

Scoliosis Research Society presents

IMAST 2015

22nd International Meeting on
Advanced Spine Techniques

JULY 8–11, 2015 • KUALA LUMPUR, MALAYSIA
KUALA LUMPUR CONVENTION CENTER



Sponsored by the Scoliosis
Research Society (SRS)

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<http://www.srs.org/imast/2015/>

Corporate Support



We are pleased to acknowledge and thank those companies that provided financial support to SRS in 2014-2015. Support levels are based on total contributions throughout the year and include the Annual Meeting, IMAST, Global Outreach Scholarships, Edgar Dawson Memorial Scholarships, SRS Traveling Fellowships and the Research Education Outreach (REO) Fund.

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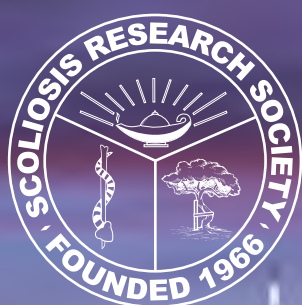
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General Information



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

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22nd IMAST Venue

Kuala Lumpur Convention Center (KLCC)
Jalan Pinang, 50450 Kuala Lumpur
Wilayah Persekutuan Kuala Lumpur, Malaysia

Future Educational Events

50th Annual Meeting & Course

September 30–October 3, 2015

Minneapolis, MN, USA

Celebrating the Past, Present and Future of Spinal Deformity Research



5th Spine Deformity Solutions: A Hands-On Course

October 22-24, 2015

Istanbul, Turkey

Lima, Peru Worldwide Conference

In Conjunction with SILACO/ ASPECIVE

October 28, 2015

Marrakech, Morocco Worldwide Conference

In Conjunction with the Moroccan Spine Society and SRS Global Outreach Program

December 4-5, 2015

23rd International Meeting on Advanced Spine Techniques (IMAST)

July 13-16, 2016

Washington, DC, USA

51st Annual Meeting & Course

September 21-24, 2016

Prague, Czech Republic

Welcome

Chair's Message

Dear Participant,

I would like to personally welcome you to Kuala Lumpur, one of the fastest growing cities in the Asia Pacific region, for what promises to be an inspiring academic meeting. As a Society we continue to make incredible strides in the field of spinal deformities and are excited to showcase these advancements at the 22nd IMAST with our colleagues from around the world.


To continue providing a world-class meeting with the best educational value and at the request of our delegation, we are excited to offer new video-based sessions including "Lunch with the Experts: Video-Based Surgical Techniques" on Saturday from 11:00-12:30. With the success of the Special Symposia last year, we will also continue to offer these sessions on Wednesday, July 8 from 15:00-16:45. The symposia topics will be "Optimal Management of Cervical Spondylotic Myelopathy" and "Management of Spinal Emergencies." After the symposium we encourage delegates to take part in the Hands-On Workshops (HOWs) which will be followed by the Welcome Reception in the exhibit hall.

In addition to the new and enhanced sessions, the program this year will include the popular complication and debates series, instructional course lectures, roundtable case discussions, and four- and two-minute podium presentations. We have increased the two-minute point presentations again this year to ensure deserving papers have a chance to present their research. Our faculty this year includes many experts from the Asia Pacific region along with experts from every discipline of spine. We encourage all delegates to engage in the interactive and innovative program we have planned.

Along with the exciting program, the city of Kuala Lumpur is a must see. In addition to a growing economy and impressive new infrastructure, Kuala Lumpur is rich in culture, nature and heritage, so be sure to get out and explore the city while you are here!

I am honored to serve as your IMAST Chairman again this year. I want to thank those whose leadership and diligent efforts have created such a successful meeting, including John P. Dormans, MD; David W. Polly, Jr., MD; Kenneth M.C. Cheung, MD; Steve D. Glassman, MD and the IMAST Committee.

With warmest personal regards,



Christopher I. Shaffrey, MD
IMAST Committee Chair



IMAST Mobile & Online App

A mobile and online app will be available to all delegates during the 22nd IMAST. The app is designed to provide all the information about IMAST & Kuala Lumpur in one convenient location and can be accessed from any smartphone or computer with an internet connection. To download the app visit <http://eventmobi.com/imast2015> or scan the QR code with your smartphone.



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

- The offline mode allows delegates to access all static content, including the agenda, speaker listing and info booth, on the app without an internet connection.
- A detailed IMAST agenda allows delegates to create a personalized schedule.
- Exhibitor information includes exhibit floor plan, company descriptions and the Hands-On Workshop schedule.
- An information booth features everything you need to know about IMAST, and its host city of Kuala Lumpur, including scientific and social program details, information on the hotels, as well as downtown Kuala Lumpur dining and attractions.
- Maps of the Kuala Lumpur Convention Center.
- An alert system for real-time updates from SRS – program changes, tour and social event notifications, and breaking news as it happens.

To learn more about the app or how to use the QR code, please refer to the insert in your registration bag or visit www.srs.org/imast/2015/.

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

<http://eventmobi.com/imast2015>

General Meeting Information

Meeting Description

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

Learning Objectives

Upon completion of IMAST, participants should be able to:

- Assess recent advances in surgical techniques for the treatment of spinal disorders, compare them with traditional treatments and determine if and/or when to use them for optimal patient care.
- Analyze indications and potential complications for various procedures and approaches related to spinal surgery, including spinal arthroplasty, dynamic stabilization, minimally invasive techniques and lateral transpsoas procedures, and apply that analysis to treatment decisions.
- Compare and contrast treatment options for various spinal disorders in order to present the full range of non-operative and operative interventions to patients to allow informed choices for optimal care and improved outcomes.
- Present a variety of new objective cost and outcome analyses of operative and non-operative interventions to better understand the cost effectiveness and cost/utility related to treatment options in both the short and intermediate time periods.

Target Audience

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

Accreditation Statement

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

Credit Designation

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

Disclosure of Conflict of Interest

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

FDA Statement (United States)

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

Insurance/Liabilities and Disclaimer

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

SRS cannot be held liable for any hindrance or disruption of IMAST proceedings arising from natural, political, social or economic events or other unforeseen incidents beyond its control. Registration of a participant or guest implies acceptance of this condition. The materials presented at this Continuing Medical Education (CME) activity are made available for educational purposes only. The material is not intended to represent the only, nor necessarily best, methods or procedures appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement or opinion of the faculty that may be helpful to others who face similar situations.

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

CME Information

CME certificates will be available to pre-registered delegates upon the opening of the meeting at www.srs.org/imast/2015/. Delegates who registered on-site may access their certificates after August 1, 2015. Certificates are NOT available to delegates registering on-site until August 1.

Delegates should log on to the website listed above and enter their last name and the ID# listed on their IMAST badge. The system will then ask delegates to indicate

General Meeting Information

which sessions they attended, and then will generate a PDF certificate which may be printed or saved to the delegate's computer. Session attendance is saved in the database, and certificates may be accessed again, in the event the certificate is lost or another copy is required.

Please note that certificates will not be mailed or emailed after the meeting. The online certificate program is the only source for this documentation. Please contact SRS at cme@srs.org for any questions. SRS asks that all CME certificates be claimed no later than November 1, 2015.

Certificates of attendance will be emailed to each delegate upon checking in at the registration desk at the meeting. Delegates will not receive a paper copy of the certificate in their registration materials. If you would like a paper copy, please stop at the registration desk before the close of the meeting. Evaluations will be available to all attendees at the commencement of the meeting. Evaluations are available at www.srs.org/imast/2015/.

Session Information

Instructional Course Lectures (ICLs)

There will be five (5) ICL sessions highlighting the latest in surgical techniques and technologies. Each session will feature four (4) concurrent didactic sessions, programmed around thematic areas and will include a balanced discussion of multiple products, techniques and advances relevant to that topic.

Debates

The debates will continue this year with four (4) sessions featuring multiple debates per session. Expert faculty will be assigned to different treatment options available for specific conditions for each debate. Debate topics and faculty are listed in the Meeting Agenda, beginning on p. 37.

Complications Series

The complications series presents a variety of illustrative case presentations, demonstrating the most common and worst complications encountered, as well as strategies to prevent and manage them. Interaction between faculty and participants will focus on treatment options with an emphasis on reducing further morbidity and improving eventual outcomes. Complication topics and faculty are listed in the Meeting Agenda, beginning on p. 46.

Two-Minute Point Presentations

Two-Minute Point Presentations will continue in the abstract portion of the program this year. These five (5) lightning rounds were selected from the abstracts submitted to the 2015 meetings. The sessions will follow a similar format to the traditional podium presentations, however, with a limited number of slides and time.

Video Based Sessions

New Session: Video-Based Session on Friday, July 10

7C: Surgical Techniques: A Video-Based Session – 10:30-11:55

Topics: Cervical Deformity Correction

Tether Technique

Lateral Interbody Fusion Technique (including ACR)

Lateral Interbody Application to Deformity Correction

Special Symposia

We encourage delegates to take part in the following afternoon activities on Wednesday, July 8.

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

1A. Optimal Management of Cervical Spondylotic Myelopathy

1B. Management of Spinal Emergencies

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

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

Attire

Business casual (sports coats) to casual (dress or polo shirts, no ties required) are appropriate for IMAST sessions. Casual attire is recommended for the Course Reception.

Two-Minute Point Presentation CDs

There are nearly 100 Point Presentations available for your review on the kiosks inside the exhibit hall located in Ballroom 1. The presentations are also available on the CD-ROM included with your registration materials.

Two-Minute Point Presentation kiosks are supported, in part, by a grant from K2M.

Exhibits & Hands-On Workshops

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 one-hour 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 cocktails and snacks will be served just outside the HOWs, as noted in the program. Please note that HOWs are non-CME sessions.

General Meeting Information

Internet Access

Wireless Internet access is available throughout the meeting space of the Kuala Lumpur Convention Center (KLCC)

To log on select...

Network = IMAST2015

Password = spine2015

Note: Internet cookies must be enabled to connect.

Wireless Internet is supported, in part, by a grant from Medtronic.

Internet Kiosks

Delegates without laptops may access complimentary Internet kiosks inside the cafe across from the registration area.

Internet Kiosks are supported, in part, by a grant from Orthofix.

Language

Presentations and course materials will be provided in English.

No Smoking Policy

Smoking is not permitted during any IMAST activity or event.

Presentation Upload Area

Location: Ballroom 2 (Main Session Hall)

Presenters may upload their PowerPoint presentations in the Speaker Ready Area located at the back of the main session room, Ballroom 2.

Hours:

Wednesday, July 8 14:00-21:00 (during the Welcome Reception)

Thursday, July 9 7:30-18:30

Friday, July 10 7:30-18:00

Saturday, July 11 7:45-12:30

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

Registration Desk Hours

Location: Level 3 Core Registration Area

Wednesday, July 8 14:00-21:00 (during the Welcome Reception)

Thursday, July 9 7:30-18:30

Friday, July 10 7:30-18:00

Saturday, July 11 7:45-12:30

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/meetings/>) four to six weeks after the meeting. New this year! - All session rooms, both main ballrooms and break-out rooms, are being recorded. If you were unable to attend a concurrent session, don't forget to watch it on the website!

Social Events

Welcome Reception

All registered delegates and registered guests are invited to pick up their registration materials and to attend the IMAST Welcome Reception on Wednesday, July 8 from 19:00-21:00. The reception will be hosted in the Exhibit Hall in the Ballroom 1 of the KLCC, where beverages and light hors d' oeuvres will be served. There is no charge for registered delegates, though a ticket must be requested at the time of registration. Registered guests may purchase a Welcome Reception ticket for \$50 USD at the time of registration. Dress for the Welcome Reception is business casual.

We encourage delegates to take part in the following afternoon activities before the Welcome Reception on Wednesday, July 8.

15:00 – 16:45 Special Symposia

1A. Optimal Management of Cervical Spondylotic Myelopathy

1B. Management of Spinal Emergencies

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

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

Course Reception

IMAST delegates and registered guests are invited to take part in a closing reception at the Thean Hou Temple in Kuala Lumpur on Friday, July 10 from 19:00 – 22:00. Join us in this beautiful Chinese temple for an evening of networking and delicious cuisine from the area. Tickets are \$25 USD each for registered delegates and \$75 USD each for registered guests and must be purchased at the time of registration. A limited number of tickets may be available onsite, but organizers strongly encourage delegates to purchase tickets in advance. Casual attire (dress or polo shirts, no ties required) is appropriate for the Course Reception, please keep in mind the event will be both indoors and outdoors.

Optional Tours

SRS is proud to be partnering with Dekon Congress & Tourism to offer the below optional tours for the 22nd IMAST. Registration for all tours will be handled through Dekon. Please note SRS is unable to assist with tour reservations.

To check the availability of a tour on-site, please visit Dekon's registration desk located next to the registration desk on level 3.

Tours	Duration	Price per Person
Hands-on Cooking Class	4 hours	\$152 USD
Journey to Discovery - Ipoh	10 hours	\$123 USD
Dinner Date in the Sky	4 hours	\$125 USD
KL Highlights Discovery	4 hours 30 minutes	\$55 USD
KL Discovery Walk (City Center)	4 hours	\$73 USD
Discover the School of Hard Knocks	3 hours 30 minutes	\$70 USD
Discover Putrajaya	3 hours 30 minutes	\$62 USD
KL Countryside Discovery	3 hours 30 minutes	\$45 USD
Journey to Discovery - Malacca	9 hours	\$120 USD
KL City Discovery	3 hours 30 minutes	\$53 USD

Meeting Overview

	Tuesday, July 7	Wednesday, July 8	Thursday, July 9	Friday, July 10	Saturday, July 11
Morning	8:00 – 17:00 Exhibit Setup	8:00 – 12:00 Exhibit Setup/ Exhibitor Registration Open Board of Directors Meeting	*7:30 – 8:30 Hands-On Workshops with Breakfast 7:30 – 18:30 Delegate Registration Open 8:15 – 8:45 Breakfast & Exhibit Viewing 8:45 – 10:15 General Session: Whitecloud Clinical Award Nominees & Presidential Address 10:15 – 11:00 Refreshment Break & Exhibit Viewing *NEW* Case Presentations in Exhibit Hall* 11:00 – 12:15 Concurrent Abstract Sessions & Debate Series	*7:30 – 8:30 Hands-On Workshops with Breakfast 7:30 – 16:45 Delegate Registration Open 8:15 – 8:40 Breakfast & Exhibit Viewing 8:40 – 9:40 Concurrent Abstract Sessions & Debate Series 9:40 – 10:30 Refreshment Break & Exhibit Viewing *NEW* Case Presentations in Exhibit Hall* 10:30 – 11:55 Concurrent Abstract Sessions & Complications Series	7:45 – 12:30 Delegate Registration Open Exhibits Closed 8:15 – 9:15 Concurrent ICLs 9:15 – 9:30 Refreshment Break 9:30 – 10:30 Concurrent Debate Sessions & Point Presentations 11:00 – 12:30 Lunch with the Experts
Afternoon		12:00 – 14:00 Exhibit Setup Board of Directors Meeting 14:00 – 21:00 Delegate Registration Opens 15:00 – 16:45 Symposia A Symposia B 16:45 – 17:00 Walking Break	*12:30 – 13:30 Lunch Exhibit Viewing Hands-On Workshops 13:45 – 14:45 Concurrent ICLs & Point Presentations 14:45 – 15:00 Refreshment Break & Exhibit Viewing 15:00 – 15:55 Concurrent Abstract Sessions, Complications Series & Point Presentations 15:55 – 16:10 Walking Break & Exhibit Viewing 16:10 – 17:10 Concurrent Roundtable & Abstract Sessions 17:10 – 17:30 Walking Break	*12:05 – 13:05 Lunch Exhibit Viewing Hands-On Workshops 13:15 – 14:15 Concurrent Roundtable Sessions & Point Presentations 14:15 – 14:30 Walking Break & Exhibit Viewing 14:30 – 15:30 Concurrent Abstract Sessions, Debates & ICLs 15:30 – 15:45 Refreshment Break & Exhibit Viewing 15:45 – 16:45 Concurrent ICLs & Point Presentations	11:00 – 12:30 *NEW* Lunch with the Experts 12:30 Adjourn
Evening		*17:00 – 19:00 Hands-On Workshops with Beverages & Snacks *19:00 – 21:00 Welcome Reception in Exhibit Hall	*17:30 – 18:30 Hands-On Workshops with Beverages & Snacks Free Evening	*19:00 – 22:00 Course Reception	

*Denotes non-CME session

Kuala Lumpur Convention Center (KLCC) Floor Plan

Level 3

Ballroom 1: Exhibit Hall

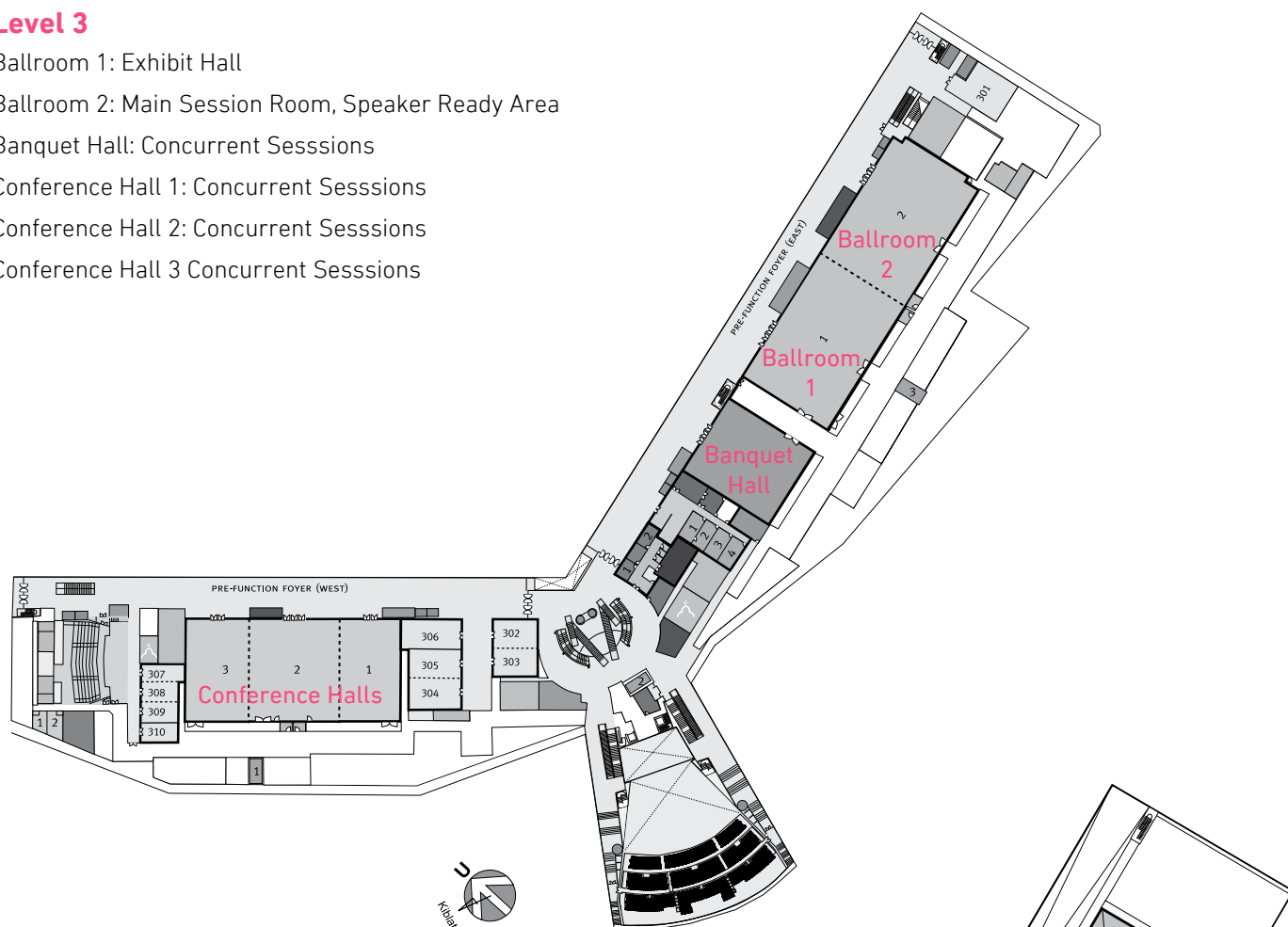
Ballroom 2: Main Session Room, Speaker Ready Area

Banquet Hall: Concurrent Sessions

Conference Hall 1: Concurrent Sessions

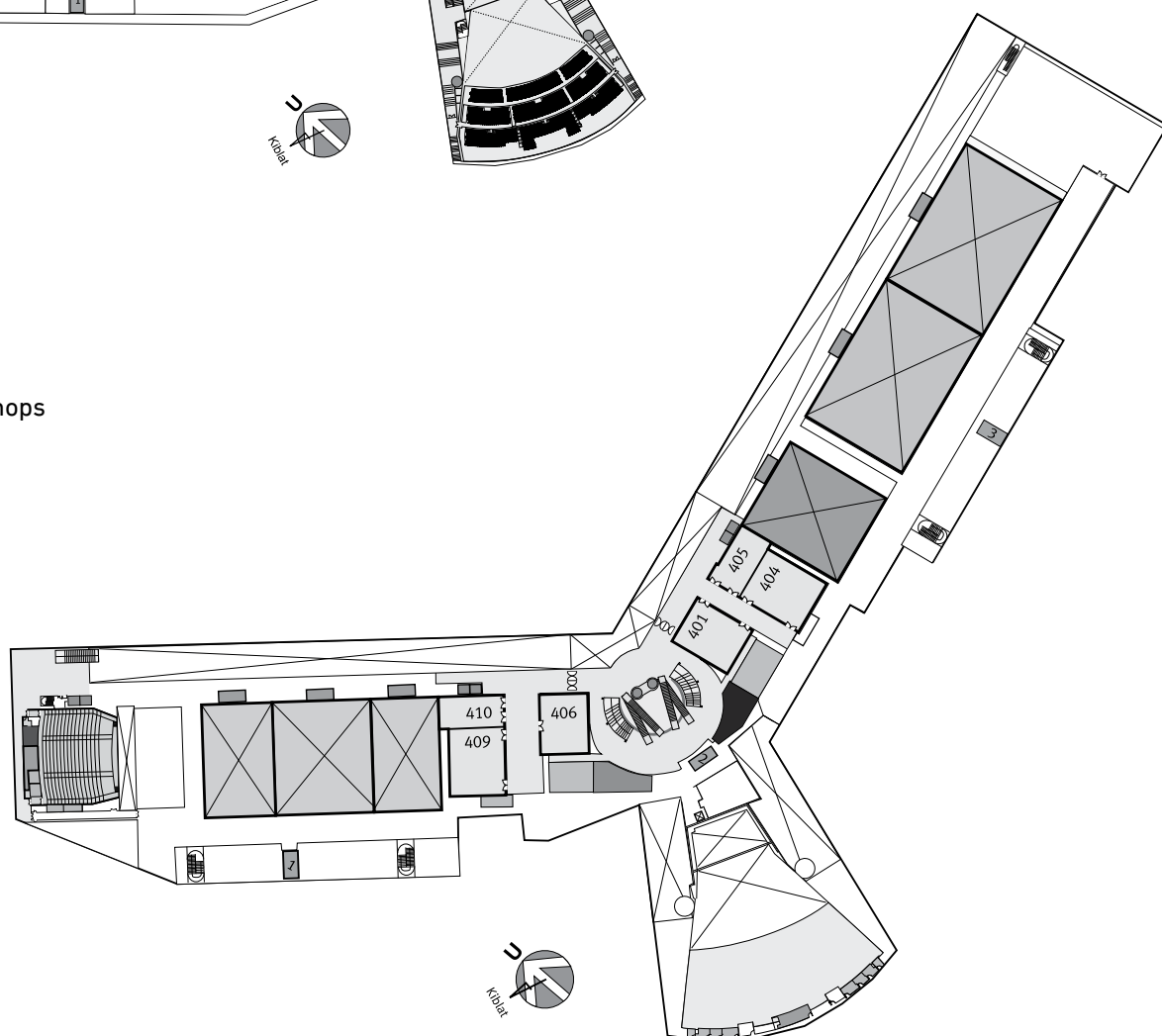
Conference Hall 2: Concurrent Sessions

Conference Hall 3 Concurrent Sessions



Level 4

Hands-On Workshops





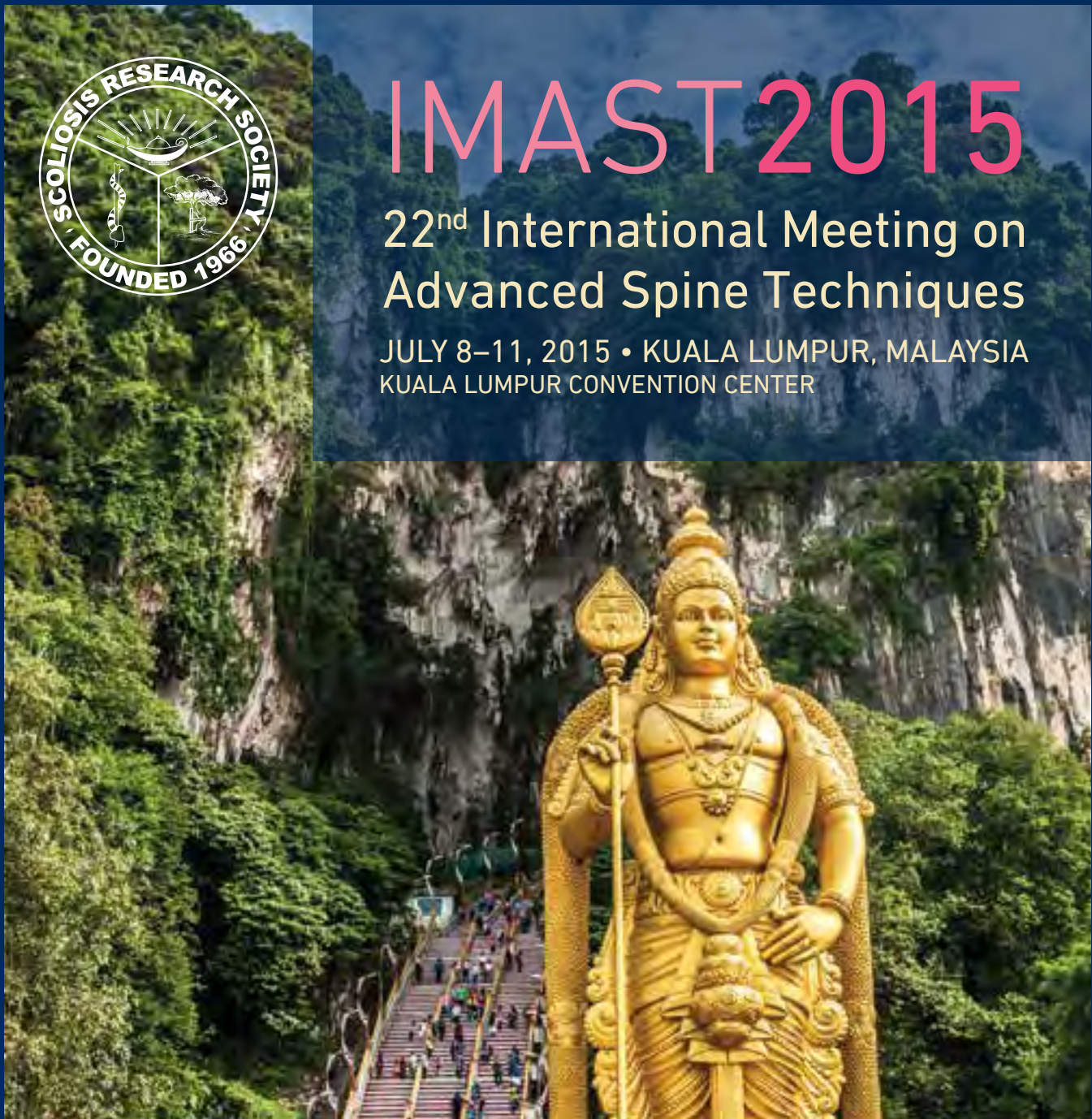
Author Disclosures



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Presentation Kiosks

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(a) Grants/ Research Support (Industry); (b) Consultant; (c) Stock/ Shareholder (self-managed); (d) Speaker's Bureau; (e) Advisory Board or Panel (Industry); (f) Salary, Contractual Services (Industry); (g) Other Financial Or Material Support (royalties, patents, etc.)

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Meeting Agenda





The Scoliosis Research Society
gratefully acknowledges Medtronic for
their support of the Wireless Internet
and Welcome Reception.

14:00 - 21:00 **Registration Open**

LEVEL 3 CORE

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

1A. Optimal Management of Cervical Spondylotic Myelopathy

ROOM: BANQUET HALL

Moderators: *Morio Matsumoto, MD & Christopher I. Shaffrey, MD*

15:00 - 15:12 **Importance of Assessing for Concurrent Deformity in the Setting of Cervical Spondylotic Myelopathy**

Christopher P. Ames, MD

15:12 - 15:24 **Factors Influencing Surgical Approach for Cervical Spondylotic Myelopathy**

K. Daniel Riew, MD

15:24 - 15:34 **Discussion**

15:34 - 15:46 **Central Cord Syndrome: Should We Operate Early or Delay Management?**

Michael G. Fehlings, MD, PhD, FRCS, FACS

15:46 - 15:58 **Advances in Techniques for Cervical Laminoplasty**

Tateru Shiraishi, MD

15:58 - 16:08 **Discussion**

16:08 - 16:32 **Debate: Cervical Stenosis and Cord Compression with T2 Signal Change and Minimal Symptoms: Operate or Follow?**

Follow: Todd J. Albert, MD

Operate: Vincent C. Traynelis, MD

16:32 - 16:45 **Discussion**

1B. Management of Spinal Emergencies

ROOM: CONFERENCE HALL 2

Moderators: *David W. Polly, Jr., MD & Hee-Kit Wong, MD*

15:00 - 15:15 **Management of Cervical Injury with Severe Neurological Deficit**

James S. Harrop, MD

15:15 - 15:30 **Managing Metastatic Disease with Neurologic Deficit**

Mun Keong Kwan, MBBS, MS(Orth)

15:30 - 15:45 **Discussion**

15:45 - 16:00 **Management of Osteomyelitis and Epidural Abscess**

John R. Dimar, II, MD

16:00 - 16:15 **Management of Post-Operative Wound Infection**

Saamyajit Basu, MD

16:15 - 16:30 **Managing Pharmacologic Anticoagulation in the Emergent Operative Setting**

Ahmet Alanay, MD

16:30 - 16:45 **Discussion**

16:45 - 17:00 **Walking Break**

17:00 - 19:00 **Hands-On Workshops****

(See "Exhibits and Hands-On Workshops (HOW) section on page 210 for more information.)

19:00 - 21:00 **Welcome Reception**

EXHIBIT HALL, BALLROOM 1

7:30 - 18:30	Registration Open LEVEL 3 CORE
7:30 - 8:30	**Hands-On Workshops with Breakfast (See "Exhibits and Hands-On Workshops (HOW) section on page 210 for more information.)
8:15 - 17:30	Exhibits Open BALLROOM 1
8:15 - 8:45	Exhibit Viewing & Breakfast BALLROOM 1
8:45 - 10:15	Session 1: General Session and Whitecloud Award Nominees ROOM: BALLROOM 2 Moderators: Henry F.H. Halm, MD & Ronald A. Lehman, MD The general session is supported, in part, by a grant from K2M.
8:45 - 8:50	Welcome Address Christopher I. Shaffrey, MD IMAST Committee Chair
8:50 - 8:54	†Paper 1: Sacral Three Column Osteotomies for Sacral Fracture after Multilevel Spinal Fusion <i>Haruki Funao, MD; Floreana Naef, MD; Richard L Skolasky, PhD, ScD; Khaled M. Kebaish, MD</i>
8:54 - 8:58	†Paper 2: Neurologic Complications in Adult Spinal Deformity Surgery: Incidence, Risk Factors and Outcomes in 558 Patients <i>Han Jo Kim, MD; Sravisht Iyer, MD; Lukas P. Zebala, MD; Michael P. Kelly, MD, MS; Daniel M. Sciubba, MD; Themistocles S. Protopsaltis, MD; Munish Chandra Gupta, MD; Brian James Neuman, MD; Gregory M. Mundis, MD; Christopher P. Ames, MD; Justin S. Smith, MD, PhD; Robert A. Hart, MD; Douglas C. Burton, MD; Eric O. Klineberg, MD</i>
8:58 - 9:02	†Paper 3: Pre-Operative Predictors of Neurological Motor Decline in Complex Adult Spinal Deformity Surgery: Results of the Prospective, International, Multicenter Scolio-RISK-1 Study in 271 Patients <i>Michael G. Fehlings, MD, PhD, FRCSC; Lawrence G. Lenke, MD; Christopher I. Shaffrey, MD; Branko Kopjar, MD, PhD, MS; Kenneth M.C. Cheung, MD; Leah Yacat Carreon, MD, MS; Mark B. Dekutoski, MD; Frank J. Schwab, MD; Oheneba Boachie-Adjei, MD, DSc; Khaled M. Kebaish, MD; Christopher P. Ames, MD; Yong Qiu, MD; Yukihiro Matsuyama; Benny T. Dahl, MD, PhD; Hossein Mehdian, MD; Ferran Pellisé, MD; Stephen J. Lewis, MD, FRCSC, MS; Sigurd H. Berven, MD</i>
9:02 - 9:09	Discussion
9:09 - 9:13	†Paper 4: Do Epidural Injections Prior to Lumbar Fusions Effect Postoperative Infection and Intraoperative Durotomy Rates? <i>Scott Yang, MD; Brian C. Werner, MD; Jourdan M. Cancienne; Adam L. Shimer; Hamid Hassanzadeh, MD; Frank H. Shen; Anuj Singla, MD</i>
9:13 - 9:17	†Paper 5: Chondrosarcomas of the Spine: Prognostic Variables for Local Recurrence and Mortality in a Multicenter Study <i>Charles Fisher, BS, MD, FRCSC, MHS; Anne Versteeg; Nicolas Dea, MD, FRCSC, MSc; Stefano Boriani, MD; Peter Pal Varga, MD; Mark B. Dekutoski, MD; Luzzati Alessandro; Ziya L. Gokaslan, MD; Richard Williams, FRCSC; Jeremy James Reynolds, FRCS (T & O); Michael G. Fehlings, MD, PhD, FRCSC; Chetan Bettegowda, MD, PhD; Laurence D. Rhines, MD</i>
9:17 - 9:21	†Paper 6: A Dissociated Effect after Ponte Release for Periapical Segmental Vertebral Rotation in Adolescent Idiopathic Scoliosis. <i>Shoji Seki, MD, PhD; Yoshiharu Kawaguchi, MD, PhD; Hiroto Makino, MD; Tomoatsu Kimura, MD, PhD</i>
9:21 - 9:28	Discussion
9:28 - 9:32	†Paper 7: Clinical and DTI Evaluation of Effectiveness of Riluzole in the Treatment of Early Cervical Spondylotic Myelopathy: A Double Blinded, Placebo-Controlled Randomised Controlled Trial <i>Ajoy Prasad Shetty, MS; Siddharth Narasimhan Aiyer, MS; Rishi Kanna, MS; S. Rajasekaran, PhD, MS</i>

9:32 - 9:36	†Paper 8: Clinical Outcome of Instrumented French Door Cervical Laminoplasty <i>Hossein Mehdian, MD; A.B. Perez Romera, MD; Luigi Aurelio Nasto, MD; <u>Michael Hutton, MD</u>; Oliver M. Stokes, FRCSC, MS</i>
9:36 - 9:40	†Paper 9: Efficiency of Lead Aprons in Blocking Radiation: How Protective are They? <i><u>Seung-Jae Hyun</u>; Ki-Jeong Kim, MD, PhD; Tae-Ahn Jahng, MD, PhD</i>
9:40 - 9:47	Discussion
9:47 - 9:52	Introduction of SRS President <i>David W. Polly, Jr., MD, SRS President-Elect</i>
9:52 - 10:07	Keynote Address <i>John P. Dormans, MD, SRS President</i>
10:07 - 10:15	Preview of the 50 th Annual Meeting & Course – Minneapolis, Minnesota, USA and 23 rd IMAST – Washington, DC, USA <i>Ronald A. Lehman, MD, SRS Program Committee Chair</i>
10:15 - 11:00	Refreshment Break & Exhibit Viewing BALLROOM 1
10:20 - 10:50	**Exhibit Hall Case Presentation #1 BALLROOM 1 <i>David W. Polly, Jr., MD</i>
11:00 - 12:15	Concurrent Sessions 2A-C: Abstract Sessions and Debate Series 2A: Whitecloud Basic Science Nominees and Top-Scoring Abstracts ROOM: BALLROOM 2 <i>Moderators: Kenneth M.C. Cheung, MD & Michael J. Yaszemski, MD, PhD</i>
11:00 - 11:04	*Paper 10: Distractional Failure Forces Comparison of Different Anchor Sites for the Pediatric Growing Rod Technique <i>Yang Junlin, MD, PhD; <u>Huang Zifang, MD, PhD</u></i>
11:04 - 11:08	*Paper 11: Does Pedicle Screw Fixation Under Age Five Cause Spinal Canal Narrowing? A CT Study with Minimum Five-years Follow Up <i><u>Sinan Kahraman, MD</u>; Meric Enercan, MD; Mutlu Cobanoglu, MD; Sinan Yilar, MD; Levent Ulusoy, MD; Ayhan Mutlu, MD; Tunay Sanli, MA; Bahadir Gokcen, MD; Erden Erturer, MD; Cagatay Ozturk, MD; Ahmet Alanay, MD; Azmi Hamzaoglu, MD</i>
11:08 - 11:12	*Paper 12: Abnormal Ultrastructure of the Osteocyte-Lacuno-Canalicular System in Adolescent Idiopathic Scoliosis: A New Novel Finding <i><u>Wayne Lee</u>; Huanxiong Chen, MD; Jiajun Zhang, MPhil; Zhiwei Wang, MD; Bobby Kinwah Ng, MD; Kwong Man Lee; Tsz Ping Lam, MD; Jerry J.Q. Feng, PhD; Jack C.Y. Cheng, MD</i>
11:12 - 11:18	Discussion
11:18 - 11:22	*Paper 13: Does Anterior Column Support (ACS) following a Pedicle Subtraction Osteotomy Reduce Rod Strain? An In Vitro Biomechanical Investigation <i><u>Dennis Hallager Nielsen, MD</u>; Martin Gehrchen, MD, PhD; Benny T. Dahl, MD, PhD; Jonathan Andrew Harris, MS; Manasa Gudipally, MS; Sean Jenkins, BS; Ai-Min Wu, MD; Brandon Bucklen, PhD</i>
11:22 - 11:26	*Paper 14: Novel Virtual Modeling of Alignment following ASD Surgery: Establishing Relationships between Compensatory Changes and Overcorrection Due to Proximal Junctional Kyphosis <i><u>Renaud Lafage, MS</u>; Shay Bess, MD; Steven D. Glassman, MD; Christopher P. Ames, MD; Douglas C. Burton, MD; Bradley Yates Harris, JD; Robert A. Hart, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; Breton Line, BS; Justin K. Scheer, BS; Themistocles S. Protopsaltis, MD; Frank J. Schwab, MD; Virginie Lafage, PhD; International Spine Study Group</i>
11:26 - 11:30	*Paper 15: Generation of FBN1 Gene Knockout Pig Model for Marfan Syndrome <i>Morio Matsumoto, MD; <u>Kota Watanabe, MD</u>; Keisuke Horiuchi, MD, PhD; Kazuhiro Umeyama, PhD; Hiroshi Nagashima, PhD</i>
11:30 - 11:37	Discussion

- 11:37 - 11:41 **Paper 16: Predictors of Length of Hospital Stay and 30-Day Readmission in Cervical Spondylotic Myelopathy Patients: An Analysis of 3057 Patients Using the American College of Surgeons Database**
Peter G. Passias, MD; Cyrus Jalai, BA; Nancy Worley, MS; Shaleen Vira, MD; Michael Gerling, MD; Virginie Lafage, PhD; Thomas J. Errico, MD
- 11:41 - 11:45 **Paper 17: Minimally Invasive Transforaminal Lumbar Interbody Fusion (MIS TLIF): Two Year Prospective Outcome Study in a Tertiary Care Hospital**
Khai Sing Lam, MD, FRCS; Ed Simor Khan, MD
- 11:45 - 11:49 **Paper 18: Use of PEEK Cages in the Treatment of Basilar Invagination by Atlantoaxial Facet Distraction (Goel Technique)**
Luis Eduardo Carelli Teixeira Da Silva, MD, MSc; Alderico Girão Campos de Barros, MD; Raphael Teofilo de Souza, MD; Gustavo Borges Azevedo, MD
- 11:49 - 11:56 **Discussion**
- 11:56 - 12:00 **Paper 19: Benefit of TLIF versus PSF in Lumbar Spine Disorders**
Steven D. Glassman, MD; Leah Yacat Carreon; Zoher Ghogawala, MD; Matthew J McGirt, MD; Kevin Foley, MD; Anthony Asher, MD
- 12:00 - 12:04 **Paper 20: Propensity Score Matched Analysis of Adult Spinal Deformity (ASD) Patients Demonstrates that Interbody and/or Posterolateral Use of Recombinant Human Bone Morphogenetic Protein-2 (rhBMP-2) Improves Fusion Rates without Increasing Complications**
Shay Bess, MD; Breton Line, BS; Eric O. Klineberg, MD; Christopher P. Ames, MD; Behrooz A. Akbarnia, MD; Oheneba Boachie-Adjei, MD, DSc; Douglas C. Burton, MD; Marilyn L. G. Gates, MD; D.Kojo Hamilton, MD; Robert A. Hart, MD; Richard Hostin, MD; Virginie Lafage, PhD; Gregory M. Mundis, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; International Spine Study Group
- 12:04 - 12:08 **Paper 21: Classification of Early Onset Scoliosis (C-EOS) Has Almost Perfect Inter and Intra Observer Reliability**
Micaela Cyr, BA; Tricia St. Hilaire, MPH; Zahoxing Pan, PhD; George H. Thompson, MD; Children's Spine Study Group; Growing Spine Study Group; Sumeet Garg, MD
- 12:08 - 12:15 **Discussion**

2B: Early Onset Scoliosis Abstracts

ROOM: BANQUET HALL

Moderators: Laurel C. Blakemore, MD & Noriaki Kawakami, MD, DMSc

- 11:00 - 11:04 **Paper 22: Safety and Compatability of Magnetically-Controlled Growing Rods and Magnetic Resonance Imaging: An In-Vitro Study**
Henry Budd; Oliver M. Stokes, FRCS, MS; Michael Hutton, MD
- 11:04 - 11:08 **Paper 23: Use of Ultrasound to Monitor Distractions by Magnetically-Controlled Growing Rods: A Longitudinal Correlation Study**
Cora Hingyee Bow; Jason Pui Yin Cheung, MBBS, MMedSc, FRCS; Dino Samartzis, PhD; Kenny Kwan, BM BCh; Kenneth M.C. Cheung, MD
- 11:08 - 11:12 **Paper 24: Cost Analysis of Magnetically-Controlled Growing Rods Compared with Traditional Growing Rods for Early Onset Scoliosis in the United States**
David W. Polly, Jr., MD; Stacey J. Ackerman, PhD; Karen B. A. Schneider, PhD; Jeff B. Pawelek; Behrooz A. Akbarnia, MD
- 11:12 - 11:18 **Discussion**
- 11:18 - 11:22 **Paper 25: Is Radiographic Control Necessary after Every Lengthening of Magnetically-Controlled Growing Rod?**
Caglar Yilgor, MD; Ahmet Alanay, MD
- 11:22 - 11:26 **Paper 26: Comparison of Primary versus Conversion Surgery with MCGR Rods in Children with EOS**
Heli Keskinen, MD; Ilkka J. Helenius; Colin Nnadi; Hilali H. Noordeen; Burt Yaszay, MD; John A. I. Ferguson, MD, FRACS; Tiziana Greggi, MD; Alpaslan Senkoylu, MD; Kenneth MC Cheung, MD; Pooria Hosseini, MD, MSc; Jeff B. Pawelek; Gregory M. Mundis, MD; Behrooz A. Akbarnia, MD
- 11:26 - 11:30 **Paper 27: Sliding-Growing Rod Technique (SGRT) in the Treatment of Early Onset Scoliosis – More Than Two Years of Follow Up**
Meric Enercan, MD; Sinan Kahraman, MD; Bahadir Gokcen, MD; Mutlu Cobanoglu, MD; Sinan Yilar, MD; Tunay Sanli, MA; Erden Erturer, MD; Cagatay Ozturk, MD; Azmi Hamzaoglu, MD

- 11:30 - 11:37 Discussion
- 11:37 - 11:41 **Paper 28: Patients Without Intraoperative Neuromonitoring (IONM) Alerts During Implantation of Rib Based Growing Constructs Did Not Sustain Neurologic Injury During Subsequent Routine Expansions**
Jaren LaGreca, BA; Micaela Cyr, BA; Tara Flynn, BA; Patrick J. Cahill, MD; Amer F. Samdani, MD; Michael G. Vitale, MD, MPH; Ron El-Hawary, MD; John T. Smith, MD; Jonathan H. Phillips, MD; John M. Flynn, MD; Michael P. Glotzbecker, MD; Sumeet Garg, MD
- 11:41 - 11:45 **Paper 29: Both Rib Based Growing Surgery and Early Primary Posterior Spinal Fusion (PSF) Control Idiopathic Scoliosis (IS) in Young Children**
Micaela Cyr, BA; Patrick J. Cahill, MD; Suhong Tong, MS; Tricia St. Hilaire, MPH; Harms Study Group; Children's Spine Study Group; Sumeet Garg
- 11:45 - 11:49 **Paper 30: Improvement in Pulmonary Function and Thoracic Height after Halo Gravity Traction for Severe Spinal Deformity**
Lauren LaMont; Wendy Wittenbrook, BS, MA, RD, CSP, LD; Dong-Phuong Tran, MS; Charles E. Johnston, MD; Brandon A. Ramo, MD; Heather D. Caine, BS; Kaitlyn Elizabeth Brown, BS; Daniel J. Sucato, MD, MS
- 11:49 - 11:56 Discussion
- 11:56 - 12:00 **Paper 31: Biomechanical Analysis of a Growing Rod with Sliding Pedicle Screw System for Early-Onset Scoliosis**
Zhihua Quyang; Robert Tisherman, BS; Wenjun Wang, MD, PhD; Patrick P. Bosch, MD; James Kang, MD; Kevin Bell, PhD
- 12:00 - 12:04 **Paper 32: Outcomes of Pelvic Fixation in Growing Rod Constructs: An Analysis of Patients with a Minimum of Four-year Follow Up**
Jaysson Brooks, MD; Amit Jain, MD; Francisco Javier Sanchez Perez-Grueso, MD; David L. Skaggs, MD, MMM; George H. Thompson, MD; Behrooz A. Akbarnia, MD; Paul D. Sponseller, MD; Growing Spine Study Group
- 12:04 - 12:08 **Paper 33: Does the "Law of Diminishing Returns" Apply to Guided Growth Constructs?**
Lindsay M. Andras, MD; Haleh Badkoobehi, MD; Alexander Broom, BA; Frances McCullough, RN; Richard E. McCarthy, MD; David L. Skaggs, MD, MMM; Growing Spine Study Group
- 12:08 - 12:15 Discussion

2C. Debate Series 1

ROOM: CONFERENCE HALL 2

Moderators: Benny T. Dahl, MD, PhD, DMSci & Mun Keong Kwan, MBBS, MS(Orth)

- 11:00 - 11:37 **Debate 1: Which Approach is Superior for Treating Adult Degenerative Scoliosis?**
MIS: Juan S. Uribe, MD
Open: Steven D. Glassman, MD
- 11:37 - 12:15 **Debate 2: What is the Best Way to Achieve Lumbar Lordosis?**
Posterior Approaches: Lawrence G. Lenke, MD
Anterior/ Lateral Approaches: Munish C. Gupta, MD

12:15 - 12:30 **Walking Break**

12:30 - 1:30 **Exhibit Viewing & Lunch**

BALLROOM 1

**Hands-On Workshops with Lunch – Level 4

(See "Exhibits and Hands-On Workshops (HOW) section on page 210 for more information.)

