dosages and time were separated into interbody and posterior fixation separately (Table 1). RAN and CMIS radiation exposure during posterior fixation were 25.9%±13.2% and 59.5%±11.2%, respectively, of the total radiation exposure.

CONCLUSION

Significant differences were found in both surgical time and radiation exposure between groups, with RAN resulting in shorter surgical times and less radiation exposure to the surgeon than CMIS. Consideration should be given to single-position LLIF procedures that utilize RAN to instrument the spine with bilateral pedicle screws.

TAKE HOME MESSAGE

Single-position robot-assisted navigation following LLIF resulted in significantly shorter surgical times and less radiation exposure than conventional minimally invasive surgery that requires repositioning.

Table 1. Surgical Time and Surgeon Radiation Exposure.

	Procedural Breakdown	Robot Assisted Navigation (Preoperative)	Conventional Minimally Invasive Surgery
Time (min) Average ± Standard Deviation	LLIF Implantation	27.4 ± 4.1	33.8 ± 9.5
	Patient Flip	-	59.8
	Posterior Fixation*	30.3 ± 3.7	29.7 ± 7.4
	Time per Screw**	2.8 ± 0.6	4.0 ± 1.2
	Total	65.4 ± 4.3	123.4 ± 15.3
Radiation (%)	Posterior Fixation*	25.9 ± 13.2	59.5 ± 11.2

*Includes registration for pre-operative workflow ** Time per screw excluding setup time

177. Utility of a Novel Biomimetic Spinal Deformity Model in Surgical Education

Michael Bohl, MD; Udaya K. Kakarla, MD; Jay D. Turner, MD, PhD; Jean-Christophe A. Leveque, MD; Rajiv K. Sethi, MD

SUMMARY

A synthetic spine model has previously been shown to replicate with high fidelity human gross anatomy, radiographic anatomy, biomechanical performance of pedicle screws, segmental range of motion, and tactile feedback of soft tissue structures including thecal sac. Customized versions of this model were made to replicate 5 patients' spinal deformities. Corrections achieved in the models were compared to corrections achieved in corresponding patients. Subjective feedback on model educational utility was collected from an international cohort of attendings and fellows.

HYPOTHESIS

A novel synthetic spine model provides high educational value in the surgical treatment of spinal deformities.

DESIGN

Prospective evaluation of new technology.

INTRODUCTION

As restrictions on surgical training have increased over the last several decades and the severity of diseases and treatment options have coincidentally expanded, the standard surgical training paradigm will necessarily evolve toward a more structured curriculum increasingly dependent on extra-clinical learning. Cadavers have long been viewed the standard in extra-clinical surgical training, but they have very limited utility in teaching spinal deformity correction techniques. The purpose of this study was to evaluate the educational utility of a novel biomietic spine model in teaching spinal deformity correction techniques.

METHODS

Five adult patients with spinal deformities (2 thoracolumbar, 3 cervicothoracic) were identified and models were manufactured to mimic their individual anatomy, bone quality, and segmental range of motion using previously published methods. Surgical corrections achieved in the models were compared to corrections achieved in the corresponding patients, and subjective feedback on model educational utility was collected from an international cohort of attendings and fellows using NASA Task Load Index (TLX) and Likert surveys.

RESULTS

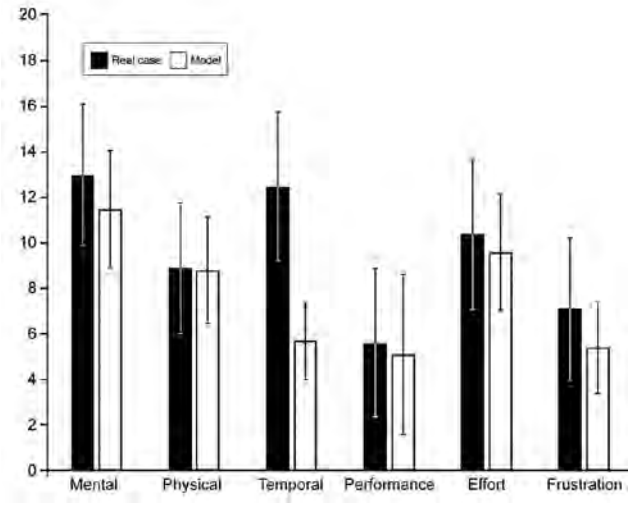
All models were corrected to within 10-deg of the patient's corrections (mean 2.3-deg, stdev 3.6-deg). TLX data demonstrated that attendings and fellows believed the models accurately replicated surgical workloads in domains of mental and physical tasks, as well as performance, effort, and frustration, but not in temporal demand. Likert surveys on model educational utility were unanimously scored the most positive response (7/7) among 11 attendings and fellows from the USA and Japan.

CONCLUSION

The tested synthetic spine models accurately replicated individual patients' deformities both anatomically and biomechanically, yielding a surgical training model with great potential educational utility. Models like these will become increasingly important in the future to improving surgical spine deformity education.

TAKE HOME MESSAGE

Biomimetic spine models can accurately replicate an patient's gross anatomy, bone quality, and segmental range of motion. These models have demonstrated high potential utility in spinal deformity surgical education.



NASA- Task Load Index scores for biomimetic spine models

178. A Three-dimensional Classification for Assessment of Brace Effectiveness

Saba Pasha, PhD

SUMMARY

in-brace spinal cobb correction and the rib-vertebrae angles are shown previously to predict the outcome of bracing, yet these measurements remain two-dimensional. a three-dimensional classification of the spine and ribcage was developed; in this classification two rib cage groups (drooping and straight), two sagittal groups (hypokyphotic and normal/hyperkyphotic), and two axial curve patterns (S shape and V shape) were determined. The bracing was most effective in straight rib cage, hypokyphotic, and V shape patients.

HYPOTHESIS

The pre-brace shape of the spine and rib cage can predict the effectiveness of TLSO bracing in adolescent idiopathic scoliosis.

DESIGN

retrospective cohort

INTRODUCTION

The predictors of successful bracing are not determined. As the brace forces are imparte via the ribs to the spine, the in-brace changes in the rib cage can predict outcomes.

METHODS

A total of 30 AIS with an apex above T10 who were prescribed a TLSO brace for the first time were included retrospectively. Two view spinal X-ray at pre- brace and in-brace (maximum 2 months apart) were used to create the 3D model of the spine and ribcage in and out of brace. The main cobb correction was assessed at 6 months and 1 year follow-ups. a classification system based on the rib cage morphology and spinal curve were developed: two rib cage groups (drooping and straight), two sagittal groups (hypokyphotic and normal/hyperkyphotic), and two axial curve patterns (S shape and V shape) Fig.1. The in- and out-brace of brace shape of the spine and ribcage were determined using this classification. A binomial logistic regression was used to predict whether the main curve progressed based on the both in and out brace groups in the three planes.

RESULTS

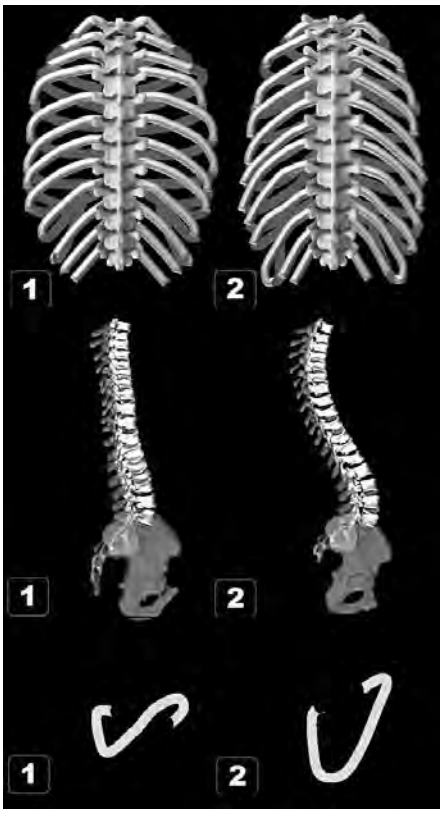
The odds of curve progression was 1.8 (95%CI [1.32-2.06]) higher in rib cage Type 2 and 1.1 (95%CI [0.96-1.8]) in sagittal profile type 1. The interaction between rib cage type 2, sagittal profile type 1 and axial type 2 resulted in curve progression.

CONCLUSION

Both changes in the sagittal profile and the shape of the ribcage are predictors of the curve progression during bracing. A 3D analysis of the shape of the ribcage allowed explaining the underlying mechanism associated with curve progression while bracing.

TAKE HOME MESSAGE

Subtype of sagittal profile (backward trunk shift with a thoracolumbar kyphosis) and in-brace ribcage morphology type (dropping on concave and/or convex sides) were risk factors of curve progression while bracing.



179. Spring-based Distraction in Early Onset Scoliosis: A Finite Element Stress Comparison to Traditional Growing Rods

Justin V.C. Lemans, MD; Manoj K. Kodigudla, MS; Amey V. Kelkar, MS; Moyo C. Kruyt, MD, PhD; René M. Castelein, MD, PhD; Anand K. Agarwal , MD; Vijay K. Goel, PhD; Aakash Agarwal, PhD

SUMMARY

This finite element (FE) study compared differences in instrumentation von Mises stresses (VMS) during motion between a spring distraction system (SDS) and a traditional growing rod (TGR) system used for treating early onset scoliosis. Two ligamentous, scoliotic FE models were created and compared; a TGR model and an SDS model. Surgical scoliosis correction was modeled, follower load was introduced and VMS was measured. A slight reduction in instrumentation VMS was observed in the SDS model compared to the TGR model.

HYPOTHESIS

We hypothesize that the Spring Distraction System instrumentation has lower von Mises stresses during motion compared to a traditional distraction-based system.

DESIGN

Finite Element Analysis

INTRODUCTION

Current growing-rod systems for Early Onset Scoliosis like the traditional growing rod (TGR) and magnetically controlled growing rod (MCGR) need to be periodically lengthened. The forces used for lengthening are not controlled, therefore instrumentation failure is often seen. We developed a Spring Distraction (growing rod) System (SDS), in which rods freely slide along each other through a polyaxial parallel connector whilst continuous distraction is achieved through two 75N titanium springs. The current finite element (FE) study compares von Mises stresses in the rods in SDS with those in TGR in an instrumented scoliotic spine model.

METHODS

A ligamentous, scoliotic, FE model was created (Figure 1). We created and compared two FE models: An SDS model with polyaxial sliding connectors (intended to reduce wear) and 75N springs, and a TGR model with parallel domino connector and no springs. Surgical correction of the curve with instrumentation was modeled by applying 20 mm distraction. After that, gravity and muscle forces were simulated through a follower load. Then, 1 Nm flexion-, extension-, lateral bending- and axial rotation moments were introduced to T2 and maximum von Mises stresses on the rods were measured.

RESULTS

After introducing follower load, maximum von Mises stresses in all four rods were lower for SDS compared to TGR. The stress reduction ranged from 10-28MPa (4-11%), depending on which rod was investigated. This reduction was combined with a small increase in spring compression, in which the SDS spring converted some of the follower load to spring energy. During 1Nm motions, stresses remained consistently lower in SDS, with the largest reductions in stress when performing flexion (6-17%), left bending (7-13%) and left rotation (7-12%).

CONCLUSION

SDS provides slightly lower von Mises stresses compared to TGR. Further research is currently pursued investigating different spring configurations and spring-force optimization.

TAKE HOME MESSAGE

The addition of SDS to standard instrumentation slightly reduces von Mises stresses on the rods, potentially reducing the incidence of rod fractures, while obviating the need for intermittent forceful distractions.

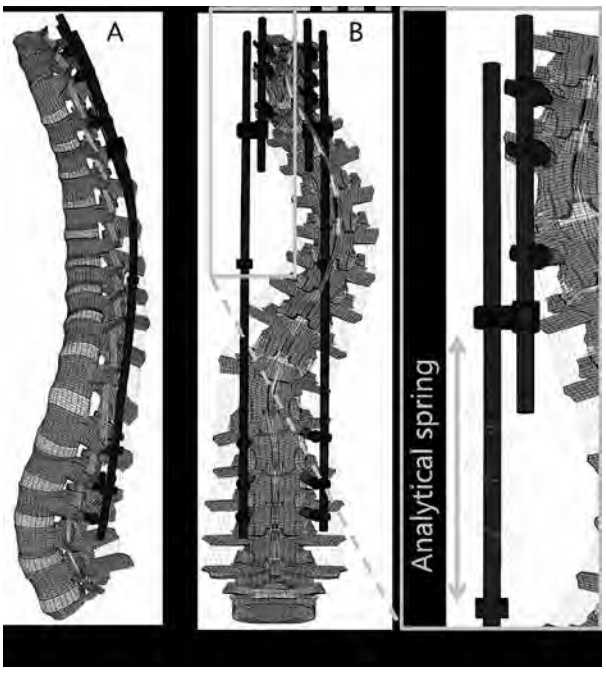


Figure 1: Sagittal (A) and posterior (B) view and close-up view of connector (C). The spring pushes the long rod and the connector (fixed to the short rod) apart, distracting the spine.

180. Optimization of Outcomes with a Novel Fusionless Posterior Dynamic Deformity Correction (PDDC) Device for Adolescent Idiopathic Scoliosis: Learning Curve Drives Indications

Ron El-Hawary, MD, MS; Randal R. Betz, MD; Baron S. Lonner, MD; Yizhar Floman, MD

SUMMARY

A learning curve was identified with the use of this novel posterior dynamic deformity correction device. An evolution towards longer constructs (5-6 levels) in more flexible patients (≤30° pre-op lateral bending) resulted in an improvement from 42% of patients to 79% of patients having ≤35° curve magnitude with minimum two year follow up.

HYPOTHESIS

There is a learning curve related to the surgical indications and to the number of levels spanned by a novel posterior dynamic deformity correction system.

DESIGN

Retrospective, multicenter

INTRODUCTION

In 2012, a fusionless PDDC to correct AIS was introduced. Our purpose was to define its learning curve.

METHODS

With minimum 2yr f/u, two groups of AIS patients with scoliosis 40-60° with pre-op lateral bend (LB) ≤35° were compared: Early (3-4 levels spanned), Late (5-6 levels). Primary outcome variable was the percentage of patients with scoliosis ≤ 35° at final f/u. Serious adverse events and re-operations were recorded. Continuous and categorical variables were assessed using t-test and binomial variables were compared to binomial outcomes using chi square.

RESULTS

Two groups were compared: Early (n=12 females; 12-16 yrs; mean Risser 3.0; Lenke type 1); Late (n=33; 30 females; 12-18 yrs, mean Risser 3.7; Lenke type 1-21; type 5-11, type 3-1). Mean pre-op scoliosis was 46° (41°-54°) Early vs 46° (40°-60°) Late (p=0.8). At final f/u, scoliosis was 38° (25°-58°) Early vs 29° (7°-56°) Late (p=0.013). At final f/u, 8% of patients Early vs 39% Late had curve ≤25° (p=0.07); 8% Early vs 48% Late had curve ≤30° (p=0.02), and 42% Early vs 70% Late had curve ≤35° (p=0.16). A subset of patients from the Late group (n=28) that had more pre-op flexibility (LB≤30°) resulted in 79% of curves ≤35° (p=0.03 vs Early). Kyphosis / lordosis were well maintained in both groups. 1 Early patient was converted to a fusion as a result of poor correction with resultant progression to >50°. 1 Late patient was converted to fusion and 2 Late patients had device failure: (1 ratchet failure resulted in re-operation for additional distraction; 1 rod breakage resulted in removal of the system).

CONCLUSION

There was a learning curve associated with the use of this novel PDDC Device. Early cases resulted in 42% of patients having curve magnitude of ≤ 35° at final f/u. This improved by spanning more levels (70% success) and also by refining indications to include only patients with pre-op flexibility ≤30° (79% success).

TAKE HOME MESSAGE

By selecting patients with pre-operative lateral bending to ≤30° and spanning 5-6 vertebral levels, successful outcomes have improved from 42% to 79% with this fusionless posterior dynamic deformity correction device.

181. Posterior Ligamentous Reinforcement does not Prevent Proximal Junctional Kyphosis in Adult Spinal Deformity

Sravisht Iyer, MD; Francis C. Lovecchio, MD; Jonathan Charles Elysée, BS; Renaud Lafage, MS; Frank J. Schwab, MD; Virginie Lafage, PhD; Han Jo Kim, MD

SUMMARY

Reinforcement of the posterior ligamentous structures with a surgical nylon tape did not reduce the rates of proximal junctional kyphosis in a cohort of adult spinal deformity patients undergoing >5 level fusion to the pelvis. These results were maintained at 1 and 2 year follow-up even after controlling for extent of correction and preoperative sagittal alignment

HYPOTHESIS

Augmentation of the posterior ligamentous structures (PLS) at the level above the upper instrumented vertebrae (UIV+1) would decrease the incidence of proximal junctional kyphosis (PJK) in adult spinal deformity (ASD) patients treated with long fusions to the pelvis.

DESIGN

Retrospective cohort study

INTRODUCTION

Violation of the posterior soft tissues is believed to contribute to the development of PJK. Augmentation of the PLS may help prevent PJK.

METHODS

A retrospective cohort study was performed of adult spinal deformity patients who underwent 5 or more level fusions to the pelvis by a single surgeon between 2014 and 2017, with a minimum of 1 year follow up. Patients were divided into two groups: PLS+ patients had reconstruction of the PLS between UIV+1 and UIV-1 with a surgical nylon tape while PLS- patients did not. Demographics, surgical data, and sagittal alignment parameters were compared between the cohorts. The primary outcome of interest was the development of PJK at final follow up (1 or 2 years). A multivariate regression model and subgroup propensity match were utilized to control for surgical and radiographic differences in the cohorts

RESULTS

108 patients met final criteria, 31 patients (28.7%) were PLS+. There were no differences with regards to preoperative or final sagittal alignment parameters, number of levels fused, rates of three-column osteotomies, and BMI ($p>0.05$), though the PLS+ cohort was older and had greater changes in SS, PT, PI-LL, SVA, and T1PA at 6 weeks ($p<0.05$). The rates of PJK for PLS+ (27.3%) and PLS- (28.6%) were similar ($p=0.827$). The choice of UIV (above or below T9) did not affect the rates of PJK (PLS+:29.4% vs. 37.8%, $p=0.547$). After controlling for sagittal correction via propensity matching, PLS+ had no impact on PJK (29% vs. 38.7%, $p=0.367$). In our multivariate analysis, only increased sagittal malalignment and failure to restore sagittal balance were retained as significant predictors of PJK. PLS+ was not retained as an independent predictor of PJK.

CONCLUSION

Our findings emphasize the multifactorial nature of PJK and the difficulty of preventing PJK with a single surgical technique

TAKE HOME MESSAGE

PLS augmentation at the UIV+1 does not substantially reduce the rates of PJK even after controlling for relevant variables such as age, pre-operative alignment and the degree of correction

	PLS+ (31)		PLS- (77)		P-Value
	Mean	SD/%	Mean	SD/%	
Age	64.1	10.4	51.3	21.4	0.002
BMI	24.9	5.2	27	6.9	0.143
Gender					0.836
Male	7	23%	16	21%	
Female	24	77%	61	79%	
ASA					0.224
1	0	0%	9	12%	
2	17	55%	36	47%	
3	7	23%	18	23%	
4	0	0%	1	1%	
Number of levels	10.7	3.8	9.7	3.8	0.331
Fusion above T10	16	52%	43	56%	0.590
PJK	9.0	27.3%	22.0	28.6%	0.827
Pre-op					
Sacral Slope	27.2	12.0	31.8	14.8	0.134
Pelvic Tilt	23.5	9.1	21.4	13.1	0.404
Pelvic Incidence	50.8	12.1	53.2	14.4	0.420
PI-LL	18.8	17.8	13.5	21.5	0.228
Lumbar Lordosis	32.0	19.1	39.7	23.6	0.111
T10-L2	-18.4	15.1	-10.9	19.7	0.059
Thoracic Kyphosis	-29.7	15.3	-34.2	18.5	0.241
Cervical Lordosis	7.8	19.7	10.5	16.6	0.491
C7 SVA	72.5	80.1	58.9	77.7	0.420
T1PA	22.8	11.2	20.4	15.3	0.430
Post-op					
Sacral Slope	29.2	10.2	32.6	12.7	0.380
Pelvic Tilt	18.4	8.6	16.5	11.6	0.583
Pelvic Incidence	47.7	12.6	49.1	14.2	0.753
PI-LL	-2.1	14.0	-1.3	15.7	0.870
Lumbar Lordosis	49.9	17.7	50.4	17.8	0.917
T10-L2	-10.3	8.3	-6.6	15.2	0.398
Thoracic Kyphosis	-39.9	12.2	-40.1	16.2	0.981
Cervical Lordosis	10.4	19.5	10.1	16.4	0.944
C7 SVA	2.6	36.7	9.8	42.7	0.584
T1PA	12.7	10.0	11.9	11.9	0.841

Table 1. Demographics, surgical factors, and sagittal alignment parameters

182. Scheuermann's Kyphosis Patients Are at a Higher Risk for PJK, Irrespective of Instrumentation Type

Vishal Sarwahi, MD; Jesse Galina, BS; *Darren F. Lui, MBBS, FRCS;* Sayyida Hasan, BS; Stephen F. Wendolowski, BS; Sean Molloy, MBBS, FRCS, MSc (eng); Adam Benton, BA (Hons) BMBS; Haiming Yu, MD; Sara Khoyratty, MBBS, MRCS; Yungtai Lo, PhD; Terry D. Amaral, MD; Aaron M. Atlas, BS

SUMMARY

A large number of SK patients have postop PJK. Higher incidence of PJK is seen with all pedicle screw fixation and UIV below T3.

HYPOTHESIS

The incidence of PJK in SK is higher in pedicle screw fixation than hybrid

DESIGN

Ambispective

INTRODUCTION

PJK has been well documented with pedicle screws in AIS patients. In Scheuermann's kyphosis (SK), PJK has been reported with hybrid fixation in the presence of shorter fusions. The literature is deficient about PJK in SK with all pedicle screw constructs.

METHODS

X-ray and chart review of all SK patients operated with all pedicle screw (PS), hybrid fixation (HF), and anterior/posterior fusions with hybrid fixation (AP) were reviewed. Number of fusion levels, percent correction, UIV, LIV, pre and postop PJK, sagittal balance, and demographic data was collected. PJK was defined as more than 10 degrees. Fisher's exact test, Kruskal-Wallis, Wilcoxon ranked sum test were used.

RESULTS

84 total patients: PS (n=29), HF (n=24), and AP (n=31). Median preop kyphosis was significantly higher in the AP compared to PS and HF (89 vs 77 vs 81.5, $p<0.001$). Median postop kyphosis was significantly higher in the PS cohort (50.3 vs HF: 45.5 vs AP: 43, $p=0.048$). Median percent correction was highest in the AP cohort (51.8 vs HF: 43.8 vs PS: 32.9, $p<0.001$). Pre and post sagittal balance was similar across the three cohorts. Pelvic parameters (pelvic incidence, pelvic tilt, sacral slope) were similar between all of the groups pre- and postoperatively ($p > 0.05$). Overall, at postop 47.6% of patients had PJK, and at final 70.2%. Immediate postop-PJK was significantly higher in PS 13.4 vs HF: 7.8 vs AP: 8, $p =0.008$). However, final PJK was similar across the three groups (PS: 19 vs HF: 15 vs AP:14, $p=0.07$). T2 was the most common UIV for AP (71%) and HF (71%) compared to T3 for PS (59%), $p<0.001$). Overall, significantly higher postop-PJK was seen with UIV below T3 (13.7 vs 9.4, $p =0.043$).

CONCLUSION

Incidence of PJK appears to be higher in SK compared to that reported in AIS. Patients with pedicle screw fixation appear to be at the highest risk. UIV at T3 or proximally has significantly lower PJK.

TAKE HOME MESSAGE

Incidence of PJK increases with SK compared to AIS. PSFwith pedicle screw fixation poses the highest risk of PJK to SK, compared to AP staged fusion or hybrid fixation.

183. En Bloc Reduction-fixation Using Intercalary Rods Achieves and Maintains Correction in the Surgical Treatment of Rigid Adult Spinal Deformities Requiring Spinal Osteotomies

Jay S. Reidler, MD; Andrew B. Harris, BS; Micheal Raad, MD; Mostafa H. El Dafrawy, MD; Majd Marrache, MD; Floreana N. Kebaish, MD; Khaled M. Kebaish, MD, FRCS(C)

SUMMARY

En bloc reduction-fixation using intercalary rods is a technique for achieving and maintaining correction while minimizing stress on junctional spinal segments in fixed rigid deformities of the spine. Our results show substantial correction of alignment that was maintained at final follow up. The rates of revision surgery for proximal junctional kyphosis were lower than that reported in the literature for similar patients.

HYPOTHESIS

We hypothesized that en bloc reduction-fixation of adult spinal deformities using intercalary rods would achieve good correction of spinal deformities and result in low rates of complications such as junctional kyphosis and hardware failure.

DESIGN

Retrospective case series.

INTRODUCTION

Correction of severe sagittal imbalance often requires the use of 3-column osteotomies, and fixation is commonly performed by sequential reduction of pedicle screws to rods spanning the full length of the deformity. Correction can be simplified by en bloc reduction-fixation using intercalary rods, a novel technique.

METHODS

We reviewed records of adult patients with spinal deformity treated with en bloc reduction-fixation by a single surgeon from 2008-2014 with 2-year follow-up. The technique involves separate rod placement and deformity correction cephalad and caudal to the osteotomy site, followed by 3-column osteotomy and en bloc reduction-fixation across the osteotomy site using intercalary connecting rods. Radiographic measurements were compared using pairwise t-tests.

RESULTS

37 patients with 2-year follow up were studied. The mean age was 60 years old, and 24 (65%) were women. 31 (84%) had previous instrumented fusion. Mean number of levels fused was 15, with an average follow-up of 3.4 years. Sagittal alignment at the level of the osteotomy changed from $24.4 \pm 14.2°$ to $6.7 \pm 7.4°$ and coronal angle from $4.1 \pm 6.3°$ to $1.2 \pm 3.0°$, both $p<0.01$. Mean C7-S1 SVA changed from 10.2 ± 8.7cm preop to 5.5 ± 4.7cm postop ($p<0.01$). All corrected parameters were maintained at final follow up ($p>0.05$). 6 patients (16%) had reoperations related to complications (including PJK: 8%, DJK: 3%, Non-Union: 3%) at an average 9.4 months (R: 0.2, 28).

CONCLUSION

The technique of en bloc reduction-fixation allows for effective correction of adult spinal deformity where a large degree of correction and 3-column osteotomy is indicated. This technique simplifies several of the potential difficulties of traditional instrumentation techniques with lower rates of revision surgery and complications compared to historical data.

TAKE HOME MESSAGE

En bloc reduction-fixation using intercalary rods can be used for fixed rigid deformities of the spine, with substantial correction of alignment that was maintained at final follow up.

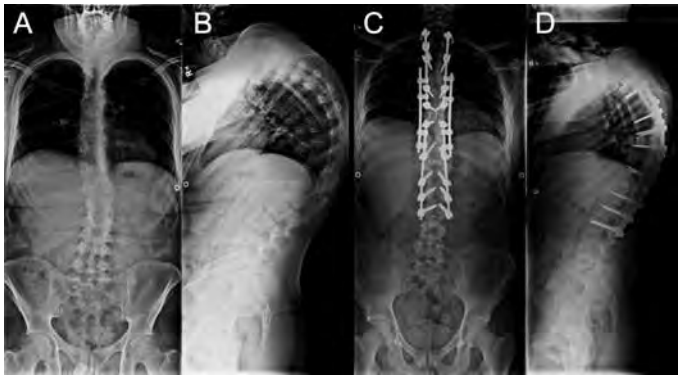


Figure 1. Pre (A, B) and postoperative (C, D) sagittal and coronal standing scoliosis radiographs after En Bloc Reduction-Fixation Using Intercalary Rods in an adult patient.

184. Surgical Indications and Clinical Results of L5 Pedicle Subtraction Osteotomy

Tomohiko Hasegawa, MD, PhD; Yu Yamato, MD, PhD; Daisuke Togawa, MD, PhD; Go Yoshida, MD, PhD; Sho Kobayashi, MD, PhD; Tatsuya Yasuda, MD; Tomohiro Banno, MD, PhD; Hideyuki Arima, MD, PhD; Shin Oe, MD; Yuki Mihara, MD; Tomohiro Yamada, MD; Hiroki Ushirozako, MD; Yukihiro Matsuyama, MD, PhD

SUMMARY

Comparison between 11 L5PSOs and 47 another lumbar level PSOs was performed. Both PSOs obtained same osteotomy angle around 30 degrees, however L5PSO obtained better lower lumbar lordosis and maximum lordosis than L1-4 PSOs with equivalent surgical invasiveness and lower reoperation rate.