13:30 - 13:45 **Walking Break**

13:45 - 14:45 **Concurrent Sessions 3A-D: Instructional Course Lectures and Two-Minute Point Presentations**

3A: Adult Deformity: Clinical & Radiographic Evaluation

ROOM: CONFERENCE HALL 1

Moderators: *Pierre Roussouly, MD & Mark Weidenbaum, MD*

- 13:45 - 13:55 **Basics of Radiographic Assessment of Spino-Pelvic Alignment**
Virginie LaFage, PhD
- 13:55 - 14:05 **The SRS-Schwab Classification**
Frank J. Schwab, MD
- 14:05 - 14:15 **Assessment of Spinal Flexibility in the Pre-Operative Planning for Adult Spinal Deformity Surgery**
Benny T. Dahl, MD, PhD, DMSci
- 14:15 - 14:25 **The Role of Radiographic and Clinical Parameters in Determining Upper Instrumented Vertebral Level in Adult**
Hee-Kit Wong, MD
- 14:25 - 14:45 **Discussion**

3B: Management of Primary Spine Tumors

ROOM: CONFERENCE HALL 3

Moderators: *Keith D.K. Luk, MD & Christopher P. Ames, MD*

- 13:45 - 13:55 **How Classification Impacts Surgical Decision Making for Spine Tumor Resection**
Laurence D. Rhines, MD
- 13:55 - 14:05 **Surgical Resection Techniques for the Mobile Spine**
Jae-Yoon Chung, MD
- 14:05 - 14:15 **Decision Making for Sacrectomy versus Partial Sacrectomy**
Michael J. Yaszemski, MD, PhD
- 14:15 - 14:25 **Reconstruction following Primary Spine Tumor Resection**
Peter S. Rose, MD
- 14:25 - 14:45 **Discussion**

3C: AIS: Clinical & Radiographic Evaluation

ROOM: CONFERENCE HALL 2

Moderators: *Geoffrey N. Askin, FRACS & Marinus De Kleuver, MD, PhD*

- 13:45 - 13:55 **Role of 3D Classification in AIS**
Baron S. Lonner, MD
- 13:55 - 14:05 **How the Lenke Classification Typically Guides Fusion Levels and When Rules Can be Broken**
Peter O. Newton, MD
- 14:05 - 14:15 **When Can Stopping Short Predictably Give Good Results in AIS?**
Kenneth M.C. Cheung, MD
- 14:15 - 14:25 **Evaluation and Management of Atypical Curve Patterns**
Amer F. Samdani, MD
- 14:25 - 14:45 **Discussion**

3D: Two-Minute Point Presentations

ROOM: BANQUET HALL

Moderators: Shay Bess, MD & Andrew K. Cree, MD

- 13:45 - 13:47 **Paper 34: Short Fusion Strategy for Posterior Correction Surgery Using Pedicle Screw Constructs in Lenke Type 5C Adolescent Idiopathic Scoliosis**
Eijiro Okada; Nobuyuki Fujita, MD, PhD; Tomohiro Hikata; Akio Iwanami; Naobumi Hosogane, MD, PhD; Ken Ishii; Masaya Nakamura; Morio Matsumoto, MD; Kota Watanabe, MD; Keio Spine Research Group
- 13:47 - 13:49 **Paper 35: Key Anchor Points for Specific Correction Maneuvers in Lenke 1 AIS: How Important is the Implant Pattern Design?**
Franck Le Naveaux, PhD candidate; Carl-Eric Aubin, PhD, P.Eng.; A. Noelle Larson, MD; Hubert Labelle, MD; MIMO Study Group
- 13:49 - 13:51 **Paper 36: A Simple Method for Assessing Rotational Flexibility in Adolescent Idiopathic Scoliosis: Modified Adam's Forward Bending Test**
Alpaslan Senkoylu, MD; Mustafa Ilhan, MD, PhD; Necdet Altun, MD; Dino Samartzis, PhD; Keith D. K. Luk, MD
- 13:51 - 13:53 **Paper 37: How Much Differential Rod Contouring Is Necessary to Biomechanically Contribute to the Transverse Plane Correction in AIS Instrumentation?**
Xiaoyu Wang, PhD; Carl-Eric Aubin, PhD, P.Eng.; Laure Boyer, MS; Franck Le Naveaux, PhD candidate; Richard M. Schwend, MD
- 13:53 - 13:55 **Paper 38: Do We Underestimate the Ability of Patients to Return to Physical and Athletic Activities after Scoliosis Surgery? A Validated Patient Questionnaire Based Study**
Stephen F. Wendolowski, BS; Vishal Sarwahi, MD; Rachel Claire Gecelter, BS; Dana Orlando; Abhijit Pawar, MD; Dan Wang, MS
- 13:55 - 13:57 **Paper 39: Obesity Markedly Increases the Rate of Deep Surgical Site Infections and Implant Failure after Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis**
Joshua M. Pahys, MD; Patrick J. Cahill, MD; Peter O. Newton, MD; Randal R. Betz, MD; Paul D. Sponseller, MD; Ronald A. Lehman, MD; Michael Kelly; Harms Study Group; Amer F. Samdani, MD
- 13:57 - 14:05 **Discussion**
- 14:05 - 14:07 **Paper 40: Correlation between Severity of Adolescent Idiopathic Scoliosis and Pulmonary Artery Systolic Pressure: A Cross-Sectional Study of 338 Patients**
Xingye Li; Zheng Li, MD; Youxi Lin; Haiwei Guo, MD; Jianxiang Shen; Fan Feng
- 14:07 - 14:09 **Paper 41: AIS Treated by PSSIF Caudal to L3: When is Fusion to L3 Stable?**
Seung-Jae Hyun; Lawrence G. Lenke, MD; Yongjung J. Kim, MD; Keith H. Bridwell, MD; Linda Koester; Kathy M. Blanke, RN
- 14:09 - 14:11 **Paper 42: What is Different About Patients with Adolescent Idiopathic Scoliosis who Achieve a Minimal Clinically Important Difference (MCID) in Appearance?**
Amer F. Samdani, MD; Tracey Bastrom, BS, MS; Robert J Ames, MD; Firoz Miyanji, MD, FRCSC; Joshua M. Pahys, MD; Michelle Claire Marks; Baron S. Lonner, MD; Peter O. Newton, MD; Harry L. Shufflebarger, MD; Burt Yaszay, MD; Patrick J. Cahill, MD; Randal R. Betz, MD
- 14:11 - 14:13 **Paper 43: Radiographic Results of Selecting the Touched Vertebra as the Lowest Instrumented Vertebra in Lenke Type 1 (Main Thoracic) & Type 2 (Double Thoracic) Curves at a Minimum Five-Year Follow Up**
Lawrence G. Lenke, MD; Peter O. Newton, MD; Ronald A. Lehman, MD; Michael P. Kelly, MD, MS; David H. Clements, MD; Thomas J. Errico, MD; Randal R. Betz, MD; Amer F. Samdani, MD; Kathy M. Blanke; Harms Study Group
- 14:13 - 14:15 **Paper 44: Selecting the Last "Substantially" Touching Vertebra as Lowest Instrumented Vertebra in Lenke 1A AIS: Radiographic Outcomes in a Minimum of Two-Year Follow Up**
Xiao-dong Qin, PhD; Lei-lei Xu, MD; Ze-zhang Zhu, MD; Jun Qiao, MD; Zhen Liu, MD; Bangping Qian, MD; Yong Qiu, MD
- 14:15 - 14:17 **Paper 45: Validating a Patient Specific Normal Sagittal Contour Prediction Model: How to Know What "Normal" Sagittal Alignment is for Each Patient**
Peter O. Newton MD; Fredrick G. Reighard, MPH; Tracey Bastrom; Joshua Doan, MEng
- 14:17 - 14:25 **Discussion**

- 14:25 - 14:27 **Paper 46: Adoption of a Performance Improvement Module (PIM) Significantly Reduced Length of Stay (LOS) following Adolescent Idiopathic Scoliosis Surgery.**
Harry L. Shufflebarger, MD; Ronald A. Lehman, MD; Michelle Claire Marks; John M. Flynn, MD; Peter O. Newton, MD; Tracey Bastrom, BS,MS
- 14:27 - 14:29 **Paper 47: In Vitro Biomechanical Range of Motion and Coronal Plane Cobb Angle Correction of Fusionless Anterior Tether Constructs for Controlled Scoliosis Correction**
William Francis Lavelle, MD; Mark Moldavsky, BS,MS; Yiwei Cai, BS; Sean Jenkins, BS; Nathaniel R. Ordway, MS; Brandon Bucklen, PhD; Rakesh Ramakrishnan, BS, MD, MBA
- 14:29 - 14:31 **Paper 48: Validation of the “Substantially” Touched Vertebra as the Lowest Instrumented Vertebra in Thoracic Major Curves with AR Lumbar Modifiers**
Joshua S. Murphy, MD; Vidyadhar V. Upasani, MD; Burt Yaszay, MD; Tracey Bastrom, BS, MS; Carrie E. Bartley, MA; Amer F. Samdani, MD; Lawrence G. Lenke, MD; Peter O. Newton, MD
- 14:31 - 14:33 **Paper 49: Is there a Gender-Specific Recruitment Pattern in the Setting of Progressive Sagittal Malalignment?**
Shaleen Vira, MD; Bassel G. Diebo, MD; Matthew Adam Spiegel, BS; Barthelemy Liabaud, MD; Jensen K Henry, BA; Jonathan H. Oren, MD; Renaud Lafage, MS; Elizabeth M Tanzi, BS, MS; Themistocles S. Protopsaltis, MD; Thomas J. Errico, MD; Frank J. Schwab, MD; Virginie Lafage, PhD
- 14:33 - 14:35 **Paper 50: Tranexamic Acid Administration in AIS Surgery Reduces Percent Total Blood Volume Loss**
Elissa Kathleen Butler, BA; David W. Polly, Jr., MD; Tara Garber, MS; Charles Ledonio, MD; Claudia S. Cohn, MD, PhD
- 14:35 - 14:37 **Paper 51: Towards a New 3D Classification for Adolescent Idiopathic Scoliosis (AIS): 3D Subgroups Derived From a Consensus Approach From Members of The SRS 3D Taskforce**
James Wu; Stefan Parent, MD, PhD; Carl-Eric Aubin, PhD, P.Eng.; Samuel Kadoury; Peter O. Newton, MD; Lawrence G. Lenke, MD; Virginie Lafage, PhD; Hubert Labelle, MD
- 14:37 - 14:45 **Discussion**

14:45 - 15:00 **Walking Break**

15:00 - 15:55 **Concurrent Sessions 4A-D:
 Concurrent Abstract Session, Complication Series and Two-Minute Point Presentations**

4A: Adolescent Idiopathic Scoliosis Abstracts

ROOM: BALLROOM 2

Moderators: Daniel J. Sucato, MD, MS & Yong Qiu, MD

- 15:00 - 15:04 **Paper 52: Coagulation Profile of Adolescent Idiopathic Scoliosis (AIS) Patients Undergoing Posterior Spinal Fusion (PSF)**
Patrick P. Bosch; Antonio Cassara, MD; Charles I. Yang, MD; Jonathan Waters, MD; Tanya S. Kenkre, PhD; Joanne A. Londino, RN, BSN
- 15:04 - 15:08 **Paper 53: Ultra Low Dose Imaging for the Follow Up of Idiopathic Scoliosis**
Brice Ilharreborde; Emmanuelle Ferrero, MD; Marianne Alison, MD; Keyvan Mazda
- 15:08 - 15:12 **Paper 54: Hydration Properties of the Lumbar Intervertebral Discs in AIS after Surgical Correction: Five-Year Follow Up and Comparison with an Age-Matched Control Group**
Kariman Abelin-Genevois, MD, PhD; Eva Polirsztok, MD, MS; Erik Estivaldez, PhD; Jerome Briot, PhD; Annick Sevely, MD; Jérôme Sales de Gauzy, MD; Pascal Swider, PhD
- 15:12 - 15:18 **Discussion**
- 15:18 - 15:22 **Paper 55: Adolescent Idiopathic Scoliosis Treated by a Less Invasive Lateral Approach**
Rodrigo A. Amaral; Rubens Jensen, MD; Luis Marchi, MS; Fernanda Fortti, BS; Etevaldo Coutinho, MD; Luiz Henrique Pimenta, MD, PhD

- 15:22 - 15:26 **Paper 56: 3D Rod Shape Change During AIS Instrumentation: How Much And Does It Impact Curve Correction?**
Franck Le Naveaux, PhD candidate; Carl-Eric Aubin, PhD, PEng.; Stefan Parent, MD, PhD; Peter O. Newton, MD; Hubert Labelle, MD
- 15:26 - 15:30 **Paper 57: Comparison of Pulmonary Function after Selective Anterior versus Posterior Fusion for the Correction of Thoracolumbar and Lumbar Curves in Adolescent Idiopathic Scoliosis**
Satoru Demura, MD; Kota Watanabe, MD; Teppei Suzuki, MD; Toshiki Saito, MD; Ayato Nohara, MD; Taichi Tsuji, MD; Ikuho Yonezawa, MD; Koki Uno; Morio Matsumoto, MD; Noriaki Kawakami, MD
- 15:30 - 15:35 **Discussion**
- 15:35 - 15:39 **Paper 58: Braces Designed with CAD/CAM and Numerical Simulations Are More Efficient and Lighter than Standard Thoraco-Lumbo-Sacral Orthoses**
Nikita Cobetto, BS, MS; Carl-Eric Aubin, PhD, PEng.; Stefan Parent, MD, PhD; Julien Clin, PhD; Soraya Barchi, BS; Isabelle Turgeon, BS; Hubert Labelle, MD
- 15:39 - 15:43 **Paper 59: Changes in Sagittal Cervical Alignment after Posterior Spinal Fusion for Adolescent Idiopathic Scoliosis: An Evaluation of 141 Patients**
Joshua M. Pahys; Jahangir K. Asghar, MD; Alexander Theologis, MD; Lucas Suder, BS; Suken A. Shah, MD; Patrick J. Cahill, MD; Amer F. Samdani, MD; Michael Kelly; Harms Study Group; Christopher P. Ames, MD
- 15:43 - 15:47 **Paper 60: Fusion of Proximal Thoracic Curve Avoids Postoperative Cervical Tilt in Adolescent Idiopathic Scoliosis Patients with Double Thoracic Curve**
Jun Jiang, MD; Bangping Qian, MD; Yong Qiu, MD; Bin Wang, MD; Yang Yu, MD; Ze-zhang Zhu, MD
- 15:47 - 15:55 **Discussion**

4B: Complication & Infection Abstracts

ROOM: BANQUET HALL

Moderators: Sigurd H. Berven, MD & John R. Dimar, II, MD

- 15:00 - 15:04 **Paper 61: Development of a Pre-Operative Adult Spinal Deformity Frailty Index that Correlates to Common Quality and Value Metrics: Length of Stay, Major Complications and Patient-Reported Outcomes**
Daniel M. Sciubba, MD; Amit Jain, MD; Brian James Neuman, MD; Khaled M. Kebaish, MD; Peter G. Passias, MD; Lukas P. Zebala, MD; Han Jo Kim, MD; Themistocles S. Protopsaltis, MD; Justin K. Scheer, BS; Justin S. Smith, MD, PhD; D. Kojo Hamilton, MD; Shay Bess, MD; Eric O. Klineberg, MD; Christopher P. Ames, MD; International Spine Study Group
- 15:04 - 15:08 **Paper 62: Analysis of ScolioRisk-1 Prospective Multicenter Database Comparing Perioperative Complications and Patient Reported Outcomes in Primary versus Revision Surgery for Severe Adult Spinal Deformity**
Amit Jain, MD; Floreana Naef, MD; Lawrence G. Lenke, MD; Christopher P. Ames, MD; Yukihiro Matsuyama; Benny T. Dahl, MD, PhD; Christopher I. Shaffrey, MD; Yong Qiu, MD; Michael G. Fehlings, MD, PhD, FRCSC; Hossein Mehdian, MD; Oheneba Boachie-Adjei, MD, DSc; Frank J. Schwab, MD; Kenneth M.C. Cheung, MD; Leah Yacat Carreon, MD, MS; Khaled M. Kebaish, MD
- 15:08 - 15:12 **Paper 63: Geriatric Risk in the Surgical Management of Infectious Spondylitis**
Jae Hong Ha, MD; Bong-Soon Chang, MD, PhD; Choon-Ki Lee, MD, PhD; Hyoungmin Kim; Jong-Hun Jung, MD; Doohyun Kwon, MD
- 15:12 - 15:18 **Discussion**
- 15:18 - 15:22 **Paper 64: Redefining Radiographic Thresholds for Junctional Kyphosis Pathologies**
Renaud Lafage, MS; Frank J. Schwab, MD; Shay Bess, MD; Douglas C. Burton, MD; Christopher P. Ames, MD; Robert A. Hart, MD; Breton Line, BSME; Justin K. Scheer, BS; Justin S. Smith, MD, PhD; Han Jo Kim, MD; Eric O. Klineberg, MD; Themistocles S. Protopsaltis, MD; Virginie LaFage, PhD; International Spine Study Group

- 15:22 - 15:26 **Paper 65: Spinal Implants Can be Inserted or Retained in Patients with Deep Spine Infection: Results from a Large Cohort Study**
Dennis Hey, MBBS (Sing), MRCS (Ire), MMED (Orth), MCI (Sing), FRCSEd (Orth), FAMS (Orth); Paul Anantharajah Tambyah, MD; Nathaniel Ng, MBBS (Sing); Chuen-Seng Tan, PhD, BSc (Hons), MSc; Hee-Kit Wong, MD
- 15:26 - 15:30 **Paper 66: Surgery in Pott's Disease: Experience of 582 Cases**
Shah Alam, MD, FRCSC, MS, FCPS (BD); Md. Rezaul Karim, MS; Sharif Ahmed Jonayed, MS, FCPS (BD); Hasan Khalid Md. Munir, D Ortho; Shubhendu Chakraborty, BS; Tashfique Alam, BS
- 15:30 - 15:35 **Discussion**
- 15:35 - 15:39 **Paper 67: Prospective Evaluation of Radiculitis Following BMP-2 Use for Interbody Arthrodesis in Spine Surgery**
Arjun S. Sebastian; Bradford Currier, MD; Mark Pichelmann, MD; Paul M. Huddleston, MD; Jeremy L. Fogelson, MD; Ahmad Nassr, MD
- 15:39 - 15:43 **Paper 68: Intraoperative Cardiopulmonary Arrest in Children Undergoing Spinal Deformity Correction: Causes and Associated Factors**
Emmanuel N Menga; Cole Hirschfeld, BS; Amit Jain, MD; Dong-Phuong Tran, MS; Heather D Caine, BS; Dolores Njoku, MD; Lori Ann Karol, MD; Paul D. Sponseller, MD
- 15:43 - 15:47 **Paper 69: Postoperative Coronal Malalignment is Associated with Significantly Poor Patient Reported Outcomes in Operatively Treated Adult Spinal Deformity**
Amit Jain, MD; Christopher P. Ames, MD; Virginie Lafage, PhD; Brian James Neuman, MD; Daniel M. Sciubba, MD; Robert A. Hart, MD; Justin K. Scheer, BS; Michael P. Kelly, MD, MS; Shay Bess, MD; Richard Hostin, MD; Christopher I. Shaffrey, MD; Munish Chandra Gupta, MD; Frank J. Schwab, MD; Khaled M. Kebaish, MD; International Spine Study Group
- 15:47 - 15:55 **Discussion**

4C: My Worst Complication Series: Strategies to Prevent/Manage 1

ROOM: CONFERENCE HALL 1

Moderators: Harwant Singh, MD, PhD & Michael J. Yaszemski, MD, PhD

- 15:00 - 15:18 **Complication 1- Adult Deformity**
Pierre Roussouly, MD
- 15:18 - 15:36 **Complication 2- Cervical Trauma**
James S. Harrop, MD
- 15:36 - 15:55 **Complication 3- Tumor**
Peter S. Rose, MD

4D: Two-Minute Point Presentations

ROOM: CONFERENCE HALL 2

Moderators: Ahmet Alanay, MD & Saumyajit Basu, MD

- 15:00 - 15:02 **Paper 70: Is Degenerative Scoliosis a Risk Factor for Adult Thoracolumbar Spinal Fractures? A 7000 Multi-Racial Asian Patients Review**
Gabriel Liu; Jun Hao Tan; Hee Kit Wong, MD
- 15:02 - 15:04 **Paper 71: Development and Validation of a Novel Adult Spinal Deformity Surgical Invasiveness Score: Analysis of 464 Patients**
Brian James Neuman, MD; Justin K. Scheer, BS; Tamir Ailon, MD, FRCSC, MPH; Eric O. Klineberg, MD; Daniel M. Sciubba, MD; Amit Jain, MD; Han Jo Kim, MD; Lukas P. Zebala, MD; Peter G. Passias, MD; Alan H. Daniels, MD; Douglas C. Burton, MD; Themistocles S. Protopsaltis, MD; D. Kojo Hamilton, MD; Christopher P. Ames, MD; International Spine Study Group
- 15:04 - 15:06 **Paper 72: Biomechanical Evaluation of Long Posterior Spinal Fusion Constructs with S2Al Fixation**
Chet Sutterlin, MD; Antony J. F. Field, FRACS; Andrew L. Freeman, MS, MSME; Lisa Ferrara, PhD
- 15:06 - 15:08 **Paper 73: Harrington Revision Surgery in Adulthood: Long-Term Outcomes**
Fethi Laouissat, MD; Clément Silvestre, MD; Kariman Abelin-Genevois, MD, PhD; Pierre Roussouly, MD
- 15:08 - 15:10 **Paper 74: Clinical and Radiographic Parameters Associated with Best versus Worst Clinical Outcomes in Minimally Invasive Deformity Surgery**
Khoi Duc Than, MD; Paul Park, MD; Kai-Ming Gregory Fu; Stacie Nguyen, MPH; Michael Y Wang, MD; Christopher I. Shaffrey, MD; Shay Bess, MD; Behrooz A. Akbarnia, MD; Vedat Deviren, MD; Juan S. Uribe, MD; David O Okonkwo, MD, PhD; Gregory M. Mundis, MD; Praveen V. Mummaneni, MD; International Spine Study Group

- 15:10 - 15:12 **Paper 75: Dedicated Surgical Measurement Software (SMS) Helps Obtain Sagittal and Pelvic Parameters More Reliably than PACS**
Munish Chandra Gupta, MD; Jensen K. Henry, BA; Frank J. Schwab, MD; Eric O. Klineberg, MD; Justin S. Smith, MD, PhD; Jeffrey L. Gum, MD; David W. Polly, Jr., MD; Barthelemy Liabaud, MD; Bassel G. Diebo, MD; D. Kojo Hamilton, MD; Robert K. Eastlack, MD; Peter G. Passias, MD; Douglas C. Burton, MD; Themistocles S. Protopsaltis, MD; International Spine Study Group
- 15:12 - 15:19 **Discussion**
- 15:19 - 15:21 **Paper 76: A New Anterolateral Retroperitoneal Approach for Lumbar Interbody Fusion from L1 to S1: A Prospective Series with Clinical Outcomes**
Joseph S. Butler, PhD, FRCS; Obiekezie Agu, FRCS; Sean Molloy
- 15:21 - 15:23 **Paper 77: Larger Global Sagittal Correction with Pedicle Subtraction Osteotomy is Associated with Increased PJK and Major Complications, but Better Correction and HRQL Scores**
Alex Soroceanu, MD, MPH, FRCSC; Justin S. Smith, MD, PhD; Virginie Lafage, PhD; Eric O. Klineberg, MD; Tamir Ailon, MD, FRCSC, MPH; Christopher P. Ames, MD; Christopher I. Shaffrey, MD; Munish Chandra Gupta, MD; Gregory M. Mundis, MD; Khaled M. Kebaish, MD; Daniel M. Sciubba, MD; Robert A. Hart, MD; Richard Hostin, MD; Frank J. Schwab, MD; International Spine Study Group
- 15:23 - 15:25 **Paper 78: Defining Normative Quality Metrics in Complex High-Risk Deformity Cases: Results from the Scolio-Risk 1 Study**
Sigurd H. Berven, MD; Rajiv Saigal, MD, PhD; Virginie Lafage, PhD; Michael P. Kelly, MD, MS; Branko Kopjar, MD, PhD, MS; Justin S. Smith, MD, PhD; Benny T. Dahl, MD, PhD; Kenneth MC Cheung, MD; Leah Yacat Carreon, MD, MS; Frank J. Schwab, MD; Kathrin Rebmann, MS; Christopher I. Shaffrey, MD; Michael G. Fehlings, MD, PhD, FRCSC; Lawrence G. Lenke, MD; Christopher P. Ames, MD
- 15:25 - 15:27 **Paper 79: The Incidence and Predictors of Early Morbidity and Mortality in Adults Undergoing Elective Fusion for Spinal Deformity**
Nathan J. Lee, BS; Jeremy Steinberger, MD; Branko Skovrlj; Javier Guzman, BS; John I. Shin, BS; Parth A. Kothari, BS; Dante M Leven, DO; John M. Caridi, MD; Samuel K. Cho, MD
- 15:27 - 15:29 **Paper 80: Complex Reconstruction for Persistent Pseudoarthrosis and Coronal Imbalance in an Adult Previous Treated with Harrington Rod Instrumentation and Multiple Revision Surgeries.**
Tina Raman, BS, MD, MS; Suresh Kevin Nayar, BS; Khaled M. Kebaish, MD
- 15:29 - 15:31 **Paper 81: Predictors of Length of Hospital Stay and 30-Day Readmission in Adult Spinal Deformity Surgical Patients: An Analysis of 963 Patients Using the American College of Surgeons Database**
Peter G. Passias, MD; Nancy Worley, MS; Cyrus Jalai, BA; Shaleen Vira, MD; Michael Gerling, MD; Virginie Lafage, PhD; Thomas J. Errico, MD
- 15:31 - 15:38 **Discussion**
- 15:38 - 15:40 **Paper 82: Defining the Role of Lower Limbs in Compensating for Sagittal Malalignment**
Renaud Lafage, MS; Barthelemy Liabaud, MD; Bassel G. Diebo, MD; Jonathan H. Oren, MD; Isaac D. Gammal, BS; Shaleen Vira, MD; Matthew Adam Spiegel, BS; Elizabeth M Tanzi, BS, MS; Themistocles S. Protopsaltis, MD; Thomas J. Errico, MD; Frank J. Schwab, MD; Virginie Lafage, PhD
- 15:40 - 15:42 **Paper 83: The Impact of Resident Involvement on Postoperative Complications following Adult Deformity Surgery (ADS)**
Parth A. Kothari, BS; Dante M. Leven, DO; Nathan J. Lee, BS; Branko Skovrlj, MD; Jeremy Steinberger, MD; Javier Guzman, BS; John M. Caridi, MD; Samuel K. Cho, MD
- 15:42 - 15:44 **Paper 84: The Ideal Lumbar Lordosis Angle for Restoring an Optimal Pelvic Tilt in Elderly Patients with Adult Spinal Deformity**
Yu Yamato, MD, PhD; Tomohiko Hasegawa, MD, PhD; Sho Kobayashi, MD, PhD; Tatsuya Yasuda, MD; Daisuke Togawa, MD; Yukihiro Matsuyama; Takahiro Iida; Akira Matsumura, MD, PhD; Naobumi Hosogane, MD, PhD; Morio Matsumoto, MD

- 15:44 - 15:46 **Paper 85: Acetabular Anteversion Changes in Spinal Deformity Correction: Implications for Hip and Spine Surgeons**
Aaron James Buckland, MBBS, FRACS; Jonathan Vigdorich, MD; Renaud Lafage, MS; Gregory M. Mundis, MD; Jeffrey L. Gum, MD; Michael P. Kelly, MD,MS; Robert A. Hart, MD; Christopher P. Ames, MD; Justin S. Smith, MD, PhD; Shay Bess, MD; Thomas J. Errico, MD; Frank J. Schwab, MD; Virginie Lafage, PhD; International Spine Study Group; Themistocles S. Protopsaltis, MD
- 15:46 - 15:48 **Paper 86: Double Level Degenerative Spondylolisthesis: What is Different in the Sagittal Plane?**
Emmanuelle Ferrero, MD; Mourad Ould Slimane; Pierre Guigui, MD
- 15:48 - 15:55 **Discussion**

15:55 - 16:10 **Refreshment Break & Exhibit Viewing**

BALLROOM 1

16:10 - 17:10 **Concurrent Sessions 5A-D: Abstract Session and Roundtable Sessions**

5A: Cervical Spine Trauma

ROOM: CONFERENCE HALL 3

Moderators: Todd J. Albert, MD & Gregory M. Mundis, Jr., MD

Case Presenters

- 16:10 - 16:25 *Vincent C. Traynelis, MD*
16:25 - 16:40 *K. Daniel Riew, MD*
16:40 - 16:55 *James S. Harrop, MD*
16:55 - 17:10 *Chung Chek Wong, MD*

5B: Adolescent Idiopathic Scoliosis

ROOM: CONFERENCE HALL 2

Moderators: Harwant Singh, MD, PhD & Daniel J. Sucato, MD, MS

Case Presenters

- 16:10 - 16:25 *Peter O. Newton, MD*
16:25 - 16:40 *Ahmet Alanay, MD*
16:40 - 16:55 *Hak-Sun Kim, MD*
16:55 - 17:10 *Stephen J. Lewis, MD, FRCSC, MS*

5C: Adult Degenerative Scoliosis

ROOM: CONFERENCE HALL 1

Moderators: Steve D. Glassman, MD & Christopher I. Shaffrey, MD

Case Presenters

- 16:10 - 16:25 *Henry F.H. Halm, MD*
16:25 - 16:40 *Frank J. Schwab, MD*
16:40 - 16:55 *Justin S. Smith, MD, PhD*
16:55 - 17:10 *Ronald A. Lehman, MD*

5D: Innovative and Diagnostic Methods Abstracts

ROOM: BANQUET HALL

Moderator: *Marinus De Kleuver, MD, PhD & Tateru Shiraishi, MD*

- 16:10 - 16:14 **Paper 87: Evaluation of Nitinol Rod Corrosion Performance in Spinal Constructs with Titanium Pedicle Screws**
Elena Lukina; Sergey Kolesov, MD, PhD; Arkadii Kazmin; Natalia Morozova; Hilali H. Noordeen; Wai Weng Yoon, MD, MBBS, FRCS Tr&Orth; Gordon Blunn; Mikhail Kollerov
- 16:14 - 16:18 **Paper 88: Palliative Surgery in Spinal Metastasis Patients with Instability Pain: The Role of Minimally Invasive Spinal Stabilization (MISt) using Fluoroscopic Guided Percutaneous Screws Technique.**
Mun Keong Kwan, MS; Chee Kean Lee, MBBS, MSOrth; Chris Yin Wei Chan, MD, MS Orth
- 16:18 - 16:22 **Paper 89: Temporary Intraoperative Instrumentation of Lowest Instrumented Vertebra +1: A Novel Technique to Help Minimize Extent of Arthrodesis in AIS**
Firoz Miyanji, MD, FRCSC; Ravi Ghag, MD, FRCSC; Burt Yaszay, MD; Christopher W. Reilly, MD; Jahangir K. Asghar, MD; Patrick J. Cahill, MD; Amer F. Samdani, MD
- 16:22 - 16:28 **Discussion**
- 16:28 - 16:32 **Paper 90: Novel Cervical Angular Measures Account for Both Upper Cervical Compensation and Sagittal Alignment**
Themistocles S. Protopsaltis, MD; Renaud Lafage, MS; Virginie LaFage, PhD; Daniel M. Sciubba, MD; D. Kojo Hamilton, MD, FAANS; Justin S. Smith, MD, PhD; Peter G. Passias, MD; Alex Soroceanu, MD; Gregory M. Mundis, MD; Eric O. Klineberg, MD; Robert A. Hart, MD; Christopher I. Shaffrey, MD; Frank J. Schwab, MD; Christopher P. Ames, MD; International Spine Study Group
- 16:32 - 16:36 **Paper 91: "Distraction Failure" in Magnetically-Controlled Growing Rods: Prevalence and Risk Factors**
Boon-Beng Tan; Dino Samartzis, PhD; Cora Hingyee Bow; Jason Pui Yin Cheung, MBBS, MMedSc, FRCS; Kenneth M.C. Cheung, MD
- 16:36 - 16:40 **Paper 92: Validity, Reliability and Responsiveness of SRS-7 as a Functional Outcome Measure for Operatively Treated Adult Spinal Deformity (ASD) Patients**
Amit Jain, MD; Virginie Lafage, PhD; Michael P. Kelly, MD, MS; Brian James Neuman, MD; Daniel M. Sciubba, MD; Shay Bess, MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; Justin K. Scheer, BS; Douglas C. Burton, MD; Munish Chandra Gupta, MD; Robert A. Hart, MD; Richard Hostin, MD; Khaled M. Kebaish, MD; International Spine Study Group
- 16:40 - 16:44 **Paper 93: The Value of Bone Biopsy during Percutaneous Vertebroplasty in Treatment of Presumed Osteoporotic Vertebral Compression Fractures**
Bahadır Gokcen, MD; Meric Enercan, MD; Emel Kaya, MD; Sinan Kahraman, MD; Sinan Yilar, MD; Mutlu Cobanoglu, MD; Tunay Sanli, MA; Erden Erturer, MD; Cagatay Ozturk, MD; Azmi Hamzaoglu, MD
- 16:44 - 16:51 **Discussion**
- 16:51 - 16:55 **Paper 94: Does MiS Surgery Allow for Shorter Constructs in the Surgical Treatment of ASD?**
Juan S. Uribe, MD; Praveen V. Mummaneni, MD; David O. Okonkwo, MD, PhD; Pierce D. Nunley, MD; Robert K. Eastlack, MD; Paul Park, MD; Behrooz A. Akbarnia, MD; Christopher I. Shaffrey, MD; Vedat Deviren, MD; Stacie Nguyen, MPH; Neel Anand, MD, Mch Orth; Adam Kanter, MD; Richard G. Fessler, MD, PhD; Gregory M. Mundis, MD; International Spine Study Group
- 16:55 - 16:59 **Paper 95: Is L1S1 Lordosis Measurement Still the Relevant Parameter to Assess Lumbar Curve Magnitude? Radiographic Study of Sagittal Lumbar Spine Alignment in 296 Healthy Volunteers**
Fethi Laouissat, MD; Pierre Roussouly, MD
- 16:59 - 17:03 **Paper 96: Biportal Endoscopic Spinal Surgery (BESS) for Treatment of Spinal Stenosis: Intra- and Extraforaminal Approach**
Chang Choi, MD, PhD; Je Chung; Dae Jung Choi, MD
- 17:03 - 17:10 **Discussion**

17:10 - 17:30 **Walking Break**

17:30 - 18:30 ****Afternoon Hands-On Workshops with Beverages and Snacks**

(See "Exhibits and Hands-On Workshops (HOW) section on page 210 for more information.)