HYPOTHESIS

L5 PSO is useful method for correction lower lumbar kyphosis and safe as another lumbar levels PSO.

DESIGN

Retrospective case series

INTRODUCTION

When we correct the lumbar kyphosis in Adult spinal deformity (ASD) patients, making appropriate L4/S1 lordosis is necessary. Because it was reported that 60- 70% of LL is built in L4/S1. Pedicle subtraction osteotomy (PSO) is one of the strongest tools to make lordosis. However L5 PSO is rarely used because it is widely regarded as difficult, dangerous and hard to obtain bony fusion due to less anchor. Therefore we investigated usefulness and surgical invasiveness of L5 PSO.

METHODS

58 rigid lumbar kyphosis cases which were performed one level PSO in our hospital from 2010 to 2017 were included. PSO level was decided by the apex location. If the apex located at vertebral body, PSO was performed the apex vertebral body. If apex located at disc level, PSO was performed lower vertebral body. L5PSO was done with four iliac screws. We compared L5 PSO and another lumbar level PSOs for osteotomy levels, age, operation time, intraoperative blood loss, reoperation rate, thoracic kyphosis, LL(L1/S1), lower LL(L4/S1), max LL and osteotomy angle. The statistical analysis was performed by Mann-Whitney U test and chi-square test.

RESULTS

The osteotomy level distribution was L1:4, L2:6, L3:10, L4:27, L5:11. Average age was 67 years. 12 males and 46 females. By the comparison between L5 and L1-4PSO, there was not the significant difference in age, operation time (L5:386 minutes, L1-4:443 minutes), intraoperative blood loss (L5:1447g, L1-4:2100g). In the preoperative X-rays, lower LL (L5:-2.2, L1-4:14.8) were significantly small in L5 group, and SS was significantly bigger. There was no significant difference in osteotomy angles (L5:28.7, L1-4:29.4). Correction of Max LL and lower LL were significantly bigger in L5PSO group. In addition, the reoperation rate was significantly lower in L5 group (L5: 9%, L1-4:21%, $P<0.01$).

CONCLUSION

L5PSO obtained better lower lumbar lordosis and maximum lordosis than L1-4 PSOs with equivalent surgical invasiveness as L1-4 PSOs.

TAKE HOME MESSAGE

L5PSO is useful and safe as another lumbar level PSO for lower lumbar kyphosis correction in adult spinal deformity.

185. The Clinical Results of Severe Potts Deformity Surgery and Related Complications

Kai Cao, MD, PhD; Rongping Zhou, MD, PhD; Lu Chen, MD; Zhimin Pan, MD, MS; Yoon Ha, MD; Junlong Zhong, MD; Quanfei Liu, MD; Zhi-min Zeng, MD

SUMMARY

Fifteen severe post-tuberculotic kyphosis Pts who underwent correction surgery were assessed in aspect of quality of life, neurological status, magnitude of correction and complications in a 2-year follow-up. The results of this study indicated that osteotomy and correction surgery improved the Pts quality of life and prevented the neurological deterioration.

HYPOTHESIS

Surgery for severe Potts deformity significantly improves the Pts quality of life and prevents the neurological deterioration in spite that correction surgery is challenging and risky.

DESIGN

A retrospective study.

INTRODUCTION

Late-onset paraplegia is inevitable if without the surgical correction intervention for post-tuberculosis kyphosis(PTK). However, in the scenario of severe Potts deformity(>90°), adequate correction is still high risky, technique-demanding and controversial. Inadequate correction is likely to result in late-onset biomechanical problems. Clinical results, technique for adequate correction and complications were reported in this study.

METHODS

Fifteen PTK Pts with kyphotic angle more than 90°(96.1±10.2°) formed this study. The indications for surgery were persistent back pain (n=8), progressive deformity (n=2) and neurological deficits (n=5). The neurological status was normal in 10 patients, Frankel D in 4 patients and Frankel C in 1 patient. The angle of deformity(Konstam angle), ODI, VAS, surgery time, EBL, surgery related complications and the loss of correction in the last follow-up were recorded.

RESULTS

The average follow-up was 25±12 mons. Solid fusion was achieved in 12 Pts, but implants failure occurred in 3 Pts. The postoperative kyphosis averaged 20.9±6.4°. The average deformity correction was 75.3±10.3° with a 78.26±5.90%. correction rate. The average loss of correction at the last follow-up was 6.8°. No patient with normal preoperative neurological status showed deterioration after surgery. Two Pts having preoperative neurodeficit recovered to Frankel E from D. Two had no change at Frankel D but one with Frankel C deteriorated to Frankel A. At the last follow-up, VAS was decreased from 7.2 to 2.0. ODI was improved from 52.4 to 15.2. Mean surgery time was 320 min, EBL was 1820 ml. Complications included temporary neuropathic girdle pain and anaesthesia, neurological dysfunction, implants failure/lose of correction and CSF leaking

CONCLUSION

Surgery for severe Potts deformity significantly improves the Pts quality of life and prevents the neurological deterioration in spite that adequate correction is still challenging and technique-demanding.

TAKE HOME MESSAGE

Properly supporting anterior column and compressing posterior column in osteotomy region can achieve adequate correction and safety for severe Potts deformity surgery.

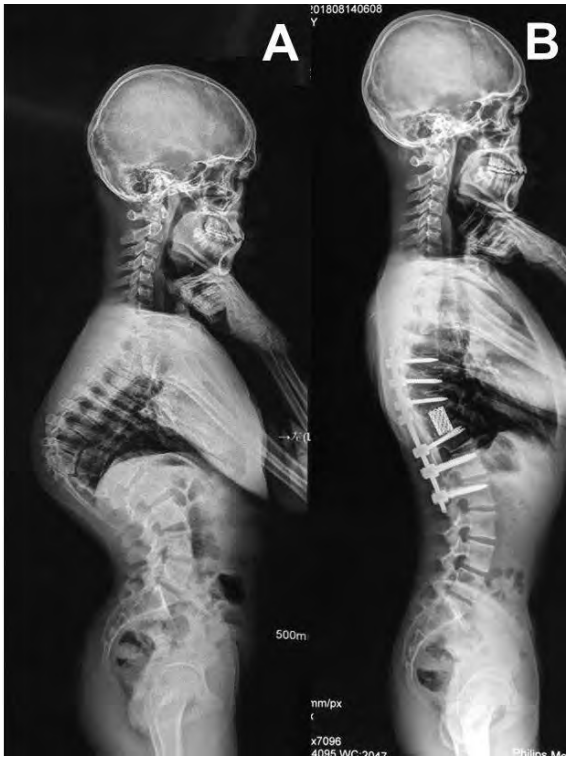


Fig. A, The lateral X-ray showed a patient having severe thoracolumbar Potts kyphosis; Fig.B, The postoperative lateral X-ray presented a nearly physiological kyphosis achieved after adequate correction without neurodeficit.

188. Impact of Cervical Range of Motion on the Global Spinal Alignment in Ankylosing Spondylitis Patients with Thoracolumbar Kyphosis Following Pedicle Subtraction Osteotomy

Bangping Qian, MD; Yong Qiu, MD; Feng Zhenhua, MS; Junyin Qiu; Hongbin Ni, MD

SUMMARY

Due to the cervical mobility, head's center of gravity (COG) plumb line (PL) and C7 PL could be simultaneously positioned over the pelvis in adult spinal deformity (ASD). However, ankylosing spondylitis (AS) patients with thoracolumbar kyphosis (TLK) may accompany with ankylosed cervical spine. When the cervical range of motion (ROM) was impaired, more posterior C7 PL and more backward pelvic rotation were observed preoperatively and at the latest follow-up

HYPOTHESIS

Global spinal alignment would be affected by the cervical ROM in AS patients with TLK

DESIGN

Retrospective single-center study

INTRODUCTION

The impact of cervical ROM on global spinal alignment has not been investigated in AS patients with TLK following pedicle subtraction osteotomy (PSO)

METHODS

AS patients who underwent lumbar PSO for TLK from January 2010 to August 2016 were reviewed. Only patients with a visible ear canal on the preoperative, immediate postoperative and final follow-up radiographs were included. Patients were grouped based on whether the cervical ROM < 40° (Group A) or > 40° (Group B)

RESULTS

A total of 43 patients (36 males and 7 females) with a mean follow-up of 2.4 years (range, 2.0 - 5.0 years) were identified. There were 21 patients in Group A and 22 patients in Group B. Patients in Group A were older than these in Group B ($P < 0.001$). The SVA COG-C7 was larger in Group A ($P < 0.001$). Furthermore, PT was higher ($P = 0.009$) and SVA C7 ($P = 0.041$) was lower in Group A. At the final follow-up, no differences regarding the radiographic parameters were observed between the 2 groups, except the higher PT ($P = 0.023$) and lower SS ($P = 0.031$) in the Group A. ODI and VAS showed no differences between the 2 groups preoperatively or at the latest follow-up

CONCLUSION

To maintain global spinal balance, the pelvis rotated further backward in response to the larger SVA COG-C7 in AS-related TLK. More careful intraoperative verification of the correction should be performed in patients with an impaired cervical ROM to ensure the acquired correction

TAKE HOME MESSAGE

C7 PL may not be appropriate for assessing the global spinal alignment in AS. Larger osteotomy procedures should be considered in AS-related TLK while cervical ROM was impaired

189. Incidence and Risk Factors for Clinical Adjacent Segment Pathology (CASP) in Lumbar Degenerative Cases: Single Centre Study of 1111 Cases with Average Follow-up of 5 Years

Saumyajit Basu, MD, FRCS; Somashekar D., MBBS, MS; Rohan B. Gala, MS; Naveen Agrawal, MS

SUMMARY

We evaluated incidence and risk factors for Clinical Adjacent Segment Pathology in patients who underwent instrumented lumbar spine fusion for lumbar degenerative disease with minimum and maximum follow up of two years and 16 years respectively. Increased age, single level fusion, floating fusion and osteoporosis were risk factors for CASP with incidence of 4.59% in our study. Majority of patients require surgery for CASP

HYPOTHESIS

Age > 50 years, Female Patients, Single Level Fusion, Floating Fusion are Risk Factors for CASP

DESIGN

Level 2, Retrospective study

INTRODUCTION

Clinical Adjacent Segment Pathology (CASP) following instrumented lumbar spine fusion is a major challenge affecting quality of life significantly. Controversy still exists regarding risk factors and management of CASP

METHODS

From 2001 to 2016, 1111 patients who had instrumented lumbar fusion with at least 2 year follow-up were included. After thorough evaluation of Clinical and radiological records, patient characteristics, surgical variables, radiographic parameters and bone-mineral-density were evaluated for patients who developed CASP

RESULTS

51 patients (28 male and 23 female) out of 1111 developed CASP (Incidence=4.59%) with mean age of 61 years and 46 patients being age more than 50 years. Indication for index surgery was spondylolisthesis in 38 and stenosis in 13 patients. Single-level fusion was done in 36, two level fusions in 14 and three level fusion in one. 37 patients (73%) had floating fusions and 14(27%) non-floating fusions. Radiologically, 30 patients developed stenosis, 17 had spondylolisthesis, 2 had instability and 2 had fractures after a mean asymptomatic period of 5.5 years. CASP at proximal level was seen in 45 patients (88%), at distal level in 3(6%) and both in 3(6%). 33 patients underwent surgery for CASP, 4 were conserved with root block, one with medications and 13 patients were lost to follow-up. Osteoporosis (T score < -2.5) was seen in 15 patients who had CASP

CONCLUSION

Incidence of CASP in our study was 4.59%. Age more than 50 years, single-level fusion, floating fusion and osteoporosis were risk factors for CASP. Majority of CASP affected proximal segment. Canal stenosis was the most common pathology of CASP. Majority of patients required second surgery for CASP

TAKE HOME MESSAGE

Risk factors for CASP should be kept in mind while operating for lumbar degenerative disease and explain about its occurrence including need for revision surgery during preoperative consent

SL. NO	VARIABLES	NUMBER OF PATIENTS
1.	Age	61 years (38 to 81 years)
	<50	5
	>50	46
2.	Sex	51
	Male	28
	Female	23
3.	Pre Operative diagnosis	
	Spondylolisthesis	38
	Lumbar canal stenosis	11
	Lumbar canal stenosis with scoliosis	2
4.	Pre existing changes at adjacent segment	9
5.	Type of index surgery	
	TLIF	12
	PLF	38
	PLIF	1
6.	Number of fusion segments	
	Single level	36
	Two level	14
	Three level	1
7.	Type of fusion	
	Floating fusion	37
	Non floating fusion	14
8.	Asymptomatic period between index surgery and development of CASP	5.5 years(1- 14 years)
9.	Type of ASP	
	Spondylolisthesis	28
	Lumbar canal stenosis	17
	Lumbar canal stenosis with scoliosis	2
	Instability	2
	Fractures	2
10.	Level of CASP	
	Proximal adjacent segment	45
	Distal adjacent segment	3
	Both segments	3
11.	Type of intervention for CASP	
	Surgery	33
	Root block	4
	Medications	1
	Lost to follow up	13
12.	Type of second surgery	
	TLIF	16
	PLF	16
	Osteotomy with PLF	1
13.	Number of patients with osteoporosis	15

Table for ASD

191. Indirect Decompression with Lateral Interbody Fusion for Severe Degenerative Lumbar Spinal Stenosis: Minimum 1-year MRI Follow-up

Takayoshi Shimizu, MD, PhD; Shunsuke Fujibayashi, MD, PhD; Bungo Otsuki, MD, PhD; Shuichi Matsuda, MD, PhD

SUMMARY

This study reports successful clinical and radiographic outcomes after indirect decompression with lateral interbody fusion (LIF) for severe degenerative lumbar spinal stenosis. Disc height was restored postoperatively, and the cross-sectional area of the dural sac on MRI expanded over time throughout a 1-year follow-up. No major perioperative complications were noted.

HYPOTHESIS

Indirect decompression with LIF for severe degenerative lumbar spinal stenosis provides successful clinical outcome with expansion of the dural sac over-time.

DESIGN

Retrospective case series in a single academic institution

INTRODUCTION

Prior studies have shown that LIF without posterior decompression can improve neurological symptoms through “indirect decompression” that results from restoration of intervertebral and foraminal heights. However, the indication for the use of

indirect decompression surgery for severe canal stenosis is still controversial.

METHODS

We included 35 patients (37 surgical levels) who were preoperatively diagnosed with severe degenerative lumbar stenosis using MRI based on previously published criteria (Grade C or D, Fig 1) These patients underwent oblique LIF with supplemental percutaneous pedicle screws without posterior decompression. All patients satisfied minimum 1-year MRI follow-up. We compared the cross-sectional area (CSA) of the thecal sac as well as clinical outcome scores (Japanese Orthopedic Association [JOA] Score) among preop, 3-week postop, and 1-year postop. Fusion status and disc height were investigated based on computed tomography scans at 1-year follow-up.

RESULTS

CSA improved over time, increasing from 54.9 mm2 preoperatively to 88.1 mm2 at 3-week postop and 135.1 mm2 at last follow-up (average 28.3 months) ($P < 0.001$). Clinical symptoms significantly improved (72.8% improvement of JOA Score at 1-year follow-up). Fusion rate at 1-year follow-up was 89.1%, and disc heights were significantly restored (preoperative 6.3 mm vs postoperative 9.8 mm, $p < 0.001$). Patients showing poor CSA expansion (<200% expansion rate) had a higher prevalence of pseudarthrosis than patients with significant CSA expansion (>200% expansion rate) (21.4% vs. 4.3% with pseudarthrosis). No major perioperative complications were noted.

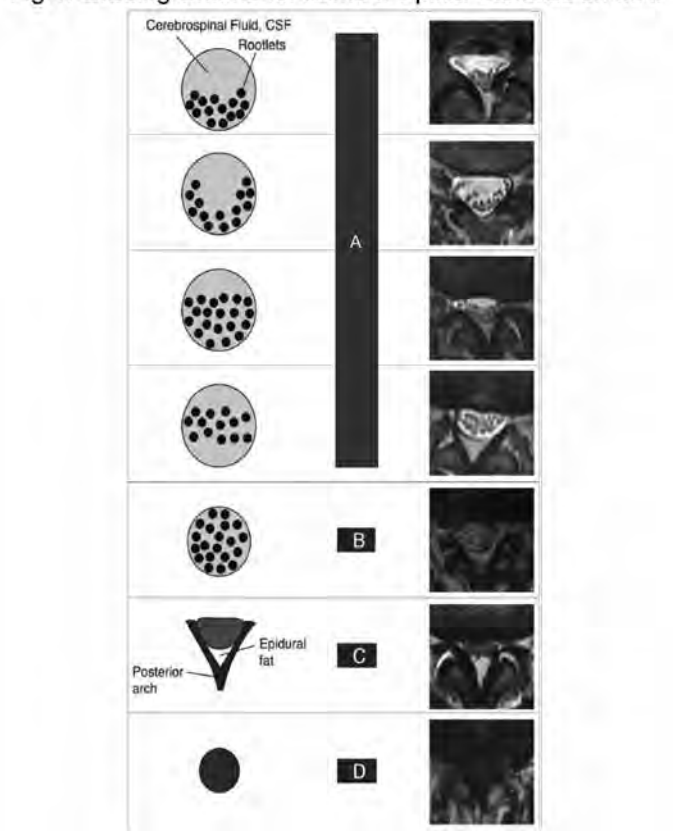
CONCLUSION

LIF with indirect decompression is a safe and effective surgical option for severe degenerative lumbar stenosis. Achieving solid fusion is critical to maintain the expansion of the dural sac through the postoperative period.

TAKE HOME MESSAGE

LIF with indirect decompression for severe degenerative lumbar stenosis provided successful surgical outcomes throughout the postoperative period, including restoration of disc height and indirect expansion of the thecal sac.

Fig 1. Grading Criteria for Lumbar Spinal Stenosis on MRI



192. Predictors of Needing Laminectomy after Indirect Decompression via Initial Anterior (ALIF) or Lateral (LLIF) Lumbar Interbody Fusion

Daehyun Park, MD; Praveen V. Mummaneni, MD; *Dean Chou, MD*

SUMMARY

The factors associated with the need for additional posterior decompression after anterior or lateral lumbar interbody fusion were investigated. Foraminal height, foraminal area, difference between the cage height and preoperative disc height, symptom duration, and visual analogue scale of leg appear to have correlation with the need for posterior decompression

HYPOTHESIS

To evaluate factors are associated with the need for additional posterior direct decompressive surgery after anterior (ALIF) or lateral (LLIF) lumbar interbody fusion.

DESIGN

Retrospective study

INTRODUCTION

There is limited evidence to predict which patients require additional posterior direct decompression after indirect decompression via AILF or LLIF.

METHODS

86 adult patients who underwent ALIF or LLIF for degenerative spondylolisthesis and foraminal stenosis were enrolled. Patient factors (age, sex, number of surgery levels, visual analogue scale (VAS) of leg and back pain), procedure related factors (cage height and lordosis) and radiographic measurements (disc height (DH),

foraminal height (FH) and area (FA), central canal diameter (CCD), and facet joint degeneration (FD)) were analyzed. All patients underwent staged surgery on two different days, with the anterior portion first followed by the posterior portion.

RESULTS

Out of 86 patients, 62 patients underwent posterior decompression, and 24 patients had no posterior decompression. There were no significant differences between groups with regards to age, sex, preoperative VAS of back pain, cage height, cage angulation, preoperative DH, FH, FA, CCD and FD ($p>0.05$). The group that underwent posterior decompression showed statistically different numbers of treated segments (1.92 versus 1.21, $p<0.01$), preoperative VAS leg (7.9 vs 6.3), symptom duration (14.2months vs 9.4months), postoperative DH improvement (61.3% vs 96.2%), postoperative FH improvement (21.5% vs 32.1%), postoperative FA improvement (24.1% vs 36.9%) and cage height minus preoperative DH (5.3mm vs 7.5mm) compared with the no decompression group.

CONCLUSION

There appears to be some correlation between the need for posterior decompression and the foraminal height, foraminal area, difference between the cage height and preoperative disc height, duration of symptoms, and VAS leg scores. In selected patients undergoing staged surgery, indirect decompression without direct decompression may be a reasonable option in treating degenerative spinal conditions.

TAKE HOME MESSAGE

ν Foraminal height, foraminal area, difference between the cage height and preoperative disc height, duration of symptom, VAS leg may have some correlation with the need for posterior decompression

193. Predictors of Segmental Lumbar Lordosis Following Posterior Interbody Fusion: Does Interbody Device Type Matter?

Charles H. Crawford III, MD; Thomas N. Epperson, BA; Jeffrey L. Gum, MD; Kirk Owens II, MD; Mladen Djurasovic, MD; Steven D. Glassman, MD

SUMMARY

Posterior interbody-device type (anterior-positioned vs. straight-in) was not associated with change in surgical level lordosis (SLL). Change in SLL ranged from a 9° loss to a 13° gain. Mean Post-operative SLL was 21°. Pre-operative SLL had a negative association with Change in SLL. Gain of lordosis >5° only occurred when Pre-op SLL <21°, and loss of lordosis >5° only occurred when Pre-op SLL >21°.

HYPOTHESIS

Posterior interbody devices (IBDs) designed for positioning in the anterior aspect of the disc space will result in greater segmental lordosis than IBDs designed for straight-in positioning.

DESIGN

Retrospective comparative observational cohort.

INTRODUCTION

Controversy exists regarding the ability of posterior IBDs to achieve lumbar lordosis. The purpose of this study was to review procedures using either an anterior-positioned or straight-in IBD design to determine if this variable or other variables were associated with success.

METHODS

A multi-surgeon, consecutive series from a large academic training-center was identified. Anterior-positioned or straight-in IBD designs were used at surgeon discretion. Pre-op and Post-op standing radiographs were measured using PACS software for surgical level lordosis (SLL), anterior disc height, mid-disc height, posterior disc height, IBD height, and IBD insertion depth.

RESULTS

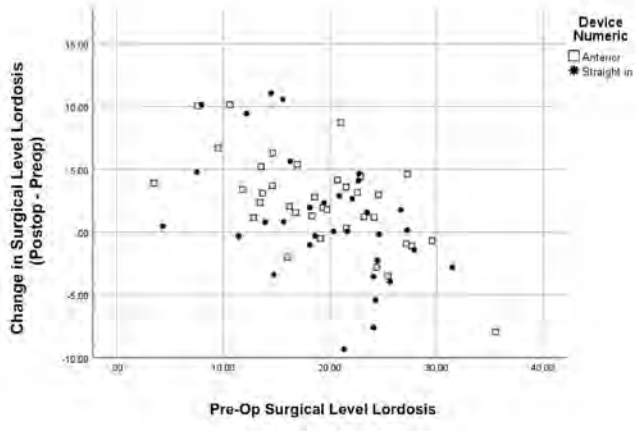
61 patients underwent a single-level, posterior lumbar interbody fusion procedure (N=37 anterior, N=34 straight-in). Mean age was 59.8+8.7 yrs. 32 were female. There was no difference between IBD type (anterior vs straight-in) for mean Pre-op SLL (19+7° vs 20+6°, p=0.7), Post-op SLL (21+5° vs 21+6°, P=0.5), or Change in SLL (2+4° vs 1+5°, p=0.2). Multivariate regression analysis showed that Pre-op SLL was the only variable associated with Change in SLL (β = -0.48, p=0.000). Change in SLL ranged from a loss of 9° to a gain of 13°. Scatter-plot shows the negative association between Pre-op SLL and Change in SLL. Gain of lordosis >5° only occurred when Pre-op SLL <21°, and loss of lordosis >5° only occurred when Pre-op SLL >21°.

CONCLUSION

There was no significant difference in Pre-op, Post-op or Change in SLL between IBD type (anterior-positioned vs. straight-in). Pre-op SLL had a significant negative association with Change in SLL. Gain of lordosis >5° only occurred when Pre-op SLL <21°, and loss of lordosis >5° only occurred when Pre-op SLL >21°.

TAKE HOME MESSAGE

Interbody-device type (anterior-positioned vs. straight-in) was not associated with Change in SLL. Gain >5° only occurred when pre-op lordosis <21°, and loss >5° only occurred when pre-op lordosis >21°.



194. Outcomes Following Discectomy for Lumbar Disc Herniation in Patients with Substantial Back Pain

Simon T. Sørensen, MS; Rachid Bech-Azeddine, PhD; Søren Fruensgaard, MD; Mikkel Ø Andersen, MD; Leah Yacat Carreon, MD, MS

SUMMARY

From the DaneSpine database, 1654 patients with lumbar disc herniation and back pain VAS > 50 who underwent a discectomy alone without fusion had statistically significant (p<0.000) improvements from baseline to 12 months post-operative for back pain (72.6 to 36.9), leg pain (74.8 to 32.6), ODI (50.9 to 25.1) and EQ-5D (0.25 to 0.65).

HYPOTHESIS

Back pain in patients with lumbar disc herniation (LDH) improves after discectomy alone without fusion.

DESIGN

Longitudinal observational cohort.

INTRODUCTION

Patients with LDH typically present with lower extremity radiculopathy. However, there are patients who have substantial back pain who are considered by some surgeons to be candidates for fusion. The purpose of this study is to determine if LDH patients with substantial back pain improve with a discectomy alone.

METHODS

The DaneSpine database was used to identify 2399 patients with LDH and baseline back pain VAS ≥ 50 who underwent a lumbar discectomy. Standard demographic and surgical variables and patient reported outcomes including back and leg pain VAS (0-100), Oswestry Disability Index (ODI), and EuroQoL 5D (EQ-5D) at baseline and 12 months postoperatively were collected.

RESULTS

A total of 1654 (69%) cases had 12 month data available, with a mean age of 48.7 year; 816 (49%) were male and mean BMI was 27 kg/m2. At 12 months postoperatively, there were statistically significant (p<0.000) improvements in back pain (72.6 to 36.9), leg pain (74.8 to 32.6), ODI (50.9 to 25.1) and EQ-5D (0.25 to 0.65) scores.

CONCLUSION

Patients with LDH who have substantial back pain can be counseled to expect improvement in their back pain 12 months after surgery after a discectomy alone.

TAKE HOME MESSAGE

Patients with LDH who have substantial back pain can be counseled to expect improvement in their back pain 12 months after surgery after a discectomy alone.

195. Correlation Between Number of Levels Involved in Lumbar Fusion and Opioid Usage after Operation

Jinhui Shi, MD; Swamy Kurra, MBBS; Alexander Edelstein, MD; Katherine H. Sullivan; Mike H. Sun, MD; Richard A. Tallarico, MD; Elizabeth A. Demers Lavelle, MD; *William F. Lavelle, MD;* Prisco J. DeMercurio, BS

SUMMARY

There is no current evidence postoperative opioid use is correlated to number of levels fused. Patients using more TMEs preoperatively tend to use more TMEs postoperatively. It is important to reduce opioid uses and seek alternative therapies after undergoing multilevel lumbar fusion surgery.

HYPOTHESIS

Determine if more levels of a lumbar fusion surgery is associated with greater amounts of opioid usage.

DESIGN

Retrospective study using case logs and ICD-9 codes

INTRODUCTION

Lumbar spinal fusion surgery often causes significant postoperative pain. One of the most used medications is opioids.

METHODS

Inclusion criteria: lumbar stenosis, neurogenic claudication, and > 18 years old. Exclusion criteria: lumbar fractures, infections and tumors, and revision surgeries. Surgical, demographic and postoperative records reviewed and documented. Patients grouped based on number of levels of lumbar fusion and interbody fusions (yes/no). Total morphine equivalents (TMEs) for 30 days preoperatively, 1, 3 and 6 month postoperatively analyzed. Anesthesia and I-STOP records used for dosage amounts. All patients had same type of postoperative opioid.

RESULTS

N=58; mean age 59 years; gender (M=35, F=23); mean number of operated levels was 3.3. 17 patients received interbody fusions. Mean Charlson Co-morbidity score was 0.7 and American Society of Anesthesiologists score was 2.6. No statistical difference of preoperative TMEs among groups (p=0.21), but patients using more TMEs preoperative used more TMEs postoperative. Postop, 3operated level group were on higher opioid dosage than 4 or 5 operated levels at 1-month follow-up and had higher opioid usage than other groups. At 3 and 6 months postop, TMEs reduced significantly in each group. No statistical difference of TMEs between operated levels groups postoperatively. At 6 months, interbody fusions significantly higher TMEs in 5 operated levels vs. other groups, p<0.001. With no interbody fusion, slight difference (p=0.06) in preoperative TMEs between groups. No difference in hospital stay or estimated blood loss among groups (p>0.05), but EBL without interbody fusion increased as more levels fused (p=0.06). Hospital stay was shorter for less operated levels. Table 1.