7:30 - 16:45	Registration Open
7:30 - 8:30	*Hands-On Workshops with Breakfast (See "Exhibits and Hands-On Workshops (HOW) section on page 210 for more information.)
8:15 - 17:00	Exhibits Open BALLROOM 1
8:15 - 8:40	Exhibit Viewing & Breakfast BALLROOM 1
8:40 - 9:40	Concurrent Sessions 6A-D: Abstract Sessions, Debate Series and Instructional Course Lecture
	6A: Adult Deformity Abstracts
	ROOM: BALLROOM 2
	Moderators: Shay Bess, MD & Virginie LaFage, PhD
8:40 - 8:44	Paper 97: Age-Adjusted Alignment Goals Have the Potential to Reduce PJK <i>Frank J. Schwab, MD; Renaud Lafage, MS; Steven D. Glassman, MD; Shay Bess, MD; Bradley Yates Harris, JD; Justin K. Scheer, BS; Robert A. Hart, MD; Breton Line, BS; Douglas C. Burton, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; Themistocles S. Protopsaltis, MD; Christopher P. Ames, MD; Virginie Lafage, PhD; International Spine Study Group</i>
8:44 - 8:48	Paper 98: Role of Ethnicity in Alignment Compensation: Propensity Matched Analysis of Differential Compensatory Mechanism Recruitment Patterns for Sagittal Malalignment in 288 ASD Patients from Japan, Korea and United States <i>Bassel G. Diebo, MD; Isaac D. Gammal, BS; Themistocles S. Protopsaltis, MD; Yoon Ha; Seung Hwan Yoon, MD, PhD; Byeongwoo Kim, MD; Morio Matsumoto, MD; Yu Yamato, MD, PhD; Daisaku Takeuchi; Naobumi Hosogane, MD, PhD; Mitsuru Yagi, PhD; <u>Virginie Lafage, PhD</u>; Christopher P. Ames, MD; International Spine Study Group</i>
8:48 - 8:52	Paper 99: Sagittal Spinopelvic Alignment in 654 Degenerative Spondylolisthesis <i>Emmanuelle Ferrero, MD; Mourad Ould Slimane; Pierre Guigui, MD</i>
8:52 - 8:59	Discussion
8:59 - 9:03	Paper 100: The Impact of Depression on Two-Year Outcomes after Adult Spinal Deformity Surgery <i>Alexander Theologis, MD; Justin K. Scheer, BS; Tamir Ailon, MD, FRCSC, MPH; Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Shay Bess, MD; Munish Chandra Gupta, MD; Eric O. Klineberg, MD; Khaled M. Kebaish, MD; Frank J. Schwab, MD; Virginie Lafage, PhD; Douglas C. Burton, MD; Robert A. Hart, MD; Christopher P. Ames, MD; International Spine Study Group</i>
9:03 - 9:07	Paper 101: Adult Spinal Deformity: National Trends in the Presentation, Treatment and Peri-Operative Outcomes from 2003-2010 <i>Peter G. Passias, MD; Cyrus Jalai, BA; Nancy Worley, MS; Bryan Marascalchi, BS, MD; Virginie Lafage, PhD; Thomas J. Errico, MD</i>
9:07 - 9:11	Paper 102: Importance of Patient Reported Individualized Goals When Assessing Outcome For Adult Spinal Deformity (ASD): Initial Experience with a Patient Generated Instrument (PGI) <i>Justin K. Scheer, BS; Malla Kate Keefe, BS; Michael P. Kelly, MD, MS; Virginie Lafage, PhD; Shay Bess, MD; Douglas C. Burton, MD; Robert A. Hart, MD; Amit Jain, MD; Themistocles S. Protopsaltis, MD; Richard Hostin, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; Frank J. Schwab, MD; Christopher P. Ames, MD; International Spine Study Group</i>
9:11 - 9:18	Discussion
9:18 - 9:22	Paper 103: Early Recovery Kinetics Predict Three-Year Outcomes in Operatively Treated Adult Patients with Spinal Deformity <i>Amit Jain, MD; Khaled M. Kebaish, MD; Daniel M. Sciubba, MD; Brian James Neuman, MD; Justin K. Scheer, BS; Frank J. Schwab, MD; Virginie Lafage, PhD; Themistocles S. Protopsaltis, MD; Douglas C. Burton, MD; Justin S. Smith, MD, PhD; Christopher I. Shaffrey, MD; Richard Hostin, MD; Chessie Robinson, MS; Christopher P. Ames, MD; International Spine Study Group</i>
9:22 - 9:26	Paper 104: Distal Iliac Screw (DIS) Fixation Technique: An Alternative Iliopelvic Fixation Technique in Adult Deformity Surgery <i>Meric Enercan, MD; Sinan Kahraman, MD; Bahadir Gokcen, MD; Mutlu Cobanoglu, MD; Sinan Yilar, MD; Tunay Sanli, MA; Erden Erturer, MD; Cagatay Ozturk, MD; Mercan Sarier, MD; Ahmet Alanay, MD; Azmi Hamzaoglu, MD</i>

- 9:26 - 9:30 **Paper 105: Selecting Caudal Fusion Levels: Two Year Functional Outcomes with Matched Pairs Analysis in Multilevel Fusion to L5 versus S1**
Heiko Koller, MD; Michael Mayer, MD; Oliver Meier, MD; Alec Gabriel Contag, BS; Alan H. Daniels, MD; D.Kojo Hamilton, MD; Justin S. Smith, MD, PhD; Shay Bess, MD; Eric O. Klineberg, MD; Christopher P. Ames, MD; Frank J. Schwab, MD; Robert A. Hart, MD; International Spine Study Group
- 9:30 - 9:40 **Discussion**
- 6B: Trauma and Tumor Abstracts**
- ROOM: BANQUET HALL
Moderators: Manabu Ito, MD, PhD & Laurence D. Rhines, MD
- 8:40 - 8:44 **Paper 106: Efficacy and Safety of Riluzole in Acute Spinal Cord Injury (SCI). Rationale and Design of AOSpine Phase III Multicenter Double Blinded Randomized Controlled Trial (RISCIS).**
Michael G. Fehlings, MD, PhD, FRCSC; Branko Kopjar, MD, PhD, MS; Robert Grossman, MD
- 8:44 - 8:48 **Paper 107: Incidence of Complications After Therapeutic Anticoagulation in the Postoperative Spine Trauma Patient**
Ehsan Jazini, MD; Brian Shiu, MD; Elizabeth Le, MD; Timothy Costales, MD; Nicholas Caffes, MD; Ebrahim Paryavi, MD, MPH; Daniel E. Gelb, MD; Eugene Koh, MD; Bizhan Aarabi, MD; Steve Ludwig, MD
- 8:48 - 8:52 **Paper 108: Is There a Role of Spinal Cord Monitoring in Surgeries for Patients with Traumatic Spinal Injuries?**
May Lin Yin; Gabriel Liu, FRCSC; Wei Ket Yang, BS; Naresh Satyanarayan Kumar, FRCSC; Leok-Lim Lau, MD; Joseph Shanthakumar Thambiah, FRCSC, MBBS; Hee Kit Wong, MD
- 8:52 - 8:59 **Discussion**
- 8:59 - 9:03 **Paper 109: Role of Bisphosphonates as Adjuvants in GCT of Spine**
Chaitanya Dev Pannu; Ankur Goswami, MS; Vijay Raghavan, MS; Shishir Rastogi; Shah Alam Khan, FRCSC, MS; Arvind Jayaswal, MS
- 9:03 - 9:07 **Paper 110: Survival and Clinical Outcomes in Patients with Metastatic Epidural Spinal Cord Compression: Result of the a AOSpine Prospective Multicentre Study of 142 Patients**
Michael G. Fehlings, MD, PhD, FRCSC; Anick Nater, MD; Lindsay Tetreault, HBSc; Branko Kopjar, MD, PhD, MS; Paul M. Arnold, MD; Mark B. Dekutoski, MD; Joel Finkelstein, MD; Charles Fisher, BS, MD, FRCSC, MHSc; John C. France, MD; Ziya L. Gokaslan, MD; Laurence D. Rhines, MD; Peter S. Rose, MD; James Schuster, MD; Alexander R. Vaccaro
- 9:07 - 9:11 **Paper 111: Ewing's Sarcoma of the Spine: Survival and Local Control in Surgically Treated Patients**
Laurence D. Rhines, MD; Michael S. Dirks, MD; Stefano Boriani, MD; Luzzati Alessandro; Michael G. Fehlings, MD, PhD, FRCSC; Charles Fisher, BS, MD, FRCSC, MHSc; Mark B. Dekutoski, MD; Richard Williams, FRCSC; Nasir A. Quraishi; Ziya L. Gokaslan, MD; Chetan Bettgowda, MD, PhD; Niccole Germscheid, MS; Peter Pal Varga, MD
- 9:11 - 9:18 **Discussion**
- 9:18 - 9:22 **Paper 112: Preoperative Embolization in Surgical Treatment of Spinal Metastases: A Randomized Clinical Trial of Efficacy in Decreasing Intraoperative Blood Loss**
Caroline Clausen, MD; Benny T. Dahl, MD, PhD; Lars V. Hansen, MD; Lars Lönn, MD, PhD
- 9:22 - 9:26 **Paper 113: Mobile Spine Chordoma: Results of 166 Patients From the AOSpine Knowledge Forum Tumor**
Ziya L. Gokaslan, MD; Patricia Zadnik, MD; Daniel M. Sciubba MD; Niccole Germscheid, MSc; C. Rory Goodwin, MD; Jean-Paul Wolinsky, MD; Chetan Bettgowda, MD, PhD; Mari Groves, MD; Alessandro Luzzati, MD; Laurence D. Rhines, MD, Charles Fisher, MD, MHSc; Peter Paul Varga, MD; Mark B. Dekutoski, MD; Michelle Clarke, MD; Michael G. Fehlings, PhD, FRCSC, FACS; Nasir A. Quraishi, FRCS; Dean Chou, MD; Jeremy James Reynolds, MD, ChB; Richard Williams, MD; Stefano Boriani, MD
- 9:26 - 9:30 **Paper 114: Revision Surgery after Incomplete Resection of Chordoma of the Cervical Spine**
Dezsö Jeszenszky, MD; Peter Obid, MD; Daniel Haschtmann, MD; Frank Kleinstück, MD; Tamas Fulop Fekete, MD
- 9:30 - 9:40 **Discussion**

6C: Debate Series 2

ROOM: CONFERENCE HALL 2

Moderators: *Benny T. Dahl, MD, PhD, DMSci & Ki-Tak Kim, PhD*

8:40 - 9:10 **Debate 1: SI Joint Arthritis is a Common Entity Requiring Surgical Intervention**

Pro: David W. Polly, Jr., MD

Con: Todd J. Albert, MD

9:10 - 9:40 **Debate 2: Transpoas versus MIS TLIF: Which is the Best Technique for Degenerative Spondylolisthesis**

Transpoas: John A. I. Ferguson, MD, FRACS

MIS TLIF: Matthew Norman Scott Young, MBBS, FRACS, FAOrthA

6D: Malaysian Spine Society ICL - Tuberculosis of Spine

ROOM: CONFERENCE HALL 1

Moderators: *Abdul Malik Mohd Hussein, MBBS, FRCS & Mohammad Abdul Razak, MD*

8:40 - 8:50 **Historical Perspective of Spinal Tuberculosis**

KS Sivananthan, DPMP, FRCS

8:50 - 9:00 **Tuberculosis of the Spine: Challenges in Diagnosis and Management**

Sabarul Afian Mokhtar, MD, PhD, MS, MD(UKM), MS(Orth), FRCS(Edinburgh), PhD(Australia)

9:00 - 9:10 **Surgical Strategies of Acute Tuberculosis Spondylitis**

Abdul Halim Yusof, MD

9:10 - 9:20 **Surgical Strategies in Post Tuberculosis Spinal Deformities**

Fazir Mohamad, MD

9:20 - 9:40 **Discussion**

9:40 - 10:30 Refreshment Break & Exhibit Viewing

BALLROOM 1

9:50 - 10:20 **Exhibit Hall Case Presentation #2

BALLROOM 1

Juan S. Uribe, MD

10:30 - 11:55 Concurrent Sessions 7A-C: Abstract Sessions and Video-Based Session

7A: Cervical Spine Abstracts

ROOM: BANQUET HALL

Moderators: *James S. Harrop, MD & Vincent C. Traynelis, MD*

10:30 - 10:34 **Paper 115: Effect Of Inclusion Of Asymptomatic Spondylotic Levels On Adjacent Segment Disease Following ACDF**

Caleb Behrend, MD; Alan Hilibrand, MD; Paul Millhouse, MD; Vismay Thakkar, MD; Alexander R. Vaccaro; Todd J. Albert, MD

10:34 - 10:38 **Paper 116: The Effect of Local Intraoperative Steroid Administration on the Rate of Post-Operative Dysphagia Following ACDF: A National Database Study of 245,754 Patients**

Jourdan M. Cancienne; Brian C. Werner, MD; Scott Yang, MD; Hamid Hassanzadeh; Francis H. Shen, MD; Anuj Singla, MD; Adam L. Shimer, BS, MD

10:38 - 10:42 **Paper 117: Polyurethane on Titanium Unconstrained Cervical Disc Arthroplasty Versus Anterior Cervical Discectomy and Fusion for the Treatment of Cervical Disc Disease. A Review of Level I-II Randomized Clinical Trials Including Clinical Outcomes**

María Aragonés, BS; Eduardo Hevia, MD; Carlos Barrios, MD; Alberto Caballero, MD

10:42 - 10:49 **Discussion**

10:49 - 10:53 **Paper 118: New Technique of C2 Decompression with Preserving C2 Attached Muscles for Cervical Myelopathy due to OPLL of Cervical Spine**

Futoshi Suetsuna, MD

10:53 - 10:57 **Paper 119: Full Body Dynamic Radiographic Analysis of Laminoplasty versus Posterior Cervical Decompression and Fusion Patients Correlated to HRQOL**

Anthony J. Boniello, BS; Themistocles S. Protosaltis, MD; Amir Amitai, MD; Vincent Challier, MD; Renaud Lafage, MS; Yuriy Trimba, BA; Emmanuelle Ferrero, MD; Matthew Adam Spiegel, BS; Emmanuel N. Menga, MD; Michael Louis Smith, MD; Peter G. Passias, MD; Yong Kim, MD; Afshin Eli Razi, MD; Virginie Lafage, PhD; Ronald Moskovich, MD, FRCS

- 10:57 - 11:01 **Paper 120: Stand Alone Anterior Multiple Levels Cervical Cage**
Sherif Mohamed El Ghamry, MSc; Youssry M.K. Elhawary, MD; Mohamed Fawzy Khattab, MD
- 11:01 - 11:08 **Discussion**
- 11:08 - 11:12 **Paper 121: Association Between T1 Slope And Kyphotic Alignment Change after Laminoplasty in Patients with Cervical Ossification of Posterior Longitudinal Ligament (OPLL)**
Yoon Ha; Byeongwoo Kim, MD; Dong Ah Shin; Seong Yi; Keung Nyun Kim; Do Heum Yoon
- 11:12 - 11:16 **Paper 122: Full Spine Radiographic Analysis of Cervical Laminoplasty versus Posterior Cervical Decompression and Fusion Correlated with HRQL**
Themistocles S. Protopsaltis, MD; Amir Amitai, MD; Anthony J. Boniello, BS; Emmanuel N. Menga, MD; Matthew Adam Spiegel, BS; Renaud Lafage, MS; Vincent Challier, MD; Yuriy Trimba, BA; Emmanuelle Ferrero, MD; Michael Louis Smith, MD; Peter G. Passias, MD; Yong Kim, MD; Afshin Eli Razi, MD; Virginie Lafage, PhD; Ronald Moskovich, MD, FRCS
- 11:16 - 11:20 **Paper 123: Screw Perforation Features in 148 Consecutive Patients Performed Computer-Guided Cervical Pedicle Screw Insertion**
Masashi Uehara; Jun Takahashi, MD, PhD; Shota Ikegami, MD, PhD; Shugo Kuraishi, MD, PhD; Masayuki Shimizu, MD, PhD; Toshimasa Futatsugi, MD; Hiroyuki Kato, MD, PhD
- 11:20 - 11:24 **Paper 124: Outcomes and Complications of Fusions from the Cervical Spine to the Pelvis: Series of 46 Cases with Average 2.7 Year Follow Up**
Han Jo Kim, MD; Sravisht Iyer, MD; Alexander Theologis, MD; Venu M. Nemani, MD, PhD; Todd J. Albert, MD; Lawrence G. Lenke, MD; Shane Burch, MD; Oheneba Boachie-Adjei, MD; Vedat Deviren, MD; Themistocles S. Protopsaltis, MD; Justin S. Smith, MD, PhD; Justin K. Scheer, BS; Jun Mizutani, MD, PhD; Eric O. Klineberg, MD; Christopher P. Ames, MD
- 11:24 - 11:31 **Discussion**
- 11:31 - 11:35 **Paper 125: Assessment of Surgical Treatment Strategies for Moderate to Severe Adult Cervical Deformity Reveals Marked Variation in Approaches, Osteotomies and Fusion Levels**
Justin S. Smith, MD, PhD; Eric O. Klineberg, MD; Themistocles S. Protopsaltis, MD; Munish Chandra Gupta, MD; Douglas C. Burton, MD; Vedat Deviren, MD; Robert K. Eastlack, MD; Marilyn L. G. Gates, MD; Peter G. Passias, MD; Gregory M. Mundis, MD; D.Kojo Hamilton, MD; Robert A. Hart, MD; Shay Bess, MD; Christopher P. Ames, MD; International Spine Study Group
- 11:35 - 11:39 **Paper 126: Focal and Dynamic Cervical Alignment Pathology Correlates with Myelopathy Severity in Cervical Deformity Patients**
Renaud Lafage, MS; Virginie Lafage, PhD; Themistocles S. Protopsaltis, MD; Robert A. Hart, MD; Peter G. Passias, MD; Eric O. Klineberg, MD; Justin S. Smith, MD, PhD; Brian James Neuman, MD; D. Kojo Hamilton, MD; Amit Jain, MD; Gregory M. Mundis, MD; Lukas P. Zebala, MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; International Spine Study Group
- 11:39 - 11:43 **Paper 127: Prospective Multicenter Assessment of Early Complication Rates Associated with Adult Cervical Deformity (ACD) Surgery in 78 Patients**
Justin S. Smith, MD, PhD; Virginie Lafage, PhD; Christopher I. Shaffrey, MD; Themistocles S. Protopsaltis, MD; Peter G. Passias, MD; Frank J. Schwab, MD; Michael F. O'Brien, MD; Munish Chandra Gupta, MD; Gregory M. Mundis, MD; Robert A. Hart, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; K. Daniel Riew, MD; Christopher P. Ames, MD; International Spine Study Group
- 11:43 - 11:47 **Paper 128: Towards a Cervical Deformity Outcome Instrument: Principal Component Analysis of 89 HRQL Questions in 476 Patients with Cervical Deformity**
Themistocles S. Protopsaltis, MD; Renaud Lafage, MS; Virginie Lafage, PhD; Frank J. Schwab, MD; Justin S. Smith, MD, PhD; Peter G. Passias, MD; Matthew Adam Spiegel, BS; Daniel M. Sciubba, MD; Gregory M. Mundis, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; Robert A. Hart, MD; Christopher I. Shaffrey, MD; Christopher P. Ames, MD; International Spine Study Group
- 11:47 - 11:55 **Discussion**

7B: Lumbar Degenerative and Spondylolisthesis Abstracts

ROOM: CONFERENCE HALL 2

Moderators: Hak-Sun Kim, MD & Keith D.K. Luk, MD

- 10:30 - 10:34 **Paper 129: High Grade Spondylolisthesis in the Young: Long Term Follow Up Results of a Progressive Reduction Technique**
Pramod Sudarshan; Aditya Prasad Panda, MS; Thirumalai Mohan, MS; Sankar Mohan, MS; Aghilavendan Paramasivam, MS; Vamsi Krishna Varma, MS; Sajan K. Hegde, MD
- 10:34 - 10:38 **Paper 130: Prediction of Surgical Outcomes and Complications with Reduction of High-Grade Spondylolisthesis**
Heiko Koller; Michael Mayer, MD; Axel Hempfing, MD; Oliver Meier, MD; Karo Mühlenkamp
- 10:38 - 10:42 **Paper 131: Modeled Cost-Effectiveness of TLIF versus PSF for Spondylolisthesis using N2QOD Data**
Leah Yacat Carreon, MD, MSc; Steven D. Glassman, MD; Kevin Foley, MD; Anthony Asher, MD; Matthew J. McGirt, MD
- 10:42 - 10:49 **Discussion**
- 10:49 - 10:53 **Paper 132: LLIF versus Minimally Invasive TLIF for Degenerative Spondylolisthesis: Results from a Prospective Multicenter Study**
SOLAS Degenerative Study Group; Jonathan Nubla Sembrano, MD; Antoine G. Tohmeh, MD; Robert Isaacs, MD
- 10:53 - 10:57 **Paper 133: Outcomes of Minimally Invasive Lumbar Fusion (MILIF) in Patients with Stenosis: A Subgroup Analysis of the MASTERS-D Study**
Paulo M Pereira, MD, PhD; Wolfgang Senker, MD; Ulrich Hubbe, MD; Neil Manson, MD; Kai Scheufler, MD; Joerg Franke, MD
- 10:57 - 11:01 **Paper 134: Expandable Technology in Minimally Invasive TLIF: A Multicenter Clinical and Radiographic Analysis of 202 Patients with Two-Year Follow Up**
Choll W. Kim, MD, PhD; James Lindley, MD; Todd Doerr, MD; Phillip G. St Louis, MD; Ingrid Luna, MPH; Piotr A. Kowalski, MS; Gita Joshua, MS
- 11:01 - 11:08 **Discussion**
- 11:08 - 11:12 **Paper 135: Are the Outcomes of Minimally Invasive Lumbar Fusion (MILIF) Affected by Age and Obesity?**
Paulo M Pereira, MD, PhD; Neil Manson, MD; Ulrich Hubbe, MD; Kai Scheufler, MD; Joerg Franke, MD; Wolfgang Senker, MD
- 11:12 - 11:16 **Paper 136: Are Minimally Invasive Robotic-Guided TLIFs more safe and accurate than Freehand Open TLIFs?**
Pramod Sudarshan; Aditya Prasad Panda, MS; Thirumalai Mohan, MS; Sankar Mohan, MS; Aghilavendan Paramasivam, MS; Vamsi Krishna Varma, MS; Sajan K. Hegde, MD
- 11:16 - 11:20 **Paper 137: Pseudoarthrosis Rate in Minimally Invasive Transforaminal Lumbar Interbody Fusion(m-TLIF): Two-Year Outcomes versus Open TLIF**
Daniel Thibaudeau, MD; Michael J. Faloon; Kimona Issa, MD; Sina Pourtaheri, BS, MD; Kumar Sinha, MD; Ki Soo Hwang, MD; Arash Emami, MD
- 11:20 - 11:24 **Paper 138: Postoperative Patient-Reported Outcomes and Revision Rates in Normal, Overweight and Obese Patients Five Years following Lumbar Fusion**
R. Kirk Owens, MD; Ikemefuna Onyekwelu, MD; Mladen Djurasovic, MD; Kelly Bratcher, RN, CCRP; Katlyn E. McGraw, BA; Leah Yacat Carreon, MD, MSc
- 11:24 - 11:31 **Discussion**
- 11:31 - 11:35 **Paper 139: Back Pain Improvement after Decompression without Fusion in Patients with Lumbar Spinal Stenosis and Clinically Significant Pre-Operative Back Pain**
Charles H. Crawford, MD; Steven D. Glassman, MD; Praveen V. Mummaneni, MD; John Knightly, MD; Anthony Asher, MD
- 11:35 - 11:39 **Paper 140: Can the EQ-5D Anxiety Domain and SF-36 Mental Health Items Predict Outcomes after Surgery for Lumbar Degenerative Disorders?**
Leah Yacat Carreon, MD, MSc; Mladen Djurasovic, MD; Mitchell J. Campbell, MD; Kirk Owens, MD; Charles H. Crawford, MD; Rolando M. Puno, MD; John R. Dimar, MD; Kelly Bratcher, RN; Katlyn E. McGraw, BA; Steven D. Glassman, MD

- 11:39 - 11:43 **Paper 141: Does Lordotic Angle of Cage Determine Lumbar Lordosis in Posterior Lumbar Interbody Fusion?**
Kyu-Jung Cho, MD; Young-Tae Kim, MD
- 11:43 - 11:47 **Paper 142: Radiological Outcomes of Peek versus Titanium Transforaminal Lumbar Interbody Cages.**
Kiran Kumar Lingutla, FRCS (Tr & Orth), MCh Ortho; Suribabu Gudipati; Raymond Pollock, PhD; Paul Davies, FRCS; Iqroop Chopra, FRCS; Sashin Ahuja, FRCS
- 11:47 - 11:55 **Discussion**

NEW SESSION

7C: Surgical Techniques: A Video-Based Session

ROOM: BALLROOM 2

Moderators: Jae-Yoon Chung, MD & Paul D. Sponseller, MD

- 10:30 - 10:51 **Cervical Deformity Correction**
Christopher P. Ames, MD
- 10:51 - 11:12 **Tether Technique**
Stefan Parent, MD, PhD
- 11:12 - 11:33 **Lateral Interbody Fusion Technique (Including ACR)**
John A.I. Ferguson, MD, FRACS
- 11:33 - 11:45 **Lateral Interbody Application to Deformity Correction**
Juan S. Uribe, MD

11:55 - 12:05 Walking Break

12:05 - 13:05 Exhibit Viewing & Lunch

BALLROOM 1

***Hands-On Workshops with Lunch*

(See "Exhibits and Hands-On Workshops (HOW) section on page 210 for more information.)

13:05 - 13:15 Walking Break

13:15 - 14:15 Concurrent Sessions 8A-E: Roundtable Sessions and Two-Minute Point Presentations

8A: MIS Deformity Correction (Adult and Pediatric)

ROOM: BANQUET HALL

Moderators: Noriaki Kawakami, MD, DMSc & Praveen V. Mummaneni, MD

Case Presenters:

- 13:15 - 13:30 *Neil Cleaver, MD, BSc, MB BS (Lond), FRACS*
- 13:30 - 13:45 *Gregory M. Mundis, MD*
- 13:45 - 14:00 *Geoffrey N. Askin, MD*
- 14:00 - 14:15 *Hee-Kit Wong, MD*

8B: PJK Prevention & Management

ROOM: CONFERENCE HALL 1

Moderators: Virginie LaFage, PhD & Pierre Roussouly, MD

Case Presenters:

- 13:15 - 13:30 *Frank J. Schwab, MD*
- 13:30 - 13:45 *Shay Bess, MD*
- 13:45 - 14:00 *Keith D. K. Luk, MD*
- 14:00 - 14:15 *Morio Matsumoto, MD*

8C: Cervical Degenerative Disease & CSM

ROOM: BALLROOM 2

Moderators: Michael G. Fehlings, MD, PhD, FRCS, FACS & Stephen J. Lewis, MD, MSc, FRCSC

Case Presenters:

- 13:15 - 13:30 Vincent C. Traynelis, MD
13:30 - 13:45 Justin S. Smith, MD, PhD
13:45 - 14:00 Kuniyoshi Abumi, MD, PhD
14:00 - 14:15 Chung Chek Wong, MD

8D: Infection

ROOM: CONFERENCE HALL 3

Moderators: John R. Dimar, II, MD & Manabu Ito, MD, PhD

Case Presenters:

- 13:15 - 13:30 Saumyajit Basu, MD
13:30 - 13:45 Mun Keong Kwan, MS
13:45 - 14:00 Sigurd H. Berven, MD
14:00 - 14:15 Andrew K. Cree, MD

8E: Two-Minute Point Presentations

Room: Conference Hall 2

Moderators: John A.I. Ferguson, FRACS & Stefan Parent, MD, PhD

- 13:15 - 13:17 **Paper 143: Blood Loss, Transfusion, and Conservation Trends in Scoliosis Surgery Over the Past 10 Years: Meta-Analysis of SRS Meeting Abstracts by the Historical Committee**
Vishal Sarwahi, MD; Stephen F. Wendolowski, BS; Dan Wang, MS; Yungtai Lo, PhD;
Abhijit Pawar, MD; Nathan H. Lebowhl, MD; George H. Thompson, MD; Behrooz A. Akbarnia, MD
- 13:17 - 13:19 **Paper 144: Implant Complications after Magnetic-Controlled Growing Rods for Early Onset Scoliosis: A Multicenter Retrospective Review**
Edmund Choi, MD; Pooria Hosseini, MD, MSc; Gregory M. Mundis, MD; Behrooz A. Akbarnia, MD; Haluk R. Berk, MD; Ilkka J. Helenius; John A. I. Ferguson, MD, FRACS; Tiziana Greggì, MD; Guido La Rosa, MD; Ahmet Alanay, MD; Alpaslan Senkoylu, MD; Kenneth MC Cheung, MD; Jeff B. Pawelek; Burt Yaszay, MD
- 13:19 - 13:21 **Paper 145: Complications Associated with Surgery For High Grade Spondylolisthesis-Patient and Surgery Related Factors: A Single Center Long-Term Follow Up of 49 Patients**
Saumyajit Basu, MD; Amitava Biswas, MS; Vignesh Pushparaj, D Ortho; Sri Krishna Chaitanya Kondety, MS; Mainak Palit; Kiran Tapal, MS; Tarun Suri, MS; Trinanjan Sarangi, MD
- 13:21 - 13:23 **Paper 146: The Safety of Percutaneous Pedicle Screws using Fluoroscopy in the Lumbosacral Junction and Lumbar Spine.**
Chee Kidd Chiu, MBBS, MSOrth; Mun Keong Kwan, MS; Chris Yin Wei Chan, MD, MS (Orth); Christian Schaefer, MD, PhD; Nils Hansen-Algenstaedt, MD
- 13:23 - 13:25 **Paper 147: Timing of Surgery for Combat-Related Spine Injury Affects Complication Rates**
Peter M. Formby, MD; Scott C. Wagner; Gregory S. Van Blaricum, MD; Alfred J. Pisano, MD; Daniel G. Kang, MD; Ronald A. Lehman, MD
- 13:25 - 13:27 **Paper 148: Predicting Extended Length of Hospital Stay in an Adult Spinal Deformity Surgical Population**
Eric O. Klineberg, MD; Peter G. Passias, MD; Cyrus Jalai, BA; Nancy Worley, MS; Daniel M. Sciubba, MD; Douglas C. Burton, MD; Munish Chandra Gupta, MD; Alex Soroceanu, MD, MPH, FRCSC; Lukas P. Zebala, MD; Gregory M. Mundis, MD; Han Jo Kim, MD; D. Kojo Hamilton, MD; Robert A. Hart, MD; Christopher P. Ames, MD; International Spine Study Group
- 13:27 - 13:35 **Discussion**
- 13:35 - 13:37 **Paper 149: Development of a Preoperative Predictive Model for Intra- or Peri-Operative Major Complications with High Accuracy Validated with 558 ASD Patients**
Justin K. Scheer, BS; Justin S. Smith, MD, PhD; Frank J. Schwab, MD; Virginie Lafage, PhD; Christopher I. Shaffrey, MD; Shay Bess, MD; Alan H. Daniels, MD; Robert A. Hart, MD; Themistocles S. Protopsaltis, MD; Gregory M. Mundis, MD; Tamir Ailon, MD, FRCSC, MPH; Douglas C. Burton, MD; Eric O. Klineberg, MD; Christopher P. Ames, MD; International Spine Study Group

- 13:37 - 13:39 **Paper 150: Risk Factors for Venous Thromboembolism following Thoracolumbar Surgery: Analysis of 43,777 Patients from ACS-NSQIP 2005-2012**
Arjun S. Sebastian; Sanjeev Kakar, MD; Amy Wagie, BS; Elizabeth B. Habermann, PhD; Bradford Currier, MD; Ahmad Nassr, MD
- 13:39 - 13:41 **Paper 151: Does Single versus Two-Stage Pedicle Subtraction Osteotomy in Spinal Deformity Surgery Influence Perioperative Complications?**
Daniel G. Kang; Ronald A. Lehman, MD; Lawrence G. Lenke, MD; Panya Luksanaprukka, MD; Torgom Abraamyan, BS; Linda Koester; Lionel Nicholas Metz, MD; Jamal McClendon, MD; Matthew Chapman
- 13:41 - 13:43 **Paper 152: Complication Rates after Spinal Surgery for Adolescent Idiopathic Scoliosis Vary Significantly Based on Reporting Methodology: Who to Believe?**
Amit Jain, MD; Paul D. Sponseller, MD; Dolores Njoku, MD; Suken A. Shah, MD; Amer F. Samdani, MD; Patrick J. Cahill, MD; Randal R. Betz, MD; Peter O. Newton, MD; Michelle Claire Marks
- 13:43 - 13:45 **Paper 153: Obese Class III Adults Have Significantly Greater Risk of Multiple Complications after Adult Deformity Surgery: An Analysis of 4,716 Patients in the ACS NSQIP Database**
Branko Skovrlj; Javier Guzman, BS; Jeremy Steinberger, MD; Parth A. Kothari, BS; Nathan J. Lee, BS; John I. Shin, BS; Dante M Leven, DO; John M. Caridi, MD; Samuel K. Cho, MD
- 13:45 - 13:47 **Paper 154: Study of Hyperamylasemia and Pancreatitis following Spinal Surgery**
Kazuyoshi Kobayashi, MD, PhD; Shiro Imagama; Zenya Ito, MD; Kei Ando; Naoki Ishiguro
- 13:47 - 13:55 **Discussion**
- 13:55 - 13:57 **Paper 155: Analysis of Complications of Surgical Management of Cervical Spondylotic Myelopathy(CSM)-171 Patients in a Single Unit with Average Follow Up 47 Months**
Saumyajit Basu, MD; Tarun Suri, MS; Sri Krishna Chaitanya Kondety, MS; Amitava Biswas, MS; Kiran Tapal, MS; Vignesh Pushparaj, D Ortho; Trinanjan Sarangi, MD
- 13:57 - 13:59 **Paper 156: Peri-Operative and Delayed Major Complications following Surgical Correction of AIS in 3530 Patients**
Carrie E. Bartley, MA; Burt Yaszay, MD; Tracey Bastrom, BS, MS; Suken A. Shah, MD; Baron S. Lonner, MD; Jahangir K. Asghar, MD; Firoz Miyanji, MD, FRCSC; Amer F. Samdani, MD; Peter O. Newton, MD
- 13:59 - 14:01 **Paper 157: Five-Year Reoperation Risk and Causes for Revision after Idiopathic Scoliosis Surgery**
Syed Imraan Ahmed, MD; Tracey Bastrom, BS, MS; Burt Yaszay, MD; Peter O. Newton, MD; Harms Study Group
- 14:01 - 14:03 **Paper 158: The Incident Trends, Epidemiology, Mortality, and Economic Evaluation of Vertebral Osteomyelitis in the United States: A Nationwide Inpatient Database Study of 283,022 Cases from 1998 to 2010**
Kimona Issa, MD; Matthew R. Boylan, BS; Michael J. Faloon; Qais Naziri, MD; Ki Soo Hwang, MD; Kumar Sinha, MD; Arash Emami, MD; Carl B. Paulino, MD
- 14:03 - 14:05 **Paper 159: Neonatal Spondylodiscitis: Case Series and Literature Review**
Luis Eduardo Munhoz Da Rocha, MD; Samuel Conrad; Carlos Abreu de Aguiar, MD; Luiz Müller Ávila, MD
- 14:05 - 14:07 **Paper 160: Is a Drain Tip Culture after Spinal Surgery Necessary?**
Kazuyoshi Kobayashi; Shiro Imagama; Zenya Ito, MD; Kei Ando; Naoki Ishiguro
- 14:07 - 14:15 **Discussion**
- 14:15 - 14:30 **Walking Break & Exhibit Viewing**

14:30 - 15:30 Concurrent Sessions 9A-D: Abstract Session, Debate Series and ICLs

9A: Kyphosis, Congenital & Neuromuscular Deformity Abstracts

ROOM: BANQUET HALL

Moderators: Daniel J. Sucato, MD, MS & Yong Qiu, MD

- 14:30 - 14:34 **Paper 161: The Influence of Thoracolumbar Spinal Correction for Adult Spinal Deformity on the Esophageal Mucosal Disorder**
Tomohiko Hasegawa, MD, PhD; Yu Yamato, MD, PhD; Sho Kobayashi, MD, PhD; Daisuke Togawa, MD; Tatsuya Yasuda, MD; Tomohiro Banno, MD; Hideyuki Arima, MD; Shin Oe, MD; Tomohiro Yamada, MD; Keiichi Nakai, MD; Yukihiro Matsuyama
- 14:34 - 14:38 **Paper 162: A New Radiolucent Dedicated Chair for Sitting-Posture Radiographs in Non-Ambulatory Children: Application to Biplanar Digital Slot-Scanning (EOS) Imaging.**
Houssam Bouloussa, MD; Arnaud Dubory, MD; Baptiste Morel, MD; Hubert Ducou le Pointe, MD, PhD; Raphaël Vialle, MD, PhD
- 14:38 - 14:42 **Paper 163: Distal Fusion Level Selection in Scheuermanns Kyphosis: Are We Fusing too Long?**
Roel Hoogendoorn, MD, PhD; Harm Graat, MD, PhD; Marinus De Kleuver, MD, PhD
- 14:42 - 14:49 **Discussion**
- 14:49 - 14:53 **Paper 164: Evaluation of Surgical Treatment of Congenital Scoliosis Associated with Split Cord Malformation**
Jianxiong Shen; Fan Feng
- 14:53 - 14:57 **Paper 165: The Effect of Spinal Osteotomies on Spinal Cord Tension and Dural Buckling: A Cadaveric Study**
Steven W. Hwang, MD; Mina G. Safain, MD; Shane Burke, BS; Ron I. Riesenburger, MD
- 14:57 - 15:01 **Paper 166: Morphological Differences of Vertebrae between Neurofibromatosis Type 1 Associated Scoliosis with and without Paraspinal Neurofibromas**
Zong-shan Hu, MD; Zhen Liu, MD; Ze-zhang Zhu, MD; Shi-fu Sha, MD; Yong Qiu, MD
- 15:01 - 15:05 **Paper 167: Long-Term Follow Up after Posterior Hemivertebra Resection and Short Segment Fusion with Pedicle Screw Fixation for Congenital Scoliosis in Children under Age 10 Years**
Dong-Gune Chang; Jae Hyuk Yang, MD, PhD; Jin-Hyok Kim, MD; Suh Woo Seung, MD, PhD; Dong-Ju Lim, MD; Se-Il Suk, MD
- 15:05 - 15:12 **Discussion**
- 15:12 - 15:16 **Paper 168: Surgical Results of Magnet Driven Growing Rods (MdGR) for Early-Onset Scoliosis (EOS) Secondary to Neuromuscular (NMS) and Syndromic Scoliosis (SS) at One Year**
Nanjundappa S. Harshavardhana; Amr Fahmy, BS, MD, MSc; Hilali H. Noordeen
- 15:16 - 15:20 **Paper 169: A Novel Method of Vertebro-Pelvic Fixation**
Alexander Kuleshov, MD, PhD; Marchel Vetrile, MD
- 15:20 - 15:24 **Paper 170: Back Pain in Cerebral Palsy Patients is Markedly Reduced after Spinal Fusion for Scoliosis**
Burt Yaszay, MD; Tracey Bastrom, BS, MS; Paul D. Sponseller, MD; Suken A. Shah, MD; Firoz Miyanji, MD, FRCSC; Jahangir K. Asghar, MD; Patrick J. Cahill, MD; Amer F. Samdani, MD; Peter O. Newton, MD
- 15:24 - 15:30 **Discussion**

9B: Debate Series 3

ROOM: CONFERENCE HALL 2

Moderators: Andrew K. Cree, MD & John R. Dimar, II, MD

- 14:30 - 15:00 **Debate 1: Sagittal Plane Assessment: Which is Better, the French or American Perspective?**
*French: Pierre Roussouly, MD
American: Frank J. Schwab, MD*
- 15:00 - 15:30 **Debate 2: Multilevel Cervical Disc Herniation**
*Arthroplasty: Matthew Norman Scott Young, MBBS, FRACS, FAOrthA
Anterior Discectomy and Fusion: Chung Chek Wong, MD
Laminoplasty: Morio Matsumoto, MD*

9C: Safety ICL

ROOM: CONFERENCE HALL 1

Moderators: *John P. Dormans, MD & James O. Sanders, MD*

- 14:30 - 14:40 **Preoperative Safety Strategies in Complex Spine Surgery**
Marinus De Kleuver, MD, PhD
- 14:40 - 14:50 **Does a Two-Attending Approach for Complex Adult Deformity Cases Improve Safety?**
Christopher P. Ames, MD
- 14:50 - 15:00 **Is There a Potential Role for Riluzole in Reducing Risk of Neurological Deficit with Three-Column Ostectomy?**
Michael G. Fehlings, MD, PhD, FRCSC
- 15:00 - 15:10 **When to Say No**
Steven D. Glassman, MD
- 15:10 - 15:30 **Discussion**

9D: Asia Pacific Spine Society ICL Part 1 - Anterior Spinal Surgery Revisited

ROOM: CONFERENCE HALL 3

Moderators: *Kenneth M.C. Cheung, MD & KS Sivanathan, DPMP, FRCS*

- 14:30 - 14:40 **Is There a Role for Anterior Fusion for Thoracic and Thoracolumbar Scoliosis?**
Geoffrey N. Askin, MD
- 14:40 - 14:50 **Anterior Growth Modulation for Thoracic Scoliosis**
Hee-Kit Wong, MD
- 14:50 - 15:00 **Thoracolumbar Fractures: Anterior or Posterior Approach?**
Jae-Yoon Chung, MD, PhD
- 15:00 - 15:10 **Defining the Role of Anterior Surgery in Adult Spinal Deformity**
Yutaka Nohara, MD, PhD
- 15:10 - 15:30 **Discussion**

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

15:45 - 16:45 **Concurrent 10A-E: Instructional Course Lectures and Two-Minute Point Presentations**

10A: Pediatric Deformity: Surgical Planning & Techniques

ROOM: BALLROOM 2

Moderators: *John P. Dormans, MD & Baron S. Lonner, MD*

- 15:45 - 15:55 **Advances in the Treatment of Congenital Scoliosis**
Laurel C. Blakemore, MD
- 15:55 - 16:05 **Advances in the Treatment of Neuromuscular Scoliosis**
Paul D. Sponseller, MD
- 16:05 - 16:15 **Advances in the Treatment of Scheuermann's Kyphosis**
Stefan Parent, MD, PhD
- 16:15 - 16:25 **Three-Column Osteomies**
Yong Qiu, MD

10B: Adult Deformity II: Surgical Planning & Techniques

ROOM: BANQUET HALL

Moderators: *Henry F.H. Halm, MD & Justin S. Smith, MD, PhD*

- 15:45 - 15:55 **Instrumentation Materials and Biomechanics**
Christopher I. Shaffrey, MD
- 15:55 - 16:05 **Planning the Surgery Ahead of Time to Get the Best Results**
Virginie Lafage, PhD
- 16:05 - 16:15 **What is the Role of the Lateral Transpoas Approach in Adult Deformity Correction and what are its Limits?**
Juan S. Uribe, MD
- 16:15 - 16:25 **Role for Three-Column Resection in Adult Spinal Deformity**
Stephen J. Lewis, MD, FRCSC, MS
- 16:25 - 16:45 **Discussion**

10C: MIS Approaches for Degenerative Disease

ROOM: CONFERENCE HALL 1

Moderator: *Chung Chek Wong, MD & James D. Schwender, MD*

- 15:45 - 15:55 **Techniques to Maximize Decompression through an MIS Approach**
Neil Cleaver, MD, BSc, MB, BS (Lond), FRACS
- 15:55 - 16:05 **Techniques to Maximize Lumbar Lordosis in Degenerative Disease through an MIS Approach**
Rod J. Oskouian, MD
- 16:05 - 16:15 **Role for Transpoas Approach in Degenerative Disease**
Praveen V. Mummaneni, MD
- 16:15 - 16:25 **Are there any Limits to Deformity Correction through MIS Techniques?**
Gregory M. Mundis, MD
- 16:25 - 16:45 **Discussion**

10D: Management of Spondylolisthesis

ROOM: CONFERENCE HALL 3

Moderator: *Kenneth M.C. Cheung, MD & James O. Sanders, MD*

- 15:45 - 15:55 **Surgical Approaches for Degenerative Spondylolisthesis in the Elderly**
Morio Matsumoto, MD
- 15:55 - 16:05 **Management of Isthmic Spondylolisthesis in Childhood**
Daniel J. Sucato, MD, MS
- 16:05 - 16:15 **Management of Spondylolysis and Low-Grade Spondylolisthesis in the Elite Athlete**
David W. Polly, Jr., MD
- 16:15 - 16:25 **How Classification Impacts Treatment of High-Grade Spondylolisthesis**
Hubert Labelle, MD
- 16:25 - 16:45 **Discussion**

10E: Two-Minute Point Presentations

ROOM: CONFERENCE HALL 2

Moderators: *Peter S. Rose, MD & Matthew Norman Scott Young, MBBS, FRACS, FAOrthA*

- 15:45 - 15:47 **Paper 171: Clinical Results Of Dynamic Stabilization Adjacent to Fusion Level: A New Lumbar Hybrid Instrumentation**
Meric Enercan, MD; Bahadir Gokcen, MD; Sinan Kahraman, MD; Mutlu Cobanoglu, MD; Sinan Yilar, MD; Tunay Sanli, MA; Erden Erturer, MD; Cagatay Ozturk, MD; Mercan Sarier, MD; Azmi Hamzaoglu, MD
- 15:47 - 15:49 **Paper 172: Two-Level Total Disc Replacement with Low Profile Cervical Disc versus Anterior Discectomy and Fusion: A Prospective, Randomized, Controlled Multicenter Clinical Trial with 24 Month Results**
Jeffrey McConnell; Randall Dryer, MD; Todd Lanman, MD; Matthew Gornet, MD; Scott D. Hodges
- 15:49 - 15:51 **Paper 173: A Biomechanical Evaluation of Two Different Hybrid Instrumentations and Their Effects on Instrumented and Adjacent Segments**
Peter Obid, MD; Gerd Huber, PhD; Michael Reichl, MD; Michael Morlock, PhD; Alexander Richter, MD
- 15:51 - 15:53 **Paper 174: 10-Year Follow Up With a Semi-Constrained Metal on Metal**
Alessio Lovi, MD; Jean-Charles Le Huec; Andrea Luca, MD; Marco Brayda-Bruno, MD
- 15:53 - 15:55 **Paper 175: Changes in the Lumbar Spine Sagittal Alignment After Oblique Implanted Total Lumbar Disc Replacement: A Two-Year Prospective Study of 52 Cases**
Eduardo Hevia; Juan Solaz, MD; Carlos Barrios, MD, PhD; Alberto Caballero, MD; Jesus Burgos Flores
- 15:55 - 15:57 **Paper 176: Clinical Outcomes of Total Lumbar Disc Replacement Implanted Through an Oblique Approach: A Prospective Analysis with Two-year Follow Up**
Eduardo Hevia; Juan Solaz, MD; Carlos Barrios, MD, PhD; Alberto Caballero, MD; Jesus Burgos Flores
- 15:57 - 16:05 **Disucssion**
- 16:05 - 16:07 **Paper 177: Correlation between Cervical Spine Sagittal Alignment and Clinical Outcome after Cervical Laminoplasty for Ossification of the Posterior Longitudinal Ligament**
Yoon Ha; Chang Kyu Lee; Dong Ah Shin; Seong Yi, MD, PhD; Keung Nyun Kim; Do Heum Yoon

- 16:07 - 16:09 **Paper 178: Spinal Cord Mri Signal Change at One Year after Cervical Decompression Surgery is Useful for Predicting Mid-Term Clinical Outcome: An Observational Study using Propensity Scores**
Shota Ikegami, MD, PhD; Jun Takahashi, MD, PhD; Hiromichi Misawa, MD, PhD; Takahiro Tsutsumimoto, MD, PhD; Mutsuki Yui, MD; Shugo Kuraishi, MD, PhD; Masayuki Shimizu, MD, PhD; Toshimasa Futatsugi, MD; Masashi Uehara, MD; Hiroyuki Kato, MD, PhD
- 16:09 - 16:11 **Paper 179: Outcomes and Revision Rates following Multilevel Anterior Cervical Discectomy and Fusion**
Kirk Owens, MD; Kelly Bratcher, RN; Katlyn E. McGraw, BA; Leah Yacat Carreon
- 16:11 - 16:13 **Paper 180: Adjacent Segment Pathology Correlated with HRQL Following Laminoplasty versus Posterior Cervical Decompression and Fusion**
Amir Amitai, MD; Themistocles S. Protopsaltis, MD; Anthony J Boniello, BS; Vincent Challier, MD; Renaud Lafage, MS; Yuriy Trimba, BA; Emmanuelle Ferrero, MD; Michael Louis Smith, MD; Peter G. Passias, MD; Yong Kim, MD; Afshin Eli Razi, MD; Virginie Lafage, PhD; Ronald Moskovich, MD, FRCS
- 16:13 - 16:15 **Paper 181: Are Bicortical Purchase of C1 Lateral Mass and C2 Pedicle Screws Safe for Internal Carotid Artery Asians?**
Chee Kean Lee, MBBS, MS Orth; Tan TiamSiong, MD; Chris Yin Wei Chan, MD, MS Orth; Mun Keong Kwan, MS
- 16:15 - 16:17 **Paper 182: Cervical Fixation Surgery for the Patients with Cervical Instability Secondary to Rheumatoid Arthritis**
Yoshihisa Sugimoto, MD, PhD; Masato Tanaka, PhD; Shinya Arataki, MD, PhD; Tomoyuki Takigawa, PhD; Toshifumi Ozaki, PhD
- 16:17 - 16:25 **Discussion**
- 16:25 - 16:27 **Paper 183: Treatment of the Adult Degenerative Scoliosis with Spondylolisthesis Grade III-IV (SPL). Is Reduction Necessary?**
Dmitrii Mikhaylov, MD; Dmitrii Ptashnikov, MD, PhD; Sergei Masevnin; Oleg Smekalenkov, PhD; Nikita Zaborovskii, MD
- 16:27 - 16:29 **Paper 184: Comparative Analysis of Radiological, Surgical and Clinical Outcome Between Different Three Lumbar Interbody Fusion Groups (ALIF, Direct Lateral Interbody Device, PLIF) in L4-5 Spondylolisthesis.**
Chul-Woo Lee, MD, PhD; Kang-Jun Yoon, MD, PhD
- 16:29 - 16:31 **Paper 185: Do Intra-Operative Radiographs Predict Final Lumbar Sagittal Alignment Following Single Level Trans-Foraminal Lumbar Interbody Fusion (TLIF)?**
Khalid M Salem, FRCS (T&O); Charles Fisher, BS, MD, FRCSC, MHS; Marcel F. Dvorak
- 16:31 - 16:33 **Paper 186: Sacro-Pelvic Parameter Changes after Surgery for High Grade Spondylolisthesis (HGS) Does Type of Fusion, Amount of Reduction And Type of Spondylolisthesis Matter?**
Saamyajit Basu, MD; Sri Krishna Chaitanya Kondety, MS(Orth); Tarun Suri, MS(Orth); Amitava Biswas, MS(Orth); Kiran Tapal, MD; Trinanjan Sarangi, MD; Vignesh Pushparaj, D Ortho; Mainak Palit
- 16:33 - 16:35 **Paper 187: Sacro-Pelvic Parameter Changes after Surgery for High Grade Spondylolisthesis (Hgs): Does Radiological Improvement Correlate with Clinical Improvement?**
Saamyajit Basu, MD; Sri Krishna Chaitanya Kondety, MS, (Ortho); Tarun Suri, MS; Amitava Biswas, MS; Kiran Tapal, MS; Vignesh Pushparaj, D ortho; Mainak Palit; Trinanjan Sarangi, MD
- 16:35 - 16:37 **Paper 188: The Use of Nitinol Rods with Degenerative Spondylolisthesis and Instability of the Lumbar Spine.**
Sergey Kolesov, MD, PhD; Dmitry Kolbovskiy, MD; Vladimir Shvets, MD, PhD; Arkadii Kazmin; Natalia Morozova
- 16:37 - 16:45 **Discussion**
- 16:45 - 17:00 **Membership Info Session**
 EXHIBIT HALL
 See page 237 for details.
- 19:00 - 22:00 **Course Reception**
 Please see page 6 for more information.

7:45 - 12:30 **Registration Open**

7:45 - 8:15 **Breakfast/ Exhibits Closed**

BALLROOM 1

8:15 - 9:15 **Concurrent Sessions 11A-C: Instructional Course Lectures**

11A: Management of Lumbar DDD

ROOM: BALLROOM 2

Moderator: Ki-Tak Kim, PhD & James D. Schwender, MD

8:15 - 8:25 **What is the Biologic Basis of Lumbar DDD and it be Reversed?**

Kenneth M.C. Cheung, MD

8:25 - 8:35 **What is the Appropriate Clinical and Radiographic Evaluation for Surgical Selection in Lumbar DDD?**

John R. Dimar, II, MD

8:35 - 8:45 **What are the Outcomes of Fusion Surgery for Lumbar DDD?**

James D. Schwender, MD

8:45 - 8:55 **Is There Still a Role for Arthroplasty in Lumbar DDD?**

Matthew Norman Scott Young, MBBS, FRACS, FAOrthA

8:55 - 9:15 **Discussion**

11B: Management of Metastatic Spine Disease

ROOM: CONFERENCE HALL 2

Moderators: Hak-Sun Kim, MD & Michael J. Yaszemski, MD, PhD

8:15 - 8:25 **The Impact of Tumor Burden and Medical Condition on the Decision to Pursue Surgical Management**

Benny T. Dahl, MD, PhD, DMSci

8:25 - 8:35 **Role of En Bloc Resection in Metastatic Disease**

Peter S. Rose, MD

8:35 - 8:45 **Surgical Approach and Role for Instrumentation in Metastatic Spine Disease**

Mun Keong Kwan, MBBS, MS Orth

8:45 - 8:55 **Role of Radiosurgery in the Treatment of Metastatic Spine Disease**

Laurence D. Rhines, MD

8:55 - 9:15 **Discussion**

11C: Emerging Technologies in Spine Surgery

ROOM: BANQUET HALL

Moderators: Todd J. Albert, MD & Hubert Labelle, MD

8:15 - 8:25 **Emerging Technologies in Complex Cervical Reconstruction**

Christopher P. Ames, MD

8:25 - 8:35 **Emerging Technologies in Spinal Cord Injury**

Michael G. Fehlings, MD, PhD, FRCSC

8:35 - 8:45 **Emerging Technologies in Pediatric Spinal Deformity**

Noriaki Kawakami, MD

8:45 - 8:55 **Advances in the Surgical Treatment of Adult Spinal Deformity**

Henry F.H. Halm, MD

8:55 - 9:15 **Discussion**

9:15 - 9:30 **Walking Break**

9:30 - 10:30 **Concurrent Sessions 12A-C: Abstract Session, Debate Series and ICL**

12A: Two-Minute Point Presentations

ROOM: BANQUET HALL

Moderators: *Baron S. Lonner, MD & Amer F. Samdani, MD*

- 9:30 - 9:32 **Paper 189: Effects of Frequency of Distraction in Magnetically-Controlled Growing Rod Lengthening on Outcomes and Complications**
Kenneth MC Cheung, MD; Kenny Kwan, BM BCh; Dino Samartzis, PhD; Ahmet Alanay, MD; John A. I. Ferguson, MD, FRACS; Colin Nnadi; Ilkka J. Helenius; Muharrem Yazici, MD; Gokhan Halil Demirkiran, MD; Behrooz A. Akbarnia, MD
- 9:32 - 9:34 **Paper 190: Can a “No Final Fusion” Produce Equal Results to Final Fusion after Growing Rod Treatment?**
Amit Jain, MD; Paul D. Sponseller, MD; Suken A. Shah, MD; George H. Thompson, MD; Jeff B. Pawelek; Behrooz A. Akbarnia, MD; Growing Spine Study Group
- 9:34 - 9:36 **Paper 191: Thoracic Volume Modeling of Growing Spine Interventions in Early-Onset Scoliosis**
David Matson; Charles Ledonio, MD; David W. Polly, Jr., MD; Jeff B. Pawelek; Behrooz A. Akbarnia, MD
- 9:36 - 9:38 **Paper 192: 3D Correction by CB Growth Rod Concept in Severe Deformities of the Immature Spine (EOS)**
Simon Toftgaard Skov, MD; Barbara Jensen, BS; Haisheng Li, MD, PhD; Ebbe Stender Hansen, MD, DMSc; Kristian Høy, MD, PhD; Miao Wang, MD, PhD; Cody Eric Bünger, MD, DMSc
- 9:38 - 9:40 **Paper 193: Evaluation of Sagittal Profile in Ambulatory Children with Early-Onset Scoliosis (EOS) Treated by Magnet Driven Growing Rods (MdGR) at Two Years**
Amr Fahmy, BS, MD, MSc; Nanjundappa S. Harshavardhana; Hilali H. Noordeen
- 9:40 - 9:42 **Paper 194: Does Initial Cast Correction Predict Treatment Success for Infantile Scoliosis?**
Jaime Andres Gomez, MD; Alexandra Grzywna, BA; Patricia Miller, MS; Lawrence I. Karlin, MD; John B. Emans, MD; Sumeet Garg, MD; James O. Sanders, MD; Paul D. Sponseller, MD; Jacques L. D'Astous, MD; Michael P. Glotzbecker, MD; Children's Spine Study Group; Growing Spine Study Group; Micaela Cyr, BA
- 9:42 - 9:50 **Discussion**
- 9:50 - 9:52 **Paper 195: Non-Fusion Surgical Correction of Thoracic Idiopathic Scoliosis using a Novel Braided UHMWPE Tether Device: 24-42 Months Results**
Hee Kit Wong, MD; John NM Ruiz, MD, FRCSC; Gabriel Liu, FRCSC
- 9:52 - 9:54 **Paper 196: The Use of Dynamic Surgical Guidance (DSG) Shortens Placement of Pedicle Screw Time While Improving Accuracy, A Teaching Instrument for Residents: A Cadaveric Study**
John I Williams, MD; Randal R. Betz, MD; Faheem Sandhu, MD, PhD; David Powell, MD; John T. Smith, MD; Hasan Syed, MD; Steven Spitz; John T. Smith, MD; Christian Jay Gaffney, MD, MSc; Lisa Kafchinski, MD; Dale T Landry, MD; John Gaughan, PhD
- 9:54 - 9:56 **Paper 197: Posterolateral Discectomies as Alternative to Anterior Posterior Spinal Fusion in Children with Severe Spinal Deformities**
Amit Jain, MD; Hamid Hassanzadeh, MD; Emmanuel N. Menga, MD; Paul D. Sponseller, MD
- 9:56 - 9:58 **Paper 198: Can S2-Alar-Iliac (S2AI) Screws Be Placed Accurately without Fluoroscopy?**
Daniel G. Kang, MD; Jacob M. Buchowski; Lawrence G. Lenke, MD; Ronald A. Lehman, MD; Panya Luksanapruksa, MD; Jamal McClendon, MD; Todd M. Chapman, MD; Lionel Nicholas Metz, MD
- 9:58 - 10:00 **Paper 199: MIS in AIS: Lessons Learned at Two-Year Follow Up**
Michael Nitikman, BS; Sameer Desai, BS; Firoz Miyanji, MD, FRCSC
- 10:00 - 10:02 **Paper 200: A Critical Analysis of Sagittal Plane Deformity Correction with Minimally Invasive Adult Spinal Deformity Surgery: A Two-Year Follow Up Study**
Gregory M. Mundis, MD; Vedat Deviren, MD; Juan S. Uribe, MD; Pierce D. Nunley, MD; Praveen V. Mummaneni, MD; Neel Anand, MD, Mch Orth; Paul Park, MD; David O. Okonkwo, MD, PhD; Michael Y Wang, MD; Shay Bess, MD; Adam Kanter, MD; Richard G. Fessler, MD, PhD; Stacie Nguyen, MPH; Behrooz A. Akbarnia, MD; International Spine Study Group
- 10:02 - 10:10 **Discussion**

- 10:10 - 10:12 **Paper 201: 28 Percent of AIS Patients Report Clinically Significant Psychopathology**
Stephanie Iantorno, BA; Austin Sanders, BA; Lindsay M. Andras, MD; Anita Hamilton, PhD; Paul D. Choi, MD; David L. Skaggs, MD, MMM
- 10:12 - 10:14 **Paper 202: The First 100 Consecutive Anterior Vertebral Body Tethering Procedures for Immature Adolescent Idiopathic Scoliosis at a Single Institution: Outcomes and Complications in the Early Postoperative Period**
Joshua M. Pahys; Amer F. Samdani, MD; Patrick J. Cahill, MD; Robert J. Ames, MD; Vishal Khatri, MD; Jeff S. Kimball; Harsh Grewal, MD; Glenn J. Pelletier, MD; Randal R. Betz, MD
- 10:14 - 10:16 **Paper 203: A Prospective, Multicenter, Randomized Controlled Trial of Nonsurgical Management versus Minimally Invasive Fusion for Sacroiliitis or Sacroiliac Joint Disruption**
David W. Polly, Jr. MD; Daniel Joseph Cher, MD; Peter G. Whang, MD; Clay Jamison Frank, MD; William Sanford Rosenberg, MD; Jonathan Nubla Sembrano, MD; Harry Lockstadt, MD, FRCSC; John Glaser, MD
- 10:16 - 10:18 **Paper 204: Early Postoperative Pain and Quality of Life following Posterior Instrumented Fusion for Lumbar Degenerative Conditions: a Prospective Randomized Study of Postoperative Bracing.**
Hany AG Soliman, MD, PhD; Stefan Parent, MD, PhD; Soraya Barchi, BS; Gilles Maurais, MD, FRCSC; Alain Jodoin, MD; Jean-Marc Mac-Thiong
- 10:18 - 10:20 **Paper 205: Variations in Sagittal Alignment Parameters Based on Age: A Prospective Study of Normal Patients using Full Length Low Dose Radiation Imaging**
Sravisht Iyer, MD; Lawrence G. Lenke, MD; Venu M Nemani, MD, PhD; Todd J. Albert, MD; Brenda A. Sides; Lionel Nicholas Metz, MD; Matthew E. Cunningham; Han Jo Kim, MD
- 10:20 - 10:22 **Paper 206: Laminectomy and Fusion versus Laminoplasty for the Treatment of Cervical Spondylotic Myelopathy: Results from the AOSpine North America and International Prospective Multicenter CSM Studies**
Carlo Santaguida, MD; Michael G. Fehlings, MD, PhD, FRCSC; Branko Kopjar, MD, PhD, MS; Paul M. Arnold, MD; Helton Luiz Aparecido Defino, MD; Shashank Kale, MD; S. Tim Yoon, MD, PhD; Giuseppe Barbagallo, MD; Ronald HMA Bartels, MD, PhD; Qiang Zhou, MD; Alexander R. Vaccaro
- 10:22 - 10:30 **Discussion**

12B: Debate Series 4

ROOM: BALLROOM 2

Moderators: Geoffrey N. Askin, FRACS & Christopher I. Shaffrey, MD

- 9:30 - 9:50 **Debate 1: Surgery versus Bracing for Thoracolumbar Fractures**
Surgery: Mark Weidenbaum, MD
Bracing: Ki-Tack Kim, PhD
- 9:50 - 10:10 **Debate 2: Thoracolumbar Fractures without Neurological Deficits are Best Treated with MIS Techniques**
Pro: Chung Chek Wong, MD
Con: Ronald A. Lehman, MD
- 10:10 - 10:30 **Debate 3: Is BMP Needed for Adult Spinal Deformity Surgery?**
Pro: Shay Bess, MD
Con: Sigurd H. Berven, MD

12C: Asia Pacific Spine Society ICL Part 2 - Correction of Severe Deformity: Tips and Tricks

ROOM: CONFERENCE HALL 2

Moderators: *Kenneth M.C. Cheung, MD & Keith D.K. Luk, MD*

- 9:30 - 9:40 **Surgical Correction of Severe Cervical Kyphosis**
Kuniyoshi Abumi, MD, PhD
- 9:40 - 9:50 **Surgical Correction of the Neglected Scoliosis**
Arvind Jayaswal, MD
- 9:50 - 10:00 **Surgical Correction of Severe Deformity due to Ankylosing Spondylitis (AS)**
Stephen J. Lewis, MD, FRCSC, MS
- 10:00 - 10:10 **Surgical Correction of Severe Lumbar Degenerative Kyphosis (LDK)**
Ki-Tack Kim, PhD
- 10:10 - 10:30 **Discussion**

10:30 - 11:00 Walking Break & Lunch Buffet

11:00 - 12:30 Session 13: Lunch with the Experts: Video-Based Surgical Techniques *NEW SESSION*

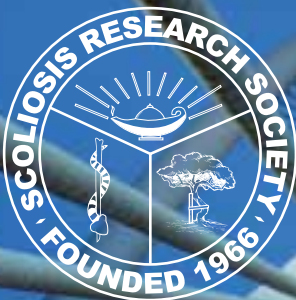
ROOM: BALLROOM 2

Moderators: *Steven D. Glassman, MD & Christopher I. Shaffrey, MD*

- 11:00 - 11:18 **Three-Column Osteotomy**
Lawrence G. Lenke, MD
- 11:18 - 11:36 **MIS Deformity Correction**
Rod J. Oskouian, MD
- 11:36 - 11:45 **Discussion**
- 11:45 - 12:03 **En Bloc Tumor Resection**
Laurence D. Rhines, MD
- 12:03 - 12:21 **Thoracoscopic Surgery**
Hee-Kit Wong, MD
- 12:21 - 12:30 **Disucssion**
- 12:30 **Adjourn**



Paper Abstracts



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Paper Abstracts

1. SACRAL THREE COLUMN OSTEOTOMIES FOR SACRAL FRACTURE AFTER MULTILEVEL SPINAL FUSION

Haruki Funao, MD; Floreana Naef, MD; Richard L. Skolasky, PhD, ScD; Khaled M. Kebaish, MD

Japan

Summary

Sacral three column osteotomies (S-3CO) for sacral fractures after multilevel spinal fusion were reviewed. To date, there was no case series describing S-3CO with assessments of standing radiographs and health related quality of life (HRQoL). A new anatomical spinopelvic parameter, lumbo-sacral angle (LSA) was defined to evaluate the lumbo-sacral sagittal alignment below S1. S-3CO significantly improved radiographic and clinical outcome. Conventional measurement of lumbar lordosis failed to adequately assess lumbo-sacral alignment. LSA would be an alternative radiographic parameter.

Hypothesis

Sacral three column osteotomies for sacral fracture with lumbo-sacral kyphosis improve radiographic and clinical outcome.

Design

Retrospective study

Introduction

Sacral fracture after multilevel spinal fusion is an uncommon complication, however, it may present as a distal junctional kyphosis in patients with osteoporosis or morbidly obese individuals, resulting in severe lumbo-sacral kyphosis and sagittal imbalance. To date, there was no case series of sacral three column osteotomies (S-3CO) for sacral fractures with assessments of standing radiographs and health related quality of life (HRQoL).

Methods

Patients that underwent S-3CO for sacral fractures after multilevel spinal fusions were enrolled. Standing radiographs and HRQoL scores were evaluated. A new spinopelvic parameter, named lumbo-sacral angle (LSA) was defined to evaluate the lumbo-sacral kyphosis below S1. LSA was defined as the angle between the inferior endplate of T12, and the perpendicular line connecting the endplates of S3-S4. Statistical analyses were performed using Student t test.

Results

Seven patients were identified with an average 42.4 months follow-up. Mean age at surgery was 60.4 years. 6 were females, and BMI was 29.4. Posterior spinal fusion with S-3CO was performed to correct focal kyphosis in all patients. Mean fused levels were 5.7 vertebrae, and all patients were fused to the pelvis. Mean surgical time was 472 minutes, estimated blood loss was 3100 ml, and ICU stay was 1.6 days. Mean radiographic changes were (pre/final); thoracic major (9.0/10.6°), lumbar major (16.1/10.2°), thoracic kyphosis (25.4/36.8°), lumbar lordosis (LL) (-59.4/-61.6°), pelvic tilt (PT) (27.7/25.2°), LSA (1.6/18.0°), and SVA (20.3/5.4cm). There was no

significant improvement in LL and PT, however, LSA and SVA significantly improved at final follow-up ($P < 0.01$). Mean SRS-22 domains were; (pre/final); activity (2.6/3.3), pain (1.8/3.2), self-image (2.5/3.3), mental (3.1/3.6), and satisfaction (1.8/2.8). ODI showed a significant decrease (50.2/36.8) ($P < 0.01$). There was motor weakness (1), dural tear (2), proximal junctional kyphosis (2), and pseudarthrosis at remote level (1).

Conclusion

Although S-3CO is considered challenging, it significantly improved radiographic and clinical outcome. Conventional LL measure failed to adequately assess lumbo-sacral alignment. LSA would be an alternative radiographic parameter.

2. NEUROLOGIC COMPLICATIONS IN ADULT SPINAL DEFORMITY SURGERY: INCIDENCE, RISK FACTORS AND OUTCOMES IN 558 PATIENTS

Han Jo Kim, MD; Sravisht Iyer, MD; Lukas P. Zebala, MD; Michael P. Kelly, MD, MS; Daniel M. Sciubba, MD; Themistocles S. Protopsaltis, MD; Munish Chandra Gupta, MD; Brian James Neuman, MD; Gregory M. Mundis, MD; Christopher P. Ames, MD; Justin S. Smith, MD, PhD; Robert A. Hart, MD; Douglas C. Burton, MD; Eric O. Klineberg, MD

United States

Summary

The overall incidence of all types of neurologic complications in adult spinal deformity (ASD) surgery was 20%. The incidence of surgical neurologic complications was 15%. There was an increased likelihood for its occurrence in revision cases and interbody use. Those who sustained neurologic complications were also more likely to undergo another operation during the follow up period. They also demonstrated lower SF-36 PCS scores at 6 weeks, but no differences in outcomes at 2 years.

Hypothesis

Neurologic complications in ASD do not compromise outcomes

Design

Retrospective Study

Introduction

The incidence of neurologic complications and risk factors for its occurrence with other complications in a large series of ASD has not been reported.

Methods

Operative pts with ASD from 2008-2014 were analyzed. Pts w/ neurologic complications were identified; demographics, operative details, radiographic, clinical outcomes compared. A sub-analysis of those with surgical (S) and non-surgical (NS) (i.e. stroke) neurologic complications was performed. Analysis was performed with t or χ^2 test as appropriate and multivariate analysis. Bonferroni correction was utilized with a significant p-value of 0.025.

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Results

558 pts met inclusion for the study with an avg age of 57 and an avg fu of 13 mo (range 0.5-3yrs). Of a total of 133 neurologic complications in 113 pts (20%), 97 (15%) were S and 36 (6%) were NS while 8 had both S and NS neurologic complications. Radiculopathy was the most common (33%) followed by motor deficit (25%), mental status change (15%) and sensory deficit (13%). Revisions and interbody use was associated with neurologic complications (OR 1.7, 95% CI 1.2 - 2.4, OR 2.1, 95% CI 1.4-3.2) while decompressions alone were not (OR 1.4, 95% CI 1.0-2.1). Osteotomies, regardless of type, did not increase the odds for neurologic complications. There were no differences in the rates of other complications although those with neurologic complications were more likely to undergo another operation during the fu period (OR 2.0, 95% CI 1.4-2.8). Pts with neurologic complications had a lower SF-36 PCS (36.7 vs 40.9 p<0.01) but similar ODI (32 vs 26 p=0.03) and SRS pain subscore (3.1 vs 3.4 p=0.03) at 6 wks. These did not reach MCID. Among patients with 2 year FU (n=229), there were no differences in final HRQOLs.

Conclusion

Neurologic complications occurred with an incidence of 20%. They were more likely to occur in revision cases and interbody use and result in revision operations. These pts demonstrated a lower SF-36 PCS at 6 weeks but did not demonstrate significant differences in the SRS or ODI. Outcomes at 2 years were similar between groups.

3. PRE-OPERATIVE PREDICTORS OF NEUROLOGICAL MOTOR DECLINE IN COMPLEX ADULT SPINAL DEFORMITY SURGERY: RESULTS OF THE PROSPECTIVE, INTERNATIONAL, MULTICENTER SCOLI-RISK-1 STUDY IN 271 PATIENTS

Michael G. Fehlings, MD, PhD, FRCSC; Lawrence G. Lenke, MD; Christopher I. Shaffrey, MD; Branko Kopjar, MD, PhD, MS; Kenneth M.C. Cheung, MD; Leah Yacat Carreon, MD, MS; Mark B. Dekutoski, MD; Frank J. Schwab, MD; Oheneba Boachie-Adjei, MD, DSc; Khaled M. Kebaish, MD; Christopher P. Ames, MD; Yong Qiu, MD; Yukihiko Matsuyama; Benny T. Dahl, MD, PhD; Hossein Mehdian, MD; Ferran Pellisé, MD; Stephen J. Lewis, MD, FRCSC, MS; Sigurd H. Berven, MD

Canada

Summary

In a prospective multicentre international study of adults undergoing correction for complex spinal deformity, we observed a 26.2% perioperative risk of neurological decline. The key risk factors for motor deficits included pre-operative myelopathy, surgery at the thoracic level, lumbar osteotomy and use of peri-operative antifibrinolytics. These results will enable the design of approaches to reduce perioperative neurological risks in complex adult spinal deformity.

Hypothesis

The precise rate of and key risk factors predisposing to neurological complications in patients undergoing surgery for complex adult spinal deformity can be determined.

Design

Prospective multicentre international study

Introduction

We sought to precisely define the neurological risks in adults undergoing corrective surgery for complex spinal deformity with the view to identify key associated risk factors.

Methods

We undertook a prospective international multicentre (15 sites) study of adults with "high risk" spinal deformity (defined as primary deformity of $\geq 80^\circ$; revision or three column spinal osteotomy; congenital spinal deformity; an associated myelopathy or significant cord compression) to determine the neurological complications and outcomes. The primary outcome measure was the decline in American Spinal Injury Association (ASIA) Lower Extremity Motor Scores (LEMS) at hospital discharge or at six weeks follow-up. Association of pre-operative characteristics with decline in LEMS was evaluated in a logistic regression model.

Results

A total of 271 subjects were enrolled with complete follow-up information. Of these, 71 (26.2%) experienced a LEMS decline at hospital discharge or at 6 weeks postoperatively. Of 56 clinical and imaging factors that had been defined pre-operatively, an association with perioperative neurological decline was found for older age, pre-operative motor deficits, pre-existing spinal cord compromise, use of antifibrinolytic measures to control blood loss, thoracic spine instrumentation and posterior lumbar osteotomy.

Conclusion

In adults undergoing correction for complex spinal deformity there is a 26.2% perioperative risk of neurological decline postoperatively or at 6 week follow-up. The key risk factors for perioperative neurological deficits include the presence of pre-operative spinal cord compromise, surgery at the thoracic level, lumbar osteotomy and use of peri-operative antifibrinolytics. Knowledge of these factors will enable design of protocols to prevent and treat perioperative spinal cord injury.

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4. DO EPIDURAL INJECTIONS PRIOR TO LUMBAR FUSIONS EFFECT POSTOPERATIVE INFECTION AND INTRAOPERATIVE DUROTOMY RATES?

Scott Yang, MD; Brian C Werner, MD; Jourdan M. Cancienne; Adam L. Shimer; Hamid Hassanzadeh, MD; Frank H. Shen; Anuj Singla

United States

Summary

The impact of pre-operative epidural injections on complications after spinal fusion has not been studied. Postoperative infection and intraoperative durotomy rates were higher after spinal fusion when LESIs were administered closer to fusion.

Hypothesis

LESIs are not associated with increased risk of postoperative infection and intraoperative durotomy with lumbar fusion.

Design

Case-control retrospective database study

Introduction

Lumbar epidural steroid injections (LESIs) are commonly performed prior to lumbar spine surgery. This study attempts to evaluate a potential association between the development of postoperative infection or intraoperative durotomy with LESI prior to lumbar spinal fusion.

Methods

A nationwide insurance based patient database was utilized for this retrospective analysis. The database was queried for LESI and 1-2 level posterior lumbar fusions. These patients were divided into 4 separate cohorts: 1) Fusion < 1 month after LESI, 2) Fusion 1-3 months after LESI, 3) Fusion 3-6 months after LESI, and 4) Control group: Fusion without prior LESI. Subsequent intraoperative durotomy and within 90-day postoperative infection rates were evaluated and compared between each group and control.

Results

The overall 3 month infection rate in lumbar spinal fusion was 1.6% (3716 out of 231,439). The infection risk increased in patients receiving LESI within 1 month (O.R. 2.66, P<0.0001), and 1-3 months (O.R. 1.58, P<0.0001) prior to surgery compared with control. The infection risk trended towards baseline after 3 months from LESI. The durotomy risk also increased in patients receiving LESI within 1 month (O.R. 1.52, P=0.0002), and 1-3 months (O.R. 1.38, P<0.0001) prior to surgery. The durotomy rate also trended towards baseline after 3 months from LESI.

Conclusion

LESIs are associated with increased risk of postoperative infection and intraoperative durotomy with lumbar spinal fusion. The highest association for both complications was demonstrated when LESI was administered closer to the time of surgery.

Table 2: Infection & Durotomy Rates Stratified by Timing of Preoperative Injection

	Time from Injection to Surgery			
	Control	0-1 Months	1-3 Months	3-6 Months
n	19152	2018	12214	24045
% Postop Infection	1.50%	8.00%	2.40%	1.00%
Odds Ratio (95% C.I.)	---	5.88 [1.12-3.04]	1.58 [1.40-1.78]	1.07 [0.96-1.19]
P-value	---	<0.0001	<0.0001	0.2751
% Intraop Durotomy	2.80%	8.20%	3.80%	2.90%
Odds Ratio (95% C.I.)	---	1.52 [1.25-1.90]	1.38 [1.25-1.52]	1.04 [0.96-1.13]
P-value	---	0.0002	<0.0001	0.1176

5. CHONDROSARCOMAS OF THE SPINE: PROGNOSTIC VARIABLES FOR LOCAL RECURRENCE AND MORTALITY IN A MULTICENTER STUDY

Charles Fisher, BS, MD, FRCSC, MHSc; Anne Versteeg; Nicolas Dea, MD, FRCSC, MSc; Stefano Boriani, MD; Peter Pal Varga, MD; Mark B. Dekutoski, MD; Luzzati Alessandro; Ziya L. Gokaslan, MD; Richard Williams, FRCSC; Jeremy James Reynolds, FRCS (T & O); Michael G. Fehlings, MD, PhD, FRCSC; Chetan Bettegowda, MD, PhD; Laurence D. Rhines, MD

United States

Summary

An ambispective multicenter database of surgically treated chondrosarcoma was analyzed to determine the influence of the Enneking classification on local recurrence and survival. Enneking inappropriate surgical management correlated to increased rates of local recurrence. Furthermore, local recurrence was strongly related to mortality.

Hypothesis

Enneking inappropriate surgical management increases the risk of local recurrence and mortality.

Design

Ambispective cohort study

Introduction

Primary spinal chondrosarcomas are rare. Best available evidence is based on small case series, thus making it difficult to determine optimal management and risk factors for local recurrence and survival.

Methods

The AOSpine Knowledge Forum Tumor developed a multicenter ambispective database of surgically treated patients with spinal chondrosarcoma. Patient data pertaining to demographics, diagnosis, treatment, cross-sectional survival, and local recurrence were collected. Tumors were classified according to the Enneking classification. Patients were divided into two cohorts: Enneking appropriate (EA) and Enneking inappropriate (EI). They were categorized as EA when the final pathological assessment of the margin matched the Enneking recommendation, and otherwise, they were categorized as EI.

Results

Between 1987 and 2011, 112 patients (37 female; 75 male) received surgical treatment for a primary spinal chondrosarcoma at a mean age of 47.4 ± 15.7 years. Patients were followed for a median period of 3.1 years (range 203 days-18.7 years). Median survival for the

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entire cohort was 8.4 years postoperative. Thirty-eight (34%) patients died and 40 (36%) patients suffered a local recurrence where 25/40 later died. Sixty-one (58%) patients received an EA procedure while 44 (42%) received an EI procedure. EI patients had a higher hazard ratio for local recurrence compared to those who received an EA procedure ($P = 0.050$). Absence of local recurrence was strongly related to survival ($P < 0.001$).

Conclusion

This is the largest multicenter cohort of spinal chondrosarcomas. EI surgical management correlated to increased rates of local recurrence. This robust correlation provides a strong rationale for surgeons to perform EA resection with disease free margins for spinal chondrosarcomas when technically feasible.



6. A DISSOCIATED EFFECT AFTER PONTE RELEASE FOR PERIAPICAL SEGMENTAL VERTEBRAL ROTATION IN ADOLESCENT IDIOPATHIC SCOLIOSIS.

Shoji Seki, MD, PhD; Yoshiharu Kawaguchi, MD, PhD; Hiroto Makino, MD; Tomoatsu Kimura, MD, PhD

Japan

Summary

Twenty AIS patients were included in this study (Thoracic: 10, thoracolumbar: 10). A devise for the measurement of vertebral rotation was attached on the uni-planar screws, and the devise was applied the rotational force of 5 kg. The angle of three periapical intervertebral rotations was measured in each intervertebral space and compared between pre- and post-Ponte Release. The significant difference between pre- and post-Ponte was recognized ($p < 0.0001$). The mean angle improved after Ponte release was 4.1 degree.

Hypothesis

Ponte release may make a change of vertebral rotation for the surgery of AIS patients.

Design

Prospective trial

Introduction

Ponte release is useful method as a posterior release in posterior spinal fusion. It is unclear that Ponte release itself makes a change of the vertebral derotation in surgery of adolescent idiopathic scoliosis (AIS) patients.

Methods

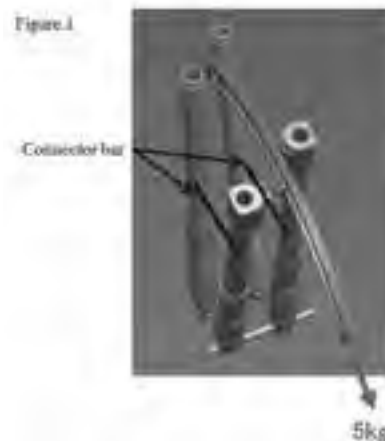
Twenty out of 36 AIS patients were included in this study (Lenke type I or II: 10, type V: 10). The mean age was 14.5 years old. All patients have been performed the posterior spinal fusion with uni-planar screws and a three periapical Ponte release. Ponte release is indicated below. After segmental uni-planar screw was inserted, the interspinous ligament, the cephalad spinous process, facet joint and the ligamentum flavum was removed, including the intracanal portion of the capsular ligament of the facet joint. The method of measurement is indicated below. A short rod was put on uni-planar screws of the concave side of the scoliosis. A devise which was newly generated by us for the measurement of vertebral rotation was attached on the bilateral uni-planar screws, and the devise was applied the rotational force of 5 kg (Fig 1). The angle of three periapical intervertebral rotations was measured in each intervertebral space and compared between pre- and post-Ponte release. In addition, comparison between thoracic curve (Lenke type I or II) and thoracolumbar curve (Lenke type V) was performed.

Results

Overall data showed that the angle of intervertebral rotation pre- and post-Ponte were 6.1 ± 1.7 , 10.2 ± 2.1 degree, respectively. The significant difference of improved rotation between pre- and post-Ponte was recognized ($p < 0.0001$). The overall improved angle after Ponte release was 4.1. The mean improved angle was 4.1 ± 2.2 in thoracic curve and 5.1 ± 1.9 in thoracolumbar curve. The improved angle of thoracolumbar curve was significantly larger than that of the thoracic curve ($p < 0.01$).

Conclusion

The Ponte release is likely to be useful in the surgery for AIS patients. Thoracolumbar curve is likely to have an advantage over thoracic curve in Ponte release.



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7. CLINICAL AND DTI EVALUATION OF EFFECTIVENESS OF RILUZOLE IN THE TREATMENT OF EARLY CERVICAL SPONDYLOTIC MYELOPATHY- A DOUBLE BLINDED, PLACEBO-CONTROLLED RANDOMISED CONTROLLED TRIAL

Ajoy Prasad Shetty, MS; Siddharth Narasimhan Aiyer, MS; Rishi Kanna, MS; S. Rajasekaran, PhD, MS

India

Summary

Management strategies in early cervical myelopathy are quite ill-defined. There is inadequate evidence to suggest superiority of surgical vs. conservative management in such scenarios. Even with conservative treatment no gold standard has been identified. We assessed the efficacy of neuroprotective drug Riluzole in the treatment of early cervical myelopathy. Benefits were assessed using change in objective clinical scores, functional outcome and analysis of diffusion tensor imaging which reflect the qualitative effects resulting from altered diffusion characteristics.

Hypothesis

Neuroprotective drug Riluzole would be beneficial in the treatment of early cervical myelopathy.

Design

Double blinded, Placebo-controlled randomised control trial.

Introduction

Treatment options in early cervical myelopathy (ECM) are not clearly defined. We present here the results of a novel pharmacotherapeutic agent Riluzole in the treatment of early cervical myelopathy.

Methods

Patients presenting with ECM defined as MJOA scores of 13 or more were recruited for the double blinded, placebo controlled randomized control trial. Total of 30 patients were studied with 15 patients each in the test and placebo group. The subjects were analysed with diffusion tensor imaging (DTI) and clinical evaluation, pre and post institution of Na⁺ channel blocker Riluzole for a period of 1 month (50 mg twice daily). Diffusion coefficient fractional anisotropy (FA), apparent diffusion coefficient (ADC), volume ratio (VR), relative anisotropy (RA) and eigenvectors were calculated.

Results

Outcomes analysis was based on clinical scores of MJOA, Nurick grading, SF-12, NDI and statistical analysis of DTI datametrics. The mean MJOA score was 15.6 (13-17) with no significant difference in the MJOA scores in either group. The mean SF-12 score was 35.54/40.14 (PCS/MCS) and changed to 37.47/41.09 (PCS/MCS) in the Riluzole group. The mean ADC, FA values were 1533.36 (1238-1779) and 494.36 (364-628) and changed to 1531.57 (1312-2091) and 484.86 (294-597) in the Riluzole group. However, the changes in the values of ADC, FA in the two groups was not statistically significant. The functional scores in the SF-12 and NDI questionnaires did not change significantly.

Conclusion

Our study did not show a significant change in the clinical outcome and DTI indices with the use of Riluzole as a standalone pharmacotherapeutic agent for early cervical myelopathy.

8. CLINICAL OUTCOME OF INSTRUMENTED FRENCH DOOR CERVICAL LAMINOPLASTY

Hossein Mehdian, MD; A.B Perez Romera, MD; Luigi Aurelio Nasto, MD; Michael Hutton, MD; Oliver M. Stokes, FRCS, MS United Kingdom

Summary

A series of 25 consecutive myelopathic patients were treated with a novel cervical laminoplasty technique, whereby the enlarged posterior arch was held open with a maxillofacial plate and screws. Mean post-operative stay was 2.4 days. At 56-months all patients reported neurological improvements and there was a 35% improvement in NDI and JOA score improved by 4.8. There were no postoperative hardware-related or neurological complications and no pseudoarthroses. Our modification of the technique has been shown to be safe and effective.

Hypothesis

Improving the stability of the enlarged posterior arch in cervical laminoplasty will be associated with fewer complications and better outcomes.

Design

Prospective enrolment of 25 consecutive patients with cervical myelopathy

Inclusion criteria - myelopathy of all aetiologies

Exclusion criteria - recognised contraindications to laminoplasty, previous posterior cervical spine surgery
Minimum follow-up - 40 months (4% patients)

Primary outcome measures - revision surgery, NDI, JOA score, VAS

Introduction

Instrumented cervical laminoplasty is associated with fewer complications such as spring-back. We describe a novel instrumented modification of the French door technique, improving the stability of the enlarged posterior arch, thereby reducing complications and improving outcomes.

Methods

A series of 25 consecutive myelopathic patients were treated with a novel cervical laminoplasty technique, whereby the enlarged posterior arch was held open with a maxillofacial plate and screws. At each level the excised lamina plus 2cm of iliac crest bone graft was screwed to a contoured 16-18 hole maxillofacial titanium mini-plate. The construct was then fixed with screws to the lateral masses, bridging the decompressed canal. Outcomes were assessed using Neck Disability Index (NDI), Japanese Orthopaedic Association (JOA) score, Visual Analogue Score (VAS) and radiographs.

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Results

There were 18 men and 7 women with a mean age of 45-years. Mean operative time was 130 minutes. The average hospital stay was 2.4 days and the patients were followed up for 56.5-months (40-72). All patients reported neurological improvements and there was a 35% improvement in NDI and JOA score improved by 4.8. There were no postoperative hardware-related or neurological complications.

Conclusion

The use of instrumentation offered immediate stability and was associated with a short post-operative stay and none of the complications associated with laminoplasty such as spring-back or trough fracture. Furthermore patients reported good improvements in NDI and JOA scores and there were no hardware associated complications or cases of neurological deterioration. This modification therefore has been shown to be safe and effective.

9. EFFICIENCY OF LEAD APRONS IN BLOCKING RADIATION – HOW PROTECTIVE ARE THEY?

Seung-Jae Hyun; Ki-Jeong Kim, MD, PhD; Tae-Ahn Jahng, MD, PhD

Korea

Summary

Single-center, prospective, randomized study of adult patients with degenerative lumbar disorders, scheduled to undergo PLIF. Instrumentation was performed in either a robot-assisted, minimally invasive approach (RO) or a conventional, fluoroscopically-assisted, open approach (FA). Use of robotic-guidance in a minimally invasive approach demonstrated a reduction of over half of the fluoro dose used in similar surgeries performed in a conventional open approach. We conclude that dose reduction is a more appropriate strategy than reliance on protection by lead aprons.

Hypothesis

Robotic surgery can reduce radiation exposure.

Design

Prospective randomized trial

Introduction

Despite the firmly established occupational risk of exposure to X-rays, these are used extensively in spine surgeries. Shielding by lead or lead-equivalent aprons is the most common protective practice, though their efficiency has shown varying results in the literature. We quantified the level of radiation blocking ability of 5 mm thickness lead aprons in a real-life setting.