CONCLUSION

No current evidence postoperative opioid use is correlated to number of levels fused. Patients using more TMEs preoperatively tend to use more TMEs postoperatively. It is important to reduce opioid uses and seek alternative therapies after undergoing mult

TAKE HOME MESSAGE

No current evidence postoperative opioid use is correlated to number of levels fused. Patients using more TMEs preoperatively use more TMEs postoperatively. Reducing opioids and seek alternative therapies is important.

Table 1: Morphine Equivalents Comparison among the Number of Operated Levels

Number of levels	N	30 days Pre-op TME	EBL (ml)	LOS (days)	1-Month Post-op TME	3- Month Post-op TME	6-Month Post-op TME
1	2	0	300	3.5	450(225-675)	0	0
2	14	186(0-600)	274	3.5	896(150 -2400)	128(0-600)	42(0-600)
3	20	434(0-1800)	502	5.5	1145(0-3450)	376(0-1800)	311(0-1500)
4	10	91(0-750)	525	5	817(225-1800)	150(0-600)	60(0-600)
5	12	196(0-710)	502	5.4	1022(112-2700)	300(0-1200)	141(0-900)
p value		0.21	0.25	0.08	0.78	0.29	0.16
Subgroup 1: Patients with Interbody Fusion							
2	5	240 (0 – 600)	450	4	673 (450-950)	210(0-600)	120(0-600)
3	7	257 (0-1800)	716	5	1045(300-1800)	300(0-1800)	0
4	3	53 (0-160)	366	4.6	975(225-1800)	0	0
5	2	655 (600-710)	187	9	1980(1260-2700)	750(600-900)	750(600-900)
p value		0.61	0.27	0.08	0.14	0.42	<0.001
Subgroup 2: Patients without Interbody Fusion							
1	1	0	300	3.5	450	0	0
2	9	156 (0-540)	186	3.4	1021(150-2400)	83(0-450)	0
3	13	537(0-1575)	410	5.6	1203(0-3450)	420(0-1350)	492 (0-1500)
4	7	107 (0-750)	592	5.2	750(225-1500)	214(0-600)	85 (0-600)
5	10	105 (0-450)	581	4.6	831(112-2550)	210(0-1200)	20(0-200)
p values		0.06	0.06	0.15	0.58	0.38	0.016

196. The MISDEF2 Algorithm: An Updated Approach to Patient Selection in Minimally Invasive Deformity Surgery

Praveen V. Mummaneni, MD; Paul Park, MD; Juan S. Uribe, MD; Michael Y. Wang, MD; Christopher I. Shaffrey, MD; David O. Okonkwo, MD, PhD; Adam S. Kanter, MD; Gregory M. Mundis Jr., MD; Robert K. Eastlack, MD; Khoi D. Than, MD; Neel Anand, MD; Kai-Ming Gregory Fu, MD, PhD; International Spine Study Group

SUMMARY

Minimally invasive surgery (MIS) is an alternative to open deformity surgery for treating patients with adult spinal deformity. Recent advances in MIS techniques including advanced anterior approaches increase the range of candidates for MIS deformity surgery. New MIS techniques have provided opportunities for greater sagittal plane correction necessitating an algorithm update. The minimally invasive spinal deformity surgery (MISDEF2) algorithm was created to provide a framework for rational decision making for surgeons who are considering MIS versus open spine surgery.

HYPOTHESIS

The MISDEF2 algorithm is a reproducible method for assessing radiological criteria for current less invasive deformity techniques

DESIGN

Survey of adult spine deformity surgeons

INTRODUCTION

MIS techniques in spinal deformity surgery continue to advance, offering the option for MIS surgery to more patients. However, a rigorous approach to radiographic analysis, taking into account different planes of deformity is essential preparation. This algorithm was designed to provide a framework for considering MIS in deformity patients.

METHODS

Through a modified Delphi approach, a new algorithm that incorporates a patient's preoperative radiographic parameters and leads to one of 4 general plans ranging from MIS direct or indirect decompression to open deformity surgery with osteotomies was developed. The authors surveyed fellowship-trained spine surgeons experienced with spinal deformity surgery and MIS deformity to validate the algorithm using a set of 24 cases to establish interobserver reliability. They were resurveyed 2 months later with the cases presented in a different sequence to establish intraobserver reliability. Responses were collected and tabulated.

RESULTS

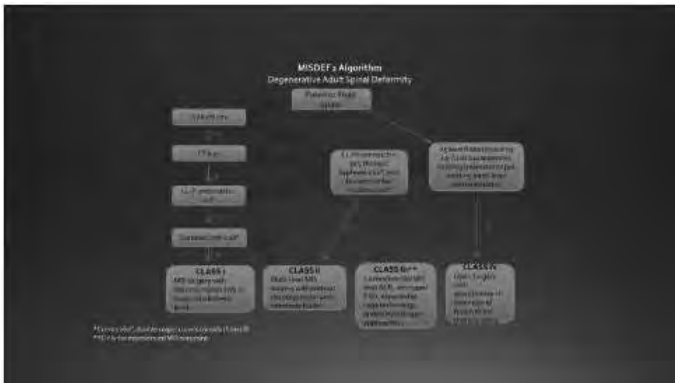
Over a 3-month period, 14 surgeons completed the surveys. Responses for MISDEF algorithm case review demonstrated an inter observer kappa of 0.85 for the first round of surveys and an inter observer kappa of 0.82 for the second round of surveys, consistent with substantial agreement. In at least 7 cases there was perfect agreement between the reviewing surgeons. The mean intra observer kappa for the 2 surveys was 0.8.

CONCLUSION

The MISDEF2 algorithm was found to have substantial inter- and intraobserver agreement. The MISDEF2 algorithm incorporates recent advances in MIS surgery. The use of the MISDEF2 algorithm provides reliable guidance for surgeons who are considering either an MIS or an open approach for the treatment of patients with adult spinal deformity.

TAKE HOME MESSAGE

The use of the MISDEF2 algorithm provides reliable guidance for surgeons who are considering either an MIS or an open approach for the treatment of patients with adult spinal deformity.



197. Radiographic Accuracy of Percutaneous Pedicle Screw Placement in Fluoroscopic- versus CT Navigation-guided Lumbar Spine Instrumentation

Ting Cong, MD; Avani S. Vaishnav, MBBS; Joseph Barbera, MD; Hiroshi Kumagai, MD; James E. Dowdell, MD; Steven J. Mcanany, MD; Sravisht Iyer, MD; Todd J. Albert, MD; (Catherine) Himo Gang, MPH; Sheeraz Qureshi, MD; *Philip J. York, MD*

SUMMARY

A radiographic study was performed to compare accuracy of percutaneous pedicle screw placement using three-dimensional intraoperative navigation guidance versus two-dimensional

fluoroscopy. CT navigation was found to significantly improve accuracy of screw placement.

HYPOTHESIS

Null hypothesis – No difference in accuracy in fluoroscopic- versus CT navigation-guided pedicle screw placement.

DESIGN

Retrospective cohort study

INTRODUCTION

Few studies have directly compared outcomes of fluoroscopic- versus CT navigation-guided pedicle screw placement. We devised a study comparing radiographic screw placement accuracy between these two surgical approaches.

METHODS

A consecutive cohort of patients undergoing primary percutaneous posterior lumbar spine instrumentation for spine fusion was retrospectively reviewed. Accuracy of screw placement was assessed using a postoperative CT scan with blinding to the surgical methods used. The Gertzbein-Robbins classification was used to grade cortical breach. Screws were further scrutinized for presence of inferior/medial pedicle breach, tip breach, endplate breach, and facet violation. Based on this data, screw accuracy was graded using an ordinal grading scheme devised a priori based on opinion amongst the authors: good (no breach), acceptable (pedicle breach within the "safe zone" of up to 4mm superior/lateral or 2mm inferior/medial, or any distance of tip breach), or poor (facet violation into unfused level, breach outside of safe zone). Statistical comparisons were made between screws placed by CT navigation and those placed by fluoroscopic guidance.

RESULTS

138 patients were included. The two cohorts are comprised of 376 screws placed by fluoroscopic guidance and 193 by CT guidance (Table 1). There was significantly more facet violation of the unfused level in the fluoroscopy group versus the CT group (9% vs 0.5%; $p<0.0001$). There was also a higher proportion of poor screw placement in the fluoroscopy group (10.1% vs 3.6%). No statistical difference was found in the rate of tip breach, inferomedial breach, or lateral breach. Regression analysis showed that fluoroscopy had twice the odds of incurring poor screw placement as compared to CT navigation.

CONCLUSION

This radiographic study evidence that CT navigation significantly improves accuracy of screw placement as compared to fluoroscopic guidance.

TAKE HOME MESSAGE

CT navigation can improve accuracy of percutaneous pedicle screw placement as compared to two-dimensional fluoroscopic guidance.

Table 1: Screw placement accuracy – Fluoroscopy vs. CT Navigation

	Fluoroscopy	Navigation	p-value
Number of screws	376	193	
Level of Screw placement			
L1	0 (0.0 %)	2 (1.0 %)	
L2	0 (0.0 %)	10 (5.2 %)	
L3	4 (1.1 %)	12 (6.2 %)	
L4	117 (31.1 %)	57 (29.5 %)	
L5	172 (45.7 %)	73 (37.8 %)	
S1	83 (22.1 %)	39 (20.2 %)	
Lateral Breach			0.627
None	347 (92.3 %)	175 (90.7 %)	
Grade I	18 (4.8 %)	12 (6.2 %)	
Grade II	7 (1.9 %)	2 (1.0 %)	
Grade III	3 (0.8 %)	2 (1.0 %)	
Grade IV	1 (0.3 %)	2 (1.0 %)	
Inferomedial breach			0.215
None	366 (97.3 %)	187 (96.9 %)	
Grade I	9 (2.4 %)	4 (2.1 %)	
Grade II	0 (0.0 %)	2 (1.0 %)	
Grade III	0 (0.0 %)	0 (0.0 %)	
Grade IV	1 (0.3 %)	0 (0.0 %)	
Tip breach			0.229
None	337 (89.6 %)	170 (88.1 %)	
Grade I	13 (3.5 %)	5 (2.6 %)	
Grade II	15 (4.0 %)	6 (3.1 %)	
Grade III	8 (2.1 %)	11 (5.7 %)	
Grade IV	3 (0.8 %)	1 (0.5 %)	
Endplate violation	1 (0.3 %)	0 (0.0 %)	
Facet violation of topmost unfused level	34 (9.0 %)	1 (0.5 %)	**<0.0001**
Accuracy of overall placement			**0.022**
Good	272 (72.3 %)	146 (75.6 %)	
Acceptable	66 (17.6 %)	40 (20.7 %)	
Poor	38 (10.1 %)	7 (3.6 %)	

198. Does Obesity Affect Long-term Outcomes of Lateral Lumbar Interbody Fusion (LLIF)?

Stuart Changoor, MD; Michael J. Faloon, MD, MS; Nikhil Sahai, MD; Conor J. Dunn, MD; Kumar G. Sinha, MD; Ki S. Hwang, MD; Arash Emami, MD

SUMMARY

Obesity has been associated with an increase in complications and increased technical difficulty of traditional spine procedures. With the increase in the obese population, surgeons have turned to minimally-invasive techniques to address this concern. This study aimed to investigate the long-term outcomes of LLIF in obese patients, and found that obese patients had a similar outcome profile and reoperation rates to nonobese patients. This suggests that obesity should not be a contraindication of this minimally-invasive approach.

HYPOTHESIS

Obese patients have poorer outcomes and increased reoperation rates after LLIF

DESIGN

Retrospective comparative study

INTRODUCTION

Obese patients can pose significant challenges to spine surgeons in lumbar fusion procedures. The increased risk of complications has led surgeons to be wary in pursing operative interventions in these patients. With the increased proportion of obese patients, it is imperative to understand the long-term outcomes in minimally-invasive approaches. The purpose of this study was to evaluate the long-term safety and efficacy of LLIF in the obese.

METHODS

A retrospective review was performed to identify patients who underwent LLIF with posterior stabilization since 2007 with a minimum of 5 years follow-up. Demographics including BMI were recorded and patients were subdivided into 2 cohorts: (A) nonobese

(BMI <30 kg/m2) and (B) obese (BMI >30 kg/m2). Functional outcomes were assessed by comparing pre- and post-operative VAS and ODI scores. Reoperation rates were compared between cohorts. Pelvic incidence (PI) and lumbar lordosis (LL) mismatch was calculated from both pre- and post-operative radiographs.

RESULTS

115 consecutive patients were included (53 nonobese & 62 obese) with a mean follow up of 95.3 months. Mean BMI was 25.3 in cohort A and 35.3 in cohort B (p<0.001). There were more females in cohort A. VAS scores decreased by a mean of 5.7 in cohort A, and 5.4 in cohort B (p=0.213). ODI improvement was also similar between the cohorts. 5.6% of nonobese patients required reoperation compared to 9.6% of obese patients (p=0.503). Both cohorts achieved a similar proportion of PI-LL mismatch correction, 85% in obese vs 78% in nonobese patients (p=0.526).

CONCLUSION

Obese patients have similar surgical outcomes to nonobese patients with respect to functional outcome scores, reoperation rates, and correction of PI-LL mismatch after long-term follow-up. With similar outcome and reoperation profiles, minimally-invasive approaches to the spine, such as LLIF, may be an acceptable alternative to traditional open procedures in obese patients.

TAKE HOME MESSAGE

With similar outcome and reoperation profiles regardless of BMI, minimally-invasive approaches, such as LLIF, may be an acceptable alternative to traditional open procedures in obese patients.

199. Perioperative Risk Factors for Early Revisions in Standalone Lateral Lumbar Interbody Fusion

Colleen Rentenberger, MD; Ichiro Okano, MD; Stephan N. Salzmann, MD; Fabian Winter, MD; Nicolas Plais, MD; Marco D. Burkhard, MD; Jennifer Shue, MS; Andrew A. Sama, MD; Frank P. Cammisa Jr., MD; Federico P. Girardi, MD; *Alexander P. Hughes, MD*

SUMMARY

Patients with a preoperative diagnosis of foraminal stenosis were more likely to require early revision surgery after standalone lateral lumbar interbody fusion (SA-LLIF). The most common reason for revision among this group was persistent or recurring neurological symptoms and/or pain.

HYPOTHESIS

Revision SA-LLIF patients have different perioperative risk factors compared to non-revision patients

DESIGN

Retrospective cohort study

INTRODUCTION

Lateral lumbar interbody fusion can be performed without supplemental posterior instrumentation. Previous reports demonstrated favorable results with SA-LLIF, however, a reoperation rate of up to 26% has been reported. It remains unclear what perioperative factors are associated with early failure after SA-LLIF.

METHODS

Data of consecutive SA-LLIF patients was reviewed. All revisions or recommendation for revision surgery within 12 months after the LLIF procedure were documented. As potential contributing variables, operative levels, preoperative clinical diagnosis, number of fusion levels, the average L1/2 QCT-vBMD value were obtained along with other demographic factors. Cage subsidence was also evaluated in patients who had radiographs/CT between 6-12 months postoperatively (n=122). Logistic regression analyses were conducted.

RESULTS

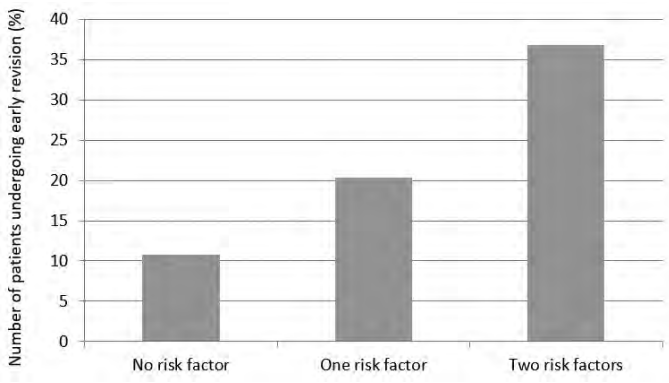
21 (15.8%) out of 133 eligible patients underwent revisions and 4 (3.0%) patients were recommended for revision surgery within one year mainly because of neurological symptoms or pain (68%). Baseline demographics showed no significant difference between the revision (RG) and the non-revision group (NRG). The average number of levels fused was 2.12 (RG) and 2.14 (NRG) (p=0.547). Significantly more RG patients had the diagnosis of foraminal stenosis (64.0% vs 39.8%, p=0.043). Although not statistically significant, the RG had a lower vBMD (p=0.097) and more severe subsidence (>50% of level collapse) (1.67 vs 1.28, p=0.130). Patients with both preoperative foraminal stenosis and severe subsidence demonstrated a trend toward a higher early revision rate (36.8%) compared to patients with no or one risk factor (10.8% and 21.2%) (p=0.075).

CONCLUSION

Patients with foraminal stenosis were more likely to have an early revision surgery after SA-LLIF primarily due to neurological symptoms/pain. This information can assist in preoperative discussions and management of patient expectations.

TAKE HOME MESSAGE

Patients with foraminal stenosis were more likely to have an early revision surgery after standalone lateral lumbar interbody fusion primarily due to neurological symptoms and/or pain.



Percentage of early revisions stratified by the number of risk factors

201. Mid-term Outcomes of Minimally Invasive Robotic Assisted vs Open Transforaminal Lumbar Interbody Fusion: A Single Centre Cohort Study

Vigneshwara M. Badikillaya, MS; Keyur Akbari; Muralidharan Venkatesan, FRCS; Vamsi Krishna Varma Penumatsa, MS; Sajan K. Hegde, MD

SUMMARY

Robotic aided spine surgery has potential for augmenting existing MIS approaches and improved accuracy of pedicle screw placement. We compared robotic MIS transforaminal lumbar

interbody fusion (TLIF) with standard open TLIF. Compared to open standard technique robot-assisted TLIF group had the advantages of greater accuracy, lower incidence of screw breach in the pedicle wall and violation of the facet joints with similar Oswestry disability index(ODI) and Visual analogue score (VAS) and achieves better surgical and clinical outcome at mid term.

HYPOTHESIS

Our null hypothesis is that robot assisted (MIS) pedicle screw placement results in improved accuracy of spinal instrumentation compared to standard free-hand technique.

DESIGN

Single center retrospective review of prospective database

INTRODUCTION

Recent years have been marked by efforts to improve the safety of pedicle screw placement in spine. Use of a new computed tomography -based robotic arm provides for image-guided surgery, which augments existing MIS approach and improves the accuracy of instrumentation. There is paucity of literature reporting outcome of robotic assisted MIS VS OpenTLIF. We report the mid-term outcome of the largest series comparing Robotic assisted Vs standard open TLIF

METHODS

Retrospective analysis of two cohorts of consecutively treated patients with Robotic assisted MIS TLIF (Group A; 158 patients, 632 screws) and free hand open TLIF (GroupB; 160 patients, 640 screws) from Jan 2012 to Dec 2014. In both group TLIF were performed on patients with stenotic spondylolisthesis and Degenerative Disc Disease with radiculopathy. The primary outcome measure was accuracy of screw placement (Rampersaud et. al) and Adjacent Segment Degeneration (ASD).Secondary parameters were operation time, blood loss, length of stay, ODI and VAS.

RESULTS

In Group A, Grade A was observed in 630 screws(99.68%).The remaining screws were graded B (n=2 [0.32%]).Group B, grade A was found in 614 screws (95.93%).The remaining screws were B (n =12 [1.8%]), C (n=9 [1.4%]) and D (n=5 [0.7%]).The comparison of "clinically acceptable" screws was different between groups (A vs B [p = 0.001]) Blood loss was lower in the robot-TLIF group than in the Open TLIF group, while duration of surgery and length of stay was not statistically different. Symptomatic ASD in group A was 0 compared to 3 cases in group B (p-0.0421),Both groups showed significant improvement in VAS and ODI at 4 year follow-up, had no statistically significant difference between groups.

CONCLUSION

The accuracy of pedicle screws were better in robotic TLIF group and at 4 years follow up had reduced rates of ASD, with similar improvement in ODI and VAS in both groups

TAKE HOME MESSAGE

The use of robotic assistance in pedicle instrumentation is more accurate and has mid term safety in terms of complications compared to free hand pedicle instrumentation.

204. Psoas Muscle Mass are Maintained and No Progress of Fatty Degeneration after LLIF

Tetsuro Hida, MD; Robert K. Eastlack, MD; Gregory M. Mundis Jr., MD

SUMMARY

Prospective study of 20 patients with degenerative lumbar disease undergoing single level lateral lumbar interbody fusion (LLIF). Psoas muscle mass was maintained and there was no progression of intramuscular fat mass 1y postop on L4-5 cross-sectional MRI. There was no association between MRI findings and postop symptoms. Our findings suggest that surgical dilation through the psoas muscle does not have a negative effect on its MRI appearance, nor clinical symptoms.

HYPOTHESIS

Psoas muscle injury normalizes following LLIF surgery.

DESIGN

Prospective observational study.

INTRODUCTION

The effect of surgical dissection through the psoas muscle on muscle volume and fatty degeneration from lateral lumbar interbody fusion (LLIF) is not well understood. This study aims to determine the effect of dilation through the psoas muscle during LLIF as assessed by MRI following a year of postop recovery.

METHODS

Consecutive patients undergoing L4-5 single level LLIF were enrolled and followed for minimum 1yr. Using pre- and 1yr postop axial T2 MRI at L4-5, the cross-sectional area (CSA) of the psoas muscle was measured both ipsi- and contralateral to the approach. Intramuscular T2 high intensity area was measured with the threshold method and defined as fat area (FA). Outcomes were assessed with ODI and NRS back and leg. We used paired T-test and Pearson's correlation for statistical analysis. $P<0.05$ was considered significant.

RESULTS

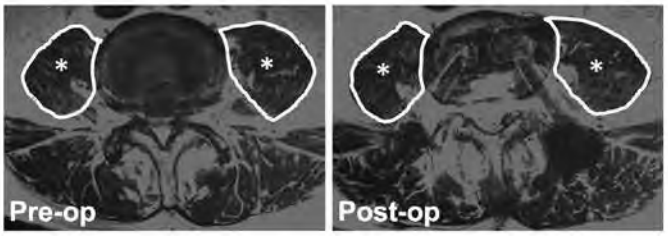
20 patients (7 males, 13 females, mean 68 years) were analyzed. There was no significant difference in CSA before and after surgery on both sides (preop/postop; 1126 ± 345 mm^2 / 1163 ± 343 mm^2 at approach side, p = 0.39; 1110 ± 279 mm^2 / 1149 ± 274 mm^2 at opposite side, p = 0.30). There was no difference in FA before and after surgery on both sides (pre-op / post-op; 43 ± 83 mm^2 / 165 ± 80 mm^2 at ipsi-, p = 0.36; 186 ± 140 mm^2 / 172 ± 92 mm^2 and contralateral side, p = 0.61). There was no difference in pre to postop CSA or FA between ipsi- and contralateral side. There were no significant correlations between clinical symptom (ODI and NRS) and muscle parameters (CSA and FA).

CONCLUSION

Psoas muscle mass was maintained at 1 yr postop despite dilation through the psoas muscle, with no evidence of fatty degeneration both ipsi- and contralateral to the approach side. There was no association between psoas image findings and postoperative symptoms. In LLIF, the influence of surgical invasion of the psoas muscle based on postop MRI characterization and clinical symptoms was insignificant.

TAKE HOME MESSAGE

In LLIF, the influence of surgical invasion of the psoas muscle based on postop MRI characterization and clinical symptoms was insignificant.



Cross sectional area of psoas muscle was measured (asterisk). Intramuscular fat area (red area on image) was measured with the threshold method (Lee, et al. Spine 2008)

205. Perioperative Outcome of Long-Construct Minimally Invasive Spinal Stabilization using Fluoroscopic Guided Percutaneous Pedicle Screws versus Conventional Open Surgery for the Treatment of Spinal Fractures in Ankylosing Disorders

Weng Hong Chung, MD, MS; Wai Leong Ng, MBBS; Chee Kidd Chiu, MBBS, MS; Chris Yin Wei Chan, MD, MS; Mun Keong Kwan, MBBS, MS

SUMMARY

This study aimed to analyze the perioperative outcomes of spinal fracture fixation in AS and DISH comparing MISt using PPS under fluoroscopic guidance and conventional open surgery. MISt using PPS has shorter operative time (179.3 ± 42.3 vs. 253.6 ± 98.7 minutes) and lower intraoperative blood loss (185.7 ± 86.4 mL vs. 885.7 ± 338.8 mL). There was no significant difference in terms of perioperative complications and union rate.

HYPOTHESIS

Minimally Invasive Spinal Stabilization (MISt) using Percutaneous Pedicle Screw (PPS) has better perioperative outcomes compared to open surgery for spinal fractures in ankylosing spondylitis (AS) and diffuse idiopathic skeletal hyperostosis (DISH).

DESIGN

Retrospective study

INTRODUCTION

Surgery for spinal fractures in ankylosed spine is associated with high morbidity and mortality rate. The benefits of long-construct MISt utilising PPS for vertebral fractures in AS and DISH has not been reported.

METHODS

21 patients with AS or DISH who were surgically treated for spinal fractures with minimum 2 year follow up were recruited. Primary outcomes included operative time, intraoperative blood loss, perioperative complications, length of hospital stay and union rate.

RESULTS

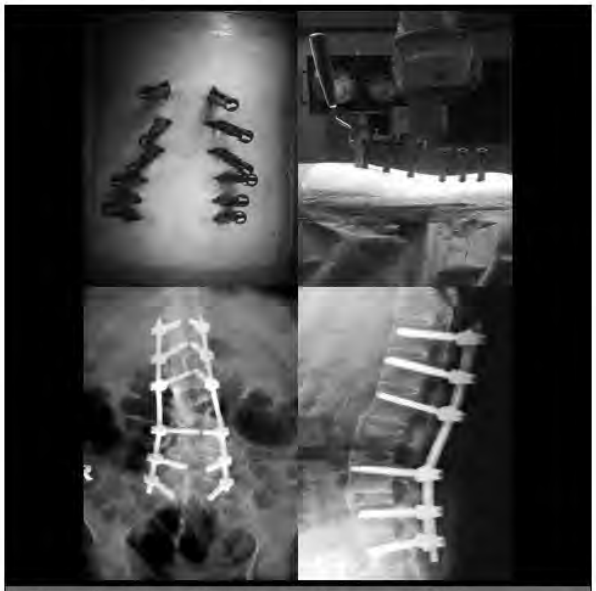
Mean age was 69.2 ± 9.9 years. 7 patients (33.3%) had AS and 14 patients (66.7%) had DISH. 17 patients had AO type B3 fracture and 4 patients had B1 fracture. There was no significant difference between open and MISt groups in terms of their American Society of Anesthesiologists score: 2.5±0.6 and 2.2±0.6 (p=0.386) and Charlson Comorbidity Index: 3.3±1.1 and 3.4±1.6 (p=0.831). MISt using PPS was performed in 14 patients (66.7%). Mean number of instrumented level in open and MISt groups were 7.7±1.7 and 7.9±1.5, respectively (p=0.775). Mean operative time in MISt and open groups were 179.3 ± 42.3 minutes and 253.6 ± 98.7 minutes, respectively (p=0.028). Mean intraoperative blood loss in MISt and open groups were 185.7 ± 86.4 mL and 885.7 ± 338.8 mL, respectively (p<0.001). There was no significant difference in union rate (100.0% vs 92.8%, p>0.999) and perioperative complications (28.6% vs 14.3%, p=0.574) between open and MISt groups.

CONCLUSION

MISt using PPS had shorter operative time and lower intraoperative blood loss in spinal fracture fixation in AS and DISH. It did not reduce the perioperative complication rate. There was no significant difference in the union rate between MISt and open surgery.

TAKE HOME MESSAGE

MISt utilising PPS reduces operative time and blood loss with comparable perioperative complications and union rate.