Methods

Single-center, prospective, randomized study of adult patients with degenerative lumbar disorders, scheduled to undergo posterior lumbar interbody fusion. Instrumentation was performed in either a robot-assisted, minimally invasive approach (RO) or a conventional, fluoroscopically-assisted, open approach (FA). Outcome

measures included the quantitative measurement of the surgeon's actual exposure to radiation as recorded by thermo-luminescent dosimeters (TLD) worn both above and under the thyroid and trunk protectors.

Results

Twenty nine patients with similar demographics and clinical indications for surgery were included in this study, 17 in the RO arm and 12 in the FA arm. The radiation blocked by the aprons, represented as the ratio of the above and under apron TLDs, ranged between 27.7-48.3% in the trunk and thyroid areas, in the RO and FA arms. This means 51.7 to 72.3% of the radiation used with either surgical approach found its way to the TLD under the apron. In the RO arm the average per-screw radiation ranged between 25.0-45.3% of the per screw exposure in the FA arm.

Conclusion

Half millimeter aprons blocked only between a quarter and half of the radiation scattered towards the surgeon. Use of robotic-guidance in a minimally invasive approach demonstrated a reduction of over half of the fluoro dose used in similar surgeries performed in a freehand, open approach. We conclude that dose reduction is a more appropriate strategy than reliance on protection by lead aprons, and recommend utilization of practices and technologies that reduce the surgical team's routine exposure to X-rays.

Per Patient	Robot (N=17)	Control (N=12)	Robot as % of Control
Eye glasses (mSv)	0.02	0.07875	25.4%
Outside of thyroid protector	0.03823	0.10375	36.8%
Inside of thyroid protector	0.02764	0.06875	40.2%
Outside of trunk protector	0.04176	0.10875	38.4%
Inside of trunk protector	0.02588	0.05625	46.0%

10. DISTRACTIONAL FAILURE FORCES COMPARISON OF DIFFERENT ANCHOR SITES FOR THE PEDIATRIC GROWING ROD TECHNIQUE

Yang Junlin, MD, PhD; Huang Zifang, MD, PhD

Summary

The distraction force of three anchor sites (rib, lamina and pedicle) were tested and compared, the result showed that lamina and pedicle can provide a similar distraction force, but better than that of rib.

Hypothesis

It is very valuable to know whether the lamina or rib can provide a similar or better distraction force with pedicle.

Design

To analysis the distraction load-to-failure force supported by pedicle, lamina or rib linked to different constructs in pediatric cadaveric thoracic spine.

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Introduction

The rib, lamina, and pedicle are three main thoracic anchor site options for proximal thoracic fixation in the growing rod maneuver. Thus, it is currently unclear which anchor sites provide greater biomechanical strengths of distraction in different parts of the thoracic spine.

Methods

Eighteen pediatric cadaveric thoracic spines with rib cages were randomly assigned into three testing groups: A (lamina and pedicle), B (rib and pedicle), and C (rib and lamina). Each specimen was sectioned into six units from T1-T2 to T11-T12. A longitudinal load-to-failure test simulating growing rod distraction force was performed with an ElectroForce®3500 machine, and yield forces were statistically analyzed.

Results

The results showed that pedicle and lamina anchors could provide a similar capacity against distraction force in group A ($P>0.05$), which was almost double that of ribs in groups B and C ($P<0.05$). The data showed that T5 and T7 pedicles and laminae seem to provide the lowest distraction force. Furthermore, break pedicle insertion provides 75.6% of distraction force compared to the same segments with intact pedicle insertion.

Conclusion

Our results suggest the lamina as a proximal thoracic anchor site for pediatric spinal deformity. The pedicle and lamina of T5 and T7 vertebrae seemed to provide a lower distraction force than other thoracic segments in our test.

11. DOES PEDICULE SCREW FIXATION UNDER AGE FIVE CAUSE SPINAL CANAL NARROWING? A CT STUDY WITH MINIMUM 5 YEARS FOLLOW-UP.

Sinan Kahraman, MD; Meric Enercan, MD; Mutlu Cobanoglu, MD; Sinan Yilar, MD; Levent Ulusoy, MD; Ayhan Mutlu, MD; Tunay Sanli, MA; Bahadir Gokcen, MD; Erden Erturer, MD; Cagatay Ozturk, MD; Ahmet Alanay, MD; Azmi Hamzaoglu, MD

Turkey

Summary

Pedicle screw instrumentation has no adverse effect on further spinal growth and does not result in iatrogenic spinal stenosis.

Hypothesis

Pedicle screw instrumentation does not effects spinal canal growth in pediatrics.

Design

Retrospective

Introduction

The influence of pedicle screw fixation on canal diameter below age 5 is controversial. Animal studies demonstrated development of canal stenosis after pedicle screw fixation. In contrast to this results, clinical studies demonstrating no spinal stenosis after pedicle screw fixation has been published. The aim of this retrospective

study was to evaluate the changes in the canal area in a group of patients who had pedicle screw fixation under age 5 for the treatment of spinal deformity at least 5 year follow-up

Methods

11 patients who had been operated due to spinal deformity under age 5 with who had a CT examination due to several reasons at least 5 years after the initial spinal operation were included in the study. All patients had congenital scoliosis and underwent hemivertebrectomy and transpedicular fixation procedures at an average age of 3.18 (range; 2 to 5). All had preoperative CT to evaluate the congenital deformities. Measurements were done at the instrumented vertebrae as well as the uninstrumented ones above and below them to evaluate; anterior vertebral body height (AVBH), posterior vertebral body height (PVBH), cranial end plate length (CrEPL), caudal end plate length (CaEPL), spinal canal area (SCA), anteroposterior diameter of vertebral body (APD) and lateral diameter of vertebral body (LD) of upper instrumented vertebra (UIV), lower instrumented vertebra (LIV), upper adjacent uninstrumented vertebra (UAV) and lower adjacent uninstrumented vertebra (LAV).

Results

The average follow-up was 7,2 (range; 5 to 12) years. 6 of the patients were over age 10 during the final CT examination while 5 were at age 7. Female to male ratio was 7 to 4. Measurement of all the parameters in 22 instrumented and 22 non-instrumented segments showed a proportional increase rather than a decrease at each segment (Figure 1). The percentage of canal area growth at UIV and LIV were 21% and 17.5% respectively.

Conclusion

Pedicle screw instrumentation has no adverse effect on further spinal growth and does not result in iatrogenic spinal canal stenosis.



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12. ABNORMAL ULTRASTRUCTURE OF THE OSTEOCYTE-LACUNO-CANALICULAR SYSTEM IN ADOLESCENT IDIOPATHIC SCOLIOSIS – A NEW NOVEL FINDING

Wayne Lee; Huanxiong Chen, MD; Jiajun Zhang, MPhil; Zhiwei Wang, MD; Bobby Kinwah Ng, MD; Kwong Man Lee; Tsz Ping Lam, MD; Jerry J.Q. Feng, PhD; Jack C.Y. Cheng, MD

Hong Kong

Summary

Recent evidences suggested the important physio- and patho-logical roles of osteocytes in bone homeostasis and quality in addition to the well-acknowledged bone multicellular unit (i.e. osteoblasts and osteoclasts). The ultrastructure of the osteocytes and their lacuno-canalicular network (collectively as OLC system) in adolescent idiopathic scoliosis (AIS) was characterized and compared with normal matched control bone biopsies. Significant abnormality was found in the ultrastructure with scanning electron microscopy (SEM) and confocal imaging from bone biopsies of AIS patients Vs normal.

Hypothesis

Abnormalities in the morphology of the OLC system could result from abnormal genetics and interaction with multiple environmental factors and manifest as abnormal bone quality that might contribute to the etiopathogenesis of AIS.

Design

This is a case-control study.

Introduction

Systemic osteopenia was found in over 30% of the AIS girls and was recognized as an important prognostic factor for curve progression. Recently, our group also reported deranged bone microarchitecture, volumetric bone mineral density and mechanical bone strength with HR-pQCT. In view of the increased recognition of the important regulatory roles of osteocytes in bone homeostasis via interconnecting lacuno-canalicular network, this pilot study aimed to determine the ultrastructure of the OLC system from bone biopsies in AIS vs normal matched controls.

Methods

This study on 10 iliac crest bone biopsies taken intra-operatively from AIS patients undergoing posterior spinal instrumentation Vs age-matched controls with bone biopsy taken as part of the respective orthopaedic procedure under strict IRB approved protocol. The fresh bone biopsies were processed and examined by acid-etched SEM, confocal microscopy and analysed quantitatively by fluorescein isothiocyanate (FITC)-Imaris technique.

Results

SEM revealed the orderly aligned normal osteocytes-spindle in shape with abundant perpendicularly radiating canaliculi; while AIS osteocytes were more rounded and irregular in shape aligned in irregular clusters with

shorter and disorganized canaliculi. Quantitative analysis of the 3D confocal images showed statistically significant differences with a mean of 41% shorter and 48% less branched canaliculi in AIS OLC system.

Conclusion

To the best of our knowledge, this is the first study demonstrating the abnormal ultrastructure of OLC in AIS subjects both qualitatively and quantitatively. Further studies will help to advance our understanding of the association between the abnormal bone quality and ultrastructure in AIS and its possible contributions to the etiopathogenesis of AIS. This study was supported by CUHK Direct Grant (4054066) and partly by RGC GRF(463113 2013/14).

13. DOES ANTERIOR COLUMN SUPPORT (ACS) FOLLOWING A PEDICLE SUBTRACTION OSTEOTOMY REDUCE ROD STRAIN? AN IN VITRO BIOMECHANICAL INVESTIGATION

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Denmark

Summary

The present study investigated whether ACS reduces rod strain, thus explaining reduced rates of rod fracture seen clinically following pedicle subtraction osteotomy (PSO). Cobalt Chrome rods (CoCr) significantly diminished strain, while the effect of ACS on motion-based changes in strain was minimal.

Hypothesis

Use of both CoCr and ACS results in significant reduction of rod strain compared to a titanium two-rod construct.

Design

An in vitro human cadaveric biomechanical study.

Introduction

Recent literature reports decreased rates of rod fracture when ACS is used at the level of the PSO; however these results are poorly understood. Presently it is unclear whether ACS prevents disc collapse or reduces rod strain as a flexion blocker. The present study seeks to understand the effect of anterior support on rod strain at the PSO-level, thus explaining the results seen clinically.

Methods

Five specimens (T12-S1) underwent PSO at L3 with pedicle screw stabilization from L1-S1. PSO was varied per specimen so the final lordosis was 70°. Specimens were subjected to 10 Nm in flexion-extension on a custom motion simulator. Linear strain gauges, on the posterior surface of the rod at PSO-level, measured surface rod strain during motion. Dual lateral interbody spacers (S) were inserted at L2-L3 and L3-L4 following testing of the primary rods. Tested constructs include: 1) titanium two-rods (Ti 2-Rod); 2) CoCr 2-Rod; 3) Ti 2-Rod+S; 4) CoCr 2-Rod+S. A one-way ANOVA assessed significant differences between constructs ($p \leq 0.05$).

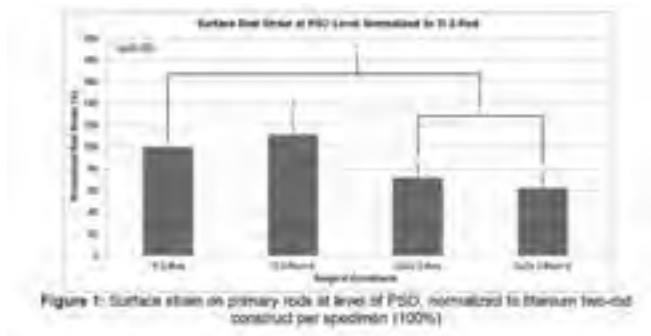
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Results

CoCr 2-Rod+S provided most resistance to surface rod strain relative to Ti 2-Rod, Fig. 1. CoCr rods reduced strain by 28.1% compared to Ti ($p \leq 0.05$) while addition of ACS further reducing strain by 9.4% ($p \leq 0.05$). Alternatively, ACS with Ti construct increased strain at the PSO by 11.6% ($p \geq 0.05$).

Conclusion

CoCr rods provided greatest reduction of rod strain at the PSO-level. While the absolute strain state of the rod is unknown, it does appear ACS minimally affects the motion-induced strain. Therefore, interbody spacers may primarily act as an anterior column support.



14. NOVEL VIRTUAL MODELING OF ALIGNMENT FOLLOWING ASD SURGERY: ESTABLISHING RELATIONSHIPS BETWEEN COMPENSATORY CHANGES AND OVERCORRECTION DUE TO PROXIMAL JUNCTIONAL KYPHOSIS

Renaud Lafage, MS; Shay Bess, MD; Steven D. Glassman, MD; Christopher P. Ames, MD; Douglas C. Burton, MD; Bradley Yates Harris, JD; Robert A. Hart, MD; Han Jo Kim, MD; Eric O. Klineberg, MD; Breton Line, BS; Justin K. Scheer, BS; Themistocles S. Protopsaltis, MD; Frank J. Schwab, MD; Virginie Lafage, PhD; International Spine Study Group United States

Summary

Postoperative analysis of sagittal alignment in patients with PJK is difficult due to the compensation for the deformity. A novel model, using pre-operative and postoperative alignment was developed and validated using data from patients without PJK at 2-year follow-up in order to eliminate the influence of PJK on global alignment. Comparing the virtual positions of patients with and without PJK reveals a significant difference in global alignment.

Hypothesis

Virtual models of the spine following ASD surgery can help improve our understanding of post-op alignment. Based on these models, PJK acts as a compensatory mechanism.

Design

Modeling of retrospective cohort.

Introduction

It is difficult to analyze patients' postoperative sagittal alignments once they develop PJK since they often dramatically compensate for the deformity. Until now, there was no effective way to model post-op alignment that was free of PJK's compensatory influence. This study proposes a novel virtual modeling technique that eliminates PJK's impact on global alignment. Examining these models will lead to a better understanding of alignment factors associated with PJK.

Methods

An ASD database was used to model virtual post-op alignments (VIRTUAL) for patients with pelvic fusion. Patients were divided into groups with/without PJK (PJK vs. NOPJK). VIRTUAL combined the 2-year post-op alignment of the instrumented segments (pelvis to UIV-1) with the pre-op alignment of the unfused segments (C2 to UIV); pelvic retroversion was corrected based on a published predictive formula. VIRTUAL was validated by comparisons to actual 2-year post-op alignment (REAL) in NOPJK patients.

Results

458 patients (78F; mean 57.9y) were analyzed. Initial validation of VIRTUAL versus REAL demonstrated coefficients of correlation above 0.880 for all measures except SVA ($r=0.604$). At 2 years, 215 (47%) patients had PJK (PJK angle= 21°). PJK patients were older than non-PJK (59.7 vs. 62.6y, $p=0.007$). On REAL, PJK had smaller PI-LL mismatch and larger TK than NOPJK (resp. PI-LL: 3.1 vs. 8.2° , TK: -44.6 vs. -37.3° , all $p < 0.001$), but similar SVA, TPA and PT. However, analysis of VIRTUAL demonstrated that PJK not only had less PI-LL (3.1 vs. 7.7°), but also less PT (20 vs. 23°), less SVA (10 vs. 24 mm) and less TPA (15 vs. 18°) than NOPJK ($p < 0.05$).

Conclusion

This novel modeling technique demonstrated high correlations with actual post-op alignment in patients without PJK. Comparing REAL to VIRTUAL models indicates that PJK may be a component of the compensatory mechanism, rather than simply an alignment failure.



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15. GENERATION OF FBN1 GENE KNOCKOUT PIG MODEL FOR MARFAN SYNDROME

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Japan

Summary

The knockout of the gene fibrillin 1 (FBN1), the causative gene for Marfan syndrome (MFS) by zinc finger nuclease (ZFN) developed pigs with Marfanoid phenotypes including pectus excavatum, disruption of the aortic wall, scoliosis and cleft palate.

Hypothesis

Genome-editing using ZFN generates FBN1 knockout pigs with MFS phenotypes.

Design

Experimental animal study using genome editing technique.

Introduction

There is no established large animal model of scoliosis created without surgical tethering. As a first step to generate genome-edited scoliosis pig model, we sought to generate a pig model for MFS which frequently develops scoliosis by knocking out FBN1, the causative gene for MFS, using ZFN.

Methods

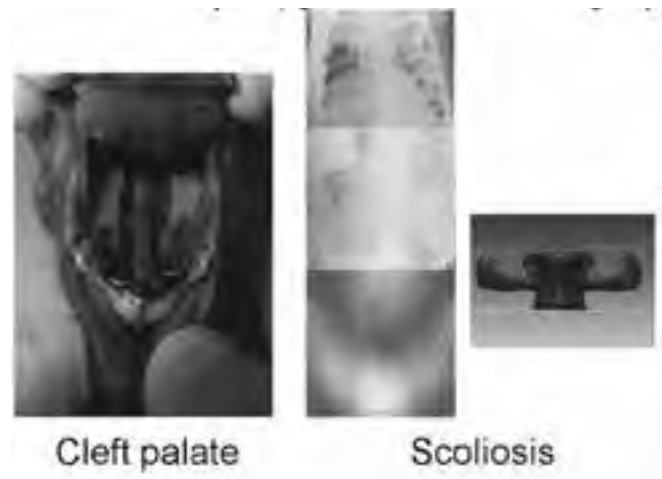
ZFN mRNAs that targeted exon 10 of FBN1 were inserted into male porcine fetal fibroblast cells by electroporation and a cell line, designated as F047 (+/Glu433AsnfsX98), was established as nuclear donor cells. After nuclear transfer, the cloned embryos were transferred into four recipient gilts after culture for 1-2 days (early group) and 5-6 days (late group).

Results

19 pigs (11 in the early group, 8 in the late group) were born. We then analyzed the phenotypes of the KO cloned pigs: In the early group, one pig had pectus excavatum and one developed mild scoliosis (Figure). In the late group, cleft palate and pectus excavatum were observed in two pigs, respectively. Disrupted elastic lamellae were present in the proximal thoracic aortas in 2 of 3 pigs which underwent histological examination.

Conclusion

Mutation of FBN1 by genome-editing produced phenotypic effects in KO cloned pigs that were similar to those of familial MFS in humans. However, although the KO cloned pig siblings had an identical genetic background, they did not exhibit a consistent phenotype. The late group exhibited MFS phenotypes more frequently than the early group. These results suggest that not only genetic but epigenetic factors may play a role in the development of MFS phenotypes. Scoliosis was identified in only one pig. Some mechanical loading may be necessary to develop scoliosis more constantly.



16. PREDICTORS OF LENGTH OF HOSPITAL STAY AND 30-DAY READMISSION IN CERVICAL SPONDYLOTIC MYELOPATHY PATIENTS: AN ANALYSIS OF 3057 PATIENTS USING THE AMERICAN COLLEGE OF SURGEONS DATABASE

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United States

Summary

Surgical intervention for cervical spondylosis with myelopathy (CSM) is common; as such, factors and complications for CSM surgery have been thoroughly investigated. Additional considerations, including length of hospital stay and 30-day readmission, are important determinants of patient costs and outcomes. However, pre-operative and intra-operative risk factors attributing to extended LOS and readmission for elective CSM surgery have not yet been identified. Baseline and surgical risk factors for extended LOS and readmission were determined for CSM surgical patients.

Hypothesis

Presence of baseline comorbidities that are indicators of poor surgical outcomes increase LOS and readmission/reoperation rate.

Design

Retrospective review of prospectively collected multicenter database.

Introduction

Cervical spondylosis with myelopathy (CSM) surgery often offers significant pain relief, but complications resulting in extended hospital length of stay (LOS) and readmission/reoperation are frequent; this study investigates pre-operative and intra-operative risk factors attributing to extended LOS and readmission for elective CSM surgical patients.

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Methods

Inclusion criteria were surgical patients diagnosed with CSM between 2010 and 2012 at institutions represented by the American College of Surgeons database. Patients with fractures, +9 levels fused, or cancers were excluded. Univariate and multivariate linear regression modeling analyses identified independent predictors for LOS and readmission.

Results

3057 CSM cases were identified between 2010-2012. Average age and BMI were 60.7 yrs and 29.2 kg/m², respectively. LOS ranged from 0-62 days. Independent positive predictors of extended LOS (≥4 days) included: age (OR 1.037, p<0.001), diabetes (OR 1.719, p<0.001), ASA class (OR 2.264, p=0.009), and op time (OR 1.008, p<0.001). Of the 979 (31.9%) surgical CSM patients with 30-day readmission data, 915 were not readmitted (93.8%), while 61 (6.2%) were. Independent positive predictors of readmission were diabetes (OR 1.460, p=0.009) and ASA class (OR 2.539, p=0.033). A sub-group analysis of readmitted patients who returned to the OR identified age (OR 0.918, p=0.004) and pulmonary comorbidities (OR 4.584, p=0.038) as significant predictors of major reoperation.

Conclusion

Elderly CSM surgical patients with pre-operative diabetes, higher ASA Class assignment, and increased op time were at risk for extended LOS. These same factors, with the exception of age, significantly predicted hospital readmission within 30 days. Of CSM patients readmitted, presence of pulmonary comorbidities increased reoperation risk, while increased age reduced this risk.

17. MINIMALLY INVASIVE TRANSFORAMINAL LUMBAR INTERBODY FUSION (MIS TLIF): 2 YEAR PROSPECTIVE OUTCOME STUDY IN A TERTIARY CARE HOSPITAL

Khai Sing Lam, MD, FRCSC; Ed Simor Khan, MD

Malaysia

Summary

MIS TLIF is a safe and effective technique in our prospective clinical study of 91 patients that achieved good to excellent clinical outcomes above the expectations of the patient. All patients showed significant improvements in their ODI, VAS score, and SF-36 domains at every time point studied that was maintained up to 24 months. Once radiological healing takes place, the patients have a steady uphill course towards improved functional recovery and reduced pain.

Hypothesis

The purpose of this prospective study is to present the clinical outcome and radiological fusion of MIS TLIF over a 24 mth period.

Design

2 year prospective clinical and radiological outcome study of MIS TLIF.

Introduction

MIS TLIF may help reduce the morbidity related to post surgical pain and improve post surgical pain, recovery and early return back to work.

Methods

91 patients underwent MIS TLIF between Aug 2007 to Feb 2012. Serial X-rays and clinical outcomes were performed at 6 wks, 3 mths, 6 mths, 12 mths and 24 mths using VAS, Oswestry Disability Index (ODI) and SF-36. Radiological fusion was assessed at 12 months using a CT-scan.

Results

There were 52 males, 39 females, with 2 year follow up, and mean age 55 yrs. 77 patients underwent single and 14 patients two level surgery. 17 patients (19%) had spondylolisthesis (13 degenerative, 4 lytic), 74 patients (81%) had degenerative disc disease with or without radicular pain. In single versus double level fusion, mean operative time was 98 (80-150) versus 160 mins (140-180), mean blood loss 150 versus 350 mls, and mean hospital stay 2.5 (1-4) versus 2.8 days (1-4). ODI improved significantly (P< 0.05) from pre-operative 51% down to 31.5% at 3 months, 21% at 6 mths and was maintained up till 24 mths. For the same time points, mean VAS back pain score improved significantly from 58% pre-op down to 32%, 29% and maintained at 24 mths at 23%, VAS leg pain improved from 55% down to 22%, 16% and maintained up to 24 mths at 15%. For mean physical (PCS) and mental (MCS) all improved significantly at every time point up till 24 mths. All patients showed either grade 1 or 2 fusion on CT-scan based on the Bridwell grading system. No patients had any radiolucency, collapse or resorption of the graft at 12 months follow up. There was 1 dural tear, 2 misplaced screws requiring repositioning, 1 pseudarthrosis requiring revision anterior fusion, and 1 bone graft migration treated conservatively.

Conclusion

MIS TLIF is a safe and effective technique that achieves good to excellent clinical outcomes above the expectations of the patient in the early post-operative period up to 24 mths.

18. USE OF PEEK CAGES IN THE TREATMENT OF BASILAR INVAGINATION BY ATLANTOAXIAL FACET DISTRACTION (GOEL TECHNIQUE)

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Brazil

Summary

Traditional treatment of basilar invagination is transoral odontoid resection and occipitocervical fusion. The Goel technique has modified the way of management, avoiding the morbidity of transoral approach. We believe that the use of peek cage provides additional benefits compared to original Goel technique.

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Hypothesis

Poly-Ether-Ether-Ketone (PEEK) cages are safe and effective for the treatment of basilar invagination by atlantoaxial facet distraction.

Design

Retrospective study of four consecutive basilar invagination patients.

Introduction

Currently, Goel technique has become more popular in the treatment of basilar invagination. Atlantoaxial facet joint distraction promotes indirect decompression and realignment of the odontoid. Originally, Goel technique uses stainless steel cages. We used PEEK cages, because of its theoretical advantages: lower rate of subsidence, higher consolidation rate and better visualization on imaging studies.

Methods

Retrospective analysis of the neurological status, pain, odontoid reduction, presence of subsidence and bone fusion with the use of PEEK cages in eight atlantoaxial joints of four patients. All patients, three female and one male, were treated with atlantoaxial facet distraction and realignment and C1-C2 arthrodesis. All patients signed the informed consent and were operated during 2013 and 2014. Patients were assessed by Visual Analog Scale (VAS) and Nurick myelopathy scale. The mean age was 50.25 ± 8.01 years (39-58 years) and the mean follow-up was $16 \pm 6:48$ months (9-22 months). Patients were evaluated at 3, 6 and 9 months after surgery through neurological examination and computed tomography (CT) at 6 months.

Results

All patients improved in VAS and Nurick scale. There were no cases of subsidence, migration or damage to the vertebral artery during inserting of the cages. Fusion was achieved in all joints, assessed by dynamic radiographs and CT. Two patients developed C2 neuropathic pain and one patient had unilateral vertebral artery injury during C2 instrumentation treated with insertion of pedicle screw to control the bleeding.

Conclusion

The use of PEEK cages in the treatment of basilar invagination by Goel technique has shown to be effective and safe. Further studies are needed to confirm our results.



19. BENEFIT OF TLIF VERSUS PSF IN LUMBAR SPINE DISORDERS

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United States

Summary

This analysis of the N2QOD registry offers valuable insight into the relative efficacy of TLIF versus PSF in standard clinical practice. TLIF generated significantly more favorable ODI outcomes than PSF for patients with spondylolisthesis, but not for patients with spinal stenosis or adjacent segment disease. There were no differences in NRS back pain or leg pain scores. There was equivalence in OR time and EBL between TLIF and PSF, potentially altering the longstanding assumption that PSF is a simpler procedure

Hypothesis

TLIF results in better outcomes than PSF.

Design

Propensity case-matched analysis of a national spine registry.

Introduction

TLIF has replaced PSF as the most commonly used fusion technique for treating lumbar degenerative disorders. Despite potential benefits including higher fusion rate and complete foraminal decompression, prior studies have often failed to document improved clinical outcomes with TLIF vs PSF.

Methods

The N2QOD database was queried for patients who had a lumbar fusion. 85% (1722) of enrolled cases had 12-month follow-up data. Patients were stratified into diagnostic categories. PSF cases within each diagnostic subgroup were propensity-matched to patients who had TLIF. There were 306 PSF patients and 1230 TLIF patients. Sufficient propensity-matched controls were available for patients with spondylolisthesis (109), spinal stenosis (63) and adjacent segment disease (47).

Results

OR time, EBL and LOS were similar between PSF and TLIF in all three propensity matched groups. In the entire unadjusted cohort, the PSF group had a higher mean EBL vs TLIF (438cc vs 347cc, $p=0.000$). Both TLIF and PSF produced statistically significant and clinically relevant improvement for all HRQOL measures at all time points, across all diagnostic indications. In the entire cohort, patients treated by TLIF had a greater 12-month ODI improvement vs PSF (24.3 vs 20.7, $p=0.006$) and were more likely to attain MCID (71% vs 63%, $p=0.007$). In the spondylolisthesis group, there was a greater improvement in ODI with TLIF vs PSF at 3 months (19.4 vs 26.0, $p=0.009$), 12 months (20.8 vs 29.3, $p=0.001$), and in percent reaching MCID at 12 months (80% vs 62%, $p=0.007$). There were no differences in ODI improvement

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between PSF and TLIF in the stenosis or adjacent segment disease groups. Improvement in back pain NRS, leg pain NRS and EQ-5D was similar in all diagnostic groups, at all time points.

Conclusion

TLIF generated significantly more favorable ODI outcomes than PSF for patients with spondylolisthesis, but not for patients with spinal stenosis or adjacent segment disease. There was also equivalence in OR time and EBL between TLIF and PSF, potentially altering the longstanding assumption that PSF is a simpler procedure.

20. PROPENSITY SCORE MATCHED ANALYSIS OF ADULT SPINAL DEFORMITY (ASD) PATIENTS DEMONSTRATES THAT INTERBODY AND/OR POSTEROLATERAL USE OF RECOMBINANT HUMAN BONE MORPHOGENETIC PROTEIN-2 (RHBMP-2) IMPROVES FUSION RATES WITHOUT INCREASING COMPLICATIONS

Shay Bess, MD; Breton Line, BS; Eric O. Klineberg, MD; Christopher P. Ames, MD; Behrooz A. Akbarnia, MD; Oheneba Boachie-Adjei, MD, DSc; Douglas C. Burton, MD; Marilyn L. G. Gates, MD; D.Kojo Hamilton, MD; Robert A. Hart, MD; Richard Hostin, MD; Virginie Lafage, PhD; Gregory M. Mundis, MD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Justin S. Smith, MD, PhD; International Spine Study Group

United States

Summary

Comparison of propensity score matched ASD patients demonstrated that posterolateral and interbody rhBMP-2 use, at reported doses, appears to be safe and promote greater fusion rates as BMP patients had similar complication rates for major, minor and specific complications at each time point and demonstrated greater fusion rates at minimum 2 year follow up than NOBMP patients. Postoperative HRQOL values were similar between groups, however longer follow up may be needed to discriminate between patients with pseudarthrosis vs. solid arthrodesis.

Hypothesis

RhBMP-2 will not increase complications or fusion rates in multi-level ASD surgery.

Design

Propensity score matched, case-control analysis of surgically treated ASD patients.

Introduction

Reports indicate rhBMP-2 may increase complications without improving fusion rates.

Methods

Analysis of surgically treated ASD patients prospectively enrolled into a multi-center database. Inclusion criteria: ASD, age ≥ 18 years, spinal fusion ≥ 4 levels, ≥ 2 years follow up. Patients divided into those receiving or not receiving rhBMP-2 (BMP vs. NOBMP). BMP patients grouped according to the location of rhBMP-2 use; posterolateral (PBMP) or interbody+posterolateral (I+PBMP). BMP patients were propensity score (PSM) matched to NOBMP according to demographics and operative procedures.

Complication type and timing (<3 months, 3-6 months, 6-12 months, and 12-24 months) recorded, spine fusion assessed (Lenke grade) and health related quality of life (HRQOL) outcomes evaluated.

Results

239 of 329 patients (mean follow up 2.8 years; range 2-5 years) had ≥ 2 years follow up. All PSM groups (PBMP vs. NOBMP and I+PBMP vs. NOBMP) had similar demographics, pre and postoperative spinal deformity, operative procedures, and follow up ($p < 0.05$). Mean total rhBMP-2 dose was PBMP (n=87)=31 mg (2.8 mg/level), and I+PBMP (n=45)= 38 mg (posterolateral=2.6mg/level; interbody=5.4mg/level). All postoperative complications were similar for all groups at each time point. BMP demonstrated greater fusion grades (PBMP=3.3 vs. NOBMP=2.8, I+PBMP=3.5 vs. NOBMP=2.7; range 1-4) and fusion rates (PBMP=83% vs. NOBMP=62%, I+PBMP=92% vs. NOBMP=62%; $p < 0.05$). Postoperative HRQOL values were similar for all groups.

Conclusion

Propensity score matched BMP vs NOBMP patients demonstrated that rhBMP-2, at reported doses, is safe and promotes greater fusion rates for ASD surgery at minimum 2 year follow up. Longer follow up may be needed to discriminate between patients with solid arthrodesis vs. pseudarthrosis.

21. CLASSIFICATION OF EARLY ONSET SCOLIOSIS (C-EOS) HAS ALMOST PERFECT INTER AND INTRA OBSERVER RELIABILITY

Micaela Cyr, BA; Tricia St. Hilaire, MPH; Zahoxing Pan, PhD; George H Thompson, MD; Children's Spine Study Group; Growing Spine Study Group; Sumeet Garg, MD

United States

Summary

C-EOS has extremely high inter and intra-observer reliability.

Hypothesis

C-EOS will show consistently high levels of agreement for both inter-observer and intra-observer reliability.

Design

Validation of a new classification scheme for children with early onset scoliosis.

Introduction

Classification systems can be useful tools for clinical care and research but must be proven as reliable.

Methods

After IRB approval, 50 cases were drawn from a prospectively collected database of patients with early onset scoliosis (EOS). Cases were selected using a stratified randomization scheme based on etiology. These cases were used to create an internet survey that was sent to pediatric orthopedic faculty, research coordinators, and fellows involved in EOS care and research. Participants were asked to classify each case and were provided with a written C-EOS scheme which could be referenced while they completed the survey. Surveys

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were sent to participants twice, to assess both intra and inter-observer reliability. Fleiss Kappa and Cohens Kappa were used to assess inter and intra-observer reliability, respectively.

Results

There were 36 total participants, 29 who completed the survey twice (21 faculty, 13 research coordinators, and 2 fellows). Overall Fleiss Kappa coefficient for inter-observer reliability was almost perfect across the major categories of etiology (0.84), major curve (0.93), and kyphosis (0.96). Overall intra-observer reliability was almost perfect with Cohen's kappa values for etiology (0.92), major curve (0.96), and kyphosis (0.98). Faculty members had almost perfect agreement for etiology (0.90), major curve (0.91), and kyphosis (0.96). Research coordinators had high levels of agreement for etiology (0.78), and almost perfect for major curve (0.95) and kyphosis (0.96). Intra-observer reliability was almost perfect across all major categories for all groups: faculty, research coordinators, and fellows.

Conclusion

The study shows high levels of inter-observer and intra-observer agreement of the C-EOS scheme. The C-EOS scheme can be used as a reliable tool for classifying EOS patients for clinical communication and research.

22. SAFETY AND COMPATABILITY OF MAGNETICALLY CONTROLLED GROWING RODS AND MAGNETIC RESONANCE IMAGING: AN IN-VITRO STUDY

Henry Budd, BS, MS; Oliver M. Stokes, FRCSC, MS; Michael Hutton, MD

Summary

The increasingly widespread adoption of magnetically controlled growth rods (MCGRs) has recently led to clinical scenarios where magnetic resonance imaging (MRI) would be a useful investigation in patients who have implanted MCGRs. This is the first study to determine the behaviour of MCGRs during and following MRI and to assess the degree of image distortion that occurs. We verify that MRI has no detrimental effect on the rod elongation mechanism and craniocervical images can be interpreted without significant magnetic artefact.

Hypothesis

MRI will not activate the magnetically controlled rod during scanning or impair the rod elongation mechanism after with no significant image distortion anticipated except in close-proximity to the magnet housing.

Design

In-vitro study of 2 MCGR rods secured in a 1.5T Phillips MRI scanner using perforated concrete blocks. They were exposed to the radio-frequency field and multiple gradient echo sequences with a phantom model placed in proximity to the rods to simulate the neuroaxis from cranium to sacrum.

Introduction

Magnetically controlled growth rods (MCGRs) are a new concept for the management of early-onset paediatric deformity enabling guided spinal growth by controlling the curvature. These rods contain a rare-earth magnet and are contraindicated for MRI. Given the necessity to perform neuroaxis MRI in a subset of paediatric deformity patients we have investigated the behavior of MCGRs during MRI to determine their compatibility with this vital imaging modality.

Methods

This in-vitro experiment secured two MCGRs in a 1.5T MRI. Repeat MRI of the neuroaxis was performed to evaluate whether the rods elongated, contracted or rotated during scanning and a phantom model was used to evaluate the artifact induced by the magnet. The ability to elongate was assessed before and after imaging with an external magnet.

Results

The rod was not activated or subsequently impaired by MRI. Image distortion of up to 30cm was seen with the phantom model measured from the magnet housing. Images from the phantom representing the brain and cervical spine were unimpaired with two asymmetrical rods placed to simulate an upper thoracic fixation.

Conclusion

This study has demonstrated that there are no detrimental effects of MRI on the MAGEC rod and imaging of the head and neck can still be interpreted. Indeed no catastrophic effects on the rod were seen that would suggest harm to the rod elongation mechanism or potentially to the patient however further in-vivo study is required before compatibility of magnetically controlled growth rods and MRI can be confirmed.



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23. USE OF ULTRASOUND TO MONITOR DISTRACTIONS BY MAGNETICALLY CONTROLLED GROWING RODS: A LONGITUDINAL CORRELATION STUDY

Cora Hingyee Bow; Jason Pui Yin Cheung, MBBS, MMedSc, ERCS; Dino Samartzis, PhD; Kenny Kwan, BM BCh; Kenneth M.C. Cheung, MD

Hong Kong

Summary

Although the use of magnetically-controlled growing rods (MCGR) can better mimic normal spine growth, more frequent distractions leads to more frequent x-rays for monitoring and associated radiation exposure. Ultrasound scanning has been shown to reliably document rod distractions in a cross-sectional study. This prospective longitudinal follow-up of patients with implanted MCGR showed that ultrasound measurements of rod distraction correlates well with that of x-rays.

Hypothesis

We hypothesized that ultrasound is as effective as x-rays in measuring interval MCGR distraction lengths.

Design

This is a prospective case series with minimum two-year follow-up of patients treated with MCGR.

Introduction

Growing rods are commonly used for surgical treatment of skeletally immature patients with scoliosis. The use of magnetically-controlled growing rods (MCGR) provides the potential for more frequent distractions to mimic normal spinal, but such frequent distractions equate to more frequent x-rays for monitoring distraction; thereby, increasing ionizing radiation exposure to the developing child. The use of ultrasound, which emits no radiation, has been found in cross-sectional studies to be reliable in measuring MCGR distractions. As such, the following study aimed to address the longitudinal clinical utility of ultrasound compared to x-ray use for MCGR distractions.

Methods

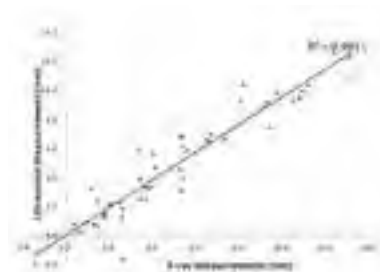
Out-patient distractions were performed at monthly intervals, targeting 2mm of distraction on each occasion. Assessment of distraction length was monitored by ultrasound at each visit, X-rays were taken every six months and compared with ultrasound measurements.

Results

13 patients (11 females, 2 males) with a minimum of 2 year follow-up were included in the study. The mean follow-up was 45.7 months (SD \pm 12.8) with mean 31 distractions (SD \pm 12.6). A total of 71 sets of x-rays were taken. The mean distracted length was 5.0 mm (SD \pm 3.7mm) on x-rays and 4.8mm (SD \pm 3.7mm) on ultrasound, with excellent correlation noted between the two imaging modalities ($r=0.948$; $p<0.0001$) (Figure 1).

Conclusion

This is the first longitudinal study to note that ultrasound assessment of MCGR distraction lengths was highly comparable to that of x-rays. Ultrasound can be a reliable alternative to x-ray use, thereby avoiding radiation exposure and its detrimental sequelae in the developing child.



24. COST ANALYSIS OF MAGNETICALLY-CONTROLLED GROWING RODS COMPARED WITH TRADITIONAL GROWING RODS FOR EARLY ONSET SCOLIOSIS IN THE UNITED STATES

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United States

Summary

A cost-minimization model estimated the cost difference between magnetically-controlled growing rods (MCGR) and traditional growing rods (TGR) for early onset scoliosis (EOS) from the United States (US) integrated healthcare delivery system perspective. For 1,000 simulated patients, MCGR had 270 fewer deep surgical site infections (SSIs) and 195 fewer revisions than TGR over the 6-year episode of care. The incremental cumulative cost (MCGR minus TGR) was cost neutral at 3 years, and \$2,218 per patient at 6 years.

Hypothesis

The cumulative cost for MCGR vs. TGR will over time become cost neutral.

Design

A cost-minimization model from the US integrated healthcare delivery system perspective tracked a cohort of 1,000 simulated patients over the 6-year episode of care. Costs were discounted at 3% per year.

Introduction

Use of TGR requires repeated invasive surgical procedures under general anesthesia to lengthen the rods as the patient grows. MCGR is lengthened non-invasively using an externally applied magnet remote control in a physician office. This reduces the need for multiple lengthening surgeries and has potential to reduce costs while improving quality of life.

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Methods

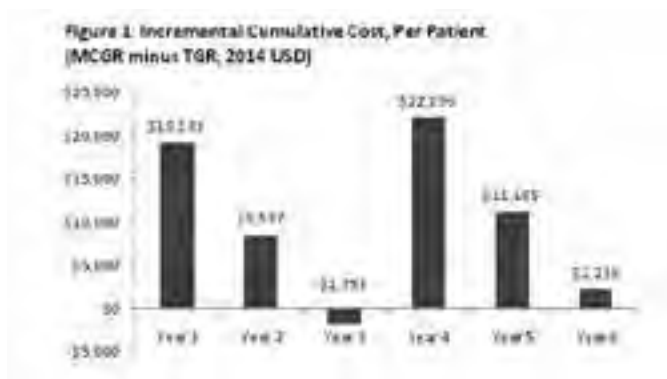
The model assumes equivalent clinical effectiveness between MCGR and TGR (curve correction and increase in thoracic height). The model estimates the costs for initial implantation, lengthening (MCGR every 3 months; TGR every 6 months), revisions, device exchange (at 3.8 years, having used a 4.8 cm rod to allow expansion), and final fusion, over a 6-year episode of care from first implantation at 6 years to final fusion at 12 years. Based on the published literature and conservative assumptions, the model accounts for SSI (2.34% per invasive surgery; 68% deep, 32% superficial [based on TGR literature]) and device failure (MCGR 0.37% and TGR 0.59%, per month). The cost of a MCGR and TGR single rod was \$17,500 and \$750, respectively, with 85% dual and 15% single rods.

Results

Of 1,000 simulated patients over 6 years, MCGR was associated with 270 fewer deep SSIs, and 195 fewer revisions due to device failure. Cost neutrality was first achieved 3 years after initial implantation (Figure 1). The incremental cumulative cost (MCGR minus TGR) over the 6-year episode of care was estimated to be \$2,218 per patient. Sensitivity analyses indicated that the results were sensitive to changes in implant cost, device failure rate, SSI rate, time to exchange surgery, and TGR lengthening setting of care (inpatient vs. same-day surgery).

Conclusion

The cost impact of MCGR is nearly offset by eliminating repeated TGR surgical lengthenings.



25. IS RADIOGRAPHIC CONTROL NECESSARY AFTER EVERY LENGTHENING OF MAGNETICALLY CONTROLLED GROWING ROD?

Caglar Yilgor, MD; Ahmet Alanay, MD

Turkey

Summary

Summary: The results of this study suggest that the radiation exposure after every lengthening of magnetically controlled growing rod (MCGR) is not justified since none of the implant related problems were diagnosed by routine x-rays(XR).

Hypothesis

Radiographic control is not necessary after every lengthening of MCGR.

Design

Retrospective analysis of consecutive patient series

Introduction

A well-accepted imaging follow-up protocol to confirm the amount of lengthening, and check for the curve and the status of the implants for MCGR is not yet established. AP-lateral XR after each lengthening (usually every 2-3 months) is suggested. The aim of this study was to find out whether radiation exposure after every lengthening can be justified or not.

Methods

A retrospective analysis of 14 consecutive patients (12F,2M) with EOS of different etiologies treated by MCGR. Mean age was 7 (3-10). Examination of the back in terms of implant prominence was done carefully after each lengthening. Lengthening interval was 2-3 months. Patients had pre- and post-lengthening AP-lateral XR in every visit in the beginning of experience and this was subsequently changed to only AP post-lengthening XR. The XR were analyzed for the presence of failure to lengthen, collapse between 2 procedures and incidental mechanical failures such as rod breakages, hook/screw pullout.

Results

Mean preop coronal Cobb of 69.6° (38-101) was corrected to 39.1° (16-76) at the final follow-up. Average follow-up was 24 months (6-52). A total of 101 lengthenings were performed. 173 pre- and post-lengthening XR (110 AP, 63 lateral) were taken. There were a total of 5 mechanical failures in 2 pts. 4 were rod or substance breakages and 1 was hook dislodgement. All 5 were diagnosed in a non-planned control with the patient applying for either prominence of implants and/or history of trauma or unremitting pain. No other incidental mechanical failures were noted in any routine XR.

Conclusion

Routine XR taken before and after each lengthening procedure of a MCGR is not likely to reveal any significant findings. Post-lengthening AP XR with a decreased frequency (every 6 months) and AP-lateral XR only after a significant complaint or clinical findings should be considered.

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26. COMPARISON OF PRIMARY VERSUS CONVERSION SURGERY WITH MCGR RODS IN CHILDREN WITH EOS

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Finland

Summary

This study compared outcomes of primary vs. conversion surgery using MCGR growing rods in children with EOS. Spinal deformity can be equally controlled after conversion from traditional growing rods into MCGR rods, but spinal growth is less in these patients.

Hypothesis

The law of diminishing returns applies to conversion patients and limited spinal growth thereof.

Design

Retrospective multicenter study

Introduction

Non-invasive distraction of growing rods is an innovative method to avoid repeated surgical lengthening of traditional growing rods in patients with EOS. As such conversion of traditional growing rods into Magnetic controlled growing rods appears to be an appealing solution. We aimed to compare outcomes of primary (P) vs. conversion (C) cases using MCGR growing rods in children with EOS.

Methods

A retrospective, multicenter study to support FDA device clearance was conducted. There were 27 P (mean age 7.0±2.2 years at surgery) and 23 C patients (mean age 7.7±2.4 years) with minimum 1 year follow-up. Inclusion criteria were: diagnosis of EOS, surgery before age 10, min 30 degree curve, thoracic spinal height <22 cm, and min 1 year follow-up with at least 3 distractions. Distractions were performed between 1 week and 3 months interval based on surgeon preference.

Results

P underwent mean 8.0±5.5 and C 3.5±2.4 lengthenings at last follow-up (p=0.0006) with 22 patients having a minimum 2-yr FU (mean FU time 22.4±7.9 months for P and 17.3±5.9 for C, p<0.05). The mean curve was 63.9±18.0 in P and 46.5±15.9 in C group preoperatively (p=0.0009) and 39.5±17.0 and 39.6±19.1 at 1-year FU (p=0.99). The mean preoperative spinal height (T1-S1) was 265±46.4 mm and 273±26.9 mm at baseline and 311±47.1 and 290±48.7 mm at 1-yr FU (p= 0.43 at baseline, p=0.18 at 1-yr FU). The mean per cent change of spinal growth from baseline at 1-year FU was 18.3±13.8 % in P group and 6.5±8.4 % in C group (p=0.007). 9 patients had 1 or more device related adverse events (2 (7.4 %)/4 (17.4 %) rod breakage, 3 (11.1 %)/0 failures to distract in the P and C group, p=0.39 and p=0.24, respectively). 8 patients needed surgical intervention (29.6 %) in P and 7 (30.4 %) in C (p=0.95). 1 patient in C developed a deep wound infection.

Conclusion

Satisfactory correction can be achieved with primary MCGR and maintained following conversion to MCGR. Spinal growth with subsequent non-invasive lengthenings is less in conversion patients compared to primary.

Table 1:

	Primary (n=27)	Conversion (n=23)	p
Major Cobb's angle(SD)			
Baseline	64 (18)	47 (18)	0.0009
Postoperative	35 (13)	36 (15)	0.69
1-yr FU	40 (17)	40 (17)	0.99
T1-S1 height, mm (mean (SD))			
Baseline	265 (46)	273 (27)	0.43
Postoperative	311 (47)	290 (31)	0.18
1-yr FU	311 (47)	290 (49)	0.18
Change from baseline at 1-yr FU	46 (14)	17 (14)	0.007

27. SLIDING-GROWING ROD TECHNIQUE (SGRT) IN THE TREATMENT OF EARLY ONSET SCOLIOSIS – MORE THAN 2 YEARS OF FOLLOW-UP

Meric Enercan, MD; Sinan Kahraman, MD; Bahadir Gokcen, MD; Mutlu Cobanoglu, MD; Sinan Yilar, MD; Tunay Sanli, MA; Erden Erturer, MD; Cagatay Ozturk, MD; Azmi Hamzaoglu, MD
Turkey

Summary

Sliding-growing rod technique provides a dynamic fixation which obtain and maintain satisfactory curve corrections in EOS and allows self growing of the spine with a rate of 1.28 mm growth per month, decreases number of lengthening procedures and demonstrated low complication rates with improved pulmonary functions.

Hypothesis

SGRT will maintain correction of EOS deformity while simultaneously allows self growing of the spine.

Design

Retrospective

Introduction

The main goal of treatment in EOS is to obtain and maintain curve correction while simultaneously preserving spinal, trunk, and lung growth. This study introduces a new surgical strategy, called sliding-growing rod technique (SGRT) developed to decrease the number of lengthening procedures. The aim of this study is to assess whether self growing system works or not, determine complication rates and effects on pulmonary functions in patients who had more than 2 yrs f/up.

Methods

15 (9F/6M) pts, mean age 6.8 (5-10) were evaluated. Surgical technique included placement of pedicle screws with a muscle-sparing technique. Following rod placement and correction, the most proximal and most distal two segments were fixed and fused; the rest of the screws were left with unlocked set screws to allow vertical growth. Proximal and distal rods are connected with side to side connectors (domino) mostly at distal level. Distal rod was fixed to domino connector whereas proximal rod kept loose to allow self growing (Figure). Preop, f/up, final x-rays and pre/postop pulmonary function tests (PFT) were evaluated.

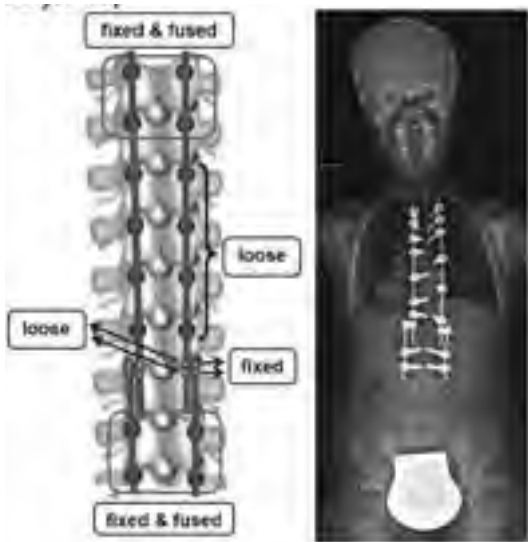
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Results

Mean f/up was 24.8 months (24-32). Ave preop MT curve of 61.1° was corrected to 23.3° with a correction rate of 62.6%. Ave TL/L curve of 43.2° was corrected to 15.5° with a correction rate of 68.7%. Preop TK of 35.1° and LL of 55.3° was maintained at 29.4° and 55.7° respectively. Mean increase in T1-T12 length was 1.14mm/month and 1.28 mm/month in T1-S1 height. No patient had neurological impairments. There was no rod breakages or other implant failure. This modification prevented 42 planned lengthening procedures. Mean preop %predicted FVC of 68.76 improved to 72.43 and mean preop %predicted FEV1 of 67.43 improved to 71.28 at the latest f/up.

Conclusion

In contrast to traditional growing rod systems, SGRT provides a dynamic fixation which allows self growing of spine with a rate of 1.28 mm per month. SGRT demonstrated low complication rates and improved pulmonary functions at the end of 2 yrs f/up.



28. PATIENTS WITHOUT INTRAOPERATIVE NEUROMONITORING (IONM) ALERTS DURING IMPLANTATION OF RIB BASED GROWING CONSTRUCTS DID NOT SUSTAIN NEUROLOGIC INJURY DURING SUBSEQUENT ROUTINE EXPANSIONS

Jaren LaGreca, BA; Micaela Cyr, BA; Tara Flynn, BA; Patrick J. Cahill, MD; Amer F. Samdani, MD; Michael G. Vitale, MD, MPH; Ron El-Hawary, MD; John T. Smith, MD; Jonathan H. Phillips, MD; John M. Flynn, MD; Michael P. Glotzbecker, MD; Sumeet Garg, MD

United States

Summary

IONM did not identify new neurologic injuries in patients undergoing rib based growing surgery expansions without a previous history of IONM alert or neurologic injury.

Hypothesis

In the absence of IONM alerts during initial implantation of rib based growing constructs, IONM does not identify new neurologic injuries in expansion procedures.

Design

Multicenter retrospective study

Introduction

The purpose of this study was to determine the rate of IONM alerts and neurologic injury during rib based growing surgery treatment.

Methods

After institutional review board approval, surgical procedures and IONM records were reviewed at 17 institutions for patients treated with rib based growing surgery from 2005-2011. All consecutive cases in patients with minimum 2 years follow-up were included. Patients with prior history of growing rods or other invasive spine-based surgical treatment were excluded. Surgeries were categorized into implant, revision, expansion, and removal procedures. Cases with IONM alerts or neurologic injury had additional detailed review. Descriptive statistics were used for data analysis.

Results

2,355 consecutive procedures (in 352 patients) consisting of 299 implant, 377 revision, 1587 expansion, and 92 removal procedures were included. 620 procedures had IONM, and 539 of those had IONM records available for review. IONM alerts occurred in 9/539 procedures (1.7%): 3 implant, 3 revision, and 3 expansion. New neurologic injury occurred in 3/2,355 procedures (0.1%), 3/352 patients (0.9%). All 3 injuries were in implant procedures, only one had an IONM alert. All 3 had upper extremity motor deficits (one had sensory deficit also). All had full recovery at 17, 30, and 124 days post-injury. One patient without prior neurologic injury or IONM alert had an IONM alert during expansion that resolved after increase in blood pressure. The remaining IONM alerts during expansions were all in children with prior IONM loss.

Conclusion

No child without prior IONM alert or neurologic injury developed a new neurologic injury during routine expansion procedures. IONM may not be necessary in patients undergoing expansion of rib base growing constructs who have not previously had neurologic injury or IONM alerts.

29. BOTH RIB BASED GROWING SURGERY AND EARLY PRIMARY POSTERIOR SPINAL FUSION (PSF) CONTROL IDIOPATHIC SCOLIOSIS (IS) IN YOUNG CHILDREN

Micaela Cyr, BA; Patrick J. Cahill, MD; Suhong Tong, MS; Tricia St. Hilaire, MPH; Harms Study Group; Children's Spine Study Group; Sumeet Garg, MD

United States

Summary

Both primary PSF and rib based growing surgery control scoliosis in patients older than 8 with IS. Rib based growing surgery patients have more surgeries than primary PSF patients.

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Hypothesis

Primary PSF for young children with IS has improved radiographic correction with fewer complications than rib based growing surgery treatment.

Design

Retrospective matched cohort analysis.

Introduction

Both PSF and growth sparing surgery have been described for children age 8-10 with moderate to severe IS. The optimal treatment strategy is not established.

Methods

After IRB approval, prospectively collected data from two multicenter registries was retrospectively queried. Patients with IS aged 8-11 and open tri-radiate cartilage were identified as either having rib based growing surgery implantation or primary PSF. Each growing surgery patient was matched with 1-4 PSF patients by age, gender, and major Cobb angle. Charts and radiographs were reviewed to collect radiographic and clinical outcomes focusing on complications and re-operations. Linear and multiple regressions were used to compare the outcome variables.

Results

The rib based growing surgery cohort had 6 patients with mean age 9.8 years (range 8-11), average follow up of 3.2 years, and 6.83 operations per patient (range 5-9). The PSF group had 12 patients with mean age 10.8 years (range 10-11), average follow up time of 2.2 years, and 1.08 operations per patient (range 1-2). Preoperative Cobb angle was not different between the growing surgery (66°) and PSF (65°) cohorts. At last follow-up, the PSF group had a significantly smaller mean Cobb angle (25°) when compared to the growing surgery group (64°), $p < 0.0001$. The thoracic height at final follow up in the growing surgery group was significantly shorter than the PSF group (52.65 mm) after controlling for preoperative thoracic height ($p = 0.032$). The rib based growing surgery group had 2/6 patients with complications, while the fusion cohort had 2/12 patients with complications. 5/6 growing surgery patients have not yet had a definitive PSF.

Conclusion

Rib based growing surgery and early primary PSF both provide control of IS. However, patients with rib based growing surgery undergo more surgical procedures. Further study is needed to determine if there are differences in complications and re-operations as the growing surgery patients proceed to definitive PSF.

30. IMPROVEMENT IN PULMONARY FUNCTION AND THORACIC HEIGHT AFTER HALO GRAVITY TRACTION FOR SEVERE SPINAL DEFORMITY

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United States

Summary

Halo gravity traction leads to significant improvement in major Cobb angle and T1-T12 height prior to definitive fusion for severe kyphoscoliosis which correlates with sustained improvement in PFTs at 2 years.

Hypothesis

Halo gravity traction (HGT) for severe kyphoscoliosis leads to significant improvements in spinal height and Cobb angles which correlates to improvements in pulmonary function testing (PFT) results.

Design

A retrospective, single institution case series.

Introduction

Severe spinal deformity can lead to significant cardiorespiratory compromise. In patients with severe spine deformity including scoliosis, kyphosis or kyphoscoliosis, HGT used preoperatively can decrease the risks associated with rapid acute correction. A significant goal in severe kyphoscoliosis correction is to improve spinal thoracic height and presumably thereby the restrictive pulmonary disease related to chest deformity.

Methods

After IRB approval, retrospective chart review was done for patients with severe spinal deformity who had PFT data available prior to preoperative HGT and definitive fusion and minimum 2 years after surgical intervention. Radiographic measurements of major Cobb angle, kyphosis, thoracic height, coronal balance and T1-S1 height was performed pre-traction, in traction, and 2 years post op and were correlated to change in PFT via Pearson correlation.

Results

17 patients had a mean age of 16 and mean major Cobb angle of 99 degrees, and kyphosis of 78 degrees. Average thoracic (T1-T12) height improved by 26% in traction (from 14.2cm to 17.9cm) and by 32% (to 18.8cm) immediately post-op and to 20cm at 2 years post operatively. Major curve magnitude improved by 33% in traction and by 57% at final follow-up. Kyphosis was improved 27% in traction and by 36% at 2 years. PFT data showed that thoracic height and T1-S1 distance were found to significantly correlate to improved FEV(R=0.537, $p = 0.032$; R=0.534, $p = 0.033$) and FVC(R=0.603, $p = 0.013$; R=0.624, $p = 0.010$) at 2 years post operatively.

Conclusion

HGT is a useful tool to safely maximize post-operative deformity correction and improve thoracic height and spine length. Improved spine length is significantly correlated to improved pulmonary function testing.

31. BIOMECHANICAL ANALYSIS OF A GROWING ROD WITH SLIDING PEDICLE SCREW SYSTEM FOR EARLY-ONSET SCOLIOSIS

Zhihua Ouyang; Robert Tisherman, BS; Wenjun Wang, MD, PhD; Patrick P. Bosch, MD; James Kang, MD; Kevin Bell, PhD

United States

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Summary

Early onset scoliosis remains a challenging condition. Current non-fusion surgeries need repeated lengthening surgeries.

Hypothesis

The GRSPSS has similar biomechanical stability as conventional instrumentation.

Design

In vitro biomechanical experiment.

Introduction

A growing rod with sliding pedicle screw system (GRSPSS) was developed to treat spinal deformities without any necessity of repeated operative lengthening. There are concerns about the stability and the fusion efficacy of the GRSPSS system due to the sliding screws. The objective of this study is to analyze the stability of the GRSPSS system.

Methods

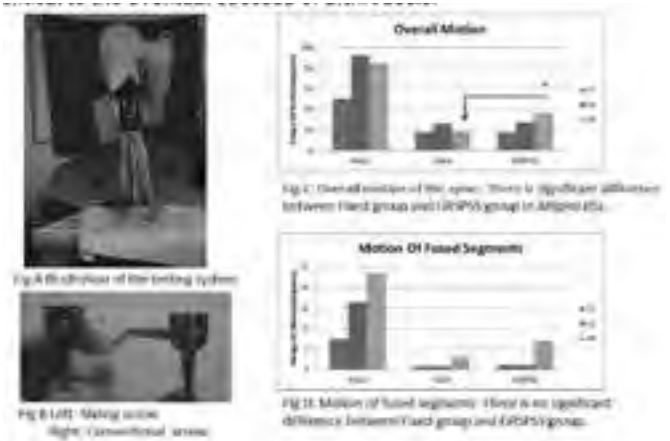
10 Fresh-frozen thoracic sheep specimens (skeletally mature, T5-T13) were tested. There were three different states Intact, GRSPSS (three pairs of conventional screws in the middle segment for fusion and four pairs in top and bottom for continuous growth) and Fixed (all screws were conventional screws). Specimens were subjected to flexion-extension (FE), lateral bending (LB), and axial rotation (AR) to 2.5Nm at 2° increments to simulate physiologic loading (Gillespie, 2004) for each state. Five VICON tracking cameras and motion tracking system were used to track motion. The robot-based spine testing system consisted of a serial-linkage robotic manipulator, a six-axis load cell positioned on the end-effector, and a custom-built specimen mounting figure (Figure A).

Results

ROM of the GRSPSS and Fixed groups decreased significantly compared to Intact group. There is no significant difference in FE, LB between the GRSPSS group and Fixed group. The ROM in AR of the GRSPSS group significant increased than Fixed group (Figure C). There is no significant difference between the fused segments of GRSPSS group and Fixed group. (Figure D)

Conclusion

The results demonstrate the GRSPSS has similar biomechanical stability in FE, LB as conventional pedicle screws but less ability to resist rotation. The GRSPSS may not be a viable clinical option for scoliosis with severe rotation deformity. Meanwhile, no significant difference in ROM in fused segments was observed between the GRSPSS group and Fixed group demonstrates both hardware systems provide equivalent construct stability in the fused apical segments which is critical to the eventual success of arthrodesis.



32. OUTCOMES OF PELVIC FIXATION IN GROWING ROD CONSTRUCTS: AN ANALYSIS OF PATIENTS WITH A MINIMUM OF 4 YEARS FOLLOW-UP

Jaysson Brooks, MD; Amit Jain, MD; Francisco Javier Sanchez Perez-Grueso, MD; David L. Skaggs, MD, MMM; George H. Thompson, MD; Behrooz A. Akbarnia, MD; Paul D. Sponseller, MD; Growing Spine Study Group
United States

Summary

This is a retrospective review of outcomes in 38 patients with growing rod constructs anchored to the ilium and/or sacrum, from a multicenter database, with minimum 4-year post-operative follow-up. Growing rod constructs anchored to the ilium had a greater correction of pelvic obliquity and major curve angle than constructs anchored to the sacrum alone. There was no difference in complications between constructs anchored to the ilium or sacrum on long-term follow-up.

Hypothesis

Growing rod (GR) constructs with iliac screw fixation provide the best correction of pelvic obliquity and sagittal alignment and the lowest complication rate; and combining S1 screws to GR constructs lowers the rate of complications.

Design

Multicenter retrospective study.

Introduction

Pelvic fixation to the ilium and/or sacrum in GR constructs has been increasingly used in patients with EOS particularly with neuromuscular etiologies. To date, radiographic outcomes and complications have not been evaluated in long-term follow-up. The purpose of this study was to evaluate which distal anchors in GR constructs provide the best correction of pelvic obliquity and sagittal parameters, and the fewest complications in patients with at least 4 years of post-operative follow-up.

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Methods

A review of 38 patients from the Growing Spine database with dual growing rods anchored to the ilium and/or sacrum. Radiographic and complication data were collected including major curve, T1-S1 length, kyphosis, lordosis, and pelvic alignment, at pre-index and latest follow-up.

Results

The mean follow-up time was 5.3 ± 0.1 years. The percent improvement between their pre-index and latest follow-up time points was evaluated for all distal fixation types. GRs with distal anchors to the ilium provided a significant improvement in major curve angle (49%, $p=0.013$) and pelvic obliquity (78%, $p=0.035$) as compared to GR constructs anchored to the sacrum only. There was no significant difference in sagittal alignment between constructs anchored to the ilium or sacrum ($p=0.884$). There was no significant difference in infection or instrumentation failure complications between iliac and sacral fixation groups, and no decrease in complications when adding S1 screw fixation. GR constructs with distal anchors that used a posterior superior iliac spine start point had a higher infection rate (60%) than distal anchors inserted via the sacral-alar-iliac technique (7%) ($p=0.002$).

Conclusion

GR constructs anchored to the ilium provide significant improvements in the major curve angle and pelvic obliquity at a minimum of 4 years of follow-up, as compared to constructs anchored to the sacrum alone.

33. DOES THE “LAW OF DIMINISHING RETURNS” APPLY TO GUIDED GROWTH CONSTRUCTS?

Lindsay M. Andras, MD; Haleh Badkoobei, MD; Alexander Broom, BA; Frances McCullough, RN; Richard E. McCarthy, MD; David L. Skaggs, MD, MMM; Growing Spine Study Group United States

Summary

The law of diminishing returns observed in growing rods does not appear to affect guided growth constructs in the same manner.

Hypothesis

Our hypothesis was that the law of diminishing returns also applies to EOS patients treated with guided growth constructs.

Design

Retrospective series.

Introduction

In early onset scoliosis (EOS) patients treated with growing rods, Sankar et al. demonstrated progressively less increase of T1-S1 length over time. This is known as the law of diminishing returns. Whether this law applies to EOS patients treated with growth guidance constructs has not been investigated.

Methods

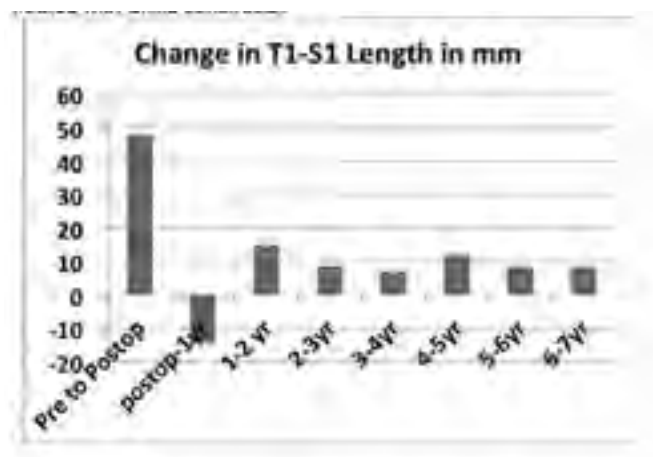
EOS patients treated with a guided growth construct at 2 centers were retrospectively reviewed. Included patients were <10 years of age at instrumentation and were followed for a minimum of 2 years. T1-S1 length was measured on upright radiographs preoperatively, postoperatively, and at annual intervals. Nonparametric analysis of variance and linear regression of the data was performed.

Results

30 patients met the inclusion criteria. Mean age at index instrumentation was 5.8 years (range 2.0 to 9.9 yr) and preoperative major curve was 69.70 (range 42-104 degrees). Mean follow-up was 4.9 yr (range 2 to 8 yr). Postoperative radiographs demonstrated an average gain of 4.8 cm in T1-S1 length from preoperative values. At year 1, however, 70% (21/30) showed a decrease in T1-S1 when compared to postoperative T1-S1. On average, T1-S1 at one year was 1.4 cm less than postoperatively. There was an overall increase in T1-S1 in years 2 through 8 (year 2= 1.5 cm, 3=0.86 cm, 4=0.71 cm, 5=1.19 cm, 6=0.85 cm, 7=0.83 cm). The increase in T1-S1 was statistically significant for years 2 through 5 ($p=0.0001$, $p=0.008$, $p=0.014$, $p=0.006$). The change in T1-S1 between yr 1 (a decrease) and yr 2 was significantly different ($p=0.0003$). There was no significant difference in the change in T1-S1 over time for the subsequent yrs ($p=0.21$, 0.79, 0.78, 0.31, 0.91, 0.27).

Conclusion

With mean follow-up of 5 years, statistically significant annual increases in T1-S1 length were sustained in patients treated with growth guidance constructs.



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34. SHORT FUSION STRATEGY FOR POSTERIOR CORRECTION SURGERY USING PEDICLE SCREW CONSTRUCTS IN LENKE TYPE 5C ADOLESCENT IDIOPATHIC SCOLIOSIS

Eijiro Okada; Nobuyuki Fujita, MD, PhD; Tomohiro Hikata; Akio Iwanami; Naobumi Hosogane, MD, PhD; Ken Ishii; Masaya Nakamura; Morio Matsumoto, MD; Kota Watanabe, MD; Keio Spine Research Group

Japan

Summary

To assess whether a short fusion strategy is applicable when treating adolescent idiopathic scoliosis with Lenke type 5C curve by posterior correction and fusion surgery using pedicle-screw constructs. SRS-22 scores and radiographic parameters other than the correction rate were equivalent between the two groups. A short fusion strategy, in which the UIV is one level caudal to the upper end vertebra, is applicable to posterior correction and fusion surgery with pedicle-screw constructs for Lenke type 5C curves.

Hypothesis

Short fusion strategy is applicable when treating adolescent idiopathic scoliosis with Lenke type 5C curve by posterior correction and fusion surgery using pedicle-screw constructs.

Design

Single institution, prospective study.

Introduction

Previous studies have discussed the selection of the lower instrumented vertebra (LIV) to best preserve motion segments and obtain coronal balance. However, reports evaluating the selection of the upper instrumented vertebra (UIV) when treating Lenke type 5C curves are not available. To assess whether a short fusion strategy is applicable when treating adolescent idiopathic scoliosis (AIS) with Lenke type 5C curve by posterior correction and fusion surgery using pedicle-screw constructs.

Methods

We evaluated 29 patients who were treated surgically for AIS with Lenke type 5C curve (mean age 16.8 ± 4.7 years; range 10-29 years). The mean follow-up period was 28.0 ± 6.3 months (24-48 months). We compared radiographic parameters and clinical outcomes between patients with an upper instrumented vertebra (UIV) at the end vertebra (EV) (n=10) and those treated by short fusion (S), with a UIV one level caudal to the EV (n=19 patients).

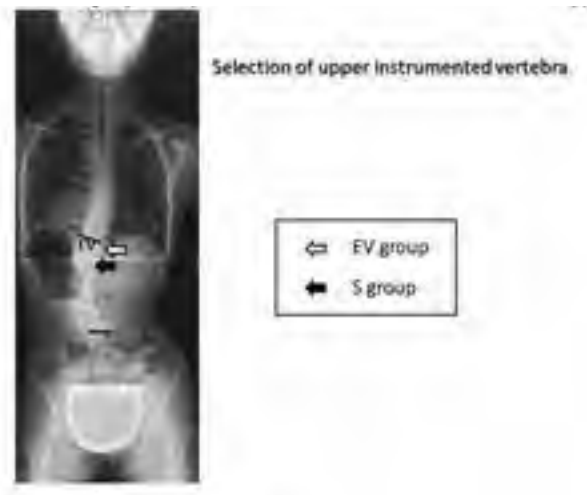
Results

In the EV group, a preoperative mean Cobb angle of $50 \pm 15^\circ$ was corrected to $8 \pm 7^\circ$, which was maintained at the final follow-up ($7 \pm 1^\circ$). In the S group, a mean preoperative Cobb angle of $47 \pm 4^\circ$ was corrected to $8 \pm 5^\circ$, but this increased significantly to $12 \pm 7^\circ$ at final follow-up (p=0.033). The mean correction rate at final follow-up was significantly lower in the S group (72%) than in the

EV group (86%) (p=0.027). Coronal and sagittal balance, thoracic kyphosis, lumbar lordosis, L4 tilt, and clinical outcomes evaluated by SRS-22 were equivalent between the two groups.

Conclusion

SRS-22 scores and radiographic parameters other than the correction rate were equivalent between the two groups. A short fusion strategy, in which the UIV is one level caudal to the upper end vertebra, is applicable to posterior correction and fusion surgery with pedicle-screw constructs for Lenke type 5C curves.



35. KEY ANCHOR POINTS FOR SPECIFIC CORRECTION MANEUVERS IN LENKE 1 AIS: HOW IMPORTANT IS THE IMPLANT PATTERN DESIGN?

Franck LeNaveaux, PhD candidate; Carl-Eric Aubin, PhD, P.Eng.; A. Noelle Larson, MD; Hubert Labelle, MD; MIMO Study Group

Canada

Summary

Implant pattern impacts the selection of correction maneuvers. Acceptable implant pattern design reveals that implant dropout in the periapical region is feasible, with minor effect on correction maneuver execution.

Hypothesis

Implant pattern design impacts correction maneuvers execution.

Design

Survey of surgeons' surgical planning.

Introduction

High-density constructs are generally considered offering increased control to perform correction maneuvers, but there is limited evidence of improved surgical outcomes. Key anchor points necessary for specific corrective maneuvers could be the basis for rational implant pattern design.

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Methods

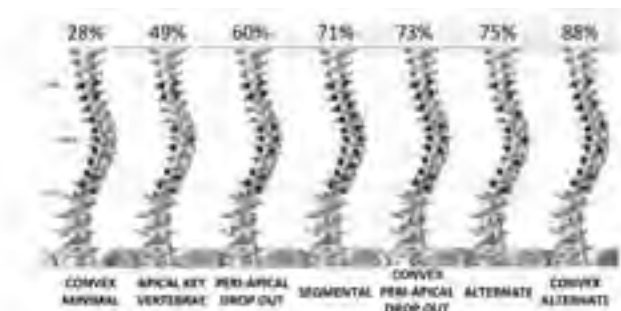
17 experienced surgeons provided their preferred correction planning for 5 Lenke 1 cases (implant pattern, correction maneuvers and implants used for their execution) and an alternate planning with their minimal acceptable implant density. They also selected acceptable implant patterns from 7 published implant configurations.

Results

The preferred correction planning involved an average of 1.65 implants/vertebra (1.24 for the alternate minimal density planning, with fewer implants used periapically). For the preferred correction planning, 88% of the available anchor points at the apex ± 1 vertebra were used for the execution of correction maneuvers, while it drops to 43% periapically. Lower-density constructs involved fewer vertebral derotation maneuvers (96 vs. 82%), more in-situ rod contouring (41 vs. 53%), compression and distraction using fewer implants (1.18 and 1.42, respectively), and derotation of fewer levels (0.40 for en bloc and 0.63 for segmental derotation) ($p < 0.05$). Alternate implant placement or dropout of periapical implants were considered acceptable ($>70\%$ agreement; cf. Figure).

Conclusion

Implant dropout in the convexity and particularly in the periapical regions is acceptable, with minor influence on surgeons' reported correction maneuvers. Implant density pattern changes involved adjustments of correction maneuvers. The impact of such changes should be studied as the optimal correction approach has not yet been determined.



36. A SIMPLE METHOD FOR ASSESSING ROTATIONAL FLEXIBILITY IN ADOLESCENT IDIOPATHIC SCOLIOSIS: MODIFIED ADAM'S FORWARD BENDING TEST

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Turkey

Summary

This study evaluated the diagnostic utility of the modified Adam's Forward Bending Test (mAFBT), which is a new physical examination method assessing rotational flexibility in adolescent idiopathic scoliosis (AIS) patients. Based on clinical and radiographic assessment of AIS patients, the study was the first to have noted a

significant correlation between radiographic and clinical flexibility indices. This new physical examination method has diagnostic utility for the assessment of rotational flexibility in AIS patients.

Hypothesis

The mAFBT is a simple and robust diagnostic physical examination method that allows evaluation of rotational flexibility in AIS patients

Design

A prospective cohort study of 40 AIS patients.

Introduction

Determination of curve flexibility is a critical parameter for the treatment plan of AIS. The Adam's Forward Bending Test (AFBT) is a reliable and non-invasive test for the diagnosis of AIS. However, it does not give any information about the flexibility of the spinal deformity. This study aims to evaluate the diagnostic utility of a modified AFBT (mAFBT) version, which addresses the coupling phenomenon of axial rotation with reference to the side-bending movement. Also, this evaluation was facilitated by the introduction of our curve flexibility index (CFI).

Methods

In the mAFBT, without coming up to an erect position, subjects were asked to bend to the convex side of the curve in the axial plane. Evaluation of the rib/loin hump flexibility was performed during this maneuver. Scoliometric measurements were done during the AFBT and mAFBT. Utilizing plain radiographs, Cobb angles were measured and curve flexibility indices were calculated. The fulcrum and side-bending were performed to assess radiographic curve flexibility. Pearson's correlation and ROC curves were used for statistical analysis. The CFI was defined as follows: $CFI = [(AFBT - mAFBT) / AFBT] \times 100$.

Results

Significant correlations were noted between the Cobb angle and AFBT ($p = 0.005$), fulcrum bending and the mAFBT ($p = 0.0001$), side-bending and mAFBT ($p = 0.0001$), and the postoperative Cobb angles and AFBT ($p = 0.003$). There were significant positive correlations between curve flexibility as based on the fulcrum bend to that of the CFI ($r = 0.347$, $p = 0.036$) and side-bending technique ($r = 0.416$, $p = 0.008$). Based on ROC analyses (AUC range = 0.71-0.78), the mAFBT demonstrated high specificity and sensitivity rates for flexible and rigid curves, respectively.

Conclusion

This is the first study to report the mAFBT and the CFI for the evaluation of AIS. The mAFBT was found to be a reliable test for clinical assessment of rotational flexibility in AIS patients.

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37. HOW MUCH DIFFERENTIAL ROD CONTOURING IS NECESSARY TO BIOMECHANICALLY CONTRIBUTE TO THE TRANSVERSE PLANE CORRECTION IN AIS INSTRUMENTATION?

Xiaoyu Wang, PhD; Carl-Eric Aubin, PhD, P.Eng.; Laure Boyer, MS; Franck LeNaveaux, PhD candidate; Richard M. Schwend, MD

Canada

Summary

This study computationally assessed the transverse plane correction and bone-screw forces using various configurations of differential rod contouring. Simulated low concave rod contouring (35°) and diameter (5.5 mm) didn't generate substantial vertebral derotation torque to correct the transverse plane deformities. Increasing the concave rod bending ($\geq 55^\circ$) and diameter (6.0 mm) augmented the torque enabling correcting the transverse plane deformities, and concomitantly involved important kyphosing effect.

Hypothesis

Only certain configurations of rod diameter and bending generate sufficient vertebral derotation torque to correct the transverse plane deformities in AIS.

Design

Biomechanical analysis of vertebral derotation using differential rod contouring in AIS through numerical simulations.

Introduction

Differential rod contouring is used to achieve 3D correction in AIS. How vertebral rotation correction is correlated with the amount of differential rod contouring is still unknown and too aggressive differential rod contouring can increase the bone-screw connection failure and neuro risks. The objective was to assess the transverse plane correction and bone-screw forces using various configurations of differential rod contouring.

Methods

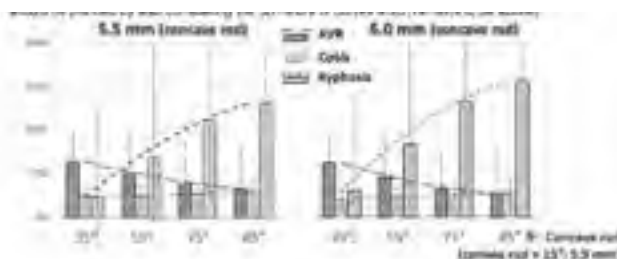
Instrumentation scenarios were computationally simulated on 6 different thoracic AIS cases. Bone-screw force and transverse plane correction were evaluated as a function of 8 different CoCr rod configurations: the concave rod was simulated with 2 diameters (5.5 and 6.0 mm) and 4 bendings (35°, 55°, 75°, 85°), while the convex rod was kept the same (5.5 mm, 15° bending).

Results

Apical vertebral rotation with 5.5 mm concave rods bent at 35°, 55°, 75° and 85° was corrected by 36±21%, 51±24%, 63±26% and 68±26% respectively; it was further improved to 39±21%, 56±24%, 69±26% and 74±26% with 6.0 mm rod. The thoracic kyphosis increased by 24±61%, 69±89%, 111±117% and 131±130% with 5.5 mm concave rod and 30±64%, 83±97%, 132±129% and 154±144% with 6.0 mm concave rod. Screw pullout force was 97±70, 111±61, 207±139, 277±166 N with 5.5 mm concave rod, and 101±75, 122±68, 237±160, 322±187 N with 6.0 mm rod.

Conclusion

Simulated low concave rod contouring (35°) and diameter (5.5 mm) didn't generate substantial vertebral derotation torque to correct transverse plane deformities. Increasing the bending ($\geq 55^\circ$) and diameter (6.0 mm) augmented the torque enabling correcting the transverse plane deformities, with concomitant important kyphosing effect. Rod contouring should be planned by also considering the 3D nature of curves which remains to be studied.



38. DO WE UNDERESTIMATE THE ABILITY OF PATIENTS TO RETURN TO PHYSICAL AND ATHLETIC ACTIVITIES AFTER SCOLIOSIS SURGERY? A VALIDATED PATIENT QUESTIONNAIRE BASED STUDY

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United States

Summary

AIS patients undergoing pedicle screw PSF are capable of returning to sports earlier than expected and at preoperative level including contact and non-contact. Younger teenagers and patients with fusion to L3 or below take longer to get back to physical and athletic activities. Earlier return to sports was not seen to have detrimental effect on curve correction and implant fixation.

Hypothesis

This study proposes that patients tend to return to sports and related activities much sooner than recommended.

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Design

A validated questionnaire based study

Introduction

The recommendation to return to physical activity after scoliosis surgery is debatable. While surgeons err on the side of delaying activities, no studies exist that evaluate when patients are actually returning to their physical and athletic activities.

Methods

A twenty-four question survey was validated. Patient demographic, XR measurements, EBL length of stay, levels fused, and operative time were recorded. Wilcoxon signed rank tests and Fisher's exact tests were utilized.

Results

82 patients completed the survey with a median age of 16 years, 51° preop Cobb, 15.8° postop Cobb, 12 levels fused, and EBL of 525ml.

By 3 months post-surgery, 75% (59/79) patients returned to school, 32% (20/63) to gym, 51% (39/77) to carrying backpacks, and 56% (44/78) to bending. 75% (55/73) returned to running by 6 months and 41% (30/73) by 3 months. By 6 months, 51% (22/43) returned to non-contact sports, and 58% (15/26) returned to contact sports. 23% (12/53) were back to either type of sport within 3 months. 77% (20/26) returned to contact sports, and 53% (22/43) returned to non-contact sports at their preoperative level.

Age at surgery (16.6 vs 14.3 years) correlated significantly with earlier return to running and ability to bend ($p = .023$, $p = .005$). Patients with fusion at or below L3 took significantly longer to return to running, bending, and carrying backpacks ($p = 0.017$, $p = 0.001$, $p = 0.005$).

At most recent follow ups, there was no loss of correction, implant failure, or complications.

Conclusion

Patients return to activities much earlier than recommended. Age, and LIV are important determinants for return to physical activity at an earlier time. A quarter of patients returned to contact/non-contact sports within 3 months, and over half returned by 6 months. Majority of the patients (93% non-contact and 96% contact sports) returned to their preoperative level within 1 year.

39. OBESITY MARKEDLY INCREASES THE RATE OF DEEP SURGICAL SITE INFECTIONS AND IMPLANT FAILURE AFTER POSTERIOR SPINAL FUSION FOR ADOLESCENT IDIOPATHIC SCOLIOSIS

Joshua M. Pahys, MD; Patrick J. Cahill, MD; Peter O. Newton, MD; Randal R. Betz, MD; Paul D. Sponseller, MD; Ronald A. Lehman, MD; Michael Kelly; Harms Study Group; Amer F. Samdani, MD

United States

Summary

Limited data exists to characterize the implications of PSF for severely overweight and underweight AIS patients. We analyzed 948 AIS patients with two year follow-up: 5.4% were severely underweight (UW) and 10.7% were obese

(OB). Obese patients demonstrated significantly increased preoperative coronal Cobb and a lower percent correction compared to normal (NL) and underweight patients. The obese group had a significantly higher rate of implant failure and deep surgical site infections than normal and underweight groups.

Hypothesis

Severely underweight and obese adolescent idiopathic scoliosis (AIS) patients are at an increased risk for complications following posterior spinal fusion (PSF).

Design

Retrospective review of a prospectively collected multicenter database.

Introduction

Obesity has been shown to impact postop complications in adults, but has been studied less in AIS patients after PSF. Severely underweight AIS patients may also be at higher risk of complications including superior mesenteric artery (SMA) syndrome. This study evaluates the relationship between the extremes of patient weight, (percentile Body Mass Index (%BMI)), on outcomes and complications in PSF for AIS.

Methods

A multicenter prospective AIS database retrospectively identified 948 patients with a minimum 2 year follow-up after PSF. Three groups were created defined by the Center for Disease Control: Underweight (UW)=%BMI<5% (n=51); Normal/Overweight (NL)=%BMI: 5-95% (n=791); Obese (OB)=%BMI: >95% (n=106).

Results

Preop, the OB group had larger major coronal Cobb, coronal imbalance and thoracic kyphosis but less lumbar lordosis vs. UW and NL ($p < 0.001$). Surgical time, blood loss, blood transfusions, fusion levels, rod diameter, and length of stay were similar for all three groups. The OB group had less curve correction vs. UW and NL ($p = 0.05$). OB patients had significantly higher rate of implant failure (OB: 3.8%; UW: 0%; NL: 0.8%, $p = 0.01$), and deep surgical site infection (SSI) (OB: 8.5%; UW: 0%; NL: 2%, $p = 0.001$). Preop, SRS scores were worse for pain, general function and total score ($0.08 < p < 0.18$) and lower for self-image at 2 years ($p = 0.056$) for OB vs. UW and NL. SMA syndrome was reported in 2 patients, both in NL group.

Conclusion

This is the largest study to date to evaluate the outcomes of PSF in severely underweight and obese AIS patients. Obese patients exhibited significantly larger pre-op major coronal Cobb and decreased curve correction when compared to underweight and normal groups. The obese group had a higher rate of implant failure and deep SSI compared to UW and NL patients.

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	Underweight	Normal Overweight	Obese	P value
Radiographs				
Preop Main Cobb	52.8	54.3	58.8	0.001
PE Major Cobb	15.9	16.9	18.5	0.056
% Correction PE	69.1%	68.3%	64.3%	0.047
2yr PO Main Cobb	17.7	19.2	21.5	0.007
Complications				
Deep SSF	0.0%	2.0%	8.5%	0.001
Implant failure	0.0%	0.6%	3.6%	0.01
Postop Weight				
Preop BMI	15.5	22.4	30.4	
2yr PO BMI	17.2	21.4	30.9	
Change in BMI Preop to 2yr PO	p=0.001	p=0.001	p=0.8	

40. CORRELATION BETWEEN SEVERITY OF ADOLESCENT IDIOPATHIC SCOLIOSIS AND PULMONARY ARTERY SYSTOLIC PRESSURE: A CROSS-SECTIONAL STUDY OF 338 PATIENTS

Xingye Li; Zheng Li, MD; Youxi Lin; Haiwei Guo, MD; Jianxiang Shen; Fan Feng

China, People's Republic of

Summary

This study examined the correlation between pulmonary arterial pressure and severity of idiopathic scoliosis. A total of 338 patients with adolescent idiopathic scoliosis were included. Preoperative radiographic records were reviewed. Doppler echocardiography was performed to measure pulmonary artery systolic pressure (sPAP). A mild correlation between sPAP and coronary Cobb angle of main thoracic curves (Spearman test, correlation coefficient = 0.187, p = 0.001) was found.