Perioperative Outcomes between Open Surgery and MISt

Outcomes	Open (n=7)	MISt (n=14)	Overall (n=21)	*P* value
Operative Time (min)	253.6 ± 98.7	179.3 ± 42.3	204.1 ± 73.3	0.028
Blood Loss (ml)	885.7 ± 338.8	185.7 ± 86.4	419.1 ± 391.9	<0.001
Complications	2 (28.6)	2 (14.3)	4 (19.1)	0.574
Union	6/6 (100)	13/14 (92.8)	19/20 (95.0)	>0.999
Length of Stay (days)	42.0 ± 25.4	21.2 ± 16.5	28.1 ± 21.7	0.057

206. A Comparison of Minimally-invasive Transforaminal Lumbar Interbody Fusion and Decompression Alone for Degenerative Lumbar Spondylolisthesis

Andrew K. Chan, MD; Erica F. Bisson, MD, MPH; Mohamad Bydon, MD; Steven D. Glassman, MD; Kevin T. Foley, MD; Christopher I. Shaffrey, MD; Eric Potts, MD; Mark E. Shaffrey, MD; Domagoj Coric, MD; John J. Knightly, MD; Paul Park, MD; Michael Y. Wang, MD; Kai-Ming Gregory Fu, MD, PhD; Jonathan R. Slotkin, MD; Anthony L. Asher, MD; Michael S. Virk, MD, PhD; Panagiotis Kerezoudis, MD;

Mohammed Ali Alvi, MD, MBBS; Jian Guan, MD; Regis W. Haid Jr., MD; Praveen V. Mummaneni, MD

SUMMARY

Minimally invasive surgical (MIS) techniques may be applied to degenerative lumbar spondylolisthesis (DLS). Some hypothesize that MIS decompression may minimize some of the limitations associated with open decompression for DLS, potentially avoiding the need for fusion. Here we utilize a multicenter, prospective registry to compare MIS transforaminal lumbar interbody fusion and MIS decompression for DLS. For symptomatic, single-level DLS, MIS TLIF was associated with fewer reoperations and superior disability, back pain, and patient satisfaction compared to posterior MIS decompression alone.

HYPOTHESIS

Minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) is superior to minimally invasive decompression for grade 1 degenerative lumbar spondylolisthesis (DLS).

DESIGN

Retrospective analysis of a prospective, multicenter registry.

INTRODUCTION

The optimal minimally invasive surgical (MIS) approach for grade 1 DLS is not clearly elucidated. This study compares the patient reported outcomes (PRO) following MIS TLIF and MIS decompression for DLS.

METHODS

608 patients from the Quality Outcomes Database Lumbar Spondylolisthesis Module underwent single-level surgery for grade 1 DLS. 143 patients underwent MIS [72 MIS TLIF (50.3%); 71 MIS decompressions (49.7%)]. Surgeries were classified as MIS if there was utilization of percutaneous screw fixation and placement of a Wiltse-plane MIS intervertebral body graft (MIS TLIF) or if there was a tubular decompression (MIS decompression). Baseline and 24-month PROs were collected and included the Oswestry Disability Index (ODI), numeric rating scale (NRS) Back Pain, NRS Leg Pain, EuroQoL-5D (EQ-5D) Questionnaire, and North American Spine Society (NASS) Satisfaction.

RESULTS

The mean age was 67.1±11.3 years (MIS TLIF 62.1 vs. MIS decompression 72.3 years;p<0.001). The proportion reaching 24-month follow up did not differ (MIS TLIF 83.3% and MIS decompression 84.5%;p=0.85). MIS TLIF was associated with higher blood loss (108.8 vs. 33.0 ml;p<0.001) and longer operative times (228.2 vs. 101.8 min;p<0.001) and hospital stays (2.9 vs. 0.7 days;p<0.001). MIS TLIF was associated with a lower reoperation rate (14.1% vs. 1.4%;p=0.004). Both cohorts improved significantly for ODI, NRS back pain, NRS leg pain, and EQ-5D at 24 months (p<0.001). In multivariate analyses, MIS TLIF—as opposed to MIS decompression alone—was associated with superior ODI change (β =-7.6; 95%CI[-15.0- -0.2];p=0.04), NRS back pain change (β =-1.5; 95%CI [-2.8- -0.3];p=0.02), and NASS satisfaction (OR=0.3; 95%CI[0.1-0.8]; p=0.02

CONCLUSION

For symptomatic, single-level DLS, MIS TLIF was associated with fewer reoperations and superior disability, back pain, and satisfaction compared to MIS decompression alone.

TAKE HOME MESSAGE

For symptomatic, single-level degenerative lumbar spondylolisthesis, MIS TLIF was associated with a lower reoperation rate and superior outcomes for disability, back pain, and patient satisfaction compared to posterior MIS decompression.

Outcomes for patients undergoing minimally invasive surgery for grade 1 lumbar spondylolisthesis	MIS TLIF (n = 72)	MIS Decompression (n = 71)	*p* value
ODI, *change*, mean ± SD	-30.3 ± 20.7	-15.1 ± 20.7	<0.001**
NRS Back Pain, *change*, mean ± SD	-4.7 ± 3.2	-1.5 ± 4.4	<0.001**
NRS Leg Pain, *change*, mean ± SD	-4.5 ± 3.9	-3.8 ± 3.7	0.32
EQ-5D, *change*, mean ± SD	+0.26 ± 0.22	+0.18 ± 0.25	0.09
NASS Satisfaction, n (%)			0.02**
1	42 (71.2)	26 (47.3)	
2	13 (22.0)	14 (25.5)	
3	1 (1.4)	6 (10.9)	
4	3 (4.2)	9 (16.4)	
Reoperations, n (%)	1 (1.4%)	10 (14.1%)	0.004**
Reasons and Timing for Reoperation	**Adjacent segment disease requiring extension of fusion** [1 (1.4%) reoperation within 12 months]	**Recurrent symptoms requiring revision decompression** [4 (5.6%) reoperations within 12 months; 2 (2.8%) reoperations between 12-24 months]	
		Recurrent symptoms requiring a fusion [2 (2.8%) reoperations within 12 months; 2 (2.8%) reoperations between 24-36 months]	

ODI – Oswestry Disability Index; NRS – Numeric Rating Scale; EQ-5D - EuroQol-5D; NASS – North American Spine Society.

208. Surgical Outcomes of 15 Cases of Dropped Head Syndrome

Yoshifumi Kudo, MD, PhD; Tomoaki Toyone, MD, PhD; Kenji Endo, MD, PhD; Yuji Matsuoka, MD, PhD; Kazuma Murata, MD, PhD; Akira Matsuoka, MD; Hiroshi Maruyama, MD; Koji Ishikawa, MD, PhD; Ryo Yamamura, MD; Yushi Hoshino, MD, PhD; Haruka Emori, PhD; Yusuke Dodo, MD; Yusuke Oshita, MD, PhD; Toshiyuki Shirahata, MD, PhD

SUMMARY

We report surgical outcomes of 16 cases of dropped head syndrome. Three cases needed multiple revision surgery because of infection and instrumentation failure. In two cases, instrumentation extended to L2 and L3 at last. Surgical intervention improved frontal gaze (93%) and activity of daily living (87%). Distal junctional fracture was the main cause of revision surgery. In case such as severe osteoporosis and hyper thoracic kyphosis, surgeons should consider that posterior fusion extend to lower thoracic or lumbar level.

HYPOTHESIS

no hypothesis

DESIGN

case series

INTRODUCTION

Dropped head syndrome (DHS) is characterized by chin-on-chest deformity which leads to difficulty of horizontal gaze, dysphagia affecting patients' quality of life. There were several case reports written about DHS surgical treatment, however, few reports have described surgical outcomes in detail.

METHODS

This study included 15 DHS patients (mean age 73) who underwent surgery from 2011 to 2018. The average follow up period was 24 month (range 12-45). We investigated surgical methods, postoperative complications, implant failure and revision surgery, changes in activity of daily living and changes in sagittal alignment.

RESULTS

All patient underwent surgery of antero-posterior fusion from C2-3 to C7 -T5. Postoperative complications were respiratory disturbance, severe dysphagia and delayed infection which required removal of implants. Implant failure occurred in two cases because of distal junctional fractures. Both of these two cases needed multiple revision surgery, and instrumentation extended to L2 and L3 at last. Finally, 14 patients (93%) attained horizontal gaze. Improvement of activity of daily living was achieved in 13 patients (87%), while 2 patients unable to return to previous activity levels. Additional thoraco-lumbar surgeries were required in two cases within four cases which showed abnormality of sagittal alignment in thoraco-lumbar spine. Radiographic parameters, CSVA(62mm to 32mm), CL(-45.3°to 14.5°), C7SVA(-3.5mm to 19.6mm) changed significantly after surgery, although no significant changes were detected in T1Slope, TK, LL, PT, PI-LL. The characteristic of the two cases which needed instrumentation to lumbar level were hyper thoracic kyphosis (>65°) and severe osteoporosis.

CONCLUSION

Surgical treatment improved frontal gaze (93%) and activity of daily living (87%). There were several postoperative complications and implant failure resulted in multiple revision surgery, and 2 patients unable to return to previous activity levels. Distal junctional fracture was the main cause of revision surgery. In case such as severe osteoporosis and hyper thoracic kyphosis, surgeons should consider that posterior fusion extend to lower thoracic and lumbar

TAKE HOME MESSAGE

λ Surgical intervention improved horizontal gaze and activity of daily living. When severe osteoporosis and hyper thoracic kyphosis exists, surgeons should consider that posterior fusion extend to lower thoracic or lumbar.

210. Factors Predicting the Effectiveness of Brace Treatment in AIS Patients with Curve more than 40 Degrees: A Minimum of One-year Follow-up

Lei-Lei Xu, PhD; Zhichong Wu, PhD; Xu Sun, MD; Zhen Liu, MD; Zezhang Zhu, MD; Yong Qiu, MD

SUMMARY

Factors related to the effectiveness of bracing in large curve remains obscure. We investigated the effectiveness of brace treatment in patients with curve larger than 40 degrees and further determined the predictive factors associated with bracing outcome. We confirmed that brace treatment could be an option for patients with curve exceeding 40 degrees who preferred conservative treatment to surgery. Patients with lager initial Risser sign, older age and major lumbar curve were more likely to have a favorable outcome.

HYPOTHESIS

Brace treatment could be an option for patients with large curve.

DESIGN

A retrospective study

INTRODUCTION

Several studies showed that bracing can be applicable to patients with lager curve. However, factors related to the effectiveness of bracing in large curve remains obscure. We aimed to investigate the effectiveness of brace treatment in patients with curve larger than 40 degrees and to further determine the predictive factors.

METHODS

A cohort of 90 patients with curve exceeding 40 degrees were recruited in the current study. All the patients were prescribed with bracing at the first visit to our center. After the completion of bracing, each patient was followed up for a minimum of two years. The curve was considered progressed if the curve magnitude increased more than 5 degrees, improved if the curve magnitude decreased more than 5 degrees, and stabled if the change was within 5 degrees. Factors including initial Risser sign, initial age, gender, curve pattern, curve magnitude, BMI and initial curve correction were compared between improved group and progressed group. The logistic regression analysis was used to determine the independent predictors of the curve progression.

RESULTS

The average age was 12.8 yrs. The mean follow-up period was 4.5 yrs. At the final follow-up, the curve improved in 28 patients, remained stable in 12 patients, and progressed in 50 patients. Intergroup comparison showed that patients with improved curve had remarkably higher grade of initial Risser sign and older initial age than those with progressed curve. At the first 3-month visit after bracing, patients with improved curve were found to have remarkable lower Cobb angle as compared with those with progressed curve. Logistic regression analysis showed that initial Risser sign of grade 0 or 1, initial age younger than 13 and initial curve correction of less than 5 degrees were significantly associated with curve progression.

CONCLUSION

Brace treatment could be an option for patients with curve exceeding 40 degrees. Patients with lager initial Risser sign, older age and major lumbar curve were more likely to have a favorable outcome.

TAKE HOME MESSAGE

Bracing could be an option for patients with large curve. patients with lager initial Risser sign, older age and major lumbar curve were more likely to have a favorable outcome.

212. Drivers of In-hospital Opioid Consumption: Single Center Analysis of 1502 Patients Undergoing 1-2 Lumbar Fusions

Jeffrey L. Gum, MD; Portia A. Steele, MS; Charles H. Crawford III, MD; Mladen Djurasovic, MD; Kirk Owens II, MD; Morgan Brown, MS; Christy L. Daniels, MS; Benjamin Martin Choi Sampedro, MS, CRNA; Timothy A. Johnson Sr., BS; John R. Dimar II, MD; Steven D. Glassman, MD; Leah Yacat Carreon, MD, MS

SUMMARY

We evaluated 1502 patients undergoing 1-2 instrumented lumbar fusions. Predictors of total in-hospital opioid consumption included a younger age, smoking status, preoperative opioid use, and number of levels fused. Several socioeconomic factors previously reported to be associated with opioid consumption such as marital status, zip code, and insurance status were not found to be predictors.

HYPOTHESIS

There are factors associated with cumulative in-hospital opioid consumption that can be modifiable.

DESIGN

Retrospective chart review

INTRODUCTION

In the midst of the current opioid crisis, as much as 25% of patients undergoing spine surgery are still on opioids at two years after surgery. In order to better understand this issue, we studied patients undergoing 1-2 instrumented lumbar fusions to identify drivers of in-hospital opioid consumption.

METHODS

Hospital administrative database and electronic medical record analysts identified consecutive patients undergoing 1-2 level instrumented lumbar fusions for degenerative lumbar conditions from 2016 to 2018. All oral, IV, or transdermal opioid dose administrations were converted to Morphine Milligram Equivalents (MME). A regression analysis was used to determine associations between post-op day 4 (POD 4) cumulative in-hospital MMEs and Zip code, ASA grade, marital status, race, insurance type, smoking status, BMI, number of levels, approach and pre-op opioid use.

RESULTS

A total of 1502 patients, 601 (40%) male, mean age of 57.5 years, were included. Total cumulative MMEs at POD 4 was 251.5 ± 203.6. Only 163 (11%) reported active opioid use prior to surgery with a mean MME of 60.66 ± 43.49. Younger age, MMEs prior to admission, current smokers and more levels fused were associated with greater cumulative in-hospital MMEs. There were no associations with surgical approach, Zip code, ASA grade, marital status, BMI, race or insurance type.

CONCLUSION

Use of opioids prior to admission and smoking are modifiable risk factors for higher in-hospital opioid consumption and can be targets for intervention prior to surgery in order to decrease in-hospital opioid use.

TAKE HOME MESSAGE

In 1502 patients undergoing 1-2 level instrumented fusions, we identified a younger age, preoperative opioid use, current smoking, and more operative levels as independent predictors of cumulative in-hospital opioid consumption.

213. Is Incision and Drainage Always Necessary for Wound Drainage Following Thoracolumbar Spine Surgery?

Brittany A. Oster, BS; Woojin Cho, MD, PhD; Hayeem L. Rudy, BS; Matthew T. Morris, MD; Jacob F. Schulz, MD; Dongyoung Kim, BS

SUMMARY

In this retrospective review, the authors seek to determine whether conservative treatment may be suitable for patients who present with postoperative wound drainage, but no other signs of surgical site infection. Drainage resolved in the majority of patients with dressing changes or antibiotics without surgical interventions. We conclude that patients presenting with isolated serosanguinous wound drainage can be successfully managed with conservative treatment. Only higher preoperative ASA score was noted to be predictive of need for surgical washout.

HYPOTHESIS

N/A

DESIGN

N/A

INTRODUCTION

The diagnosis of surgical site infection (SSI) is a clinical one, with the most common presenting symptom being wound drainage. The specificity of this finding, however, is low. Patients with wound drainage are presumed to have an SSI and undergo empiric surgical debridement when conservative management may have been sufficient. In this study, the authors seek to determine whether conservative treatment may be suitable for those patients who present with early postoperative wound drainage, but no other signs of SSI.

METHODS

The authors retrospectively reviewed clinical data of adult and pediatric patients who underwent thoracolumbar spine surgery at a single center from 2012-2017. Patients were included if serosanguinous drainage was present at follow-up visit within 8 weeks of surgery. Patients with fevers, chills, purulent discharge, fluctuance, wound dehiscence, or erythema were treated surgically and were excluded from this study. Patients were grouped based on whether conservative treatment alone was successful at resolving the drainage.

RESULTS

A total of 60 patients met inclusion criteria and were treated initially with a conservative approach. Drainage resolved in 51 patients (group A), and a total of 9 patients had drainage that did not resolve with conservative management, requiring surgical washout (group B). In group A, 41 patients were treated with antibiotics and 10 with dry dressing changes, while in group B, 7 were treated with antibiotics and 2 with dressing changes (p=0.857). Groups were similar in terms of age, BMI, smoking status, DM, revision vs. primary surgery, number of levels operated upon, EBL, surgery time, days admitted, and drainage latency. Group B showed a significantly greater preoperative ASA score than group A (2.89±0.33 vs. 2.06±0.61, p <.0001).

CONCLUSION

We conclude that isolated serosanguinous wound drainage found at outpatient follow-up from thoracolumbar spine surgery may be successfully managed conservatively in a majority of patients. Of all variables measured, only higher preoperative ASA score was noted to be predictive of treatment failure, defined as eventual need for surgical washout.

TAKE HOME MESSAGE

Patients presenting with isolated serosanguinous wound drainage following thoracolumbar spine surgery can be successfully managed with conservative treatment as opposed to surgical washout as long as ASA score is low.

RESULTS:

	Group A: Conservation Treatment Only	Group B: Conservative Treatment + Surgical Washout	P Value
N	51	9	
Age	33.82±20.52	35.36±25.91	0.869
BMI	28.55±6.84	26.60±8.41	0.549
Smoking status			0.895
Current	8	2	
Former	6	0	
Never	37	7	
DM status			.6123
Yes	5	2	
No	46	7	
ASA score	2.06±0.61	2.89±0.33	<0.001
Surgery status			.2443
Revision surgery	6	3	
Primary surgery	45	6	
Number of levels	7.22±5.02	8.11±4.37	0.592
Estimated Blood Loss (cc)	485.59±415.44	972.22±886.75	0.103
Surgery time (min)	326.46±187.20	615.40±368.17	0.154
Days admitted	5.24±3.67	12.00±13.46	0.172
Drainage latency (days)	15.00±9.60	13.78±10.95	0.76

Figure 1: Results of Conservative Treatment Only vs Conservative Treatment with Surgical Washout

214. Laser Marking as the Origin of Spine Rod Fractures: A Single Center Study

SUMMARY

Reed Ayers, PhD, MS, BS; Vikas V. Patel, MD, BS, MA; David C. Ou-Yang, MD; Christopher M.J. Cain, MD, PhD; Michaela S. Pott, BS; Evalina L. Burger, MD; Christopher J. Kleck , MD

Evauation of spine instrumentation removed during revision surgery can elucidate unique modes of failure of spine rods. A fractographic analysis of spine rod fractures over the course of two years shows a large percentage of rod fractures originated at laser marks. Of the nine fractured rods, five had laser markings, four of which the fracture originated at the laser marking.

HYPOTHESIS

Failure analysis of explanted hardware elucidates unconsidered instrumentation failure mechanisms.

DESIGN

This is a prospective analysis of revision surgical cases in which instrumentation was removed. This hardware was examined using failure analysis techniques.

INTRODUCTION

While numerous clinical studies describe instrumentation failure, they do not detail the root cause of such failures. This limits our understanding of these metal alloys and their mechanism of failure. The characterization of fracture surfaces, metal micro-structure, surface chemistry and profile can more accurately elucidate the root causes of instrumentation failure.

METHODS

A consecutive series of patients undergoing revision surgery with hardware removal were selected. Failure analysis included metallography, fractography, surface characterization, tissue pathology and metal ion concentrations.

RESULTS

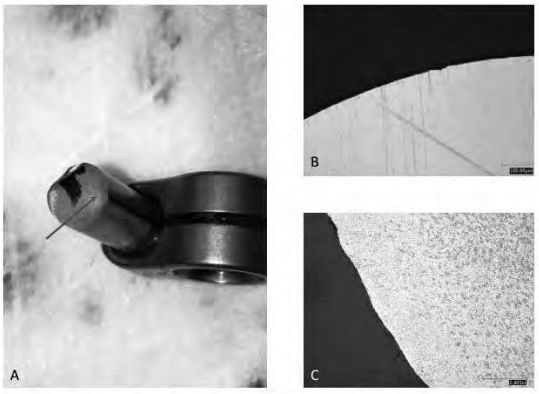
Fifty-five patients (30 male, 25 female; average age 59.5±14.5 years; average BMI 29.1±6.0) undergoing revision were included in this study. Fourteen revisions involved instrumentation failure. Nine failures were due to fracture of the spine rods. Five of the nine rods had laser marks extending the length of the rod. Four of the five rods showed fracture origin at the laser mark. Laser marks showed notching and subsurface modification of the alloy to a more fatigue intolerant phase of the metal. Figure 1A shows fractured rod immediately upon explantation. The telltale half-moon shape at the laser mark indicates fracture origin.

CONCLUSION

Continued failure analysis of explanted instrumentation may further elucidate alternative failure mechanisms not described in the clinical literature. Laser marking can result in metallurgical changes such as notching (Figure 1B) and subsurface metal crystal grain modification that lowers fatigue resistance (Figure 1C).

TAKE HOME MESSAGE

Laser marking can be detrimental to the biomedical alloy high cycle fatigue life. Some implant failures may be due to manufacturing processes and not due to surgical procedure or patient.



A) [left image] Fatigue fracture surface observed in operating room. Note red arrow indicating half-moon at the laser mark denoting fracture origin. B) [top right] Notch due to laser mark on CoCrMoC rod. C) [bottom right] Subsurface Ti alpha phase.

215. Infradjacent Segment Disease after Lumbar Fusion: An Analysis of Pelvic Parameters

Adam Nessim, BS; *Woojin Cho, MD, PhD;* Ariella Applebaum, BS; Dongyoung Kim, BS; Richard J. Sekerak, BS; Samuel H. Brill; Soo Yeon Kim, MD

SUMMARY

This study investigated the incidence and risk factors associated with the development of infra-adjacent segment disease following lumbosacral fusion. A retrospective review of 2069 sequential patients that underwent lumbosacral fusion surgery from 2008-2016 at a single academic medical center identified 81 patients who developed sacroiliac joint (SIJ) dysfunction during follow up. The data showed an incidence of 3.9% and indicated that a reduced pelvic tilt or L5 incidence may serve as risk factors for development of SIJ degeneration.

HYPOTHESIS

Pelvic parameters post lumbosacral fusion will correlate with the risk for developing infra-adjacent segment disease.

DESIGN

Observational Cohort

INTRODUCTION

Adjacent segment degeneration (ASD) to both proximal and distal areas of spinal fusion is a major post-operative complication of lumbar fusion. The goal of this study is to determine the incidence and risk factors associated with the development of infra-adjacent segment disease following spinal fusion, focusing on the effect of lumbosacral fusion on the SIJ.

METHODS

Total of 2069 sequential patients that underwent lumbosacral fusion surgery from 2008-2016 at a single academic medical center was retrospectively reviewed. Among them, patients who developed SIJ dysfunction were identified. SIJ dysfunction was defined as patients who received an SIJ injection with clinical evidence of improvement. Control group consisted of patients that also received a lumbosacral fusion, but showed no history of subsequent SIJ dysfunction. Controls were matched with cases based on levels of fusion, age, gender, BMI, and Charleson comorbidity score. Pre-and post-operative pelvic parameters were measured, including pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), lumbar lordosis (LL), lumbar sagittal alignment (LSA), L4 incidence, and L5 incidence.

RESULTS

Out of 2069 patients who underwent lumbosacral fusion, 81 patients (3.9%) met the criteria for SIJ dysfunction. Measurements were made for 47 out of the 81 patients who had SIJ dysfunction, and had both pre- and post-operative imaging. Measurements for 44 matched controls were also taken. Post-operative pelvic tilt was significantly lower in SIJ dysfunction patients compared to the control group (20.82° ± 2.19 vs. 27.28°±2.30; $p < 0.05$), as was L5 incidence (28.64°±3.38 vs. 37.11°±3.50; $p < 0.05$).

CONCLUSION

ASD incidence at the SIJ post lumbosacral fusion surgery was 3.9% and these patients had a significantly lower PT and L5 incidence compared to the control group, indicating that these pelvic parameters may be associated with the development of ASD at SIJ. Lower PT may be derived from weak hamstring muscles, ultimately predisposing a patient to SIJ dysfunction.

TAKE HOME MESSAGE

Pelvic tilt and L5 incidence post lumbosacral fusion may serve as risk factors for determining the likelihood of developing infra-adjacent segment disease of which the incidence was 3.9%.

216. Does Structural Compromise of the Aorta in Patients with Aortic Pathologies Predict Increased Spinal and Vascular Complications and Reoperations in Patients Undergoing Anterior Approach to the Spine?

Neil V. Shah, MD, MS; Pelin Celiker, BS; Cirous Sadeghi, MD; Mahee Islam; Ishaan Jain, BS; Joseph P. Scollan, BS; Madhu Oad, BS; Peter L. Zhou, MD; Bassel G. Diebo, MD; Carl B. Paulino, MD

SUMMARY

Anterior spinal fusion (ASF) presents unique challenges in approach, but it is not well documented whether structural aortic pathology, including aneurysms, dissections, or atherosclerosis, impacts short-term postoperative outcomes following anterior approach to the spine. It is not clear whether structural deterioration or compromise of the aorta impacts complication, revision, and readmission rates. In a propensity score-matched analysis between aortic-compromised (AComp) and non-compromised (No-Comp) patients, we observed no adverse impact on complications, anterior spinal or vascular revision/re-repair, or readmissions through 2Y-follow-up.

HYPOTHESIS

AComp pts undergoing ASF will have comparable adverse outcomes through 90D and 2Y FU to No-AComp pts.

DESIGN

Retrospective cohort

INTRODUCTION

ASF presents anatomic challenges; reports have detailed vascular injuries during anterior spinal exposure/approach. No study has evaluated if structural aortic pathology impacts outcomes, or need for vascular repair following ASF. We sought to evaluate the impact of AComp in the setting of ASF on adverse outcomes.

METHODS

Using NY Statewide Planning and Research Cooperative System (SPARCS), we identified thoracolumbar ASF pts with baseline AComp (aneurysm, dissection, atherosclerosis, aortitis, or aortic tumors) and 1:1 propensity score-matched them to No-AComp pts by age, sex, race, and Charlson/Deyo index. Pts were compared at 90D and 2Y FU for vascular/med/surg complics, readmissions, and revisions (i.e. subsequent anterior spinal approach or major vessel repair/revision). Multivariate binary stepwise logistic regression identified independent outcome predictors.

RESULTS

90 pts reached 90D FU (45 each); 64 pts reached 2Y FU (32 each). AComp and No-AComp had comparable demographic data: age (63.6 vs 65.4 Y), sex (57.8 vs 53.5% male), and LOS (5.3 vs 8 D), $p>0.05$. Through 90D FU, AComp had similar individual vascular complics, including iatrogenic puncture (6.7 vs 0%), hemorrhage (0 vs 2.2%), and hematoma (2.2% each), and overall vascular

complics (8.9 vs 4.4%). Overall complics (33.3 vs 31.1%) were comparable, though No-AComp pts had higher overall surg complics (11.1 vs 0%, p=0.021). Through 2Y FU, AComp vs No-AComp had comparable vascular (9.4 vs 0%), overall complics (34.4 vs 40.6%), and all other outcomes, all p>0.05. Neither group reported revisions through 2Y FU. AComp did not increase odds of any adverse outcomes through 2Y FU, including vascular, med, surg, overall complics and anterior or vascular revisions/repairs.

CONCLUSION

Aortic compromise in the setting of thoracolumbar ASF did not predispose this small cohort pts to adverse vascular complications or anterior spinal/vascular revision/repair through 2Y FU.

TAKE HOME MESSAGE

Baseline structural aortic pathology may not adversely impact risk of anterior spinal or vascular revision/repair for patients who undergo thoracolumbar spinal fusion via anterior approach.

218. Rates of Readmission in Spine Surgery: Is Decreased Length of Stay Beneficial to Patients?

Avery Brown, BS; Katherine E. Pierce, BS; Cole Bortz, BA; Haddy Alas, BS; Dennis Vasquez-Montes, MS; Brooke K. O'Connell, MS; Rivka C. Ihejirika, MD; Frank A. Segreto, BS; Jonathan Haskel, MD; Daniel James Kaplan, MD; Bassel G. Diebo, MD; Michael C. Gerling, MD; *Peter G. Passias, MD*

SUMMARY

Rising costs of healthcare have driven efforts to reduce the financial burden of providing care while maintaining the quality of care received. These two principles should be able to work in tandem but are often at odds. Shortening hospital lengths of stay (LOS) reduces costs associated with inpatient care and exposure to hospital acquired pathogens. However, readmissions and post-operative complications ultimately increase the burden of care and negatively impact the patient's outcomes.

HYPOTHESIS

Reduced hospital LOS following spine surgery may be contributing to readmissions and post-operative complications.

DESIGN

Retrospective review of ACS-NSQIP 2012-2016.

INTRODUCTION

Recent efforts have been made to decrease hospital LOS to lower costs and other complications. However, spine surgery patients undergo complex operations. There has been limited discussion regarding potential benefits and challenges for patients related to shorter LOS.

METHODS

Included: elective spine surgery patients >18 years in the American College of Surgeons' National Surgical Quality Improvement Program database from 2012-2016. Excluded: baseline infections or emergent surgeries. Descriptive statistics assessed demographics. Post-oper complications classified by the Clavien-Dindo system and days to readmission post initial operation were assessed. Pearson bivariate correlations and logistic regression analysis assessed LOS ≤1 day and days to unplanned readmission.

RESULTS

237,446 spine patients were included in the analysis (age: 57.8 ± 14.2 gender: 48% F BMI: 30.6 ± 6.6). From 2012-2016, the average LOS decreased from 3.13 ± 5.32 days to 2.96 ± 4.66 days as total number of surgeries increased from 24,071 in 2012 to 55,549 in 2016 (p<0.001). The mean days from initial surgery to readmission had a decreasing trend from 2012-2016 (14.01 ± 7.99 to 13.46 ± 8.02, p=0.092). Pearson bivariate correlations between LOS ≤1 day and decreasing days to readmission was the strongest in 2016 (2012-2016 r:-0.17, -0.19, -0.20, -0.22, and -0.23, all p=<0.001). Logistic regression analysis found that LOS ≤1 day showed an increase in the odds of readmission from 2012-2016 (2.29 [2.00-2.63], 2.33 [2.08-2.61], 2.35 [2.11-2.61], 2.27 [2.06-2.49], 2.33 [2.14-2.54], all p<0.001).

CONCLUSION

Hospital LOS has been consistently decreasing, despite an increase in spine surgeries. More recent spine surgeries demonstrated LOS <1 day were more likely to be readmitted sooner in relation to their initial surgery. More discussion is needed on whether both institutions and patients mutually benefit from decreased LOS.

TAKE HOME MESSAGE

LOS has been consistently decreasing, despite rises in spine surgeries. More recent surgeries demonstrated LOS <1 day were more likely to be readmitted sooner in relation to their initial surgery.

219. An Analysis of United States Medicare Reimbursement Rates in Spine Surgery: 2000-2018

Jack M. Haglin, BS; Jakub Godzik, MD; Kent R. Richter, BS; Tyler S. Cole, MD; Luis Manuel Tumialán, MD; Alan H. Daniels, MD

SUMMARY

Considering fluctuating policy, variance in proposed payment models, and the presence of ever-rising healthcare costs, there is noted financial uncertainty regarding healthcare in the United States. Despite this, there has been relatively little study regarding reimbursement models and trends in reimbursement rates. This study demonstrates that Medicare reimbursement for the most commonly performed spine surgery procedures has decreased by nearly 26% when adjusting for inflation from 2000-2018. This finding is important when evaluating current reimbursement models and defining future policy.

HYPOTHESIS

Medicare reimbursement may not be keeping up with the rate of inflation over the last 19 years.

DESIGN

Analysis of a publicly available, government-regulated reimbursement database.

INTRODUCTION

There is a paucity of data regarding financial trends for procedural reimbursements in spine surgery. A comprehensive understanding of such trends is important as continued progress is made to advance agreeable reimbursement models in spine surgery. The purpose of this study was to evaluate monetary trends in Medicare

reimbursement rates for the 15 most common spinal surgery procedures from 2000 to 2018.

METHODS

The National Surgery Quality Improvement Project (NSQIP) database (2016) was queried to determine the 15 most performed spine surgery procedures during this year. Next, the Physician Fee Schedule Look-Up Tool from the Centers for Medicare & Medicaid Services was queried for each of the top 15 most utilized CPT codes in spine surgery, and physician reimbursement data was extracted. All monetary data was adjusted for inflation to 2018 US dollars (USD) utilizing changes to the consumer price index (CPI). The R-squared and both average annual and the total percentage change in reimbursement were calculated based on these adjusted trends for all included procedures.

RESULTS

After adjusting for inflation, the average physician reimbursement for all procedures decreased by 25.8% from 2000 to 2018. The greatest mean decrease was seen in anterior cervical arthrodesis (-32.1%), while the smallest mean decrease was in vertebral body excision (-13.3%). From 2000 to 2018, the adjusted reimbursement rate for all included procedures decreased by an average of 1.7% each year, with an average R-squared value of 0.69. (Table 1)

CONCLUSION

This is the first study to evaluate trends in procedural Medicare reimbursement for spine surgery. When adjusted for inflation, Medicare reimbursement to physicians for included procedures has steadily decreased from 2000 to 2018. Increased awareness and consideration of these trends will be important for policy-makers, hospitals, and surgeons in order to assure continued access to meaningful surgical spine care in the United States.

TAKE HOME MESSAGE

This study demonstrates that United States Medicare reimbursement to physicians for the most commonly performed spine surgery procedures has decreased by nearly 26% when adjusting for inflation from 2000-2018.

CPT Code	Procedure	Average % Change Year to Year Adjusted	R^2	Total % Change 2000-2018 Adjusted
63030	Lumbar laminotomy with nerve root decompression and/or excision of herniated disk	-1.0%	0.25	-19.0%
63047	Laminectomy, facetectomy, and/or foraminotomy for treatment of lumbar stenosis, single vertebral segment	-1.9%	0.68	-29.7%
22612	Lumbar arthrodesis, posterior or posterolateral technique, single level	-1.6%	0.73	-25.7%
22630	Arthrodesis, posterior interbody technique, including laminectomy and/or discectomy to prep interspace, single interspace, lumbar	-1.6%	0.77	-25.3%
22558	Arthrodesis, anterior interbody technique, including minimal discectomy to prepare interspace	-1.9%	0.69	-29.9%
63042	Laminotomy with decompression of nerve root(s), partial facetectomy, foraminotomy and/or excision of herniated disc, single interspace	-1.6%	0.68	-25.7%
63081	Vertebral corpectomy, partial or complete, anterior approach with decompression of spinal cord and/or nerve root(s)	-1.9%	0.66	-30.5%
63005	Laminectomy with exploration and/or decompression of cord and/or cauda equina without facetectomy, foraminotomy or discectomy	-1.6%	0.54	-26.0%
63267	Laminectomy for excision or evacuation of intraspinal lesion other than neoplasm, extradural	-1.7%	0.60	-27.9%
63056	Transpedicular approach with decompression of spinal cord, equina and/or nerve root(s) (eg herniated intervertebral disc), single segment	-1.9%	0.70	-30.0%
22845	Anterior instrumentation for anterior cervical discectomy with interbody fusion	-1.7%	0.50	-26.1%
22554	Anterior cervical arthrodesis, anterior interbody technique, including minimal discectomy	-2.1%	0.98	-32.1%
22590	Arthrodesis, posterior technique, cranio-cervical (occiput-C2)	-1.4%	0.83	-21.9%
22114	Partial excision of vertebral body, for intrinsic bony lesion, without decompression	-0.8%	0.82	-13.3%
22840	Placement of posterior non-segmental instrumentation	-1.6%	0.89	-25.0%
Average Procedure		-1.7%	0.69	-25.8%

Table 1. Adjusted Monetary Reimbursement Trends. All values adjusted for inflation.

Table 1. Adjusted Monetary Reimbursement Trends. All Values Adjusted for Inflation.

220. Predictors and Etiologies of Reoperation in a Large, Single-center Cohort of Surgical Spine Patients

Haddy Alas, BS; Avery Brown, BS; Katherine E. Pierce, BS; Cole Bortz, BA; Dennis Vasquez-Montes, MS; Erik Wang, BA; Dainn Woo, BS; Edem J. Abotsi, BA; Ethan W. Ayres, MPH; Jordan Manning, BA; Christopher G. Varlotta, BS; Constance Maglaras, PhD; Mohamed A. Moawad, MPH; Bassel G. Diebo, MD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; Michael C. Gerling, MD; *Peter G. Passias, MD*

SUMMARY

Spine surgery encompasses a broad variation of complex procedures and deformities. While reoperation rates have historically been recorded as high as 16% in spine literature (Malter et al., 1998), surgical technique has continued to advance in an effort to reduce adverse events such as reoperation and improve patient quality of life. This large, single-center study identifies categorical and individual predictors of reoperation within an all-spine patient population.

HYPOTHESIS

Specific diagnosis-based, region-based, and intervention-based predictors of reoperation exist within an all-spine surgical cohort.

DESIGN

Retrospective review

INTRODUCTION

Spine surgery encompasses a broad variation of procedures, ranging from minimally invasive to highly complex.

METHODS

Patients≥ 18 years undergoing elective spine surgery with full BL to 1-year follow up were isolated in a single academic center (Spine Quality Database). Surgical data was grouped by absence or presence of >1 revision surgery (NoReop vs Reop). Descriptives were used for overall rates and etiologies. Reop groups were compared across outcome measures using chi-square and ANOVA with effect size sampling(eta2>0.2 considered significant). Multivariate analysis with conditional forward regression analyzed top categories of reop: Regional, Diagnosis, or Interventional. Secondary analysis identified differences in perioperative outcomes, never events[deep/superficial SSI, UTI, pulmonary] between primary & revision cases.

RESULTS

6,089 pts met inclusion criteria. Of 7,107 total surgeries, 542 were reoperations. Table 1 shows group differences in demographics, surgical factors, and perioperative outcomes. By diagnosis, Pseudarthrosis had the highest incidence, followed by Adjacent Segment Disease, Kyphosis, and Flatback. The top category of predictors was Primary Diagnosis: top individual predictors were [1]Pseudarthrosis [2]Adjacent Segment Disease [3]Flatback [4] Kyphosis. The second best category of predictors was Region: [1] Lumbar [2] Thoracic [3] Cervical. The least predictive category was Intervention: decompression with fusion was a significant predictor of revision compared to decompression alone. Secondary analysis revealed revision had significantly more levels fused, longer op times, and LOS than primaries, with significantly higher rates of never events, specifically deep SSI and pulmonary events(DVT, PE).

CONCLUSION

The strongest categorical predictor of reoperation was Diagnosis, followed by Region and Intervention. Top three individual predictors were pseudarthrosis, adjacent segment disease, and flatback, respectively, while the top regional-based predictor was lumbar.

TAKE HOME MESSAGE

Revision surgeries had significantly higher rates of never events and inferior perioperative outcomes likely due to increases invasiveness. Top categorical predictors of revision were primary diagnosis, region, and intervention, respectively.

	No Reop	Reop	p or eta squared
Demographics			
Age	55.2±17.8	57.2±14.7	0.014(eta)
Gender	54.10%	52.70%	0.524
BMI	28.2±6.4	28.8±6.4	0.766(eta)*
CCI	0.47±1.12	1.17±1.46	0.047(eta)
Surgical Factors			
Anterior approach	12.3%	7.20%	<0.001*
Posterior approach	51.2%	71.40%	<0.001*
Combined approach	6.1%	20.10%	<0.001*
Cervical Region	12.4%	16.10%	0.019*
Thoracic Region	10.0%	20.30%	<0.001*
Lumbar Region	38.8%	80.10%	<0.001*
ASD(Y/N)	11.10%	29.70%	<0.001*
Corpectomy	1.40%	3.00%	0.01
PSO	2.10%	5.00%	<0.001*
Peri-Operative Factors			
Levels Fused	4.31	4.46	0.024(eta)
EBL(mL)	498.7	662.2	0.033(eta)
Op time(min)	223.6	272.4	0.144(eta)
LOS(days)	3.56	4.82	0.026(eta)

Diagnosis	N	% of Total Reops (542)	N Reop/Incidence	% Reop/Incidence
Pseudo	156	28.78%	156/554	28.2%
Adjacent Segment	93	17.16%	93/479	19.4%
Kyphosis	92	16.97%	92/767	12%
Flatback	45	8.30%	45/319	14.10%
Fracture Unspecified	25	4.61%	25/236	10.60%
PJK/DJK	23	4.24%	23/212	10.85%
Pars Fracture	17	3.14%	17/184	9.23%
Infection	15	2.77%	15/212	7.10%

By Top Diagnosis	OR	Lower CI	Upper CI	p
Pseudoarthrosis	6.31	5.096	7.82	<0.001
Adjacent Segment	3.38	2.64	4.33	<0.001
Flatback	2.06	1.48	2.87	<0.001
Kyphosis	1.85	1.45	2.34	<0.001
By Region				
Cervical	1.39	1.09	1.77	0.008
Thoracic	2.66	2.11	3.35	<0.001
Lumbar	6.23	5.00	7.75	<0.001
By Intervention				
Fusion with Decompression	1.5	1.07	2.11	0.018
Decompression Only	na	na	na	removed from model

Table 1: Univariate analysis of demographics, surgical factors, and periop outcomes(top) with multivariate analysis of top categories predicting reoperation. Statistical significance was set to p<0.05.

221. A Cost Benefit Analysis of Increasing Surgical Technology in Lumbar Spine Fusion

Peter G. Passias, MD; Avery Brown, BS; Haddy Alas, BS; Cole Bortz, BA; Katherine E. Pierce, BS; Erik Wang, BA; Hamid Hassanzadeh, MD; Lawal A. Labaran, BS; Varun Puvanesarajah, MD; Dainn Woo, BS; Jordan Manning, BA; Ethan W. Ayres, MPH; Edem J. Abotsi, BA; Christopher G. Varlotta, BS; Mohamed A. Moawad, MPH; Constance Maglaras, PhD; Dennis Vasquez-Montes, MS; Bassel G. Diebo, MD; Charla R. Fischer, MD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; Michael C. Gerling, MD

SUMMARY

In a retrospective review of a single center spine surgery database, patients undergoing open, minimally invasive or robot-assisted lumbar fusion surgery were assessed for costs of baseline surgery, quality-adjusted life years (QALY), as well as cost per QALY. Matching for levels fused, robotic cases were found to have higher baseline costs than open and MIS cases (p<0.05), as well as higher costs per QALY one year postop and to life expectancy.

HYPOTHESIS

Economic outcomes of lumbar fusion varies significantly between open, MIS & robot-assisted surgery patients.

DESIGN

Retrospective review of a single center spine surgery database.

INTRODUCTION

Numerous advances have been made in spinal fusion, such as minimally invasive (MIS) & robotic-assisted surgery. However, it is unknown how these advances impact cost of care

METHODS

Patients ≥18yo undergoing lumbar fusion surgery included. Patients categorized into 3 groups based on procedure type: open, MIS, robotic. Open included posterior spinal fusion. MIS included TLIF or LLIF with percutaneous screws. Robotic included robot-assisted interbody fusion. Propensity score matching (PSM) among groups for number of levels fused. Costs calculated using PearlDiver database. For robotic cases, costs reflective of operational fees & initial purchase costs. Complications & comorbidities (CC) & major CC (MCC) assessed according to CMS.gov manual definitions. QALY & cost/QALY calculated using 3% discount rate to account for residual decline to life expectancy (78.7 years). Cost/QALY calculated for Y1 & life expectancy, assuming no loss of benefit.

RESULTS

360 PSM patients (120 open, 120 MIS, 120 robotic) included. Descriptive stats: 58.8±13.5yrs, 50%F, BMI29.4±6.3, op time 294.4±19min, LOS 4.56±3.31days, EBL 515.9±670cc, 2.3±2.2 levels fused. Postop complication rate highest in robotic ($p<0.05$). Revision rates comparable among groups ($p>0.05$). Factoring in complications, revisions, purchasing & operating fees, costs of robotic cases highest (Fig 1,$p<0.05$). Sub-analysis of 42 patients with BL & Y1 EQ5D data: Y1 cost/QALY for open, MIS, robotic was $296,624.48, $115,911.69, $592,734.30, respectively. If utility gained sustained to life expectancy, cost/QALY was, respectively, $14,905.75, $5,824.71, $29,785.64

CONCLUSION

Matching for levels fused, robot-assisted patients had 30% higher costs of surgery & rate of complications than MIS & open spine surgery patients. While Y1 economic outcomes weren't optimal for robotic surgery cases, projected costs per QALY at life expectancy well below established acceptable thresholds

TAKE HOME MESSAGE

Robot-assisted patients had 30% higher baseline surgery costs than MIS & open patients. While Y1 robotic surgery economic outcomes weren't optimal, projected costs/QALY at life expectancy were below acceptable thresholds.

Figure 1.

	Robotic	Open	MIS	p-value
Baseline Surgery Cost	$60,047.01	$42,538.98	$41,471.21	<0.05
Revision Rate	3.0%	3.0%	5.0%	>0.05
Non-reimbursable Event	12.0%	8.0%	7.0%	<0.01

222. rhBMP-2 in Single-level Transforaminal Lumbar Interbody Fusion: Does Dosage Matter?

Dennis G. Crandall, MD; Andrew Chung, DO; Nina, J. Lara, MD; Jan Revella, RN; *Michael S. Chang, MD*

SUMMARY

Existing evidence suggests that the off-label use of rhBMP-2 in the setting of Transforaminal Lumbar Interbody Fusion (TLIF) may promote fusion rates similar to that of autograft. However, the effect of rhBMP-2 dosing on outcomes requires continued study.

HYPOTHESIS

Use of higher dosages of rhBMP-2 in the setting of single-level TLIF will improve fusion rates with no difference in rates of complications

DESIGN

Retrospective cohort study of prospectively collected data from a single surgical practice

INTRODUCTION

The effect of rhBMP-2 dosing on outcomes has not been well-established. The purpose of this study was to determine the effect of increasing dosages of rhBMP-2 on post-operative clinical and radiographic outcomes in the setting of single-level TLIFs.

METHODS

148 single-level fusions with TLIF were performed for degenerative lumbar disease. 3 cohorts were identified based on dosages of rhBMP-2 utilized (0 mg, 2 mg, 4 mg). Patients who received rhBMP-2 for posterolateral fusion were excluded from this study. Complications and revision surgery that occurred within 2 years of the index surgery were all recorded. Pre-operative VAS-BP, VAS-LP, and ODI were collected. These measures were further obtained at 6 weeks, 3 months, 6 months, 1 year, and at 2 years. Radiographic union was assessed based off of flexion and extension films.

RESULTS

Mean age of patients undergoing fusion was 57.0 (sd = 13.3). There were no clinically meaningful or statistically significant differences in baseline patient characteristics between groups. There were only 3 (2.0%) cases of radiculitis. The rates of non-union were 4.5% (0 mg), 2.4% (2 mg), and 0% (4 mg); $p = 0.257$. Otherwise, there were no differences in peri-operative complication rates between groups. Revision fusion was more common with no use of rhBMP-2 (25.0%) when compared to the 2 mg (14.3%) and 4 mg (11.3%) groups; $p = 0.156$. At 2-years, the 4 mg cohort had the greatest improvements in all patient reported outcome measures although these differences were not statistically significant.

CONCLUSION

Use of a moderate 4 mg dosage of rhBMP-2 may be associated with improved clinical and radiographic parameters following single-level TLIF. Importantly, risks of known rhBMP-2 related complications such as radiculopathy and seroma appear to be low at this dosage.

TAKE HOME MESSAGE

The utilization of increasing dosages of rhBMP-2 is safe and may be clinically effective in patients undergoing single-level TLIF

223. Drivers for Non-home Discharge In 1502 Patients Undergoing 1-2 Lumbar Fusions

Jeffrey L. Gum, MD; Portia A. Steele, MS; Charles H. Crawford III, MD; Mladen Djurasovic, MD; Kirk Owens II, MD; Morgan Brown, MS; Christy L. Daniels, MS; Steven D. Glassman, MD; Leah Yacat Carreon, MD, MS

SUMMARY

We evaluated 1502 patients undergoing 1-2 level instrumented lumbar fusions. Factors associated with non-home discharge included living in an underserved zip code, on government insurance, being unmarried, higher BMI, more operative levels, and older age at time of surgery.

HYPOTHESIS

There are factors associated with being discharged to a non-home location after an elective 1-2 level instrumented lumbar

fusion that, if identified, can be useful to allow for early post-discharge planning.

DESIGN

Retrospective chart review.

INTRODUCTION

Provisions in the Patient Protection and Affordable Care Act (PPAC) include alternative payment models that shift away from fee-for-service reimbursement and provide incentives to improve value. These reimbursement models could incorporate the post-discharge facility care and it is therefore important to identify drivers of additional cost, especially in the setting of unexpected non-home discharge.

METHODS

Hospital administrative database and electronic medical record analysts identified consecutive patients undergoing 1-2 level instrumented lumbar fusions for degenerative lumbar conditions from 2016 to 2018. Discharge disposition was determined as home vs Non-Home (NH). A regression analysis was used to determine associations between NH discharge and an underserved Zip code, ASA grade, marital status, race, insurance type, smoking status, BMI, number of levels, approach and revision surgery.

RESULTS

A total of 1502 patients (601; 40% male) were included with a mean age of 57.5 years. The majority were discharged home (1216; 81%). Of the 286 (19%) not discharged home, the majority went to a skilled nursing facility (248). Factors associated with a NH discharge were living in an underserved Zip code, not being married, being on government insurance, having more levels fused, higher BMI and older age. Length of stay (5.64 vs 3.03 days, $p<0.000$) was longer and total hospital direct cost ($21,204 vs $17,518, $p<0.000$) was higher in NH patients compared to those discharged to home.

CONCLUSION

Patients living in an underserved zip code, not married, higher BMI, older, and having government insurance are more likely to be discharged to a non-home facility after undergoing 1-2 instrumented lumbar fusions. Identification and early intervention to place these patients even before admission may decrease the length of hospital stay and cost.

TAKE HOME MESSAGE

In patients undergoing 1-2 level fusions, older age, living in underserved zip code, higher BMI, being unmarried, and government insurance were associated with discharge to a facility other than home.

224. Medical Issues Complicate 90 Day Return to the ED after Spinal Deformity Surgery: A Review of 346 Patients

Vishal Sarwahi, MD; Jesse Galina, BS; *Sayyida Hasan, BS;* Stephen F. Wendolowski, BS; Aaron M. Atlas, BS; Yungtai Lo, PhD; Terry D. Amaral, MD

SUMMARY

Return to the ED continues to be a quality measure in healthcare. The purpose of this study was to describe one institution's experience with visits to the ED following spinal deformity surgery. 11.8% of patients returned to ED within 90 days mostly with medical complaints – more than half by 30 days. There were no risk factors identified, however, a majority of complaints appear to be preventable.

HYPOTHESIS

Postoperative ED visits within 90 days are preventable.

DESIGN

Ambispective study

INTRODUCTION

Return to the hospital after surgery is frequently being used as a quality metric. The purpose of this study is to evaluate the reasons and risk factors for ED visits less than 90 days.

METHODS

A review of spinal deformity surgeries between 2011-2018 was performed. Radiographic, operative, and hospital stay data was collected. Median and interquartile range (IQR) was with Wilcoxon-Signed Rank and Kruskal-Wallis tests. Patients who returned to the ED for any reason within 90 days were analyzed. ED visits were categorized as medical and surgical. Medical visits included but not limited to fever, pain, and seizures. Surgical visits included but not limited to wound infection, and surgical site infection.

RESULTS

346 patients were included: 274 idiopathic scoliosis, 48 neuromuscular, 10 Scheurmann's kyphosis, 3 spondylolisthesis (grade 4), and 11 other. 41 patients (11.8%) returned to the ED within 90 days. 32 (78%) returned with medical-related complaints: pain (n=14), fever (n=6), constipation (n=4), spasm/seizures(n=2), syncope (n=3), fall (n=1) and dysnea(n=2). 9 (22%) returned with surgical-related complaints: drainage from incision (n=6), wound infection (n=2), and baclofen pump failure (n=1). 65.8% (n=27) returned to the ED within 30 days. There was no significant difference in age (13.19 vs 12.42 years, p=0.27), BMI (18.27 vs 17.13,p=0.33) preoperative Cobb (47.30 vs 46.0, p=0.731), preoperative kyphosis (16 vs 17,p=0.971), and levels fused (10 vs 11,=0.359) between those did not return to the ED and those who did. Blood loss (300 vs 350ml,p=0.973), surgical time (230 vs 228,p=0.180), and length of stay (4 vs 4,p=0.94) were also similar between the two cohorts. Neuromuscular distribution was also similar (12.8% vs 21.9%).

CONCLUSION

11.8% of patients returned to ED within 90 days, mostly with medical complaints – more than half by 30 days. Although no risk factors were found in this study, the findings present an opportunity to better improve discharge planning and care coordination.

TAKE HOME MESSAGE

ED returns are preventable and, in altering this pattern, we can increase overall quality of care.

225. Bone Mineral Density T-score is an Independent Predictor of Major Blood Loss in Adult Spinal Deformity Surgery

Andrew B. Harris, BS; Caleb Gottlich, MS, BS; Micheal Raad, MD; Varun Puvanesarajah, MD; Floreana N. Kebaish, MD; Corinna Zygourakis, MD; Jay Khanna, MD; Khaled M. Kebaish, MD, FRCS(C)

SUMMARY

In our single-center study of 91 patients undergoing spinal fusion for Adult Spinal Deformity (ASD), we have demonstrated that each standard deviation lower T-score is associated with 2.5 times greater odds of significant blood loss after controlling for procedural and medical covariates. Surgeons should anticipate the potential for increased blood loss in patients with lower bone mineral density.

HYPOTHESIS

Lower bone mineral density (BMD) is associated with greater odds of major blood loss in Adult Spinal Deformity (ASD) surgery.

DESIGN

Cross-sectional study

INTRODUCTION

Blood loss is an important cause of morbidity in ASD surgery. Thus, identifying potentially modifiable factors associated with increased EBL in ASD surgery is important. Bone mineral density (BMD), as measured by Dual-energy X-ray Absorptiometry (DEXA), is important for stable instrumented fixation and is often measured preoperatively in ASD patients, however, the association between BMD and intraoperative blood loss in ASD patients has not been studied.

METHODS

Patients were studied who received spinal fusion for ASD (>5 levels fused) at a single academic center from 2010-2018. The lowest preoperative T-score was recorded for patients who had preoperative DEXA scans within the past year. Patients were excluded who had liver/kidney disease or were on prescription anticoagulant medication. Major blood loss was defined as >2L using the 90th percentile of the population. Binomial regression was performed controlling for age, number of vertebra fused, 3-column osteotomy, primary vs. revision surgery, preoperative platelet count, and if the patient was taking medication for osteoporosis. Significance was set at p=0.05.

RESULTS

91 patients were identified in the final cohort. Mean age was 63 ± 11.6 years, 81% female. 56 (62%) of cases included revision of previous instrumentation. Patients had a mean SVA of 9.6 ± 8.6cm and median of 9 vertebra fused (range 5-22). The average T-score was -1.2 ± 1.0. Each point lower T-score was associated with significantly higher odds of major blood loss (OR 2.5, 95% CI 1.0 – 5.9) when controlling for age, number of vertebra fused, 3-column osteotomy, preoperative platelet count and primary vs. revision surgery.

CONCLUSION

Lower preoperative T-score is independently associated with increased odds of significant blood loss in ASD surgery.

TAKE HOME MESSAGE

Lower bone mineral density is independently associated with greater odds of significant blood loss in Adult Spinal Deformity patients.

226. A Prospective Analysis of Minimally Invasive Surgery for Adult Spinal Deformity: A Multicenter Study

Gregory M. Mundis Jr., MD; Paul Park, MD; Robert K. Eastlack, MD; Juan S. Uribe, MD; Stacie Tran, MPH; Kenyu Ito, MD; Pierce D. Nunley, MD; Michael Y. Wang, MD; Richard G. Fessler, MD, PhD; Neel Anand, MD; Adam S. Kanter, MD; David O. Okonkwo, MD, PhD; Christopher I. Shaffrey, MD; Praveen V. Mummaneni, MD; International Spine Study Group

SUMMARY

Traditional deformity surgery for ASD is effective but results in extensive exposure related morbidity. MIS approaches are less morbid however high-level evidence for efficacy is lacking. In this prospective, multi-center investigation, 64 ASD patients treated minimally invasively were found to have significant radiographic and clinical improvement with a modest complication rate.

HYPOTHESIS

In patients with adult deformity, minimally invasive techniques result in significant radiographic and clinical improvement.

DESIGN

Prospective, non-randomized multi-center investigation

INTRODUCTION

Traditional surgery for adult spinal deformity (ASD) is effective but results in exposure related morbidity. Minimally invasive spine surgery (MISS) can minimize this morbidity but high-level evidence for efficacy is lacking. This study presents the first prospective, multi-center investigation of MISS for ASD.

METHODS

Patients ≥18 years old with at least one of the following criteria: coronal curve (CC) ≥20°, SVA > 5cm, PT > 25°, thoracic kyphosis (TK) > 60° were included. All patients had MIS surgery including interbody work: TLIF, LLIF, ALIF, ACR and percutaneous posterior fixation. 64 patients with min 1-year follow-up were included. Subgroup analysis of 28 with at least one Schwab ++ modifier was performed to evaluate those with more severe deformity (SD).