Hypothesis

There is a relationship between scoliosis and pulmonary arterial pressure.

Design

This study examines the correlation between pulmonary arterial pressure and radiographical measurements of idiopathic scoliosis.

Introduction

Previous researches have proved that scoliosis is responsible for compromised pulmonary functions and right heart failures. Pulmonary hypertension was considered involved in the development of cardiac consequences. However, the relationship between scoliosis and pulmonary arterial pressure was not well established. The objective of this study is to examine the correlation between pulmonary arterial pressure and severity of idiopathic scoliosis.

Methods

A total of 338 patients with idiopathic scoliosis aged 14-20 year old were included. Their preoperative radiographical records were reviewed to measure their coronary Cobb angle of each curvature as well as location and direction of apex. Doppler echocardiography was performed preoperatively to measure tricuspid regurgitation velocity (TRV) and diameter of inferior vena cava (IVC). Pulmonary artery systolic pressure (sPAP) can further be calculated by modified Bernoulli equation. Statistical analyses were used to identify correlation between sPAP and feature of scoliosis.

Results

The average age was 15.6 years, of them 82.8% were female. 305 patients bore thoracic curves, 265 patients bore thoracolumbar/lumbar curves. Among 305 thoracic curves, 276 (90.5%) were right curves. sPAP calculated from TRV varied from 5.0 to 37.6 mmHg. 1 patient cannot exclude pulmonary hypertension. A mild correlation (Spearman test, correlation coefficient = 0.187, p = 0.001) between sPAP and coronary Cobb angle of main thoracic curves was found. Correlations between sPAP and degree of other curves were not significant. Patients with higher sPAP (>20mmHg) also bore larger angle of thoracic curve (mean MT 42.16° vs 52.45°, U-test, p=0.002). There was no significant difference of sPAP between right and left thoracic curves.

Conclusion

There was a mild correlation between sPAP and coronary Cobb angle of main thoracic curves. There was no relationship between sPAP and direction of the curvatures.

41. AIS TREATED BY PSSIF CAUDAL TO L3: WHEN IS FUSION TO L3 STABLE?

Seung-Jae Hyun; Lawrence G. Lenke, MD; Yongjung J. Kim, MD; Keith H. Bridwell, MD; Linda Koester; Kathy M. Blanke, RN

Korea

Summary

We identified risk factors for the presence of distal AO or DJK in AIS treated by PSF to L3 with min. two year F/U. Prevalence at ultimate FU was 13.1%. To prevent AO or DJK following PSF to L3, the CSVL should touch L3 on upright and bending films, the L3/4 disc should be flexible, L3 should be neutral (<15°) and ≤2 cm from the CSVL, and pts. should be ≥Risser 2.

Hypothesis

To prevent AO or DJK following PSF to L3, the CSVL should touch L3 on upright and bending films, the L3/4 disc should be flexible, L3 should be neutral and pts. should not be immature.

Design

Retrospective study

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Introduction

The purpose of this study was to identify risk factors for distal AO or DJK in AIS treated by PSF to L3 with min. two year F/U.

Methods

AIS patients undergoing PSF to L3 by 2 senior surgeons from 2000-2010 were analyzed. Distal AO and DJK were deemed poor radiographic results and defined as >3 cm of deviation from L3 to the CSVL, or >10° angle at L3-4 on the AP or lat. xray at ultimate FU. New stable (SV) and neutral vertebra (NV) scores were defined for this study: (SV-1: CSVL passes between medial pedicle borders of the LIV; SV-2: CSVL touches the pedicle or edge of the LIV; SV-3: CSVL doesn't touch the LIV), and (NV-1: LIV is 1 vertebra proximal to the NV; NV-2: LIV is 2 vertebra proximal to the NV; NV-3: LIV is 3 vertebra proximal to the NV). The total stability score was the sum of the SV and NV scores).

Results

10 of 76 patients (13.1%) were included in the poor radiographic outcome (PX) group. The other 66 patients were included in the good radiographic outcome (GX) group. Lower Risser grade (p=0.003), more SV-3 on standing (p=0.004) and side bending films (p=0.002), higher NV score (p=0.02), higher total stability score (p=0.0001), rigid L3-4 disc (p=0.0001), more rotation (p=0.005) and deviation (p=0.006) of L3 were identified risk factors for AO or DJK. Multiple logistic regression results indicated that the parameters above were independent predictive factors. Age, number of fused vertebrae, curve correction, preoperative L3-4 disc angle did not differ significantly between the 2 groups. Although there was significant improvement (p=0.023) of the of SRS-22 average scores only in the GX group, there was no significant difference in the scores between the groups.

Conclusion

The prevalence of AO or DJK at ultimate FU for AIS with LIV at L3 was 13.1%. To prevent AO or DJK following fusion to L3, we recommend that the CSVL touch L3 in both standing and side bending, the L3/4 disc is flexible, L3 is neutral (<15°) and ≤2 cm from the midline and the patient is ≥Risser 2.

Table 1. Definition of gravity, rotational and total stability score

Gravity stability score		Rotational stability score		Total stability score	
SV	LIV to CSVL	NV	LIV to NV	SV (0-3)	NV (0-3)
SV-1	CSVL passes between medial pedicle borders of the LIV	NV-1	LIV is one vertebra proximal to NV		
SV-2	CSVL touches the LIV	NV-2	LIV is two vertebra proximal to NV		
SV-3	CSVL does not touch the LIV	NV-3	LIV is three vertebra proximal to NV		

SV, stable vertebra; NV, neutral vertebra.

42. WHAT IS DIFFERENT ABOUT PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS WHO ACHIEVE A MINIMAL CLINICALLY IMPORTANT DIFFERENCE (MCID) IN APPEARANCE?

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United States

Summary

We wished to identify factors associated with an SRS-22 Appearance domain score increase greater than the MCID in surgically treated patients with AIS. Preoperative factors associated with attaining the MCID included those patients who were underweight with low SRS Appearance domain scores and greater trunk shift. Postoperatively, those patients with greater % correction of the major Cobb angle, lower apical lumbar translation, and a greater improvement in trunk shift were most likely to attain the MCID.

Hypothesis

Factors exist which can predict which patients will attain the MCID following surgery for AIS.

Design

Retrospective review of prospective data set.

Introduction

Previous work has determined the MCID for the appearance domain of the SRS-22 questionnaire to be an increase of ≥ 1.0 (Sanders, Spine 2010). The purpose of this study was to identify factors associated with an SRS-22 appearance domain score increase greater than the MCID.

Methods

A prospectively collected multicenter database was retrospectively reviewed to identify surgically treated AIS patients with a minimum 2-year follow-up. 1020 patients were divided into two cohorts: "I"= improved after surgery (Appearance ≥ 1.0) and "NI"= not improved after surgery (Appearance < 1.0). The two cohorts were compared using clinical and radiographic measures.

Results

Overall, 663 patients (65%) were improved greater than the MCID and 357 (35%) were not improved. Both groups were similar with respect to many pre- and postoperative factors, notably: preoperative major Cobb angle (I=56°, NI=55°, p=0.2), postoperative coronal balance (I=1.2 cm, NI=1.2 cm, p=0.9), shoulder height difference (I=0.9 cm, NI=1.0 cm, p=0.1), and thoracic rib prominence (I=6.6°, NI=6.4° cm, p=0.6). The Improved cohort harbored a greater percentage of underweight patients (I=73%, NI=27%, p=0.07), with lower pre-op SRS Appearance scores (I=3.1, NI=3.5, p<0.001) and trunk shift (I=2.1 cm, NI=1.8 cm, p=0.03). Postoperatively, those patients with

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greater % correction of the major Cobb angle (I=63%, NI=61% cm, p=0.02), lower apical lumbar translation (I=1.3 cm, NI=1.5 cm, p<0.01), and a greater decrease in trunk shift (p<0.01) were most likely to attain the MCID.

Conclusion

Our results imply that several factors influence which patients are most likely to attain the MCID following surgery for AIS. Some factors such as preoperative appearance scores and body weight are patient specific; others such as percent correction, improvement in trunk shift, and lumbar apical translation can be influenced by the surgeon.

	I (n=66)	**NI* (n=25)	P value
Age ± SD (years)	14.7 ± 2.4	14.6 ± 1.6	0.764
Femoral R (%)	52.0(±3.1)	20.0(±6.1)	0.001
Preoperative SRS-22 Appearance Score	3.1 ± 0.6	3.3 ± 0.4	<0.001
1 Yr SRS-22 Appearance Score	4.6 ± 0.4	4.9 ± 0.3	<0.001
Preoperative BMI	21.1 ± 4.4	21.6 ± 4.2	0.007
Percent Underweight (%)	72.7	72.7	0.074
Curve Type n (%)			0.05
Lenke 1	290 (44.2)	149 (42.0)	
Lenke 2	137 (18.2)	77 (21.6)	
Lenke 3	86 (9.7)	89 (25.0)	
Lenke 4	39 (4.8)	12 (3.4)	
Lenke 5	189 (16.1)	83 (23.6)	
Lenke 6	72 (8.0)	21 (5.9)	
Approach n (%)			0.16
Anterior	49 (6.0)	11 (3.0)	
Posterior	527 (68.5)	318 (89.5)	
Anterior/Posterior/Minimally	32 (4.0)	19 (5.3)	
Preoperative Major Cobb ± SD (°)	55.7 ± 12.6	54.6 ± 12.4	0.199
Preoperative Lumbar Cobb ± SD (°)	19.7 ± 11.4	18.9 ± 11.1	0.794
Major Cobb Percent Corrected ± SD (%)	31.1 ± 7.3	34.1 ± 7.3	0.179
1 Yr Major Cobb Percent Corrected ± SD (%)	69.4 ± 1.4	61.3 ± 1.4	0.021
2 Yr Lumbar Cobb Percent Corrected ± SD (%)	62.2 ± 1.9	65.3 ± 2.0	0.005
Thoracic RB Translation			
Preoperative ± SD (°)	17.1 ± 6.0	13.8 ± 6.1	0.111
2 years ± SD (°)	6.4 ± 4.1	6.4 ± 4.4	0.839
Cervical Balance (C7 to CSVL)			
Preoperative ± SD (mm)	2.0 ± 1.4	2.0 ± 1.3	0.859
2 years ± SD (mm)	1.2 ± 0.8	1.2 ± 0.9	0.863
Shoulder Height			
Preoperative ± SD (mm)	1.1 ± 1.0	1.3 ± 1.0	0.793
2 years ± SD (mm)	0.8 ± 0.8	0.9 ± 0.8	0.772
Trunk Shift			
Preoperative ± SD (mm)	2.1 ± 1.3	1.8 ± 1.1	0.002
2 years ± SD (mm)	0.8 ± 0.7	1.0 ± 0.8	0.051
Lumbar Apical Translation			
Preoperative ± SD (mm)	1.4 ± 2.1	2.1 ± 2.1	0.231
2 years ± SD (mm)	1.1 ± 1.1	1.7 ± 1.1	0.094
Apical T5-T12			
Preoperative ± SD (°)	23.5 ± 11.1	23.4 ± 14.2	0.903
2 years ± SD (°)	21.0 ± 9.9	21.7 ± 8.8	0.860

43. RADIOGRAPHIC RESULTS OF SELECTING THE TOUCHED VERTEBRA AS THE LOWEST INSTRUMENTED VERTEBRA IN LENKE TYPE 1 (MAIN THORACIC) & TYPE 2 (DOUBLE THORACIC) CURVES AT A MINIMUM 5-YEAR FOLLOW-UP

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United States

Summary

Selecting the touched vertebra (TV) as the lowest instrumented vertebra (LIV) for Lenke types 1A & 2A AIS curves produced optimal LIV positioning at a minimum 5 yrs postoperatively. Fusing short of the TV in 1A and 2A curve patterns produced increased translation of the LIV relative to the center sacral vertical line (CSVL).

Hypothesis

Selecting the TV as the LIV in Lenke 1 & 2 curve patterns in AIS will produce optimal LIV positioning at a min. 5 yrs postoperative f/u.

Design

Retrospective radiographic review of all Lenke type 1 & 2 AIS curves in a multicenter database.

Introduction

A prior study showed the TV, defined as the most cephalad thoracolumbar/lumbar vertebra "touched" by the center sacral vertical line (CSVL), as a potential landmark vertebra & recommended LIV as well. We evaluated a large cohort of Lenke type 1 & 2 cases to determine if selecting the TV as the LIV will produce optimal positioning at a min. 5 yrs postoperative.

Methods

299 pts with Lenke 1 (n=207) or Lenke 2 (n=92) AIS curves at a min. 5 yr f/u were evaluated. The TV was selected on the preoperative x-ray by 2 independent examiners & confirmed for agreement. The LIV selected was compared to the preoperative TV as well as the LIV - CSVL distance at min. 5yr f/u. Comparison was made on the LIV-CSVL distance in pts fused short of the TV, to the TV or distal to the TV using standard statistical software.

Results

When comparing the entire cohort, differences in 5 yr LIV-CSVL absolute values between the 3 groups approached, but did not reach, significance (p=0.055). In a subanalysis of the lumbar A modifiers (n=161), main effect ANOVA indicated a significant difference among the 3 groups (p=0.002). Post hoc comparison revealed that pts fused short of the TV had significantly greater LIV-CSVL distance values than those fused to the TV (p=0.006) & those fused distal to the TV (p=0.002). There was no significant difference among the 3 groups when looking at lumbar B (n=76, p=0.424) & lumbar C (n=62, p=0.326) modifiers.

Conclusion

Selecting the touched vertebra (TV) as the LIV for Lenke type 1A & 2A curves produced optimal LIV positioning at a min. 5 yrs postoperatively, while fusing short of the TV showed statistically increased LIV to CSVL translation. Understanding & utilizing the TV rule assists the surgeon in proper LIV selection in Lenke type 1A & 2A curve patterns for AIS.

TV-LIV	5 year postoperative CSVL-LIV distance					
	Preop Lumbar Modifier "A"	Preop Lumbar Modifier "B"		Preop Lumbar Modifier "C"		
	Mean (mm)	SD (mm)	Mean (mm)	SD (mm)	Mean (mm)	SD (mm)
TV<L1 (LIV dorsal to TV)	1.01*	1.48	1.14	1.01	1.13	0.89
TV=L1 (LIV=TV)	1.25*	0.85	1.27	1.02	1.25	0.85
TV>L1 (LIV below TV)	1.31*	1.04	0.96	0.89	1.04	0.79
	Tp=0.006	Letter values did not show significance				
	Tp=0.002					

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44. SELECTING THE LAST “SUBSTANTIALLY” TOUCHING VERTEBRA AS LOWEST INSTRUMENTED VERTEBRA IN LENKE 1A AIS: RADIOGRAPHIC OUTCOMES IN A MINIMUM OF 2-YEAR FOLLOW-UP

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Summary

The last cephalad vertebra touched by the CSVL (LTV) was classified into Substantially Touched Vertebra (STV) and non-Substantially Touched Vertebra (nSTV) according to the position of CSVL on the vertebra. A poorer correction of the lumbar curve and higher incidence of distal adding-on were observed in Lenke 1A AIS patient with nSTV selected as lowest instrumented vertebra (LIV). Better outcome can be achieved when patients were instrumented at least to nSTV+1 or STV.

Hypothesis

Selecting nSTV, nSTV+1, or STV as LIV can result in different long-term outcomes of correction surgery for Lenke 1A AIS.

Design

A retrospective study.

Introduction

Previous studies have documented promising outcomes when LTV was selected as LIV in correction surgery of Lenke 1A AIS. However, it might be confusing to determine the proper LTV when CSVL slightly touches the vertebra. Hereby, LTV was classified into STV and nSTV according to the position of CSVL. The long-term outcomes of correction surgery for Lenke 1A AIS were compared among those with nSTV, nSTV+1 or STV selected as LIV.

Methods

104 patients were included in the current study with a minimum of 2-year follow-up after selective posterior thoracic fusion surgery. STV was defined as the LTV where CSVL was between the pedicles or touching the pedicle. nSTV was defined as the LTV where CSVL was touching the corner of the vertebra lateral to the pedicle border. Patients with nSTV, nSTV+1, or STV selected as LIV were assigned to three groups accordingly. Surgical outcome of the three groups were compared in terms of the incidence of distal adding-on, LIV position relative to the CSVL and tilt of the first disc below the instrumentation.

Results

Distal adding-on was observed in 23 patients (22.1%) at the final follow-up. The incidence of adding-on was significantly higher in the nSTV group than the STV group (70.0% vs. 10.0%, $P < 0.01$) as well as the nSTV+1 group (70.0% vs. 11.4%, $P < 0.01$). Similarly, patients in the nSTV group were found to have significant increase in the LIV position relative to the CSVL (14.7mm) and the tilt of the first disc below the instrumentation (5.6°) as compared with those in nSTV+1 group (6.7mm, 2.7°) and STV group (6.4mm, 2.2°) ($P < 0.01$). Moreover, there was

no significant difference between the nSTV+1 group and the STV group with regard to the incidence of adding-on, the LIV position relative to the CSVL and the tilt of the first disc below the instrumentation.

Conclusion

Selecting nSTV+1 or STV as LIV could facilitate a promising outcome for patients undergoing selective posterior thoracic fusion surgery.

45. VALIDATING A PATIENT SPECIFIC NORMAL SAGITTAL CONTOUR PREDICTION MODEL – HOW TO KNOW WHAT “NORMAL” SAGITTAL ALIGNMENT IS FOR EACH PATIENT

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Summary

This study validated a previously established patient specific model created to predict “normal” sagittal contour based on fixed pelvic parameters for a given adolescent with no known spinal deformity.

Hypothesis

The predictive algorithm of the normal spinal sagittal alignment will be validated.

Design

Retrospective analysis.

Introduction

Understanding what “normal” sagittal alignment is for an individual is an important preoperative determinant for surgical interventions designed to restore normal sagittal alignment. The purpose of this study was to develop and validate a predictive algorithm to generate normal patient specific sagittal spinal alignment based primarily on a given patient's pelvic incidence.

Methods

150 “normal” adolescents (75 for algorithm development, 75 for validation) had upright biplanar spinal radiographs obtained. A predictive model was created based on each patient's pelvic incidence (PI), sagittal T1 offset, and kyphosis/lordosis inflection point from the first 75 patients. This model was created to predict the sagittal position of each vertebra from T1 to L5. The second 75 patients were used to test the model's validity. For each set of patients the mean absolute error (MAE) in predicted versus actual position for each vertebra was determined.

Results

The development and validation cohorts were similar: age 14.5 vs 14.4 years, PI 47 vs 46°, thoracic kyphosis 40 vs 42°, lumbar lordosis 37 vs 43°. The predictive algorithm generated vertebral body positions with MAEs that ranged from 1.3mm at L5 to 4.1mm at T8. Importantly, there was no significant difference in MAE per level between the two cohorts, suggesting no difference in the effectiveness of the model between development and validation phases.

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Conclusion

The algorithm performed well, with less than 5mm of error in vertebral body position at the apex of kyphosis. This model will help surgeons evaluate the sagittal deformity of a given patient (related to the PI) relative to predicted normal for that individual (quantifying the relative magnitude of sagittal deformity), as well as assess the sagittal plane correction following surgical treatment. Defining the goal (patient specific normal) and how well the goal was met are critical in improving sagittal plane correction strategy.

46. ADOPTION OF A PERFORMANCE IMPROVEMENT MODULE (PIM) SIGNIFICANTLY REDUCED LENGTH OF STAY (LOS) FOLLOWING ADOLESCENT IDIOPATHIC SCOLIOSIS SURGERY.

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United States

Summary

11 surgeons in 8 institutions developed and implemented a PIM to decrease length of stay after surgery for AIS. The group averaged 1 day less in 2014 compared to 2013. Diverse practices can achieve similar improved results with proper parameters.

Hypothesis

Development and implementation of attainable postoperative parameters will decrease LOS.

Design

Multicenter prospective study of AIS patients undergoing surgery.

Introduction

Multicenter Dashboard reporting was established among 11 surgeons in 8 centers in 2011. Multiple parameters were tracked, including length of stay (LOS) after posterior surgery for adolescent idiopathic scoliosis (AIS). From this performance improvement module (PIM), best practice guidelines (BPG) were developed for the postoperative hospital course. (See Table 1)

Methods

AIS patients were prospectively enrolled in a multicenter database, with a rigorous quality assurance (QI) process of all data. Multiple parameters were recorded, including: radiographic parameters by a central digital method, SRS scores, LOS, blood loss, operative time, neuromonitoring events, infections, and reoperations. After comparing two year follow up data from 2012 and 2013, the group implemented a uniform postoperative plan (early mobilization, conversion to oral analgesics, regular diet), with the goal to decrease LOS by 20%.

Results

LOS for 244 patients in 2013 was compared to 200 patients in 2014, for the group and each surgeon. For 2013 the median LOS was 5 days (3-10) and for 2014, 4 days (2-9), $p < .001$. For individual surgeons (N=11), 2 had no change (LOS=4 days), 7 had 1 day decrease in

LOS (4 days), and 2 had 2 days decrease (LOS= 3 days). All changes were significant ($p < .05$). The group reduced the total LOS by 159 days (compared to 2013) with the implementation of a standardized postop BPG (goal for discharge on postop day 4).

Conclusion

A heterogenous group of 11 surgeons at 8 geographically and culturally diverse institutions, developed a Best Practice Guideline (BPG) for LOS in AIS utilizing open group discussions of dashboard reporting. A uniform, postoperative management plan/BPG was adopted. There was a 20% reduction in LOS with likely cost savings. Quality and performance improvement was obtained by monitoring outcomes, identifying best practice, developing consensus, generalized implementation and continued reporting.

LOS	Diet	Activity	Drain	IV	Narcotic	Titrated	Painy
POD1	Liquids	Walking			PCA	0.5mg/kg	Yes
POD2	Regular	Walking 2	Remove		25Watts + Percuss	Same	Yes
POD3	Reg.	Same		IVC	IVC/PERCUT	T/C	IVC
POD4	Reg.	Home			Follow up protocol		

47. IN VITRO BIOMECHANICAL RANGE OF MOTION AND CORONAL PLANE COBB ANGLE CORRECTION OF FUSIONLESS ANTERIOR TETHER CONSTRUCTS FOR CONTROLLED SCOLIOSIS CORRECTION

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United States

Summary

Anterior tethering allows for scoliosis correction while still promoting growth and mobility. Cadaveric specimens were tested in a load control protocol with the following constructs 1) T4-T12 rigid; 2) T4-T12 sequentially tensioned; 3) T4-T12 tensioned at T12; and 4) T4-T12 no tension. Significantly more correction was achieved with sequential tensioning and the majority of the change occurred at the superior levels. Tensioning at every level did not show a significant biomechanical advantage and was more mobile than a rigid rod.

Hypothesis

Sequential tensioning will result in reduced motion and greater coronal plane correction compared to tensioning only at the inferior level.

Design

In vitro biomechanical study

Introduction

Fusionless scoliosis correction has gained popularity for treating skeletally immature patients. Anterior tethering allows for correction while still allowing growth and mobility. In vitro range of motion (ROM) of anterior tether constructs and changes in Cobb angles are evaluated in a biomechanical model.

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Methods

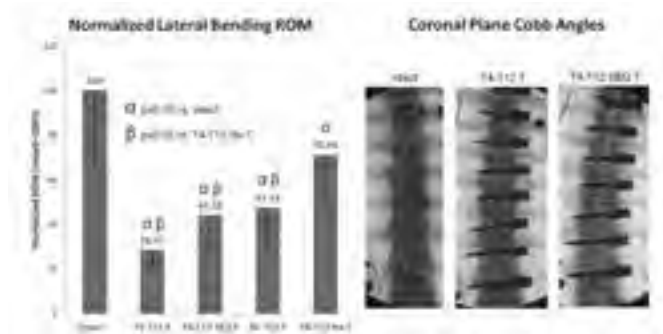
Eight T3-L1 specimen (2M 6F; 57±20 years) underwent ROM testing, with an applied lateral bending moment of 6 Nm at 1°/sec, using a 6 DoF machine. All specimens were tested intact and with the following constructs 1) T4-T12 rigid (T4-T12 R); 2) T4-T12 sequentially tensioned (T4-T12 SEQ T); 3) T4-T12 tensioned at T12, (T4-T12 T); and 4) T4-T12 no tension (T4-T12 No T). Repeated measures ANOVA with Tukey's post hoc analysis was used to compare ROM and a student t-test assuming equal variances was used for comparing Cobb angles ($p \leq 0.05$).

Results

Normalized ROM for intact was 100(±33.30)%. The T4-T12 R construct reduced motion to 28.47(±8.87)%. The T4-T12 SEQ T, T4-T12 T, and T4-T12 No T constructs resulted in a stepwise increase in motion to 44.18(±15.34)%, 47.33(±17.62)%, and 70.94(±18.85)%, respectively, compared to intact. There was no significant difference between the T4-T12 SEQ T and T4-T12 T ($p > 0.05$) constructs. The average change in T4-T12 Cobb angle from intact was 4.6(±3.2)° and 9.9(±5.5)° for the T4-T12 T and T4-T12 SEQ T constructs respectively ($p = 0.05$).

Conclusion

Significantly more correction was achieved with sequential tensioning. Tensioning at every level did not show a significant biomechanical advantage and was more mobile than a rigid rod. Clinical studies are needed to fully understand the immediate and long-term effect of tethered constructs.



48. VALIDATION OF THE "SUBSTANTIALLY" TOUCHED VERTEBRA AS THE LOWEST INSTRUMENTED VERTEBRA IN THORACIC MAJOR CURVES WITH AR LUMBAR MODIFIERS

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United States

Summary

Previously published guidelines recommended fusing distally to the last substantially touched vertebra (STV) for Lenke 1A curves with L4 tilt to the right. This study found that choosing the STV as the lowest instrumented

vertebra in all thoracic major curves with an AR lumbar modifier significantly decreased the risk of distal adding-on. Skeletally immature patients fused short of the STV had a very high risk of adding-on.

Hypothesis

Choosing the substantially touched vertebra (STV - most caudad vertebra with pedicle touched by the center sacral vertical line) as the lowest instrumented vertebra (LIV) in patients with a thoracic major curve and AR lumbar modifier (Lenke A with L4 tilt to the Right) minimizes the risk of distal adding-on.

Design

Review of a prospectively collected, multi-center database of adolescent idiopathic scoliosis patients.

Introduction

Previous studies have recommended fusing distally to the STV in patients with Lenke 1AR curves. The purpose of this study was to determine whether this recommendation was valid for all thoracic major curves (Lenke type 1-4) with lumbar AR modifiers and to identify patients who could be fused short of the STV.

Methods

164 patients with a thoracic major curve and AR lumbar modifier who underwent posterior spinal fusion between 2008 and 2012 were reviewed. All patients had minimum 2-year follow-up. Radiographic and SRS-22 outcomes measures were compared between patients fused to the STV and those fused short of STV. We also determined the variables that were associated with an acceptable alignment despite being fused short of the STV.

Results

Ninety-one patients were fused to the STV and 64 patients were fused short. 10% of patients fused to the STV compared to 22% of patients fused short had greater than 5° of change in the thoracic Cobb and distalization of the end Cobb vertebra during the post-operative period ($p = 0.039$). In addition, 1% of those fused to the STV compared to 11% of patients fused short had disc angulation change greater than 5° below the LIV ($p = 0.009$). Of the 64 patients fused short of SVT, those with Risser 2-5 had a significantly lower risk of adding-on (19%) than Risser 0-1 (78%) ($p = 0.001$).

Conclusion

Choosing the STV as the LIV in thoracic major curves with an AR lumbar modifier significantly decreases the risk of distal adding-on. The risk of adding-on in skeletally mature patients fused short of STV is less, but remains.

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49. IS THERE A GENDER-SPECIFIC RECRUITMENT PATTERN IN THE SETTING OF PROGRESSIVE SAGITTAL MALALIGNMENT?

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Summary

Little is known regarding gender-specific compensatory recruitment for sagittal malalignment. 879 females were propensity matched for age and pelvic incidence with 879 males and full body xrays were obtained. Differences in sagittal compensatory parameters were assessed. For a given lack of lumbar lordosis, men recruit more knee flexion and females recruit more pelvic tilt and hip extension. These findings can be put in perspective with purported gender differences in musculature (gluteal vs. quadriceps muscle recruitment).

Hypothesis

Gender related differences exist in compensatory recruitment to progressive sagittal malalignment.

Design

Retrospective review.

Introduction

There is growing interest and need for personalized care in the setting of deformity management and its evaluation. While extensive knowledge has been gained from recent research on sagittal alignment, little is known regarding gender-specific answers to sagittal plane deformity.

Methods

Single center study of patients with full body xray. A group of female patients were age and pelvic incidence propensity matched to a group of males. Patients were stratified into five groups of progressive PI-LL mismatch (<0°, 0°-10°, up to >30°). Radiographic parameters were measured using dedicated software. Differences between PI-LL groups were assessed with ANOVA, and between genders by unpaired t-test.

Results

1,758 patient visits were included: 879 females (54yo, BMI 26kg/kg2) and 879 males (54yo, BMI 28 kg/kg2). At lowest level of malalignment (Fig), females had less SVA, less knee flexion, and less ankle dorsiflexion. For PI-LL 0-10, females had more PT and TK. With progressive malalignment (PI-LL 10-20), females had significantly less knee flexion and more PT (group 4: 32.6 vs. 28.9°, this group had higher PI (62.3 vs 55.6°). Similarly, at highest level of malalignment, females had more PT (37.3 vs 34.1°, this group had higher PI (66.5 vs. 59.4°) and less knee flexion. Hip extension (measured by sacro femoral angle SFA) was significantly higher in females in all PI-LL mismatch groups. ANOVA analysis revealed that both

genders progressively recruited knee flexion and pelvic tilt with increased PI-LL mismatch, except that at the highest PI-LL mismatch group, only males continue to recruit knee flexion (all p<0.05).

Conclusion

This study demonstrated that, for a given lack of lumbar lordosis, men recruit more knee flexion and females recruit more pelvic tilt and hip extension. These findings can be put in perspective with purported gender differences in musculature. Future work is required to assess gender based morphologic differences in soft tissue distribution (for example, gluteal vs. quadriceps muscle recruitment and fat content).

Figure 1: Gender composition of compensatory mechanisms by adjusted PI-LL mismatch

	<0°		0-10		10-20		20-30		>30	
	F	M	F	M	F	M	F	M	F	M
# Pts	409	370	203	204	120	171	70	73	77	83
PT	10.3	12.8	21.8	18.9**	25.1	24.8	32.7	28.2**	37.3	34.2**
TK	48.3	50.4	47.1	43.9**	43.8	44.8	38.7	38.6	31	28.7*
SVA	-8.3	1.0**	20.4	23.2	43.2	48	57.4	65	113.4	118.8
KA	-3.1	2.4**	2	4.3	4.5	8.3**	8.8	8	11.5	15.3**
AA	8.3	5.9**	15.1	8.4	8.6	7	8.7	3.9	8.3	9.7
SFA	136.7	134.7**	205.8	201.1**	208.2	205.8*	212.7	207.7**	214.3	207.6**

* p < 0.05, ** p < 0.01, *** p < 0.001

50. TRANEXAMIC ACID ADMINISTRATION IN AIS SURGERY REDUCES % TOTAL BLOOD VOLUME LOSS

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Summary

Corrective surgery for Adolescent Idiopathic Scoliosis (AIS) is associated with significant blood loss. Administration of tranexamic acid (TXA) reduces calculated % total blood volume loss (%TBV) by 30% compared to no TXA administration.

Hypothesis

TXA administration reduces %TBV loss in AIS surgery compared to controls.

Design

This was a retrospective comparative case-control study evaluating all multilevel spinal fusion operations for AIS by a single surgeon from October 2011 to August 2014.

Introduction

Multilevel spinal fusion surgery for adolescent idiopathic scoliosis (AIS) is typically associated with significant blood loss. Anti-fibrinolytics such as tranexamic acid (TXA) have been proposed to reduce both blood loss and the need for transfusions.

Methods

Efficacy of TXA was evaluated by comparing mean estimated blood loss (EBL) and %TBV loss (calculated by Nadler™'s formula: males = 0.3669 * Ht m3 + 0.03219 * Wt kg + 0.6041; females = 0.3561 * Ht m3 + 0.03308 * Wt kg + 0.1833). Clinical factors including number of levels fused and length of operation were tested for correlation with % TBV loss.

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Results

From 2011 to 2014, 36 adolescents underwent AIS surgery (18 with and 18 without TXA). Mean age was 16 (± 3) years and 86% (31/36) were female (controls 15/18 and TXA 16/18). There were no statistically significant mean differences between the (-)TXA and (+)TXA groups in terms of the following: BMI (20.2 vs 22.2); estimated blood volume (3380 mL vs 3797 mL); levels fused (9.6 levels vs 10.5 levels); EBL (583 mL vs 474 mL) ($p = 0.18$); and EBL per level fused (61 mL/level vs 43 mL/level). Percent total blood volume loss and % TBV per level fused was significantly less in the TXA group (12% and 1%) compared to control group (17% and 2%) ($p < 0.05$). There was a moderate but significant direct correlation between number of levels fused ($p = 0.024$) and length of operation ($p = 0.007$) with % total blood volume loss.

Conclusion

Administration of TXA during pediatric scoliosis surgery reduced % total blood volume loss by 30% compared to no TXA.

	TXA -	TXA +	Significance
n	18	18	ns
F:M	15:3	16:2	ns
#levels fused	9.6 (± 2.0)	10.5 (± 2.2)	ns
EBV (mL)	3381 (± 477)	3797 (± 894)	ns
BMI	20.2 (± 3.3)	22.2 (± 5.2)	ns
EBL (mL)	583 (± 316)	474 (± 382)	ns
EBL/level fused (mL)	61 (± 33)	43 (± 20)	ns
% TBV (total)	17.3 (± 8.8)	12 (± 8.6)	$p < 0.05$

51. TOWARDS A NEW 3D CLASSIFICATION FOR ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS): 3D SUBGROUPS DERIVED FROM A CONSENSUS APPROACH FROM MEMBERS OF THE SRS 3D TASKFORCE

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Canada

Summary

Eleven distinct 3D subgroups were identified among 952 3D reconstructions of pre-operative AIS cases using a fuzzy clustering approach with ten distinct 3D parameters. Four experienced surgeons then reviewed these subgroups and complete agreement was reached that the 3D subgroups were different and that the surgical plan would differ among the subgroups.

Hypothesis

Clinically distinct 3D groups exist to describe AIS and are different from those outlined in the Lenke classification, and should be treated with a specific surgical plan.

Design

A total of 952 3D spine reconstructions of pre-operative patients with AIS were analyzed using a fuzzy clustering algorithm. Consensus was then established among 4 experienced spine deformity surgeons for the 3D subgroups based on 1) if the subgroups were different and 2) if the curve pattern presented would be treated differently or not.

Introduction

Better understanding of the 3D deformity present in AIS should provide a more comprehensive approach to help guide surgical treatment. The SRS 3D taskforce mandate is to develop a 3D surgical classification of AIS and surgical approaches using 3D criteria. This study presents the consensus reached to identify clinically significant 3D subtypes identified in a large 3D database.

Methods

Ten 3D parameters were used to define the groups: Cobb angles, apical axial rotations and planes of maximal curvature of three spinal levels (proximal thoracic, mid-thoracic and thoracolumbar/lumbar), max. kyphosis and lordosis. A fuzzy c-means clustering algorithm was used, with 5-15 possible clusters allowed. Consensus was established based on representative cases selected among the 3D subgroups that were presented to a panel of 4 surgeons.

Results

The algorithm optimized the number of clusters to 11. Cluster size varies between 11(1.16%) and 230(24.2%). To simplify visual representation and comparison, a Da Vinci (top) view was created for each cluster, illustrating 8 of the parameters used. A one-way ANOVA showed a significant difference between groups for at least the 8 parameters included in the Da Vinci view. Complete agreement was reached that all subgroups differed significantly and that the surgical plan would differ between different clusters.

Conclusion

We have found 11 groups with distinct 3D spinal deformities and treatment approaches. Complete agreement among the four surgeons indicates that these subgroups are clinically relevant and will serve as the basis for a new 3D classification.



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52. COAGULATION PROFILE OF ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS) PATIENTS UNDERGOING POSTERIOR SPINAL FUSION (PSF)

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United States

Summary

Healthy AIS patients exhibit signs of fibrinolysis during PSF.

Hypothesis

Bleeding during PSF for AIS is due to fibrinolysis.

Design

Prospective analysis of bleeding parameters in AIS patients undergoing PSF.

Introduction

Blood loss is a significant morbidity of spinal surgery for scoliosis but poorly understood.

Methods

Consecutive AIS patients undergoing PSF at a tertiary pediatric hospital were screened for inclusion. Patients with any abnormal pre-operative coagulation results were excluded. A coagulation profile, including Thromboelastogram (TEG), was collected on subjects at incision and hourly throughout the case.

Results

Fifty-eight patients were analyzed. The mean age was 13.5 years old; mean surgical length was 3 hours and 23 minutes; and a mean of 11.1 levels were fused. The mean estimated blood loss (EBL) was 809 mL. Twenty-seven patients received allogeneic blood. The mean for all coagulation parameters remained within normal ranges. The pro-thrombin time (PT) increased slightly from 14.2 sec. at incision to 16.1 sec. by 3 hours. Platelets decreased from 230,000/ μ L to 184,000/ μ L at closure. From the TEG, the R times, representing initial clot formation, decreased from 4.6 to 3.4 minutes at 2 hours. The MA (platelet function) remained stable at 66 mm through the 3 hour mark. The Lysis at 30 minutes (LY30), an indicator of clot stability, changed from 2.2% to 3.9% at incision to 3 hours, respectively. Indicators of fibrinolysis included the presence of fibrin degradation products in 11 patients by 2 hours and in 24 by 3 hours; D-dimer was present in 33 patients by 2 hours. Patients were given a "DIC score" based on elevated PT and indicators of fibrinolysis. Patients who received allogeneic blood had a greater increase in PT ($p = 0.0007$) and in DIC score (0.008). The change in PT ($r=0.35$), DIC score ($r=0.33$), and MA ($r=-0.33$) during surgery and the pre-operative fibrinogen ($r=-0.30$) correlated significantly (p -values < 0.05) with EBL/lev.

Conclusion

Healthy AIS patients exhibited evidence of fibrinolysis while undergoing PSF. These data support the use of anti-fibrinolytics and may provide a basis of comparison for future study on their efficacy in this patient population.

53. ULTRA LOW DOSE IMAGING FOR THE FOLLOW-UP OF IDIOPATHIC SCOLIOSIS

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France

Summary

Adolescent idiopathic scoliosis (AIS) required repeated radiological monitoring. Therefore, minimizing radiation exposure according to ALARA concept is essential. The aim of this study was to analyze reproducibility of EOS microdose protocol and evaluate its use in clinical practice. Measurement reproducibility of EOS "fast spine" microdose is similar to standard EOS reproducibility. 3D reconstructions of main spinal parameters are faster. While quality of images is slightly inferior, the radiation dose is very low: 40 times less than a standard x-ray.

Hypothesis

Ultra low dose imaging enables to follow up AIS patients with less radiation.

Design

single center prospective study.

Introduction

In adolescent idiopathic scoliosis (AIS), repeated radiological monitoring is required to determine curve prognosis and therapeutic strategy. Radiosensitivity of the organs in pediatric patients is higher. Therefore, minimizing radiation exposure according to the ALARA concept (as low as reasonably achievable) is essential. A biplanar slot scanning system allows significant dose reduction with three dimensional (3D) reconstructions. With recent technical advances, further dose reduction can be obtained with this system, at a cost of a slight reduction in image quality. The aim of this study was to analyze the reproducibility of this new protocol and evaluate its use in routine clinical practice.

Methods

AIS patients underwent fullspine EOS imaging using a microdose protocol. Three observers performed two times each 3D reconstructions of the spine with fast spine SterEOS software. Usual coronal and sagittal spinopelvic parameters were measured. Reproducibility and accuracy of the measurement was assessed with the ISO norm 5725-2.

Results

36 patients were included, with a mean age of 12.8 years, and a mean Cobb angle of 25° (10° to 68°). Radiation dose with EOS microdose was 6 times less than with standard EOS (63 μ Gy). The mean time needed for 3D fast spine reconstruction was 5 minutes. Interobserver reproducibility was 2° to 5° for spinal parameters, and 1° to 5° for pelvic parameters. Intraclass coefficients of correlation were between 0.86 and 0.98.

Conclusion

Measurement reproducibility of EOS fast spine microdose is similar to standard EOS reproducibility reported in the literature. 3D reconstructions of the main spinal parameters are faster. While the quality of images is

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slightly inferior, the radiation dose is very low: 40 times less than a standard x-ray. Therefore, EOS fast spine microdose is as reliable as standard EOS and can be considered for routine radiographic follow-up of AIS patients.

54. HYDRATION PROPERTIES OF THE LUMBAR INTERVERTEBRAL DISCS IN AIS AFTER SURGICAL CORRECTION: FIVE YEARS FOLLOW-UP AND COMPARISON WITH AN AGE-MATCHED CONTROL GROUP

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France

Summary

We compared disc hydration properties of adolescent idiopathic scoliosis before and 5 years after spinal fusion with an age-matched control group. We conducted a prospective MRI follow-up of 23 patients. Disc and nucleus volumes were reconstructed on T2 weighted sequence. In the scoliotic group, vd and vn were lower than control group, hydration ratio (Vn/Vd) was lower. After surgery, subjacent discs rehydrated. AIS induces a loss of IVD hydration. Surgical correction can reverse homeostasis disturbances related to spinal deformity.

Hypothesis

Scoliosis may alter intervertebral disc hydration and induce early degenerative changes.

Design

To compare the disc hydration properties of adolescent idiopathic scoliosis (AIS) before and 5 years after spinal fusion with an age matched control group.

Introduction

Intervertebral discs (IVD) assume the mechanical support and flexibility of the spine. The supportive function is under the influence of disc hydration. Scoliosis induces a chronic asymmetric loading of the IVD that may alter the disc nutrition and may induce early degenerative changes.

Methods

We conducted a prospective MRI follow up of 23 AIS patients (average follow up period 5,5 years). Patients underwent pre and post-operative T2 weighted MRI sequence. Specific software was developed to reconstruct disc and nucleus volumes (vd, vn). Hydration content was determined by the ratio vn/vd expressed in percentage. A comparative control group of 20 patients was matched by age. Controls were selected in the PACS database and medical charts were reviewed to exclude any deformity or disease affecting the spine. Disc hydration content was measured using the same protocol.

Results

In the control group, volumetric parameters increased during growth spurt and were correlated to age (vd: $R^2=0.49$, $p<0.001$); vn: $R^2=0.33$, $p=0.02$). Disc hydration content remained constant (mean 28%). In the scoliotic group before surgery, vd and vn were lower than normal

values hydration ratio was lower (mean 24%). At latest follow-up, Vd remained constant while vn increased significantly. Disc hydration content was boosted at a mean value of 32% ($p=0;001$, Mann Whitney Wilcoxon test).