RESULTS

Mean age was 67.5 years. Mean levels instrumented 4.3, EBL 366.5 cc, and LOS 6.9 days. Significant ($p<0.05$) improvements in SVA (54cm to 33.3cm), PI-LL (13.6° to 6.3°), CC (22.9° to 15.5°) were observed. Significant ($p<0.05$) improvements in ODI (44.9 to 27.8), SRS (2.8 to 3.7), VAS back (7.1 to 2.8) and VAS leg (6 to 3.1) were noted. Complications occurred in 21 patients (32.8%), 13 (20.3%) major, including 5 (7.8%) neurologic, with a 1 year reoperation rate of 15.6% (n=10). In SD patients (n=28), similar improvements in SVA (94.5cm to 45.9cm), PI-LL (25.6° to 9.5°), PT (26.9° to 22.7°), CC (20.4° to 12.8°), ODI (49.8 to 30.8), SRS-22 (2.8 to 3.5), VAS back (7.4 to 3.2), VAS leg (5.8 to 3.7) were found ($p<0.05$). Mean age was 69.5 years and mean levels treated 5.1, EBL 464.6 cc, and LOS 7.8 days. Complications occurred in 14 (53.8%), 8 (28.6%) major, including 2 (7.1%) neurologic with 6 requiring a reoperation (21.4%)

CONCLUSION

MIS for ASD resulted in meaningful symptomatic improvement. Complication rates are similar to historic norms with a fairly high reoperation rate at one year. Longer follow up will be necessary to

evaluate the durability of this approach in the treatment of adult deformity.

227. 3D Rapid Prototyping Curve-specific Model: An Affordable Approach to Reduce Medial Pedicle Screw Perforation in the Thoracic and Lumbar Spine

Nanfang Xu, MD; Miao Yu, MD

SUMMARY

Pedicle screws are commonly used in posterior surgical deformity correction for scoliosis. Yet risk of injury to the adjacent neurovascular tissue remains a significant concern among spine surgeons. Recent developments aiming at reducing malposition-related complications included navigation, patient-specific template, etc. 3D rapid prototyping scoliosis model represents a cheaper and more accessible approach. Specifically, intra-operative use of these models were shown to reduce medial pedicle perforation in the thoracic and lumbar scoliotic spine in an analysis of 1485 screws.

HYPOTHESIS

Intra-operative use of 3D rapid prototyping (3DRP) scoliosis model can increase accuracy of pedicle screw placement in the thoracic and lumbar spine.

DESIGN

Diagnostic study of consecutive patients.

INTRODUCTION

Pedicle screws are commonly used in posterior surgical deformity correction. Yet risk of injury to the adjacent neurovascular tissue remains a significant concern. Recent developments, including navigation, patient-specific template, and others have been investigated to improve accuracy of screw placement; however, their accessibility and cost-effectiveness remain in question.

METHODS

A retrospective review on scoliosis patients operated on by a single surgeon from 2014 to 2018 identified 48 patients with curve-specific models manufactured by 3DRP and used intra-operatively for guidance of instrumentation. They were age and gender-matched to 48 scoliosis patients in whom pedicle screws were placed following the standard free-hand technique. Screw position was determined on CT by a grading system as Grade 0 (no violation), Grade 1 (<2mm perforation), Grade 2 (<4mm perforation, with possible complications), or Grade 3 (>4mm perforation, with high risk of complications).

RESULTS

1485 screws (686 in the 3DRP group vs. 799 in the control group) were analyzed. Patients in the 3DRP group had higher Cobb angles and more challenging deformity (mostly congenital scoliosis). Although the overall percentages of critical perforations (those with risk of complications) were comparable between the two groups, the distribution of screw perforation were different. Screws in the 3DRP group were less likely to be critical both medially and laterally, and more likely to be critical anteriorly. Furthermore, laterally and anteriorly, the difference between the two groups were largely due to a difference in Grade 2 perforation, whereas medially, the difference resulted from a higher percentage of both Grade 2 and Grade 3 perforation.

CONCLUSION

3DRP scoliosis model represents an affordable and accessible approach to reduce medial pedicle screw perforation with high risk of complications in the thoracic and lumbar spine.

TAKE HOME MESSAGE

3D rapid prototyping curve-specific scoliosis model represents an affordable and accessible approach to reduce medial pedicle perforation in the thoracic and lumbar scoliotic spine in an analysis of 1485 screws.

229. The Application of 3D Printing Guide Template for Pedicle Screw Placement in Surgery of Severe Spine Deformity

Yan Zeng, MD; Zhongqiang Chen, MD

SUMMARY

In the surgery for severe spine deformity, the identification of local bone structure is difficult. It is frequent as the dysplasia of pedicle, rotation of vertebrae, hypogenesis or position variance of blood vessel and neurological elements. A 3D printing guide template for pedicle screw implant according to the data of preoperative thin layer CT scan of the most severe part of the deformity may solve this problem more efficiently.

HYPOTHESIS

In the surgery for severe spine deformity, a 3D printing guide template made from preoperative thin layer CT scan data may achieve more safe and effective pedicle screw implant.

DESIGN

A prospective study

INTRODUCTION

To evaluate the results of 3D printing guide template for assistant pedicle screw placement in severe spine deformity.

METHODS

Preoperative thin layer CT scan of surgical area was performed, and 3D printing technique was applied to design and make the guide template for pedicle screw implant according to the data of the most severe part. The guide template was placed on the model of deformed spine to affirm the location and direction of pedicle screws before surgery, and attached tightly with bone elements to guide the pedicle drilling and screw implant during surgery. The position of pedicle screws were evaluated by CT scan and graded for accuracy after surgery.

RESULTS

From July 2016 to June 2018, twelve patients were enrolled into the study, including 7 male and 5 female. The average age was 32.4 years. All the patients had a Cobb angle over 70°. The etiology included: congenital deformity for 5 cases, neurofibromatosis kyphoscoliosis for 2 cases, and idiopathic scoliosis for 5 cases. The average deformity correction rate was 60.3%. Totally 170 screws were implanted using guide template. With CT analysis, 158 (92.9%) screws were fully inside the pedicle. In the other 12 screws, 10 of them had a deviation less than 2mm, and 2 of them had a deviation between 2 to 4mm. No patient had neurological or blood vessel complication.

CONCLUSION

A relative high accuracy can be achieved with the application of 3D printing guide template assisted pedicle screw implant technique in surgery for severe spine deformity. Further effort is still needed to improve the technique and decrease the screw deviation.

TAKE HOME MESSAGE

In the surgery for severe spine deformity, a 3D printing guide template made from preoperative thin layer CT scan data may achieve more safe and effective pedicle screw implant.

230. The Impact of Preoperative Cannabis on Outcomes Following Cervical Spinal Fusion: A Propensity Score-matched Analysis

Neil V. Shah, MD, MS; Cameron R. Moattari, BS; Joshua D. Lavian, BS; Marine Coste, BA; David Kim, BS; Sirish Khanal, BS; Joseph P. Scollan, BS; George A. Beyer, MS; Patrick J. Morrissey, BS; Nathan S. Kim, BA; Peter G. Passias, MD; Renaud Lafage, MS; Han Jo Kim, MD; Carl B. Paulino, MD; Frank J. Schwab, MD; Virginie Lafage, PhD; Bassel G. Diebo, MD

SUMMARY

Clinical outcome studies in baseline Cannabis users undergoing cervical spine surgery are limited. Utilizing the NY Statewide Planning and Research Cooperative System (SPARCS), propensity score-matched cannabis users and non-users undergoing cervical fusion (CF) were compared. Comparison of outcomes between baseline cannabis users undergoing CF and non-cannabis users revealed cannabis as a strong, independent predictor of increased 90-day readmissions. Of particular interest within this cohort should be postoperative analgesic requirements and what role this plays in readmission rates.

HYPOTHESIS

Adverse outcomes would be comparable between the cannabis use group and the non-use group undergoing cervical fusion (CF).

DESIGN

Retrospective cohort

INTRODUCTION

Cannabis is the most commonly used illicit drug in the USA. Studies evaluating cannabis use and its impact on outcomes following CF are limited. We compared 90D complication and readmission rates and 2Y revisions between baseline cannabis users and non-users following CF.

METHODS

All pts ≥18y who underwent CF from 2009-13 were identified via the SPARCS database and included if they had ≤90D FU for complications and readmissions or 2Y FU for revisions. Pts with preoperative cannabis abuse/dependence identified (Cannabis). Pts were excluded for systemic disease, osteomyelitis, cancer, trauma, or concomitant substance or polysubstance abuse/dependence. Cannabis pts were 1:1 propensity score-matched by age, gender, race, Deyo score, surgical approach, and tobacco use to Non-Cannabis users prior to comparison of hospital-related parameters, rates of 90D complications and readmissions, and 2Y revisions. Multivariate binary stepwise logistic regression models identified independent predictors of these outcomes.

RESULTS

432 pts (n=216 each) were identified, with comparable age, sex, Deyo scores, tobacco use rates, and distribution of anterior or posterior approach (all p>0.05). Cannabis pts were more frequently African American (27.8vs.12.0%), primarily utilized Medicaid (29.6vs12.5%), and incurred lengthier LOS (3.0vs1.9 days), all p≤0.001. Both cohorts experienced comparable rates of 90D medical, surgical and overall complications (5.6vs3.7%) and 2Y revisions (4.3vs2.8%), p≤0.430. Cannabis users experienced higher 90D readmission rates (11.6vs6.0%, p=0.042). Cannabis use independently predicted of 90D readmission (OR=2.0, 95%CI, 1.0-4.1, p=0.049), but did not predict any 90D complications or 2Y revisions (all p>0.05).

CONCLUSION

Baseline cannabis dependence/abuse was associated with increased 90D readmission odds following CF. Further investigation of the physiologic impact of cannabis on musculoskeletal pts may identify what measurable or overlooked pt factors contribute to this association.

TAKE HOME MESSAGE

Cannabis abuse/dependence was a strong, independent predictor of increased 90-day readmission rates following cervical spinal fusion when compared to a propensity score-matched cohort.

231. Cochlear Implants in Scoliosis Patients: Survey and Review

Barry R. Bryant, BS; Caleb Gottlich, MS, BS; Derek T. Nhan, BS; Brian T. Sullivan, MD; Anna McClung, BSN; David Price Roye Jr., MD; Muharrem Yazici, MD; Patrick J. Cahill, MD; Paul D. Sponseller, MD, MBA

SUMMARY

Little is known regarding the effects of MRI, electrocautery, and transcranial stimulation on cochlear implants (CI) in scoliosis patients. We developed a survey looking at surgeons' experiences with CI patients and conducted a literature review to investigate adverse events and recommendations for utilization of these modalities. Both our survey and the literature review showed TcMEP and electrocautery had low incidence of adverse events in CI patients. Use of MRI in CI patients is more ambiguous and requires further investigation.

HYPOTHESIS

Our goal is to better characterize management of cochlear implants (CI) in patients with pediatric spinal deformity.

DESIGN

Survey and Literature Review

INTRODUCTION

The number of implanted CI devices surpasses 300,000 worldwide. Little is known in regards to the safety of magnetic resonance imaging (MRI), electrocautery (EC), and transcranial stimulation for motor evoked potentials (TcMEP) in CI spine patients.

METHODS

A survey was developed on the risks associated with electromagnetic interference in CI patients and was dispersed to the members of the Growing Spines Study Group (GSSG) and the Children's Spine Study Group (CSSG). Further, a literature review

was conducted to compare our survey findings with previously reported events.

RESULTS

Thirty-six pediatric orthopaedic surgeons completed the survey (response rate 31%) with a total of 77 CI patients operated on for their spinal deformity (avg 2.14 pts/surgeon). No adverse events (AE) were reported. Only 47% of surgeons reported having safely used MRI on CI patients, 79% for EC, and 95% for TcMEP. Reported adaptations included using a weaker magnetic field for MRI (1.5T), magnet removal from the CI, CT instead of MRI, and using bipolar instead of monopolar EC. Among those surveyed 86% made an adaptation to their MRI protocol, 53% for EC, and 30% for TcMEP. A review of the literature concerning management of patients with CI yielded 34 articles with 23 addressing MRI use, 6 EC, and 5 TcMEP. There were no AE reported in recent literature concerning the use of TcMEP or EC. The literature on the use of MRI in CI patients was less defined with 25% of the literature we surveyed reporting adverse events (AE) or actively recommending avoiding MRI. The most common AE were pain, occurring 33-70% of the time and device dysfunction less than 10%.

CONCLUSION

Based on both our literature review and survey findings, the use of EC and TcMEP is considered safe in CI patients. MRI has a more ambiguous safety profile in CI patients based on previous reports, although no adverse events were reported in our survey after magnetic field modification. This study provides only initial experience and more information is needed before formal guidelines can be recommended.

TAKE HOME MESSAGE

Based on literature review and survey responses, TcMEP and electrocautery can be safely used in CI patients. MRI has a more mixed safety profile and requires further study.

Table 1. Summary of survey and literature review findings.

Modality	Safely used when indicated	Survey	Literature Review
MRI	47% n=15	No complications or adverse events MRI lower setting (1.5T) (n=5) Turn off CI (n=4) Surgical removal of CI (n=1) CT myelogram instead (n=1)	23 articles 25% of articles reported adverse events or recommended not using MRI Pain: 33-70% of time Severe dysfunction of CI: less than 10%
Electrocautery	79% n=24	No complications or adverse events Dissect only below C-spine (n=6) Turn off CI (n=4) Use bipolar not monopolar (n=3) Use lower threshold (20-30) (n=3) Plasma blade not monopolar (n=1)	6 articles No adverse outcomes reported
TcMEP	95% n=21	No complications or adverse events Turn off CI (n=4) Surgical removal of CI (n=1) Inform neurophysiologist (n=1) Less frequent/lower level (n=1)	5 articles No adverse outcomes reported

232. PROMIS Better Reflects the Impact of Length of Stay and the Occurrence of Complications Within 90 Days than Legacy Outcome Measures for Lumbar Degenerative Surgery

Cole Bortz, BA; Katherine E. Pierce, BS; Haddy Alas, BS; Avery Brown, BS; Dennis Vasquez-Montes, MS; Erik Wang, BA; Christopher G. Varlotta, BS; Dainn Woo, BS; Edem J. Abotsi, BA; Jordan Manning, BA; Ethan W. Ayres, MPH; Yael Ihejirika, BA; Rivka C. Ihejirika, MD; Bassel G. Diebo, MD; Tina Raman, MD; Michael C. Gerling, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Themistocles S. Protopsaltis, MD; Aaron J. Buckland, MBBS, FRACS; *Peter G. Passias, MD*

SUMMARY

The Patient Reported Outcome Measurement Information System (PROMIS) aims to offer a valid and efficient means of capturing spine surgery patient clinical outcomes. To date, few studies have compared PROMIS and legacy outcome measures like the Oswestry Disability Index (ODI) for their sensitivity in reflecting the impact of perioperative complications and length of stay (LOS). This study shows that the PROMIS domains of Physical Function and Pain Interference reflect the impact of perioperative complications and LOS better than ODI.

HYPOTHESIS

PROMIS reflects the impact of complications and LOS better than ODI.

DESIGN

Retrospective review

INTRODUCTION

Few studies have compared PROMIS and legacy outcome measures like the ODI for their sensitivity in reflecting the impact of complications and LOS.

METHODS

Included: patients>18yrs undergoing thoracolumbar surgery with available pre-, 3-month postop ODI and PROMIS scores. Bivariate correlation assessed relationships between clinical outcomes (LOS, complications) and scores for both PROMIS (Physical Function, Pain Intensity, Pain Interference) and ODI. Linear regression predicted the relationship between complication incidence and postop ODI and PROMIS scores.

RESULTS

Included: 182 patients (55±16 yrs, 45% female) undergoing thoracolumbar surgery. Common diagnoses were: stenosis (62%), radiculopathy (49%), herniated disc (48%), degenerative spondylolisthesis (25%). Overall, 58% of patients underwent fusion (2.6±2.9 levels), 50% underwent laminectomy, 83% of cases involved posterior-only approach, and 18% combined. Significant pre- to postoperative improvement was observed for ODI and all PROMIS domains (all $p<0.001$). Mean LOS was 2.7±2.8 days. Overall complication rate was 17%; common complications were cardiac, neurologic, and urinary (all 2%). Pre- to postop changes in Pain Intensity ($r=0.167$, $p=0.024$) and Physical Function ($r=-0.169$, $p=0.023$) correlated with LOS; changes in ODI did not ($p=0.179$). Changes in ODI and PROMIS did not correlate with complication occurrence; however, postop scores for Physical Function ($r=-0.205$, $p=0.005$) and Pain Interference ($r=0.182$, $p=0.014$) both

showed stronger correlations with complication occurrence than ODI (r=0.143, p=0.055). Complication occurrence predicted postop Physical Function (R^2=0.037, p=0.005) and Pain Interference (R^2=0.028, p=0.014) scores, but not ODI.

CONCLUSION

PROMIS domains of Physical Function and Pain Interference better reflected periop complications and LOS than the legacy patient reported outcome ODI, suggesting PROMIS may offer more utility as an outcomes assessment instrument.

TAKE HOME MESSAGE

Compared to the legacy outcome metric ODI, PROMIS better reflects the impact of periop complications and LOS for patients undergoing surgery for degenerative lumbar conditions.

233. Systemic Review of Outcomes Following 10-year Mark of Spine Patient Outcomes Research Trial (SPORT)

Brittany A. Oster, BS; Sina Rashidi Kikanloo, BS; Nicole L. Levine, BA; Jayson Lian, BS; Dongyoung Kim, BS; *Woojin Cho, MD, PhD*

SUMMARY

The Spine Patient Outcomes Research Trial (SPORT) was a landmark randomized control trial. We aimed to summarize the 10-year clinical outcomes of SPORT for intervertebral disc herniation (IDH), spinal stenosis (SpS), and degenerative spondylolisthesis (DS). Results showed significantly greater improvements in primary outcomes in those patients with IDH and DS who were treated surgically. Significantly greater improvement through 4-year follow-up was observed in patients with SpS that received surgical treatment, though this difference diminished at 8-year follow-up.

HYPOTHESIS

Review of 10-year SPORT would be valuable

DESIGN

Systematic Review

INTRODUCTION

The Spine Patient Outcomes Research Trial (SPORT) was a landmark randomized control trial including approximately 2,500 patients at 13 clinics across the country. SPORT compared surgical and nonoperative management of the three most common spinal pathologies. We aim to summarize the 10-year clinical outcomes of SPORT for intervertebral disc herniation (IDH), spinal stenosis (SpS), and degenerative spondylolisthesis (DS).

METHODS

We performed a comprehensive search of Pubmed, MEDLINE, and EMBASE for all English-language studies of all levels of evidence pertaining to SPORT, in accordance with Preferred Reported Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The inclusion criteria were English-language studies that evaluated outcomes or complications of SPORT. Exclusion criteria were non-English language, review articles, commentary reports, or conference abstracts only.

RESULTS

For patients with IDH, the OBS cohort analysis revealed greater improvement in all primary outcomes at 3-month and 2-year follow-up in patients treated surgically, while analysis of the RTC cohort failed to show a significant difference based on the intent-to-treat principle. However, 4-year and 8-year as-treated analysis showed statistically greater improvements in patients managed surgically. In patients with SpS, surgical intervention showed significantly greater improvement in pain and physical function scales through 2 years. This difference was maintained through 4-year follow-up. However, between 4 and 8 years, the difference between the two groups diminished. In the patients with DS, the intent-to-treat analysis failed to show a significant difference between the patients treated surgically. However, as-treated analysis revealed statistically greater improvements at 6 weeks, 2 years, and 4 years in patients treated surgically.

CONCLUSION

SPORT demonstrated significantly greater improvements in patients with IDH and DS who were treated surgically. However, in patients with SpS who were managed surgically, the statistically significant improvements seen at 4 years diminished at 8 years.

TAKE HOME MESSAGE

Results of SPORT showed greater improvements in patients with IDH and DS who were treated surgically. However, the improvement seen early on in patients with SpS diminished at 8 years.

234. Radiation Exposure Using Traditional Fluoroscopy Versus Low-dose Enhanced Imaging in Minimally Invasive Spine Surgery

Dainn Woo, BS; Jordan Manning, BA; Ethan W. Ayres, MPH; Erik Wang, BA; Christopher G. Varlotta, BS; Dennis Vasquez-Montes, MS; Yong H. Kim, MD; Themistocles S. Protopsaltis, MD; Michael L. Smith, MD; Charla R. Fischer, MD; John A. Bendo, MD; Jeffrey Andrew Goldstein, MD; Jonathan R. Stieber, MD; *Aaron J. Buckland, MBBS, FRACS*

SUMMARY

Widespread use of fluoroscopy in spine surgery especially in cases using minimally invasive techniques raises concern for radiation exposure to patients, surgeons, and OR staff. With increasing popularity of minimally invasive procedures, novel imaging modalities using low-dose enhanced imaging (LEI) has been advocated to preserve resolution and reduce radiation exposure. This study demonstrates significant reduction and consistency in radiation dosage using (LEI) compared to traditional fluoroscopy in minimally-invasive (MIS) spine surgery without increased complication risk.

HYPOTHESIS

Low dose enhanced imaging (LEI) reduces radiation exposure in MIS spine surgery compared to traditional fluoroscopy (TF).

DESIGN

Retrospective review of operative patients at a single institution.

INTRODUCTION

Widespread use of fluoroscopy in MIS spine surgery raises concern for perioperative radiation exposure to patients, and surgeons. Novel imaging modes that enhance images taken with low-dose radiation to preserve resolution have been suggested as a means to reduce radiation exposure.

METHODS

Consecutive MIS TLIF and XLIF patients who received intra-op LEI and patients who received TF were included. Radiation dosage (mGy) was obtained from fluoroscopy reports. LEI patients were propensity score matched (PSM) by body mass index (BMI), levels fused and operative time to patients who received TF. Independent sample t-tests assessed radiation dosage between all LEI patients and all TF patients, with sub-analyses in XLIF and MIS TLIF patients. Dosage consistency was reported by variance and range in each group.

RESULTS

92 patients (49F, age 58±11.4) who underwent MIS TLIF(n=48) or XLIF(n=44) were included. 23 (11 XLIF, 12 MIS TLIF) received LEI, and after PSM, 33 XLIF and 36 MIS TLIF matched patients were included. T-test showed 48.4% reduction in radiation in LEI compared to TF patients (26.6 vs 55mGy, p<.001). There was a significant difference between LEI and TF in MIS TLIF patients (26.98mGy vs 51.25mGy, p=.006) and in XLIF patients (26.2mGy vs 59.18mGy, p=.003). In the TF group, there was larger variance in radiation dosage (SD=50mGy, range 8.1 to 268.9mGy) compared to the LEI group (SD=13.48mGy, range 7.28 to 59.14mGy). There were no major complications or return to OR due to screw malposition within 1 year in either group.

CONCLUSION

Low-dose enhanced imaging in MIS surgery significantly reduces radiation exposure compared to traditional fluoroscopy. LEI remains consistent in dosage compared to large variability in radiation with traditional fluoroscopy.

TAKE HOME MESSAGE

Low-dose-enhanced-imaging in MIS surgery significantly reduces mean and maximal radiation exposure compared to traditional fluoroscopy and remains consistent in radiation dosage with each use with no apparent increase in complications.

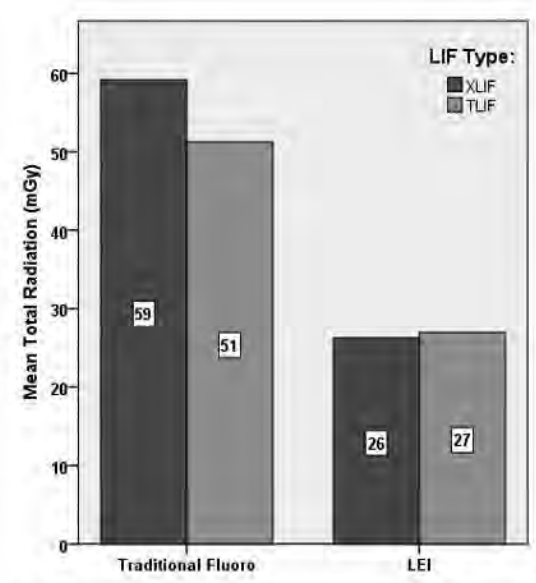


Figure 1. Traditional fluoroscopy versus low radiation enhanced imaging.

Traditional fluoroscopy versus low radiation enhanced imaging.

235. High Axial Facet Angle Correlates with Poor Fluoroscopic Percutaneous Pedicle Screw Placement

Ting Cong, MD; James E. Dowdell, MD; Avani S. Vaishnav, MBBS; Steven J. Mcanany, MD; Sravisht Iyer, MD; Todd J. Albert, MD; (Catherine) Himo Gang, MPH; Sheeraz Qureshi, MD; *Philip J. York, MD*

SUMMARY

A radiographic study was performed to evaluate the effect of axial facet angle on fluoroscopic percutaneous pedicle screw placement accuracy. It was found that higher axial facet angle is significantly correlated with poor screw placement at L4 and L5.

HYPOTHESIS

High axial facet angle correlates with poor pedicle screw placement in percutaneous fluoroscopic pedicle screw placement.

DESIGN

Radiographic correlation study

INTRODUCTION

Anatomic variations in facet joint orientation is a concern in spine surgery as it can negatively impact pedicle screw placement accuracy. We designed a radiographic study to quantify the effect of axial facet angle on percutaneous pedicle screw placement.

METHODS

95 consecutive patients who underwent minimally-invasive fluoroscopic instrumented fusion of the lumbar or lumbosacral spine were included. Postoperative CT was used to categorize pedicle screw placement as: good (no breach), acceptable (breach within safe zone and/or any amount of tip breach), poor (outside safe zone, and/or violation of unfused facet, and/or unfused endplate violation). Safe zone was defined as 4mm lateral or 2mm inferomedial breach of pedicle cortex. Axial facet angle was measured against a mid-sagittal line. Global mean axial facet angles at L4, L5, and S1 were calculated. Axial facet angles associated with poorly placed screws were compared to the global means at L4 and L5.

RESULTS

349 pedicle screws were analyzed. Of these, 38 (10.7%) were categorized as poor placement, and of these 31 (82%) were due to unfused facet violation. Global axial facet angle means were 36.8 degrees for L4, 45.8 for L5, and 50.5 for S1. Mean axial facet angles associated with poorly placed screws were 42.7 degrees for L4 and 51.4 degrees for L5 – these angles are higher than the global means (Figure 1) at L4 ($p = 0.063$) and L5 ($p = 0.028$). Sub-group analysis demonstrated that the mean axial facet angles associated with unfused facet violation was 44.0 degrees for L4 and 53.2 degrees for L5. These means were significantly higher than the global means (Figure 1) at L4 ($p = 0.027$) and L5 ($p = 0.009$). No poor screw placement was found at the S1 level.

CONCLUSION

Increased axial facet angle significantly correlates with poor screw placement and especially with facet violation in percutaneous fluoroscopy-guided pedicle screw placement. Care should be taken to evaluate for high axial facet angles in pre-operative planning.

TAKE HOME MESSAGE

Increased axial facet angle significantly correlates with poor screw placement and especially with facet violation in percutaneous fluoroscopy-guided pedicle screw placement.

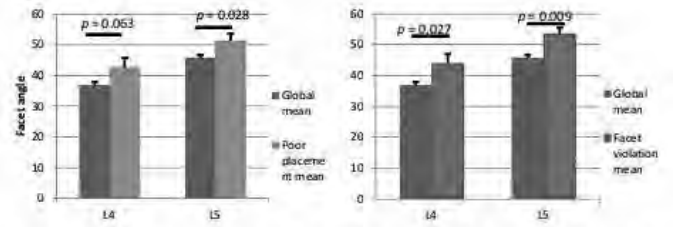


Figure 1: Mean axial facet angle of poorly placed pedicle screws (left) and of those with facet violations (right) compared to global L4 and L5 axial facet angle means.

236. Comparing Patient-reported Outcome Scores Among Spine Patients: Motor Vehicle Accident Insurance vs. Workers Compensation vs. General Population

David N. Bernstein, MBAMA; Kathleen Fear, PhD; Emmanuel N. Menga, MD; Addisu Mesfin, MD; Paul T. Rubery Jr., MD

SUMMARY

Patients seeking spine care who have MVA insurance, which may represent potential pending litigation, or WC have worse self-reported physical function, pain coping mechanisms, and depression than the general spine population. This may be due to hopes of external gains, monetary or otherwise, or because injuries leading to such situations are genuinely more severe.

HYPOTHESIS

Our primary null hypothesis is that Patient-Reported Outcomes Measurement Information System (PROMIS) Physical Function (PF), Pain Interference (PI), and Depression scores at new patient spine visits are not different based on insurance type (Motor Vehicle Accident (MVA) insurance vs. workers compensation (WC) vs. general population)

DESIGN

Retrospective review of prospectively collected data

INTRODUCTION

Many patients with MVA insurance have concerns regarding causation of their injuries and may be prone to litigation. There is a concern that patients seeking spine care with MVA insurance or WC may report worse symptoms than the general spine population in order to gain external benefit.

METHODS

Patients presenting to a tertiary academic spine clinic between 02/2015 and 01/2018 for a new patient visit completed PROMIS PF, PI and Depression CATs. Patients were divided into three groups: 1) MVA insurance, which may be used as a proxy for potential pending litigation; 2) WC; 3) all other patients. Bivariate analyses were used to: 1) compare patient characteristics; 2) compare mean PROMIS scores; and 3) compare PROMIS score floor effects.

RESULTS

15,158 new patient visits (general pop: 14,452; WC: 336; MVA: 370) fit our inclusion criteria. Patients with MVA insurance or WC had worse PROMIS PF (37.0 vs. WC: 36.7 vs. general pop: 40.4), PI (65.7 vs. WC: 65.9 vs. general pop: 61.7), and Depression (55.1 vs. WC: 54.5 vs. general pop: 50.8) scores than the general population. PROMIS Depression and PROMIS PI had lower floor effects in the MVA insurance and WC groups (Depression: MVA, 6.2% vs. WC, 8.3% vs. general pop, 12.5%; PI: MVA, 0.5% vs. WC, 0.3% vs. general pop, 2.8%). All differences were statistically significant at $p<0.01$.

CONCLUSION

Patients seeking spine care who have MVA insurance, which may represent potential pending litigation, or WC have worse self-reported physical function, pain coping mechanisms, and depression than the general spine population. This may be due to hopes of external gains, monetary or otherwise, or because injuries leading to such situations are genuinely more severe.

TAKE HOME MESSAGE

Patients seeking spine care who have MVA insurance or WC have worse self-reported physical function, pain coping mechanisms, and depression than the general spine population.

PROMIS Domain	Patient Group	Patients	Mean Score	SD	Difference vs. General Population (95% CI)	Floor Score Evaluations
Depression	MVA	370	55.07	10.09	4.24 (3.2-5.29)	23 (6.22%)
	Workers Comp	336	54.54	10.72	3.72 (2.56-4.88)	28 (8.33%)
	General	14,452	50.83	10.37	–	1,808 (12.51%)
Pain Interference	MVA	370	65.69	6.72	4.01 (3.31-4.71)	2 (0.54%)
	Workers Comp	336	65.94	6.17	4.26 (3.58-4.94)	1 (0.3%)
	General	14,452	61.68	8.38	–	400 (2.77%)
Physical Function	MVA	370	37.00	7.72	-3.38 (-4.18 - -2.58)	–
	Workers Comp	336	36.75	7.11	-3.63 (-4.4 --2.85)	–
	General	14,452	40.37	8.65	–	–

A comparison of PROMIS scores & floor effect by insurance type (all differences significant at $p<0.01$)

237. 2-year Experience with Fenestrated Pedicle Screw Cement Augmentation in Spine Surgery: A Safety and Efficacy Study

Ruwan Ratnayake, MD; Houssam Bouloussa, MD, MS; Kamran Majid, MD, MBA; Calvin C. Kuo, MD; Ravi S. Bains, MD

SUMMARY

Fenestrated pedicle screw cement augmentation in spine surgery has recently been FDA approved. We reported our practice pattern (regional distribution and indications), perioperative outcomes (failure rate) and complications (cement embolus, pulmonary embolism, perivertebral cement leaks, mortality) with a new FPSCA system comprising an integrated cement-application device since its inception at our institution in 2017.

HYPOTHESIS

We hypothesized that fenestrated pedicle screw cementation augmentation was a safe procedure despite a very low risk of cement embolus.

DESIGN

Retrospective cohort study.

INTRODUCTION

Fenestrated pedicle screw cement augmentation (FPSCA) in spine surgery has recently been FDA approved in 2016. Although numerous biomechanical studies support its use to increase pull-out strength, few studies report its safety and efficacy in a

broad scope of indications. Our goal was to report our practice pattern, perioperative outcomes and complications with a new FPSCA system.

METHODS

Forty-three patients underwent FPSCA (2.5mL of high viscosity polymethylmetacrylate per screw) between September 2017 and November 2018 by six surgeons at our institution for degenerative disease, tumor, trauma or deformity correction. Baseline demographics, bone density, operative data, perioperative complications and postoperative X-rays or computed tomography were reported.

RESULTS

Average age was 64.9±17.6 years. Mean follow-up was 15.5±12.3 weeks. 23 patients (53.5%) had osteoporosis or osteopenia. 175 cement-augmented pedicle screws were used in constructs totaling 276 screws (63.4%). Regional distribution was: thoracic (18%), lumbar (58.1%), thoracolumbar (23.2%). Indication were: deformity (37.2%), tumor (27.9%), trauma (7%) and degenerative conditions (44.1%). Most augmentations were performed at a combination of the UIV, UIV –1, and LIV. Systematic verification of screw depth before injection prevented rod insertion difficulties. Complications comprised cement leakage (22 patients, 51.1%), hardware failure (4 patients, 9.3%) and non-cement related pulmonary embolism (two patients). 56 leaks occurred and concerned segmental veins (38 leaks, 67.8%), basivertebral veins (8 leaks, 14.2%), a cortical defect (4 leaks, 9.3%) or the spinal canal (6 patients, 13.9%). No symptomatic cement embolism or perioperative cement-related death occurred.

CONCLUSION

This is the largest mixed-indication case-series on record in North America. Fenestrated pedicle screw augmentation in spine surgery can be a safe and effective method of increasing fixation in osteopenic bone.

TAKE HOME MESSAGE

Fenestrated pedicle screw cement augmentation is a safe and effective method for enhanced spinal fixation in multiple settings. Cement leaks were extremely common though not symptomatic in this cohort.

238. A Novel Preoperative MRI Based Lumbar Muscle Health Calculation to Predict Patient Reported Health Related Quality of Life Scores

Sohrab Virk, MD; Avani S. Vaishnav, MBBS; Jung Mok, BS; Yahya A. Othman; Philip J. York, MD; Steven J. Mcanany, MD; Sravisht Iyer, MD; Todd J. Albert, MD; (Catherine) Himo Gang, MPH; Sheeraz Qureshi, MD

SUMMARY

We developed a score of lumbar muscle health which corresponds to pre-operative health related quality of life scores (HRQOLs) for patients requiring an operation for lumbar degenerative conditions. This score grades the lumbar indentation value, goutallier classification and paralumbar cross sectional area and it has statistically significant correlations with VAS-leg, VAS-back, ODI, SF-12 and PROMIS. This MRI based lumbar muscle health calculation serves to elucidate the soft tissue factors impacting a patient's disability related to lumbar spine pathology.

HYPOTHESIS

An MRI based lumbar muscle health calculation can predict HRQOL scores for those with lumbar degenerative conditions.

DESIGN

Retrospective review of imaging and outcome scores

INTRODUCTION

Poor lumbar muscle health has been implicated as a source of disability for patients with low back/radicular pain. We wanted to evaluate the relationship between muscle health and HRQOLs.

METHODS

Surgical pts requiring a MIS decompression and/or fusion were assessed for HRQOLs and their MRI scans were evaluated for lumbar indentation value(LIV), Goutallier classification (GC) and paralumbar cross-sectional area (PL-CSA). We scaled the PL-CSA by BMI(PL-CSA/BMI). HRQOL scores collected included VAS leg/back, ODI, SF-12 mental and physical health and PROMIS. We performed a linear regression analysis to determine the relationship of LIV, PL-CSA, PL-CSA/BMI and HRQOLs. We performed an ANOVA analysis to identify the relationship between GC and HRQOLs. We combined our measurements to create a score to quantify muscle health and determined whether this score correlated with HRQOLs based on an ANOVA analysis.

RESULTS

92 patients were included. The average age was 57.9+/-14.4 years old(49 men and 43 women). The PL-CSA/BMI ratio significantly correlated with pre-op SF-12 PHS($p = 0.03$), VAS back(0.007) and VAS Leg ($p = 0.002$). Pts with less than 130 of the PL-CSA/BMI ratio had statistically significant worse PROMIS(35.9 vs 29.7, $p = 0.007$), ODI(39.4 vs 50.2, $p = 0.01$), SF-12 PHS(35.5 vs 28.7, $p = 0.001$), VAS leg(7.3 vs 5.5, $p = 0.007$) and VAS back(7.9 vs 4.9, $p = 0.002$) scores. We combined our results and scored each pt from 1-3 based upon whether there LIV <10mm or >10mm(0 or 1), GC >2 or <=2(0 or 1) and whether PL-CSA/BMI was >130 or <130(0 or 1). Pts were stratified from 0-1 (poor), 2 (adequate) and 3 (good). Higher scores corresponded to better VAS back($p = 0.014$), VAS leg($p = 0.01$), SF-12 PHS(0.027), ODI($p = 0.022$) and PROMIS($p = 0.001$) scores.

CONCLUSION

When patien have low PL-CSA/BMI, GC and LIV this corresponds to worse HRQOLs. This lumbar muscle health score is a valid screen for pts with poor muscle health contributing to their disability.

TAKE HOME MESSAGE

A portion of a patient's disability prior to MIS lumbar decompression/fusion surgery can be explained by this MRI based lumbar muscle health calculation.

239. Can We Predict Imbalance in Patients? Analysis of the CDC National Health and Nutrition Examination Survey

Bassel G. Diebo, MD; Sarah Stroud, AB; Jeffrey J. Varghese, MD, BS; Neil V. Shah, MD, MS; James C. Messina, BS; Frank S. Cautela, BS; George A. Beyer, MS; Qais Naziri, MD; Barthelemy Liabaud, MD; Vincent Challier, MD; Renaud Lafage, MS; Elian Shepherd MD, MD; Peter G. Passias, MD; Virginie Lafage, PhD; Frank J. Schwab, MD; Carl B. Paulino, MD

SUMMARY

Utilizing the CDC NHANES, patients with global body imbalance were found to be frail, malnourished, and had multiple comorbidities compared to patients reporting no imbalance. Imbalance was also associated with difficulty performing simple, dynamic functional performance assessments. Structured, timed tests that assess dynamic functional status, such as walking 20 feet, standing from an armless chair, and climbing stairs, are useful for preoperative optimization and risk-stratification of patients' imbalance or fall risk prior to spinal realignment surgery.

HYPOTHESIS

Abnormal laboratory parameters as well as difficulty with functional assessments correlate with self-reported imbalance.

DESIGN

Observational cohort

INTRODUCTION

Understanding global body balance can optimize the postoperative course for patients undergoing spinal or lower limb surgical realignment. We sought to characterize self-reported imbalanced patients and identify predictors for imbalance within a nationally-representative cohort.

METHODS

The CDC establishes a representative sample annually via the National Health and Nutrition Examination Survey (NHANES). We queried all NHANES datasets (only 1999-2004) with the question: "During the past 12 months, have you had dizziness, difficulty with balance or difficulty with falling?" 31,126 pts were then stratified into Imbalance and Balance cohorts. Univariate analyses compared pts with Imbalance (n=2,638) to Balance for demographics, comorbidities, nutritional parameters, functional test performance measures, and laboratory tests. Regression models were used to identify independent predictors of imbalance.

RESULTS

Of 9,964 pts, imbalanced (26.5%) were older (65.4 vs 60.6 yrs), with more females (60% vs. 48%). Imbalanced reported higher rates of osteoporosis (14.4 vs. 6.6%), arthritis (51.6 vs. 31.9%), low back pain (54.4 vs 32.7%), neck pain (10.8 vs. 4.3%), and depression/anxiety rates (1.5 vs. 0.6%). Imbalance had more pts experiencing difficulties climbing 10 steps (43.8 vs. 21%), stooping/crouching/kneeling (74.3 vs. 44.7%), standing up from armless chairs (49.6 vs. 21%), and standing up on their own (4.0 vs. 0.9%) and needing greater time to walk 20ft (9.5 vs. 7.1s). Imbalance patients had significantly lower caloric and dietary intake. Regression showed that difficulties with small object finger-grasp (OR:1.73), female sex (OR:1.43), difficulties standing for long times (OR:1.29), difficulties stooping/crouching/kneeling (OR:1.28), and increased 20ft walk time (OR:1.06) were independent predictors of Imbalance, all $p<0.05$.

CONCLUSION

Imbalanced patients were found to be frail, undernourished, and had identifiable comorbidities. Imbalance pts were also detectable using simple functional assessments.

TAKE HOME MESSAGE

Structured tests that assess dynamic functional status can potentially be useful for preoperative optimization and risk-stratification for imbalance and fall risk in patients undergoing surgical realignment of the spine.

Functional Test	% of Imbalance Patients	% of Balance Patients	P-value
Stooping/Crouching/Kneeling	74.3	45.7	< 0.001
Standing for Prolonged Periods of Time	61.6	20.2	< 0.001
Lifting or Carrying	52.6	24.3	< 0.001
Rising from Armless Chair	49.6	21.0	< 0.001
Walking up 10 Steps	43.8	21.0	< 0.001
Grasping Small Objects	32.2	27.6	< 0.001
Standing Up on Their Own	4.0	0.9	< 0.001

Table. Comparison of proportion of imbalance and balance patients reporting difficulty during physical assessment and performance measures.

240. Evaluation of Health Related Quality of Life Improvement in Patients Undergoing Spine vs Adult Reconstructive Surgery

Christopher G. Varlotta, BS; Dennis Vasquez-Montes, MS; Jordan Manning, BA; Erik Wang, BA; Mohamed A. Moawad, MPH; John A. Bendo, MD; Charla R. Fischer, MD; James Slover, MD; Ran Schwarzkopf, MD; Jonathan Vigdorchik, MD; Roy Davidovitch, MD, MD; Joseph Zuckerman, MD; *Aaron J. Buckland, MBBS, FRACS*

SUMMARY

This study compares PROMIS results for patients undergoing common single-level spinal surgery, total hip arthroplasty (THA) and total knee arthroplasty (TKA) procedures. The results of this study show that although spine surgery patients have lower baseline (BL) and 6 month (6M) PROMIS scores than adult reconstruction patients, spine surgery patients showed more improvement in PROMIS scores from BL to 6M.

HYPOTHESIS

Spine surgery patients may have more PROMIS improvement than adult reconstruction patients have despite having lower BL PROMIS scores.

DESIGN

Retrospective review of single-level spine surgery, THA, and TKA patients.

INTRODUCTION

The discussion regarding value based care has evolved in recent years, yet the ability to report Health Related Quality of Life (HRQoL) between different disease states has been limited by differing metrics. The advent of Patient Reported Outcome Information System (PROMIS) provides the ability to compare differing disease states and procedures.

METHODS

Patients>18 years old who underwent spine surgery (ACDF, Lami, MLD, TLIF) or adult reconstruction surgery (THA or TKA) with BL & 6M PROMIS scores of Physical Function, Pain Interference, and Pain Intensity were grouped by surgery type. Paired t-tests calculated differences in BL, 6M, and change in PROMIS scores for spine & adult reconstruction patients. Subsequent paired t-tests compared spine surgery PROMIS improvement vs THA & TKA PROMIS improvement.

RESULTS

172 spine surgery patients (54.6yrs; 42.9%F) & 333 adult reconstruction pts were compared (65.8yrs; 59.8%F). Spine surgery patients undergoing ACDF, Lami, MLD, or TLIF had more disability and pain at BL than THA & TKA patients, according to Physical Function , Pain Interference and Pain Intensity (Table 1, p<.01). At 6M, spine surgery patients had more disability and pain compared to adult reconstruction patients; However, patients across all spine procedures experienced greater improvement in Physical Function & Pain Interference (p<.01) despite similar Pain Intensity improvement (Table 1).

CONCLUSION

Patients undergoing single level spinal surgery had lower initial PROMIS scores compared to those undergoing adult reconstructive surgery. Despite meaningful improvements in both groups, spinal surgery patients demonstrated more improvement in physical function and pain interference scores. Future study is required to assess the value base of spinal and adult reconstruction surgery, including durability.

TAKE HOME MESSAGE

Although patients undergoing spine surgery had lower initial PROMIS scores than adult reconstruction patients had, spine surgery patients showed greater PROMIS improvement at six-month post-operative time point.

	Surgery	N	Baseline Mean ± SD	6-Month Mean ± SD	Δ	p-value	p-value Improvement vs THA	p-value Improvement vs TKA
Physical Function	ACDF	37	20.14 ± 18.52	28.19 ± 17.84	5.05	0.00	0.00	0.00
	Lami	31	8.71 ± 6.15	20.82 ± 17.41	12.11	0.00	0.01	0.00
	MLD	58	14.2 ± 16.07	29.35 ± 22.39	15.15	0.00	0.00	0.00
	TLIF	46	9.26 ± 9.09	22.11 ± 20.63	12.85	0.00	0.01	0.00
	THA	131	35.94 ± 4.95	41.18 ± 6.38	5.24	0.00		
	TKA	202	35.01 ± 4.23	38.9 ± 3.28	3.89	0.00		
Pain Interference	ACDF	37	84.08 ± 22.66	69.03 ± 26.31	-15.05	0.00	0.02	0.00
	Lami	31	89.84 ± 12.94	75.74 ± 22.48	-14.10	0.00	0.00	0.00
	MLD	58	91.84 ± 9.88	79.34 ± 16.58	-12.50	0.00	0.02	0.00
	TLIF	46	91.02 ± 12.9	79.15 ± 22.43	-11.87	0.00	0.00	0.00
	THA	131	63.94 ± 5.98	55.76 ± 9.42	-8.18	0.00		
	TKA	202	63.83 ± 6.4	57.84 ± 8.37	-5.99	0.00		
Pain Intensity	ACDF	37	53.57 ± 7.61	47.86 ± 7.89	-5.71	0.00	0.01	0.77
	Lami	31	58.1 ± 6.04	48.99 ± 9.28	-9.11	0.00	0.65	0.08
	MLD	58	58.17 ± 6.54	49.04 ± 7.49	-9.13	0.00	0.46	0.04
	TLIF	46	56.05 ± 7.66	48.96 ± 7.8	-7.10	0.00	0.09	0.55
	THA	131	53.4 ± 6.72	43.49 ± 8.93	-9.91	0.00		
	TKA	202	53.84 ± 7.23	47.6 ± 8	-6.23	0.00		

Table 1. Baseline, 6M, and change in PROMIS metrics in ACDF, Laminectomy, MLD, TLIF vs THA and TKA patients.

241. Timing of Surgery for Thoracolumbar Spine Trauma: Patients without Neurological Injury

Jack H. Ruddell, BA; John M. DePasse, MD; Oliver Y. Tang, BS; Alan H. Daniels, MD; *Jack M. Haglin, BS*

SUMMARY

Severity-adjusted timing-outcome analysis of 49,309 patients with thoracolumbar fracture and no neurological injury from a national inpatient database demonstrated lowest odds of mortality, complications, and infection following surgery on post-admission day 1 or 2. In contrast, ≥7-day delay to fusion was associated with longest total and postoperative lengths of stay, highest hospital charges, and greatest risk of in-hospital mortality and complications.

HYPOTHESIS

Surgical timing following thoracolumbar trauma may affect patient outcomes.

DESIGN

Retrospective cohort of de-identified National Inpatient Sample data (2004-2014).

INTRODUCTION

Previous investigations have examined surgical timing, but consensus is lacking regarding optimal timing for thoracolumbar fusion for patient outcomes. This investigation analyzes the effect of surgical timing on in-hospital mortality, complications, length of stay (LOS), and hospital charges in thoracolumbar fracture patients without neurological injury.

METHODS

Non-elective cases containing ICD-9-CM diagnosis codes for closed thoracic/lumbar spinal fracture and procedure codes for thoracolumbar/lumbosacral fusion were analyzed. Open, cervical, and sacral fracture cases were excluded. Classification of time from hospital admission to fusion: same-day, 1-2-day, 3-6-day, and ≥7-day delay. Multifactorial logistic and linear regressions were performed to assess effect of surgical timing on mortality, complications, LOS, and hospital charges, controlling for age, sex, fusion approach, and multi-system injury severity score.

RESULTS

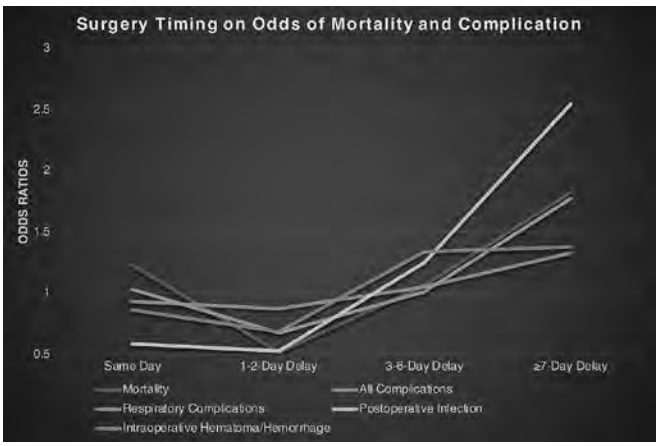
Of 49,309 patients evaluated, those fused on post-admission day 1 or 2 (n=20,998) had the lowest odds of in-hospital mortality (OR=0.513; 95% CI, 0.307-0.857), all complications (OR=0.868; 95% CI, 0.765-0.985), intraoperative hemorrhage or hematoma formation (OR=0.683; 95% CI, 0.475-0.982), respiratory complications (OR=0.673; 95% CI, 0.474-0.955), and postoperative infections (OR=0.523; 95% CI, 0.347-0.789) when compared to other timing groups. Conversely, a ≥7-day delay to fusion (n=5,742) conferred the highest odds of in-hospital mortality (OR=1.818; 95% CI, 1.108-2.981), complications (1.322; 95% CI, 1.119-1.562), and infections (OR=2.544; 95% CI, 1.676-3.861), as well as the longest postoperative LOS and highest total charges (p<0.001).

CONCLUSION

Severity-adjusted analyses indicate that surgery on post-admission day 1 or 2 was associated with decreased mortality and all analyzed in-hospital complications. Early fusion with close attention to patient-specific factors when considering same-day intervention for thoracolumbar fracture may result in more favorable outcomes.

TAKE HOME MESSAGE

Early surgery with close attention to patient-specific risk factors when considering same-day intervention for thoracolumbar fracture may result in better patient outcomes and more cost-effective healthcare.



In-hospital mortality, complication, and infection odds ratios for each surgical timing group compared to the rest of the cohort, controlling for injury severity, age, sex, and fusion approach.

242. Deep Wound Infection in Adult Patients Undergoing 3-Column Osteotomy: Single-center Retrospective Review of 41 Consecutive Patients and Comparison to Published Standards

Kristen E. Jones, MD; Youssef J. Hamade, MD, MS; Jack Leschke, MD; Jonathan N. Sembrano, MD; David W. Polly Jr., MD

SUMMARY

Deep wound infection requiring surgical I&D occurred in 2.4% (1/41) of our adult patients undergoing 3CO. While underpowered to reach statistical significance, we demonstrate a low rate of infection compared to recently published standards from 3CO patients in the ISSG (7.3%; 6/82) and patients scoring similarly on Spine Surgical Invasiveness Index (6.7%; 3/45). Ongoing study of our intraoperative infection risk-reduction protocol is merited to power an adequate cohort.

HYPOTHESIS

We hypothesize that our intraoperative infection risk-reduction protocol for adult spinal deformity patients undergoing 3CO results in a reduced rate of deep wound infection requiring surgical I&D compared to published standards.

DESIGN

Single-center retrospective review

INTRODUCTION

Wound infection following 3-column osteotomy (3CO) in adult spinal deformity surgery is a costly and significant complication occurring in 7.3% of patients among senior ISSG surgeons (Smith et al 2017). Known risk factors for wound infection include operative time, blood loss, elevated BMI, hypertension, diabetes, and Spine Surgical Invasiveness Index (SSII) score of >21. Prior SSII cohort patients with scores of 21-25 demonstrated a 6.7% infection rate (Cizik et al 2012). We report our intraoperative infection risk-reduction protocol and comparative infection rates.

METHODS

A 40-month retrospective review of a single institution's consecutive adult patients undergoing 3CO with the following intraoperative protocol: dual-surgeons, TXA, timed redosing of IV antibiotics, frequent irrigation with antibiotic-saline, and intrawound vancomycin powder. Wound infection was defined as fluid collection requiring surgical I&D for treatment, per standard definition in Cizik 2012 and Smith 2017.

RESULTS

41 patients met inclusion criteria and were 65.9% female, average age 58.8 years (17-80), BMI 33.5 (15.9-57.5), had previous fusion across 3CO site (90%), hypertension (53.6%), and diabetes (34.1%). Average levels fused were 8.4 (4-22), posterior-only approach was used in 95%. Average operative time was 5.9 hours (3.9-12.9) with EBL 1602ml (450-4180). 3CO level was performed at L4 (16), L5 (10), L3 (6), L1 (4), L2 (1), and thoracic spine (4). Average SSII score was 21.8 (10-43). One patient (2.4%) had a deep wound infection requiring surgical I&D.

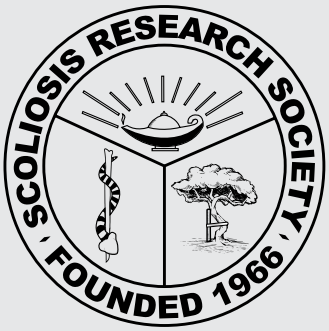
CONCLUSION

Our intraoperative infection risk-reduction protocol results in a 2.4% rate of deep wound infection in high-risk 3CO patients, lower than prior ISSG and SSII cohorts. While underpowered to reach statistical significance, our protocol merits further study.

TAKE HOME MESSAGE

Rate of wound infection in adult 3CO patients was 2.4% (1/41) using our infection risk-reduction protocol, lower than comparable cohorts from ISSG (7.3%;6/82) and SSII (6.7%;3/45), meriting further study.

EXHIBITS & WORKSHOPS



The Scoliosis Research Society gratefully acknowledges Zimmer Biomet for their grant support of the IMAST Wireless Internet.

EXHIBITS AND HANDS-ON WORKSHOPS

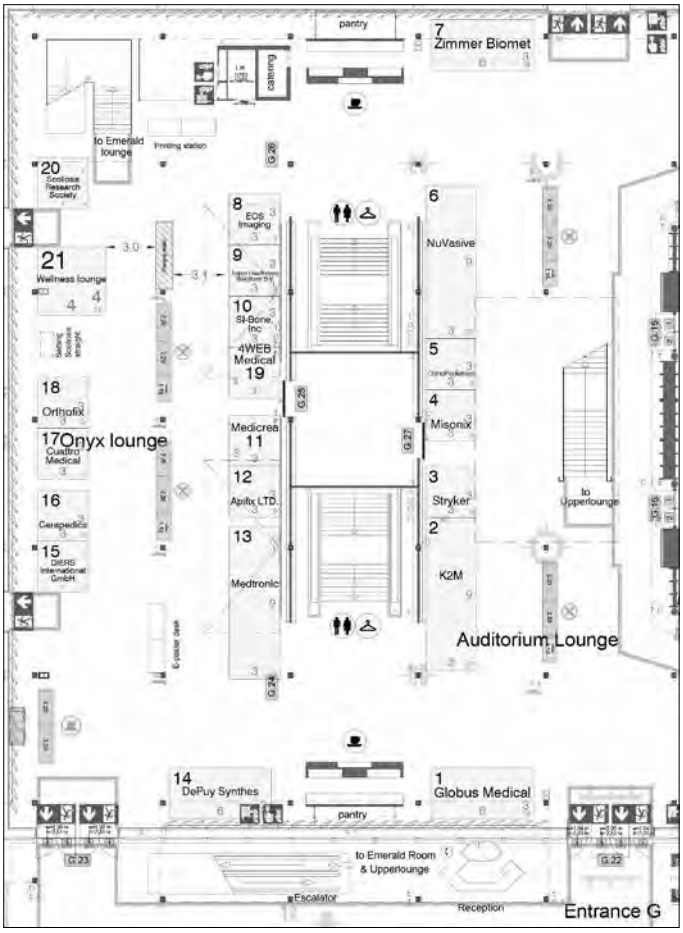
IMAST EXHIBIT HALL

Many new spinal systems and products are on display in the Exhibit Hall. We encourage you to visit the exhibits throughout the meeting to learn more about the technological advances.

The IMAST Exhibit Hall is located in the Auditorium & Onyx Lounge

Hours:

Wednesday, July 17	17:30-19:00 (Welcome Reception)
Thursday, July 18	8:30-17:00
Friday, July 19	8:30-15:45
Saturday, July 20	Exhibits Closed



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EXHIBITOR DESCRIPTIONS

APIFIX, LTD. – BOOTH #12

Misgav Business Park
17 Techelet St.
Misgav 20174,
Israel
www.apifix.com

ApiFix Ltd. is a leading motion-preserving scoliosis correction company with a unique platform technology and a game-changing approach to spine deformity treatment. ApiFix's Minimally Invasive Deformity Correction (MID-C) System is a posterior dynamic deformity correction system that enables surgeons to perform a novel treatment providing permanent curve correction while retaining spine flexibility with a least invasive approach. The MID-C system has been used to treat more than 300 young patients diagnosed with progressive scoliosis with follow-up exceeding seven years. FDA approval via a Humanitarian Device Exemption (HDE) pathway is expected in 2019.

Young scoliosis patients whose curvature is diagnosed as progressive have two standard treatment options depending on the severity: non-surgical management (bracing) – which does not correct the deformity – or fusion surgery. Spinal fusion surgery involves permanently fusing multiple vertebrae in an invasive surgical procedure with a long recovery, resulting in a permanent reduction of the patients' range of motion and a future of additional surgical interventions.

The unique ApiFix approach provides a viable alternative to bracing and spinal fusion for many patients as the least invasive spine deformity correction option. The MID-C system acts as an "internal brace" with a patented unidirectional, self-adjusting rod mechanism and motion-preserving polyaxial joints allowing additional post-operative correction over time and is removable. The ApiFix device is implanted in a unilateral posterior procedure where patient recovery is relatively pain-free and is measured in days, not months. The MID-C System has CE Mark approval and is available in Europe, Israel, Singapore and Canada.

CERAPEDICS – BOOTH #16

11025 Dover Street
Suite 1600
Westminster, CO 80021
USA
www.cerapedics.com

Cerapedics is an advanced orthobiologics company focused on developing its proprietary biomimetic small peptide molecule (P-15) for commercialization in spinal applications. i-FACTOR™ Peptide Enhanced Bone Graft (P-15/ABM) is only the 2nd FDA PMA Approved bone graft on the market, and it has shown statistical superiority to local autograft through an IDE trial on single-level ACDFs in overall clinical success at one year. i-FACTOR™ is the only biologic bone graft in orthopedics that incorporates a small peptide as an attachment factor to stimulate the natural bone healing process. This novel mechanism of action (Attract, Attach, Activate) is designed to support safer and more predictable bone formation compared to other commercially available bone growth factors.

CUATTRO MEDICAL – BOOTH #17

150 Capital Drive
Golden, CO 80401
USA
med.cuattro.com

Cuattro is a world leader in digital radiography system design, installation, and support. Cuattro's innovative digital radiography platforms include both full room and retrofit solutions for orthopedic, hospital, urgent care, and family practice applications. Cuattro is pleased to announce the release of the new Cuattro ONE (pending FDA clearance) a long format, 17" X 51" Digital Detector. The Cuattro ONE is designed to facilitate long format spinal and full leg length procedures with unprecedented speed and simplicity. ONE exposure, ONE image, in under ONE minute.

DEPUY SYNTHES** – BOOTH #14

325 Paramount Drive
Raynham, MA 02767
USA
www.depuysynthes.com

DePuy Synthes, part of the Johnson & Johnson Medical Devices Companies, provides one of the most comprehensive orthopaedics portfolios in the world. DePuy Synthes solutions, in specialties including joint reconstruction, trauma, craniomaxillofacial, spinal surgery and sports medicine, are designed to advance patient care while delivering clinical and economic value to health care systems worldwide. For more information, visit www.depuysynthes.com.

DIERS INTERNATIONAL GMBH – BOOTH #15

Dillenbergweg 4
Schlangenbad 65388
Germany
www.diers.eu

DIERS Medical Systems is an innovative company offering a radiation-free system for assessment of the spine and trunk. Using surface topography, the DIERS formetric system can provide a 3-D reconstruction of the spine as a static measurement or while the spine is in motion. The addition of lower extremity video analysis and foot pressure measurements from the integrated treadmill turns the spine system into a fully functional gait lab.

The DIERS formetric system provides reliable outcomes data for clinicians who treat patients with scoliosis, kyphosis, neuromuscular disorders, gait abnormalities, adult degeneration, spinal fusions, and can even be used in patients with total joint replacement or sports medicine.

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EXHIBITOR DESCRIPTIONS

EOS IMAGING – BOOTH #8

10 Rue Mercoeur
Paris 75011
France
www.eos-imaging.com

EOS imaging designs, develops and markets advanced imaging and image-based solutions for musculoskeletal pathologies and orthopedic surgical care. A low dose or Micro Dose EOS exam provides full body, stereo-radiographic images in weight-bearing positions. The frontal and lateral images are acquired simultaneously in less than 20 seconds without magnification. The accompanying sterEOS workstation enables you to create patient-specific 3D models, calculate over 100 clinical parameters automatically and generate customizable patient reports. EOS also offers online 3D Services and cloud-based, 3D surgical planning software solutions for the spine, hip and knee. The EOS platform connects imaging to care by adding value along the entire patient care pathway from diagnosis to follow-up.

GLOBUS MEDICAL, INC.** – BOOTH #1

2560 General Armistead Avenue
Audubon, PA 19403
USA
www.globusmedical.com

Globus Medical, Inc. is a leading musculoskeletal solutions company and is driving significant technological advancements across a complete suite of products ranging from spinal and trauma therapies to regenerative solutions, to robotics, navigation and imaging. Founded in 2003, Globus' single-minded focus on advancing spinal surgery has made it the fastest growing company in the history of orthopedics. Globus is driven to utilize superior engineering and technology to achieve pain free, active lives for all patients with musculoskeletal disorders.

K2M** – BOOTH #2

600 Hope Parkway
Leesburg, VA 20175
USA
www.k2m.com

K2M Group Holdings, Inc. is a global leader of complex spine and minimally invasive solutions focused on achieving three-dimensional Total Body Balance™. Since its inception, K2M has designed, developed and commercialized innovative complex spine and minimally invasive spine technologies and techniques used by spine surgeons to treat some of the most complicated spinal pathologies. K2M has leveraged these core competencies into Balance ACS™, a platform of products, services, and research to help surgeons achieve three-dimensional spinal balance across the axial, coronal and sagittal planes, with the goal of supporting the full continuum of care to facilitate quality patient outcomes. The Balance ACS platform, in combination with the Company's technologies, techniques and leadership in the 3D-printing of spinal devices, enable K2M to compete favorably in the global spinal surgery market.

MEDICREA - BOOTH #11

50 Greene Street
5th Floor
New York, NY 10013
USA
www.medicrea.com

The MEDICREA® Group is pioneering the transformation of spinal surgery through artificial intelligence, predictive modeling and patient specific implants with its UNiD ASI™ (Adaptive Spine Intelligence) proprietary software platform, services and technologies.

MEDTRONIC** – BOOTH #13

2600 Sofamor Danek Drive
Memphis, TN 38017
USA
www.medtronic.com

As a global leader in medical technology, we improve the lives and health of millions of people each year— with our innovative therapies, services, and solutions. Learn how we're taking healthcare Further, Together at Medtronic.com

MISONIX – BOOTH #4

1938 New HWY
Farmingdale, NY 11735
USA
www.misonix.com

Misonix recognized leader in developing ultrasonic surgical devices for hard and soft tissue removal. The BoneScalpel is a unique tissue-selective ultrasonic osteotome allowing for en-bloc bone removal and refined osteotomies while sparing soft tissue structures. Many surgeons have noted the BoneScalpel as one of the greatest advancements in spine surgery.

NUVASIVE** – BOOTH #6

7475 Lusk Blvd
San Diego, CA 92121
USA
www.nuvasive.com

NuVasive is the leader in spine technology innovation, focused on transforming spine surgery and beyond with minimally disruptive, procedurally integrated solutions designed to deliver reproducible and clinically-proven surgical outcomes. The Company's portfolio includes access instruments, implantable hardware, biologics, software systems for surgical planning, navigation and imaging solutions, magnetically adjustable implant systems for spine and orthopedics, and intraoperative monitoring service offerings.

ORTHOFIX – BOOTH #18

3451 Plan Parkway
Lewisville, TX 75056
USA
www.orthofix.com

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EXHIBITOR DESCRIPTIONS

ORTHOPEDIATRICS – BOOTH #5

2850 Frontier Drive
Warsaw, IN 46582
USA
www.orthopediatrics.com

Founded in 2006, OrthoPediatrics is an orthopedic company focused exclusively on providing a comprehensive product offering to the pediatric orthopedic market to improve the lives of children with orthopedic conditions. OrthoPediatrics currently markets 26 surgical systems that serve three of the largest categories within the pediatric orthopedic market. This offering spans trauma & deformity, scoliosis and sports medicine/other procedures. OrthoPediatrics' global sales organization is focused exclusively on pediatric orthopedics and distributes its products in the United States and 38 countries outside the United States.

SI-BONE, INC. – BOOTH #10

471 El Camino Real, Suite 101
Santa Clara, CA 95050
https://si-bone.com

SI-BONE, Inc. is a leading medical device company that has developed the iFuse Implant System®, a proprietary minimally invasive surgical implant system to fuse the sacroiliac joint. The triangular implants were designed specifically to stabilize and fuse the heavily loaded SI joint. More than 37,000 procedures have been performed with the iFuse Implant System – the Method of Choice for SI Joint Fusion®. The iFuse Implant, available since 2009, is the only device for treatment of SI joint dysfunction supported by significant published clinical evidence, including level 1 trials, showing safety, effectiveness and durability, including lasting pain relief.

STRYKER – BOOTH #3

2 Pearl Court
Allendale, NJ 07401

USA
www.stryker.com

Stryker is one of the world's leading medical technology companies and, together with our customers, is driven to make healthcare better. We offer innovative products and services in Orthopaedics, Medical and Surgical, and Neurotechnology and Spine that help improve patient and hospital outcomes.

TOPIC HEALTHCARE SOLUTIONS B.V. – BOOTH #9

Materiaalweg 4
5681 RJ Best
Postbus 440
5680 AK Best
The Netherlands
www.topic.nl

Topic Healthcare Solutions is offering hospital solutions that make a meaningful difference in your workflow management. Using smart technology, we increase workflow efficiency, resource utilization and support patients and staff with personalized on-time information.

Our WISH system (Workflow Improvement System for Hospitals) combines innovative electronics with predictive deep learning algorithms to create user-specific communication strategies.

WISH Smart OR is able to predict the actual surgery end-time in real-time and informs users about relevant changes. This allows hospital staff to coordinate their efforts and appointments efficiently and conveniently, resulting in a smoothly running organization.

Topic Healthcare Solutions is currently performing research to develop a system to optimize the surgical instrument net size. This will lead to a significant reduction in sterilization costs and workload, and will provide surgeons with the surgical sets they truly need.

ZIMMER BIOMET* – BOOTH #7

10225 Westmoor Drive
Westminster, CO 80021
USA
www.zimmerbiomet.com

Zimmer Biomet Spine is a leader in restoring mobility, alleviating pain, and improving the quality of life for patients around the world by delivering surgeons a comprehensive portfolio of quality spine technologies and procedural innovation, best-in-class training, and unparalleled service via a network of responsive team members and sales professionals.

4WEB MEDICAL – BOOTH #19

2801 Network Blvd
Suite 620
Frisco, TX 75034
www.4webmedical.com

4WEB Medical is an implant device company founded in 2008 in Frisco, Texas. Thirty years of research in topological dimension theory led to the discovery of a novel geometry, the 4WEB, that can be used as a building block to create high-strength, lightweight web structures. The company leveraged this breakthrough along with cutting-edge 3D printing technology to develop 4WEB Medical's proprietary truss implant technology platform. The 4WEB Medical product portfolio currently provides implant solutions for Neuro and Orthopedic surgeons. The platform includes the Cervical Spine Truss System, the Anterior Spine Truss System, the Posterior Spine Truss System, the Lateral Spine Truss System, and the Osteotomy Truss System. 4WEB is actively developing truss implant designs for knee, hip, trauma and patient specific orthopedic procedures.

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EXHIBITOR DESCRIPTIONS

SCOLIOSIS RESEARCH SOCIETY MEMBERSHIP – BOOTH #20

555 E Wells Street
Suite 1100
Milwaukee, WI 53202
USA
www.srs.org

Founded in 1966, the Scoliosis Research Society is an organization of medical professionals and researchers dedicated to improving care for patients with spinal deformities. Over the years, it has grown from a group of 37 orthopaedic surgeons to an international organization of more than 1,300 health care professionals. SRS is open to orthopaedic surgeons, neurosurgeons, researchers and allied health professionals who have a practice that focuses on spinal deformity.

Prospective members and new candidate members are invited to attend a membership information session Friday, July 19 from 17:10–17:40 in the Forum room.

WELLNESS LOUNGE – BOOTH #21

The IMAST Wellness Lounge, located in the Exhibit Hall (booth #21) will be open during all exhibit hours to be used by the attendees to relax and recharge. The Wellness Lounge will include comfortable seating, healthy snacks and water. Make sure to stop by and "recharge" during the busy meeting.

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HANDS-ON WORKSHOPS

IMAST delegates are encouraged to attend the Hands-On Workshops (HOWs) during breakfast and lunch on Thursday and Friday and Thursday afternoon. Each workshop is programmed by a single- supporting company and will feature presentations on topics and technologies selected by the company. Catering will be located in the back of each workshop room.

*Please note: CME credits are not available for Hands-On Workshops.

HOWs are located in G103-G107 on the first floor (second level) of the RAI Amsterdam Convention Centre.

SCHEDULE

	Thursday, July 18	Friday, July 19
MORNING	**8:00-9:00**	**8:00-9:00**
G103	DePuy Synthes	K2M
G104		Medtronic
G105		DePuy Synthes
G106		Zimmer Biomet
LUNCH	**13:05-14:05**	**12:15-13:15**
G103	K2M	K2M
G104	Medtronic	Globus Medical, Inc.
G105	NuVasive	Medicrea
G106	Globus Medical, Inc.	
G107	Zimmer Biomet	
AFTERNOON	**18:00-19:00**	
G103	K2M	

WORKSHOP DESCRIPTIONS

THURSDAY, JULY 18 – 8:00-9:00

DePuy Synthes
Room: G103

Innovations in Pediatric Spinal Deformity – Masters' Techniques and Case Based Discussion
Faculty*: Deszo Jeszenszky, MD; Stefan Parent, MD, PhD; Suken A. Shah, MD*
Highlighting The Management of Congenital Scoliosis utilizing Open Wedge Osteotomy and other techniques; 3D Prediction, Planning and Evaluation; and Sagittal Plane Restoration in AIS

THURSDAY, JULY 18 – 13:05-14:05

K2M
Room: G103
Modern Approaches to Thoracolumbar Deformity Correction
Faculty: *Robert Lee, BSc, FRCS; Joseph O'Brien, MD, MPH*
Technology has changed how thoracolumbar surgery is approached in 2019. This workshop will focus on deformity correction using MIS lateral, Anterior to the psoas methods, thoracic lateral methods, ALL releases and all percutaneous screws. Posterior work will include MIS pelvic / S2AI fixation.

Medtronic
Room: G014
Building Constructs for Challenging Deformities
Faculty: *Ronald A. Lehman Jr., MD and Ian Harding, MD*
Objectives: In this workshop we will discuss the use of various surgical constructs to address challenging sagittal and coronal deformities of the spine. Topics of discussion will include the pros and cons of anterior, lateral, and posterior approaches, decompression options, and creating constructs capable of sustaining the desired correction. Discussion around construct demands will include anatomical considerations, interbody selection, rod placement, and the selection of biologics to attain fusion.

NuVasive
Room: G105
Advanced Techniques in Complex Deformity Procedures
Faculty: *Tyler R. Koski, MD and Christopher I. Shaffrey, MD*
Program Synopsis: An overview of the most compelling solutions for complex surgery – capitalizing on our understanding of the importance of sagittal alignment, junctional issues and the evolution of techniques for posterior based stabilization approaches.

Globus Medical, Inc.
Room: G106
Ahead Today, Advancing Tomorrow with ExcelsiusGPS®: Single Position Lateral and Complex Spine Clinical Applications
Faculty: *Themistocles S. Protopsaltis, MD*

Zimmer Biomet
Room: G107
Surgeon Preservation: Considerations for Using Power in Pedicle Preparation and Screw Insertion
Faculty: *Han Jo Kim, MD*
Join Han Jo Kim, MD for a hands-on demonstration and discussion on technique and use of power instrumentation for simple, controlled pedicle preparation and screw insertion.

HANDS-ON WORKSHOPS

THURSDAY, JULY 18 – 18:00-19:00

K2M
Room: G103
Strategies and Techniques for Adult Revision Surgery
Faculty: *Jeffrey Gum, MD; Ronald A. Lehman Jr., MD; Justin S. Smith, MD, PhD*
Revision surgery is becoming a bigger factor in adult deformity surgery as more and more patients receive spine surgery. This workshop is intended to discuss current tips and techniques for dealing with challenging revisions.

FRIDAY, JULY 19 – 8:00-9:00

K2M
Room: G103
How I Benefit from Navigation in My Daily Practice
Faculty: *John R. Dimar II, MD; Priv.-Doz. Dr. med. Berk Orakcioglu; Julien Tremlet, MD*
This workshop will discuss reasons to integrate a Navigation system into your daily practice. Faculty will share experiences for overcoming changes in workflow, OR setup, and building trust with the system.

Medtronic
Room: G104
Navigation and Robotics in Spine Surgery: Should it be Standard of Care?
Faculty: *Jeffrey Gum, MD and Hamid Hassanzadeh, MD*
Objectives: In this workshop we will discuss the use of navigation and robotics in spine surgery. Topics of discussion will include the evolution and current status of these technologies in the spine market, the types of cases being done with each technology, workflow considerations, and the potential impact on surgical outcomes.

DePuy Synthes
Room: G015
Innovations in Adult Spinal Deformity – Masters' Techniques and Case Based Discussion
Faculty: *Munish C. Gupta, MD; Heiko Koller, MD; Baron Lonner, MD*
Highlighting the benefits and challenges associated with current treatment options for the correction of Complex Adult Spinal Deformity: Cervical to Pelvis

Zimmer Biomet
Room: G106
Titanium or PEEK: A Collegial Discussion on Practical Applications in Interbody Fusion
Faculty: *Han Jo Kim, MD; Justin S. Smith, MD, PhD*
Join Han Jo Kim, MD and Justin Smith, MD for a discussion on the best applications for Titanium and PEEK technology. Topics for discussion include patient indications and perioperative care for achieving the best outcomes.

FRIDAY, JULY 19 – 12:15-13:15

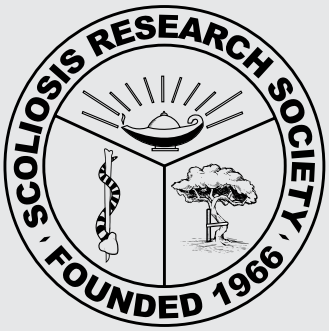
K2M
Room: G103
Sagittal Plane Alignment in AIS
Faculty: *Laurel C. Blakemore, MD; René M. Castelein, MD, PhD; Ilkka J. Helenius, MD, PhD*
Sagittal balance is a valuable component of correction in adolescent idiopathic deformity patients. This workshop will review three different perspectives surrounding AIS correction techniques, tips and considerations.

Globus Medical, Inc.
Room: G104
REFLECT™: A Non-Fusion Technique for Adolescent Idiopathic Scoliosis (AIS)
Faculty: *Randal Betz, MD*

Medicrea
Room: G105
Improving Spinal Deformity Surgery Outcomes Using AI, Predictive Modeling, and Patient-Specific Implants.
This workshop is a great opportunity to discuss the big challenges in spinal deformity and learn how Medicrea UNiD ASI™ (Adaptive Spine Intelligence) proprietary software platform, services and technologies help improve clinical outcomes, streamline operational processes, and reduce spinal care costs.

NOTES

AUTHOR INDEX



The Scoliosis Research Society thanks our ASLS Directed Research Partners Globus Medical, ISSGF, K2M, Medtronic, and NuVasive.

AUTHOR INDEX

Key: *1-75 = Paper Presentations; 100-242 = E-Posters; CC = Cases & Cocktails; CP = Case Presentation; DB = Debate; GS = General Session; ICL = Instructional Course Lecture*

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ABOUT SRS

Founded in 1966, the Scoliosis Research Society is an organization of medical professionals and researchers dedicated to improving care for patients with spinal deformities. Over the years, it has grown from a group of 37 orthopaedic surgeons to an international organization of more than 1,300 health care professionals.

MISSION STATEMENT

The purpose of the Scoliosis Research Society is to foster the optimal care of all patients with spinal deformities.

MEMBERSHIP

SRS is open to orthopaedic surgeons, neurosurgeons, researchers and allied health professionals who have a practice that focuses on spinal deformity.

Active Fellowship (membership) requires the applicant to have fulfilled a five-year Candidate Fellowship and have a practice that is 20% or more in spinal deformity. Only Active Fellows may vote and hold elected offices within the Society.

Candidate Fellowship (membership) is open to orthopaedic surgeons, neurosurgeons and to researchers in all geographic locations who are willing to commit to a clinical practice which includes at least 20% spinal deformity. Candidate Fellows stay in that category for five years, during which time they must demonstrate their interest in spinal deformity and in the goals of the Scoliosis Research Society. Candidate Fellows may serve on SRS committees. After five years, those who complete all requirements are eligible to apply for Active Fellowship in the Society. Candidate Fellowship does not include the right to vote or hold office.

Associate Fellowship (membership) is for distinguished members of the medical profession including nurses, physician assistants, as well as orthopaedic surgeons, neurosurgeons, scientists, engineers and specialists who have made a significant contribution to scoliosis or related spinal deformities who do not wish to assume the full responsibilities of Active Fellowship. Associate Fellows may not vote or hold office, but may serve on committees.

Senior Candidate Fellowship (membership) is limited to senior surgeons, neurosurgeons and to non-physicians members of allied specialties. This candidacy is a path to SRS Active Fellowship. Senior surgeons have the opportunity to become Active Fellows of SRS in two years and not 5 years like the regular Candidate Fellowship track. They must have 20 years of experience (time spent with fellowship and training does not count), be a full professor, head of spine unit or chief of spine division, clinical practice which includes 20% spinal deformity. After two years, those who complete all requirements are eligible to apply for Active Fellowship in the Society. Senior Candidate Fellowship does not include the right to vote or hold office.

See the website (www.srs.org/professionals/membership) for membership requirement details and printable membership application. Or visit the SRS Booth (#20) to learn about membership or complete the application onsite.

PROGRAMS AND ACTIVITIES

SRS is focused primarily on education and research that include the Annual Meeting, the International Meeting on Advanced Spine Techniques (IMAST), Worldwide Courses, a Global Outreach Program, the Research Education Outreach (REO) Fund which provides grants for spine deformity research, and development of patient education materials.

WEBSITE INFORMATION

For the latest information on SRS meetings, programs, activities and membership please visit www.srs.org. The SRS Website Committee works to ensure that the website information is accurate, accessible and tailored for target audiences. Site content is varied and frequently uses graphics to stimulate ideas and interest. Content categories include information for medical professionals, patients/public, and SRS members. For more information please visit the SRS website at www.srs.org.

SOCIETY OFFICE STAFF

Tressa Goulding, CAE
– Executive Director (tgoulding@srs.org)

Lily Atonio
– Education and Program Manager (latonio@srs.org)

Alysha Chapman, CNP
– Membership & Development Manager (achapman@srs.org)

Ann D'Arienzo, CMP
– Senior Meetings Manager (adarienzo@srs.org)

Jenifer Heller
– Meetings Manager (jheller@srs.org)

Courtney Kissinger
– Senior Education Manager (ckissinger@srs.org)

Lauren Kritter
– Education Manager (lkritter@srs.org)

Ashtin Neuschaefer
– Director of Administration (aneuschaefer@srs.org)

Shawn Storey
– Website and Program Manager (sstorey@srs.org)

SCOLIOSIS RESEARCH SOCIETY

555 East Wells Street, Suite 1100
Milwaukee, WI 53202
Phone: 414-289-9107
Fax: 414-276-3349
www.srs.org

SOCIAL MEDIA

Stay up to date with SRS during IMAST and share your experiences.
#SRSIMAST19

Twitter: @srs_org
Facebook: Scoliosis Research Society
Instagram: @srs_org
LinkedIn: Scoliosis Research Society

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SCOLIOSIS RESEARCH SOCIETY

55th Annual Meeting

PHOENIX, ARIZONA • SEPTEMBER 9-12, 2020

Abstract Submission Open:
November 1, 2019 - February 1, 2020

Registration Opens:
April 2020

www.srs.org

NEW DATES!

IMAST 2020

ATHENS, GREECE
APRIL 1–4, 2020

Abstract Submission Open:
August 1 - November 1, 2019

Registration Opens:
December 16, 2019

www.srs.org

MEETING OVERVIEW

WEDNESDAY, JULY 17, 2019		
11:00-17:00	Board of Directors Meeting; Exhibit Set-up	
14:00-19:00	Registration Open	Auditorium Foyer
17:30-19:00	Welcome Reception	Exhibit Hall – Auditorium & Onyx Lounge
19:15-20:30	Cases & Cocktails Sessions	G103, G104, G105, G106
THURSDAY, JULY 18, 2019		
7:30-17:30	Registration Open	Auditorium Foyer
8:00-9:00	*Hands-On Workshops with Breakfast	G103, G104, G105, G106
8:30-9:00	Coffee & Exhibit Viewing	Exhibit Hall – Auditorium & Onyx Lounge
9:00-11:15	Session 1: Whitecloud Nominees & Presidential Address	Auditorium
11:15-11:50	Refreshment Break & Exhibit Viewing	Exhibit Hall – Auditorium & Onyx Lounge
11:50-12:53	Concurrent Sessions 2A-B: Abstract Presentations	Auditorium, Forum
12:53-14:05	Lunch & Exhibit Viewing;	Exhibit Hall – Auditorium & Onyx Lounge
13:05-14:05	*Hands-On Workshops	G103, G104, G105, G106
14:10-15:10	Concurrent Sessions 3A-B: ICLs	Auditorium, Forum
15:20-16:20	Concurrent Sessions 4A-B: Debates	Auditorium, Forum
16:20-16:50	Refreshment Break & Exhibit Viewing	Exhibit Hall – Auditorium & Onyx Lounge
16:50-17:50	Concurrent Sessions 5A-B: ICLs,	Auditorium, Forum
18:00-19:00	*Hands-On Workshops with Beverages & Snacks	G103, G104, G105, G106
FRIDAY, JULY 19, 2019		
7:30-16:30	Registration Open	Auditorium Foyer
8:00-9:00	*Hands-On Workshops with Breakfast	G103, G104, G105, G106
8:30-9:00	Coffee & Exhibit Viewing	Exhibit Hall – Auditorium & Onyx Lounge
9:00-10:10	Concurrent Sessions 6A-B: Abstract Presentations	Auditorium, Forum
10:10-10:40	Refreshment Break & Exhibit Viewing	Exhibit Hall – Auditorium & Onyx Lounge
10:40-12:05	Concurrent Sessions 7A-B: Abstract Presentations	Auditorium, Forum
12:05-13:15	Lunch & Exhibit Viewing;	Exhibit Hall – Auditorium & Onyx Lounge
12:15-13:15	*Hands-On Workshops	G103, G104, G105, G106
13:25-14:10	Concurrent Sessions 8A-B: Case Presentations	Auditorium, Forum
14:10-14:50	Refreshment Break & Exhibit Viewing	Exhibit Hall – Auditorium & Onyx Lounge
14:50-15:50	Concurrent Sessions 9A-B: ICLs	Auditorium, Forum
16:00-17:00	Session 10: Challenges in Cervical Deformities	Auditorium
17:10-17:40	SRS Member Info Session	Forum
SATURDAY, JULY 20, 2019		
8:30-11:00	Registration Open	Auditorium Foyer
9:00-10:00	Session 11: Surgical Video Session	Auditorium
10:15-11:15	Session 12: My Worst Complications	Auditorium
11:15-11:30	Walking Break & Lunch Pick Up	Auditorium Lounge
11:30-13:00	Session 13: Lunch with the Experts	Auditorium
13:00	Adjourn	
**Denotes Non-CME Session*		

SRS-0519-621

WIRELESS INTERNET

Network = IMAST2019
Password = spine2019

Wireless Internet is supported, in part, by Zimmer Biomet.

#SRSIMAST19