Conclusion

AIS induces a loss of IVD hydration. The correction-fusion induces expansion of the nucleus, but at constant disc volume. Our results suggest that scoliosis surgery performed at the end of growth can reverse the discs constraints related to spinal deformity. However subjacent discs become hyper hydrated after surgery. This may be a consequence of homeostasis restoration but also excessive stress induced by spinal fusion on the lumbar spine.

55. ADOLESCENT IDIOPATHIC SCOLIOSIS TREATED BY A LESS INVASIVE LATERAL APPROACH

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Brazil

Summary

Initial results of eleven adolescent idiopathic scoliosis (AIS) cases treated by a less invasive lateral approach. The treatment resulted in good correction of the principal curve with lateral or posterior supplementation, and no major complication occurred.

Hypothesis

It is possible to treat thoracolumbar AIS with a less invasive lateral approach without the addition of major complications.

Design

Single-center study; consecutive enrollment; AIS treated surgically by a less invasive lateral approach; minimum follow up - 3 months; primary outcome: complications/revision; secondary outcome: deformity correction.

Introduction

Anterior instrumentation for AIS has the theoretical advantage of providing the same correction than the traditional posterior approach while instrumenting fewer vertebrae, and providing good kyphosis correction.

Methods

Eleven patients (all female): two 1C, one 1A, one 3A, and seven 5C. Mean age, 15.5 years (12-28). Lateral approaches in lateral decubitus with an expandable retractor. ALL release followed by maneuvers, interbody grafting, w/ or w/o lateral or posterior instrumentation. Lateral route through two or only one small incision at medial axillary line on the convex side of the curve (w/out 2-2.5 inches rib window).

Results

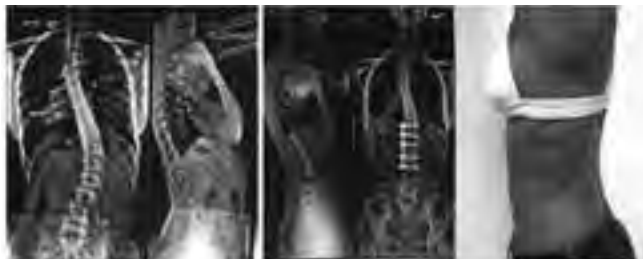
Mean 5.6 levels treated (4-11, range; T1-L4). Four patients only with interbody fusion. Seven patients with supplementation (two posterior, five lateral). Average EBL of 350mL (50-1000); average surgical duration of 312min (180-400), with no major intraoperative complication. Chest tubes used as precaution in four cases (36%). One

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case with postop pneumonia. One reoperation: distal level extension. Average results follow: thoracic curves, 41° to 26° ($p=0.006$); lumbar curves, 45° to 30° ($p<0.001$); SVA, -2cm to +1cm ($p=0.03$). Coronal plumb line did not change. Lateral/posterior screws resulted in better corrections of the thoracolumbar curves ($p=0.008$).

Conclusion

Results from AIS cases treated through a less invasive lateral approach either with lateral or posterior supplementation are promissory. Further studies are needed to address if it is possible to save mobile segments and achieve suitable kyphosis values, without additional complications.



56. 3D ROD SHAPE CHANGE DURING AIS INSTRUMENTATION: HOW MUCH AND DOES IT IMPACT CURVE CORRECTION?

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Canada

Summary

There is an important reduction of the concave rod curvature after the surgical correction maneuvers, and the deformed rods end in an oblique plane deviated from the sagittal plane. The initial rods' contour, despite their shape change, impacts the transverse plane deformity correction and resulting sagittal profile.

Hypothesis

Initial rods contour impacts 3D curve correction despite their shape change after the instrumentation.

Design

3D analysis of rod contouring and correction in AIS.

Introduction

Intraoperative flattening of rods is known to reduce the correction capability of the instrumentation, but has not been studied in 3D. The objective was to evaluate the 3D rod shape change during surgical maneuvers and postoperatively, and its effect on 3D curve correction.

Methods

5.5mm CoCr rods of 35 right thoracic AIS cases intraoperatively were measured prior their insertion and after the correction maneuvers, and 1 week postoperatively, using 3D reconstruction techniques. The rod curvature, maximal deflection and orientation of

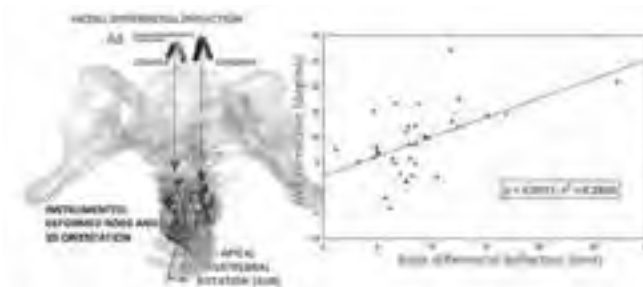
its plane of maximum curvature (PMC) were computed at each stage, and the relationship with Cobb angles, kyphosis and apical vertebral rotation (AVR) was assessed.

Results

Main thoracic Cobb angle was corrected from $58\pm 10^\circ$ to $15\pm 8^\circ$ and AVR from $18\pm 6^\circ$ to $9\pm 6^\circ$. Prior to insertion, rod curvature and deflection were higher for the concave rod ($39\pm 8^\circ/25\pm 6\text{mm}$) than the convex rod ($26\pm 5^\circ/17\pm 3\text{mm}$). Only the concave rod shape changed after the correction maneuvers ($18\pm 6^\circ/11\pm 5\text{mm}$; $p<0.001$) but stayed unchanged postoperatively. After surgery the rod PMC was oblique with respect to the sagittal plane (concave: $27\pm 19^\circ$ /convex: $15\pm 12^\circ$) (Figure). There was a linear relationship between initial concave rod curvature and kyphosis change ($R^2=0.58$) and between initial differential concave/convex rod deflection and AVR correction ($R^2=0.28$) ($p<0.01$).

Conclusion

There is an important change of the concave rod profile during surgery, and both rods end in a plane deviated from the sagittal plane. There is a direct relationship between initial rods' contour and the transverse plane deformity correction and resulting sagittal profile.



57. COMPARISON OF PULMONARY FUNCTION AFTER SELECTIVE ANTERIOR VERSUS POSTERIOR FUSION FOR THE CORRECTION OF THORACOLUMBAR AND LUMBAR CURVES IN ADOLESCENT IDIOPATHIC SCOLIOSIS

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Japan

Summary

The pulmonary function after selective anterior versus posterior fusion in thoracolumbar and lumbar AIS patients was investigated. The vital capacity and predicted VC after ASF did not return to preoperative values at 2 years, suggesting the possible influence of the thoracotomy with separation of diaphragm in the early postoperative period.

Hypothesis

The anterior thoracolumbar approach with separation of the diaphragm could negatively affect pulmonary function in the early postoperative period.

Design

Retrospective multicenter study

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Introduction

Selective anterior spinal fusion (ASF) has been the standard treatment of thoracolumbar and lumbar curves in AIS. One of the advantages of ASF has been the ability to achieve good coronal correction with fewer levels fused than in posterior spinal fusion (PSF). However, the anterior approach to the thoracolumbar spine requires thoracotomy with separation of diaphragm. The objective of this study was to compare the effect of ASF versus PSF on pulmonary function testing (PFT).

Methods

A multicenter series of AIS patients (Lenke 5C and 6C) who underwent selective spinal fusion were retrospectively reviewed. Sixty seven patients (all female) were included (mean age 15.8 years). There were 36 patients in the ASF group and 31 patients in the PSF group. Demographic, radiographic measurements, and PFT data from preoperative and 2 year time points were analyzed.

Results

Preoperatively, there were no significant differences in vital capacity (VC), forced expiratory volume in one second, and %VC between groups. The ASF group patients were more likely to be fused shorter (4.5 instrumented vertebra length) than those in the PSF group (5.2, $p < 0.05$). At 2-year follow-up, there was no statistical difference on absolute values and percent predicted values in both groups. However, the ASF group showed decreases in VC (pre $2.8 \pm 0.4L$, 2-years $2.7 \pm 0.4L$, $p < 0.05$) and %VC (pre $85 \pm 12\%$, 2-years $82 \pm 13\%$, $p < 0.05$) compared to preoperative values. In contrast, all absolute values and percent predicted values remained stable in the PSF group (VC: pre $2.9 \pm 0.4L$, 2-years $2.9 \pm 0.4L$, ns).

Conclusion

Preoperative PFT values were similar for selective anterior versus posterior fusion patients with Lenke 5C and 6C curves. However, PFT values after ASF did not return to the preoperative baseline at 2 years, suggesting the possible influence of the thoracotomy with separation of diaphragm in the early postoperative period.

58. BRACES DESIGNED WITH CAD/CAM AND NUMERICAL SIMULATIONS ARE MORE EFFICIENT AND LIGHTER THAN STANDARD THORACO-LUMBO-SACRAL ORTHOSES

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Canada

Summary

A prospective Randomized Controlled Trial (RCT) was designed to assess braces designed using Computer Aided Design and Manufacturing (CAD/CAM) and finite element modeling (FEM) for the conservative treatment of adolescent idiopathic scoliosis (AIS).

Hypothesis

Braces designed with CAD/CAM and FEM are more efficient than standard TLSO.

Design

Prospective RCT comparing standard TLSO's fabricated using CAD/CAM approach, with TLSO's additionally designed using FEM and optimization.

Introduction

The purpose of this study was to assess the effectiveness of braces designed using CAD/CAM and FEM simulation compared to CAD/CAM only for the conservative treatment of AIS.

Methods

Forty AIS patients were recruited in a prospective RCT. For the control group, the brace was designed using a scan of the patient's torso and a conventional CAD/CAM approach (CtrlBrace). For the test group, the brace was additionally designed using FEM and 3D reconstructions of the spine, rib cage and pelvis (NewBrace). NewBrace design was simulated and iteratively optimized to maximize the correction and minimize the contact surface and material (Figure).

Results

Both groups had comparable age, sex, weight, height, curve type and severity. Scoliosis Research Society standardized criteria for bracing were followed. Average Cobb angle prior to bracing was 27° and 28° for the main thoracic (MT) and lumbar (L) curves respectively for the control group, while it was 33° and 28° for the test group. CtrlBraces immediately reduced MT and L curves by 8° (29%) and 10° (40%) respectively, compared to 14° (43%) and 13° (46%) for NewBraces which were also 50% thinner and had 20% less covering surface than CtrlBraces (Figure). NewBraces showed a clinically and statistically significantly greater MT Cobb angle correction and similar (slightly greater) lumbar correction.

Conclusion

Braces designed with CAD/CAM and FEM simulation were more efficient and lighter than standard TLSO. These results suggest that the long term effect of bracing in AIS may be improved using this new platform for brace fabrication.



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59. CHANGES IN SAGITTAL CERVICAL ALIGNMENT AFTER POSTERIOR SPINAL FUSION FOR ADOLESCENT IDIOPATHIC SCOLIOSIS: AN EVALUATION OF 141 PATIENTS

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Summary

Cervical kyphosis is associated with decreased quality of life in adults. We analyzed the sagittal cervical alignment in 141 AIS patients with 2-year followup. The incidence of postoperative cervical kyphosis was 64.4%. Preoperative cervical kyphosis (C2-C7 Cobb), lower thoracic kyphosis (T2-T12 Cobb), and lower T1 slope correlated with postoperative cervical kyphosis. Patients with preoperative cervical kyphosis demonstrated lower postoperative SRS scores than patients with preoperative cervical lordosis. Patients with postoperative thoracic kyphosis >40° achieved or maintained postoperative cervical lordosis.

Hypothesis

The presence of cervical kyphosis (CK) in adolescent idiopathic scoliosis (AIS) patients leads to a poorer health related quality of life (HRQoL) measures.

Design

Retrospective review of a prospectively collected multicenter database.

Introduction

Loss of normal thoracic kyphosis (TK: T2-T12 Cobb) is often seen in AIS patients, however, its effect on the cervical sagittal alignment before and after PSF has been less well studied. CK is strongly associated with reduced HRQoL measures and increased disability scores in adults, however its effects in the AIS population is unknown.

Methods

A multicenter, prospective AIS database retrospectively identified 141 patients with minimum 2-year followup after PSF with preop, initial postop, and 2 year postop X-rays that included the skull to pelvis. CK was defined as a positive C2-C7 Cobb>0°, while cervical lordosis (CL) was negative.

Results

Factors associated with developing post-op CK were: preop CK (p=0.001, r=0.28), lower preop/postop TK (p<0.01, r=-0.37), lower preop/postop T1 slope (p<0.01, r=-0.62), and negative postop C7 sagittal vertical axis (p=0.04, r=-0.39). 75% of patients with preop CK remained kyphotic at 2 years (p=0.001) and had lower preop/postop SRS scores (pain, function, total score; p<0.05).

At 2 years, mean TK measured 32.9°±10.3°, which was an increase of 17.3% from preop (p=0.6). 76 patients (54%) had an increase in TK, while TK decreased in 65 patients (46%). Sub-analysis revealed that patients with postop TK>40°, reliably maintained or achieved postop CL (p=0.007). TK>40° was seen in only 23% of patients.

Conclusion

This is the largest study to date to evaluate the cervical alignment in AIS patients before and after PSF. Preop cervical kyphosis (CK) led to a higher rate of cervical kyphosis and decreased SRS scores at 2 years post-op. Postop thoracic kyphosis>40° consistently resulted in maintaining/achieving cervical lordosis. In our cohort, however, cervical lordosis was only present in 35.6% of patients at 2 years postop.

	2 year PO Cervical Kyphosis (CK) (n=92)	2 year Postop Cervical Lordosis (CL) (n=49)	P Value
Preop C2-C7 Sagittal Cobb	8.3°	-11.4°	0.01
2yr PO C2-C7 Sagittal Cobb	13.1°	-11.7°	<0.0001
Preop T2-T12 Sagittal Cobb	31.2°	40.3°	0.009
2yr PO T2-T12 Sagittal Cobb	51.3°	37.6°	<0.0001
Preop T1 Slope	30.3°	33.4°	0.01
2yr PO T1 Slope	15.3°	35.1°	<0.0001
Preop C7 SVA	1.2mm	1.6mm	0.8
2yr PO C7 SVA	21.8mm	1.7mm	0.04

2yr PO: 2 year postoperative
SVA: Sagittal Vertical Axis
CK: Cervical Kyphosis
CL: Cervical Lordosis

60. FUSION OF PROXIMAL THORACIC CURVE AVOIDS POSTOPERATIVE CERVICAL TILT IN ADOLESCENT IDIOPATHIC SCOLIOSIS PATIENTS WITH DOUBLE THORACIC CURVE

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China, People's Republic of

Summary

We performed a radiographic study to evaluate the cervical tilt in adolescent idiopathic scoliosis (AIS) patients with double thoracic curve after partial or non fusion of the proximal thoracic (PT). The results demonstrated that full fusion of the PT curve with the correction of T1 tilt helps to avoid the deterioration of the cervical tilt in AIS patients with structural PT curve.

Hypothesis

Patients with right-elevated shoulder gain deteriorated cervical tilt with PT curve not fused.

Design

A retrospective radiographic study.

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Introduction

This study aims to evaluate the postoperative cervical tilt in AIS patients with double thoracic curve treated by either full fusion or partial/non fusion of the PT curve and to analyze the mechanism underlying this phenomenon with the purpose of aiding spine surgeons with preoperative planning.

Methods

A total of 30 AIS patients with double thoracic curves and preoperative right-elevated shoulder underwent posterior spinal instrumentation from 2009 to 2011 were included in this study. All the subjects were divided into 2 groups according to the selection of upper instrumented vertebra (UIV). There were 14 cases in full fusion group (Group A, proximally fused to T1 or T2) and 16 cases in partial/non fusion group (Group B, proximally fused to T3 or below). Standing anteroposterior X-ray films of the spine were obtained preoperatively, one week after the operation, and at a minimum of two-year follow-up were analyzed with respect to the following parameters: cervical tilt, T1 tilt, PT Cobb angle, main thoracic (MT) Cobb angle, PT apical vertebral translation (AVT), MT AVT and radiographic shoulder height (RSH).

Results

Most of the patients in these two groups gained satisfactory shoulder balance after the operation. However, the cervical tilt significantly improved in group A ($p < 0.001$) but deteriorated in group B ($p < 0.001$). In group A, the decrease of cervical tilt significantly positively correlated with that of T1 tilt ($p < 0.001$). In group B, the increase of cervical tilt significantly positively correlated with both that of T1 tilt ($p < 0.001$) and that of PT AVT ($p < 0.05$).

Conclusion

Patients with right-elevated shoulder gain improved shoulder balance but deteriorated cervical tilt after partial/non fusion of PT curve. Full fusion of PT curve and correction of T1 tilt are crucial for preventing the deterioration of cervical tilt in AIS patients with double thoracic curve.

61. DEVELOPMENT OF A PREOPERATIVE ADULT SPINAL DEFORMITY FRAILTY INDEX THAT CORRELATES TO COMMON QUALITY AND VALUE METRICS: LENGTH OF STAY, MAJOR COMPLICATIONS AND PATIENT REPORTED OUTCOMES

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Summary

The aim of our study was to develop a frailty score based on preoperative measures of the patient physical condition that would correlate to common quality and value metrics. We found that in operatively treated adult patients with spinal deformity, high frailty index predicted greater complications, higher length of stay and worse self-reported outcomes before and after spinal surgery.

Hypothesis

A frailty index (FI) can preoperatively predict operative quality and value metrics: major complications, length of stay and self-reported outcomes after adult spinal deformity (ASD) surgery.

Design

Retrospective.

Introduction

Surgical treatment of patients with ASD is associated with substantial cost and complications. The aim of our study was to develop a FI based on preoperative measures of the patient physical condition that would correlate to common quality and value metrics.

Methods

Operatively treated ASD patients were identified, and intra-, peri-, and postoperative major complications were noted over a 2-yr F/U. Univariate logistic regression analyses were performed on 50% random sample to analyze the association between patient age, Oswestry Disability Index (ODI), Charlson comorbidity score (CCS), and comorbidities not included in the CCS such as hypertension, and between major complication development. Factors that were found to be significant were differentially weighted to construct FI, which was validated on the remaining 50% sample.

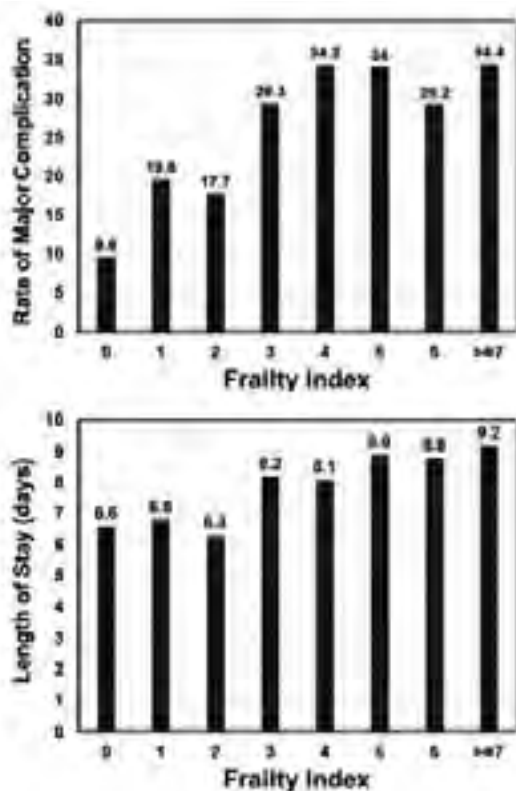
Results

Following variables were significantly associated with complications and were used to calculate FI: age (assigned 0/1/2 points), CCS (0/1/2 points), depression (0/1 point), osteoporosis (0/1 point), hypertension (0/1 point), and ODI (0/1/2 points). The rate of major complications increased significantly with FI ($P < 0.01$); there was a 2.7-fold odds of developing major complications in patients with $FI \geq 3$ vs. those $FI \leq 2$ (32.0% vs. 14.7%). Patients with $FI \geq 3$ also had significantly longer length of stay ($P = 0.002$), and significantly worse baseline ($P < 0.001$) and 2-yr F/U ($P = 0.009$) SRS total scores, despite both groups achieving significant improvements in SRS total scores postoperatively ($p < 0.001$). On logistic regression analysis, FI stratified major complications better than ASA or CCS alone.

Conclusion

In operatively treated ASD patients, $FI \geq 3$ predicted greater complications, higher length of stay and worse self-reported outcomes before and after spinal surgery.

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62. ANALYSIS OF SCOLIRISK-1 PROSPECTIVE MULTICENTER DATABASE COMPARING PERIOPERATIVE COMPLICATIONS AND PATIENT REPORTED OUTCOMES IN PRIMARY VERSUS REVISION SURGERY FOR SEVERE ADULT SPINAL DEFORMITY

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United States

Summary

Our aim was to study the differences in perioperative complications and in patient reported outcomes in patients undergoing primary vs. revision surgery for adult spinal deformity (ASD). We found that patients undergoing revision surgery for ASD experience no significant increase in perioperative neurologic or other major complications compared to primary. Revision patients experienced similar improvements in self-image at 6-month follow-up compared to primary patients, despite of being significantly older.

Hypothesis

There are significantly fewer perioperative complications and better patient reported outcomes in patients undergoing primary vs. revision surgery for adult spinal deformity (ASD).

Design

Retrospective review of prospective ScolioRisk-1 database

Introduction

The aim was to study the effect of history of prior spine surgery on complication and outcomes in ASD patients.

Methods

A multicenter prospective database of severe ASD patients was used to compare patients who underwent primary (N=106) vs. revision (N=167) surgeries with respect to: surgical characteristics, perioperative complications and patient reported outcomes.

Results

Revision patients were significantly older than primary patients (61 vs. 51 years, $P < 0.001$). There were no significant differences in the two groups in operative time, blood loss, or the rate of BMP use. Pedicle subtraction osteotomy was more common in the revisions patients (64% vs. 38% in the primary, $P < 0.001$). Vertebral column resection was more common in primary patients (31% vs. 18% in revision, $P = 0.012$). There were no significant differences in the two groups in perioperative neurologic or other major complications (Table 1). At baseline, revision patients were significantly more debilitated than primary as measured via ODI ($P < 0.001$), and SRS22 function ($P < 0.001$), pain ($P < 0.001$) and self-image domains ($P = 0.002$). Both groups experienced significant improvements in their SRS self-image scores by 6-months follow-up ($P < 0.001$ each).

Conclusion

Patients undergoing revision surgery for ASD experience no significant increase in perioperative neurologic or other major complications compared to primary. Revision patients experienced similar improvements in self-image at 6-month follow-up compared to primary patients, despite of being significantly older.

**While the database is not yet locked, the data presented are subject to minor changes.

Table 1: Perioperative Neurologic and Other Major Complications

	Primary Group N (%)	Revision Group N (%)	P-Value*
Cord Deficit	5 (7.8%)	4 (2.4%)	0.838
Motor Deficit	11 (10.4%)	19 (11.4%)	0.797
Sensory Deficit	8 (7.5%)	18 (10.8%)	0.550
Radicalopathy	3 (2.8%)	8 (4.8%)	0.413
Incontinence	0 (0%)	2 (1.2%)	0.258
Stroke	1 (0%)	2 (1.2%)	1.158
Cardiac Arrest	1 (0%)	0 (0%)	1
Deep Wound Infection	2 (1.9%)	7 (4.2%)	0.700
Deep Vein Thrombosis	3 (2.8%)	7 (4.2%)	0.548
Pulmonary Embolism	1 (0.9%)	2 (1.2%)	0.818
Pneumonia	2 (1.9%)	8 (4.8%)	0.215

*2-tail of propounding was used to calculate P-values. Significance was set at $P < 0.05$.

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63. GERIATRIC RISK IN THE SURGICAL MANAGEMENT OF INFECTIOUS SPONDYLITIS

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Korea

Summary

Clinical outcomes in the surgical management of infectious spondylitis in elderly patients were comparable to those in younger patients. Body mass index (BMI), American Society of Anesthesiologists (ASA) grade, Charlson Comorbidity Index (CCI) scores, and serum albumin levels, rather than age, were significantly associated with clinical outcomes.

Hypothesis

The purpose of this study was to evaluate and compare clinical outcomes in patients over and under 65 years of age who have undergone surgery for infectious spondylitis, and to identify any prognostic factors.

Design

Retrospectively, we reviewed 97 consecutive patients who received surgical treatment for infectious spondylitis. Patients with a previous history of spine surgery or spinal intervention within 1 month were excluded. Among the 60 patients enrolled, 26 were over 65 years of age and 34 were under 65. The minimum follow up period was 1 year, with 86.7% of patients fulfilling this criteria. Primary outcome measures were postoperative complications and control of infection upon follow up.

Introduction

Although elderly patients account for approximately 40% of total patients treated surgically for infectious spondylitis, there are few studies comparing clinical outcomes in elderly and younger patient groups.

Methods

Retrospectively, we reviewed patients' comorbidities, preoperative serum albumin levels, postoperative complications, and control of infection upon follow up.

Results

Postoperative complication rates ($p=0.764$) and infection control rates ($p=0.275$) were not significantly different between the two groups. Univariate analysis did not show correlation between age and clinical outcome, while BMI ($p=0.04$), CCI ($p=0.017$), ASA grade ($p=0.006$), and serum albumin ($p=0.003$) were associated with overall postoperative complications. BMI ($p=0.002$) and CCI ($p=0.000$) were also associated with postoperative fatalities. X^2 test for trend also showed that CCI ($p=0.018$), ASA grade ($p=0.007$), low serum albumin ($<3.5\text{mg/dL}$; $p=0.004$) were associated with postoperative complications. Logistic regression analysis showed that ASA grade ($p=0.034$) and BMI ($p=0.044$) were related to overall postoperative complications. ROC curve analysis using ASA grade and BMI to predict major postoperative complications and fatality showed an area under curve value of 0.793 ($p=0.001$) and 0.942 ($p=0.002$), respectively.

Conclusion

BMI, ASA grade, CCI scores, and serum albumin levels, rather than age, may be useful in predicting clinical outcome in surgery for infectious spondylitis in elderly patients.

64. Redefining Radiographic Thresholds for Junctional Kyphosis Pathologies

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United States

Summary

The incidence of radiographic PJK is reportedly over 40%, but its clinical impact remains uncertain. Analyzing 44 patients revised for proximal junctional pathology, new radiographic thresholds were defined using the angle between UIV and UIV+2 and the listhesis between UIV and UIV+1. In 856 patients, 10% matched this new PJK criteria, whereas 37% matched the old criteria. However, 20% of patients matching the new criteria had to have revisions versus 7% of the old criteria.

Hypothesis

The definition of radiographic PJK is too broad to capture the difference between a failure and a reciprocal change.

Design

Retrospective cohort.

Introduction

While proximal junctional pathologies (PJP) such as kyphosis (PJK) or failure have been reported in over 40% of adult spinal deformity (ASD) corrections, their clinical impact is unclear. This study intends to redefine thresholds and mechanisms of PJP and evaluate its clinical impact.

Methods

The mechanisms of failure in 44 ASD patients who underwent revision for PJP were identified by an orthopedic surgeon and classified as kyphosis or listhesis. The pre-revision junctional angle (UIV to UIV+2), and sagittal listhesis (from UIV to UIV+1) grouped by UIV (T9 and below, T8 and above) were measured as new thresholds of PJP. These thresholds were then applied to a retrospective database of 856 ASD patients. The PJP incidence of kyphosis and/or listhesis vs. the classic PJK definition was investigated as well as the likelihood of a revision surgery.

Results

144 patients were revised for PJP (mean $64.8y \pm 10.9$, 84% F). The mean PJK angle and listhesis were $28 \pm 13^\circ$ and $4 \pm 6\text{mm}$ (with an increase of $21 \pm 14^\circ$ and $4 \pm 6\text{mm}$ from baseline). Patients with $UIV \leq T9$ had less listhesis than those with $UIV \geq T8$ (2 vs. 9mm, $p < 0.0$). The analysis of the 856 patients (58y, 75% F) showed that at 6wk FU, 34.7% met the classic PJK definition, and 8.3% met the new criteria (6% kyphosis, 2.4% listhesis, 1% both). The

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real revision rate for PJP at 6 weeks was 3%. At 1YR FU, 37.9% of the patients met the classic criteria of PJP, while 10.1% met the new one. The real revision rate for PJP at 1 YR was 4.7%. Although the classic criteria identify more patients at 1 YR FU, only 7% of classic criteria patients were revised for PJP vs. 20% with new criteria.

Conclusion

This study expands the objective criteria of proximal junctional pathology, differentiates those criteria based on UIV levels and captures more clinically relevant revisions. 20% of patients matching the new criteria required revision versus 7% with old criteria. The 2 mechanisms of failure identified (junctional angle and listhesis) improved the radiographic definition to make it more clinically impactful.

65. SPINAL IMPLANTS CAN BE INSERTED OR RETAINED IN PATIENTS WITH DEEP SPINE INFECTION – RESULTS FROM A LARGE COHORT STUDY

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Singapore

Summary

We conducted a large, retrospective, cohort study of all patients with deep spine infection managed at a large tertiary hospital over 13 years. There was no significant difference in terms of re-operation or relapse for patients treated with antibiotics alone, antibiotics with debridement, or antibiotics with debridement and instrumentation. However, the in-hospital mortality was lower for patients treated with instrumentation. There was also no significant difference in re-operation, relapse, or mortality in patients treated with or without removal of implants.

Hypothesis

We compared the mortality, re-operation and relapse rates in patients with spine infection treated with antibiotics alone, antibiotics with debridement, or antibiotics with debridement and instrumentation. We also examined the outcomes in patients treated with or without removal of spinal implants.

Design

We conducted a large, retrospective, cohort study of all patients with deep spine infection managed at a large tertiary hospital over 13 years.

Introduction

Conventional practice suggests that implants should not be inserted or retained in patients with deep spine infection. However, there are concerns about spinal stability and a paucity of evidence supporting current practices.

Methods

Clinical and demographic parameters were compared between treatment groups and outcomes were analyzed. A multivariable logistic regression model was used to determine significant predictors of each outcome.

Results

The study included 104 patients with deep spine infections and a minimum follow-up of 2 years. There was no significant difference in terms of re-operation or relapse for patients treated with antibiotics alone, antibiotics with debridement, or antibiotics with debridement and instrumentation. However, the in-hospital mortality was lower for patients treated with instrumentation compared to antibiotics alone (OR 0.826; $p=0.021$), and antibiotics with debridement (OR 0.821; $p=0.013$). Appropriate empirical antibiotics were associated with reduced mortality (OR 0.684; $p=0.001$).

There was no significant difference in re-operation (OR 0.977, $p=0.681$), relapse (OR 0.983, $p=0.901$), or mortality rates (OR 1.021, $p=0.857$), in patients treated with retention of implants compared to those with implants removed. Patients with thoracic spine involvement increases the rates of relapse (OR 1.26; $p=0.001$) and re-operation (OR 1.101; $p=0.002$).

Conclusion

Spinal instrumentation in an infected spine is safe and may be associated with a lower mortality rate. In an infected spine with pre-existing implants, there appears to be no additional benefit in removal of the implants. Large prospective studies should be conducted to validate this observation.

66. SURGERY IN POTT'S DISEASE – EXPERIENCES OF 582 CASES

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Bangladesh

Summary

To evaluate the efficacy and clinical outcome of surgical treatment of spinal tuberculosis treated by different approaches consisting decompression surgery, autogenous bone grafting and anti-TB chemotherapy. Before that a strong evidence based diagnosis must be established which can be done by clinical features, MT test and MRI of spine. Because vertebral body collapse from TB may be misdiagnosed as compression fracture.

Hypothesis

Surgery is always rewarding in Pott's disease.

Design

Prospective study.

Introduction

Tuberculosis of the spine is the most common and dangerous form of TB infection accounting 50 to 60% of osseous tuberculosis. Although uncommon, spinal TB still occurs even in both developed and developing

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countries. The diagnosis of spinal tuberculosis is difficult and it commonly presents at an advanced stage. Delay in establishing diagnosis and management cause spinal cord compression and spinal deformity.

Methods

582 patients with tuberculosis of the cervical, thoracic and lumbar spine with moderate to severe cord compression were studied. Variable degrees of neurological deficit with deformity were treated at NITOR and BSOH, DHAKA in the period from January, 2003 to July, 2014. Thoracotomy along with anterolateral decompression and autogenous strut bone grafting with simultaneous fixation by screws and rods were done in 113 cases. Posterior decompression, posterior interbody and posterolateral fusion by bone graft with stabilization by transpedicular screws and rods were done in rest 469 cases. The later gives 180 degree spinal cord access. Appropriate anti TB drugs were given to all patients for 18-24 months. The follow-up period was 3 months to 10 yrs.

Results

427 (73.4%) cases with neurological deficits recovered totally or partially. 11 (2%) cases were lost from follow-up. X-ray showing bony fusion was achieved in all cases for mean of 6 months (ranging 4-8 months). There was no recurrence. 7 (5.1%) cases developed bed sore postoperatively. Excellent result was seen in 70% cases, Fair 15%, Good 10% & Poor in 5% cases. There was injury to the Dorsal Aorta during implant removal on request of 1 patient & was managed on the OT table with the help of vascular surgeon.

Conclusion

For patients with spinal tuberculosis anterior debridement, auto graft bone fusion, anterior or posterior fixation appears to be effective in arresting disease, correcting kyphotic deformity and maintaining correction until solid spinal fusion.

Age Group	Total No.	Number of patients (n, %)				
		1	2	3	4	5
10-20	11 (1.9%)	4	4	3	0	0
20-30	140 (24.2%)	42	38	35	15	10
30-40	162 (27.9%)	48	45	40	20	15
40-50	145 (25.1%)	45	40	35	20	15
50-60	100 (17.3%)	30	25	20	10	15

*No. of patients were lost from follow up

67. PROSPECTIVE EVALUATION OF RADICULITIS FOLLOWING BMP-2 USE FOR INTERBODY ARTHRODESIS IN SPINE SURGERY

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United States

Summary

In a prospective evaluation of BMP-2 in TLIF, no significant evidence of postoperative radiculitis was observed. BMP-2 improves short term fusion rates and appears to be safe and efficacious for TLIF.

Hypothesis

No difference in postoperative radiculitis after use of BMP-2 in TLIF would be observed.

Design

Non-randomized prospective clinical study.

Introduction

Bone morphogenetic protein (BMP) is being used increasingly as an alternative to iliac crest autograft in spinal arthrodesis. Use of BMP in transforaminal lumbar interbody fusion (TLIF) has raised concerns regarding inflammation or heterotopic ossification occurring near nerve roots leading to postoperative radiculitis. Prospective studies regarding use of BMP in TLIF are lacking.

Methods

From 2009-2013, 77 patients were enrolled. Use of BMP-2 was determined on an individual basis. Demographic and operative characteristics were recorded. Fusion rates were determined by a blinded reviewer and several functional outcomes were collected including visual analog pain scores (VAS), Oswestry Disability Index (ODI), Sciatica Bothersome Index (SBI), and Short Form-36 (SF-36) scores.

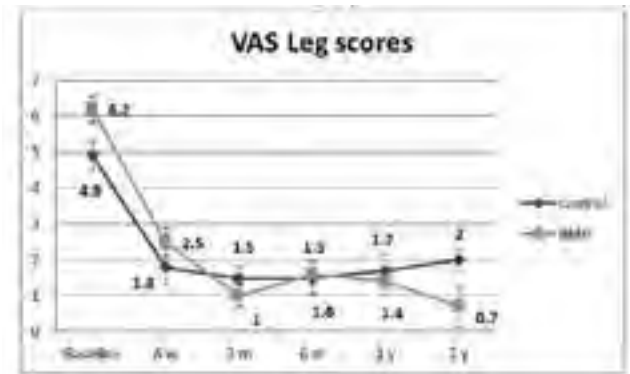
Results

Of the 77 patients enrolled, 29 received BMP and 48 did not. There were no significant differences with regards to age, sex, diabetes, tobacco use, revision surgery, and number of levels. Increased use of allograft spacers (60.4% vs. 3.5%, $p < .001$), iliac crest autograft (41.7% vs. 6.9%, $p = .001$), and blood loss (1035.2 vs. 608.6 cc, $p = .042$) were noted in the control group. There were significant improvements in postoperative leg pain as measured by VAS leg and SBI scores for the entire cohort without clinically significant differences between study groups. Similar improvements were also found in VAS back, ODI, and SF-36 scores for the cohort. A significantly increased six-month fusion rate was noted in the BMP group (82.8% vs. 55.3%, $p = .024$) with no significant difference at 12 months (100% vs. 86.8%, $p = .147$) and 24 months (100% vs. 90.9%, $p = .466$) follow up.

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Conclusion

Use of BMP in TLIF did not lead to significant postoperative radiculitis as measured by VAS leg and SBI scores. BMP did increase short term fusion rates and led to less blood loss. Outcome scores also improved following TLIF with no difference between BMP and control groups. Careful use of BMP in TLIF appears to be both safe and efficacious.



68. INTRAOPERATIVE CARDIOPULMONARY ARREST IN CHILDREN UNDERGOING SPINAL DEFORMITY CORRECTION: CAUSES AND ASSOCIATED FACTORS

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United States

Summary

Spinal deformities in children are associated with abnormalities and comorbidities that can lead to substantial risks during surgery. There are no studies evaluating the incidence of and risk factors for intraoperative cardiopulmonary arrest (CA) in children undergoing spinal fusion for deformity correction. This study reports on the incidence of Intraoperative Cardiopulmonary Arrest in Children Undergoing Spinal Deformity Correction, the Causes and Associated Factors

Hypothesis

Pediatric patient with non-idiopathic scoliosis are at increased risk for cardiopulmonary arrest during spinal deformity surgery

Design

Retrospective Study.

Introduction

Intraoperative cardiopulmonary arrest (CA), defined as an event requiring cardiopulmonary resuscitation (CPR) while in the operating room, is a potentially fatal complication of surgical spinal deformity correction. Increased EBL, proportion of blood volume lost and electrolyte imbalance were associated with increased risk for cardiopulmonary arrest.

Methods

We reviewed records of all pediatric patients (0 - 18 years) who underwent surgery at 2 pediatric tertiary-care hospitals from 2004 through 2014. Univariate logistic regression was used to analyze associations of patient

age, sex, diagnosis, curve size, EBL, body weight, number of vertebral levels fused, and proportion of blood volume lost with risk of CA. (Significance, $P < 0.05$). We classified the proximate causes of CA as volume/electrolyte problems, anaphylaxis, primary rhythm disturbance, or airway problems.

Results

CA occurred in 12 of 2524 (0.5%) patients. Neuromuscular scoliosis patients had a 3.4-fold relative risk of CA compared with non-neuromuscular disorders ($P = 0.025$). At time of CA, hemoglobin 5 g/dL in 4 patients, potassium > 5.5 mEq/L in 6 patients, and ionized calcium < 1 mmol/L in 3 patients. There was a significant difference between the CA and non-CA groups in the mean number of vertebral levels fused (16 vs. 12, $P < 0.01$), patient weight (33 kg vs. 49 kg, $P < 0.01$), mean EBL (3.1 L vs. 1 L, $P < 0.01$), and proportion of blood volume lost (1.5 vs. 0.33, $P < 0.01$). The causes of intraoperative CA were volume/electrolyte (9 patients) and anaphylaxis, primary rhythm disturbance, and airway (1 patient each). 11 of 12 patients were successfully resuscitated, and 1 patient died.

Conclusion

Intraoperative CA occurs in approximately 0.5% of children undergoing spinal fusion surgery. Patients with neuromuscular disorders are at a significantly greater risk of CA. Total blood loss and proportion of blood volume lost, body weight, and number of vertebral levels fused are significant risk factors for CA.

69. POSTOPERATIVE CORONAL MALALIGNMENT IS ASSOCIATED WITH SIGNIFICANTLY POOR PATIENT REPORTED OUTCOMES IN OPERATIVELY TREATED ADULT SPINAL DEFORMITY

Amit Jain, MD; Christopher P. Ames, MD; Virginie Lafage, PhD; Brian James Neuman, MD; Daniel M. Sciubba, MD; Robert A. Hart, MD; Justin K. Scheer, BS; Michael P. Kelly, MD, MS; Shay Bess, MD; Richard Hostin, MD; Christopher I. Shaffrey, MD; Munish Chandra Gupta, MD; Frank J. Schwab, MD; Khaled M. Kebaish, MD; International Spine Study Group

United States

Summary

The aim of our study was to analyze the relationship between coronal malalignment and patient-reported outcomes in operatively treated adult patients with spinal deformity (ASD). We found that operatively treated ASD patients with coronal malalignment postoperatively report poor outcomes.

Hypothesis

Postoperative coronal malalignment leads to worse patient-reported outcomes in operatively treated adult patients with spinal deformity (ASD).

Design

Retrospective review of prospective ASD registry

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Introduction

Positive sagittal malalignment has been shown to be associated with worse patient-reported outcome scores in pain, function, and self-image. The impact of coronal malalignment on patients' quality of life is not well defined.

Methods

Surgical ASD patients with 2-year clinical follow-up were identified. Patients who had postoperative sagittal alignment of ≥ 4 cm were excluded to isolate the effect of coronal malalignment. The remaining 280 patients were divided into 4 groups based on C7 plumbline (C7PL); group 1: pre- and postop C7PL < 4 cm (N=151), group 2: preop C7PL ≥ 4 cm, postop < 4 cm (N=60), group 3: preop and postop C7PL ≥ 4 cm (N=37), and group 4: preop C7PL < 4 cm and postop ≥ 4 cm (N=32). Patient-reported outcomes were compared at the 6-week, 1-year and at 2-year follow-up. Significance was set at $P < 0.05$.

Results

There were no significant differences in the 4 groups in age ($P=0.158$), gender ($P=0.250$), levels fused ($P=0.109$), or in the preoperative ODI ($P=0.350$), PCS ($P=0.175$), SRS-22 total ($P=0.427$) and appearance scores ($P=0.216$), or in the 6-week follow-up ODI ($P=0.70$), PCS ($P=0.916$), SRS-22 total ($P=0.941$) and SRS appearance scores ($P=0.889$). At the 1-year follow-up, there was a significant difference in: ODI ($P=0.022$), PCS ($P=0.032$), SRS total ($P=0.012$) and appearance scores ($P=0.013$). At the 2-year follow-up, there was a significant difference in: ODI ($P=0.036$) and the SRS appearance scores ($P=0.003$). Compared to patients in group 1, group 4 had significantly worse ODI, PCS, and SRS total and appearance scores at both 1- and 2-year follow-up. Patients in group 3 had significantly worse ODI and PCS at the 1-year follow-up, but not at the 2-year follow-up, compared to patients in group 1.

Conclusion

Operatively treated ASD patients with coronal malalignment postoperatively demonstrate poor outcomes. Patients whose coronal alignment was aggravated postoperatively demonstrated worst outcomes.

70. IS DEGENERATIVE SCOLIOSIS A RISK FACTOR FOR ADULT THORACOLUMBAR SPINAL FRACTURES?: A 7000 MULTI-RACIAL ASIAN PATIENTS REVIEW

Gabriel Liu; Jun Hao Tan; Hee Kit Wong, MD

Singapore

Summary

The aim of this study was to investigate if scoliosis is a risk factor for development of spinal fractures. A retrospective cross-sectional study was conducted using spinal images from DEXA scans of individuals aged ≥ 40 years to identify spinal fractures in a multi-racial Asian country. In our study, we found that the fracture rate in Asian adults over 40 years is 3%. Patients with Cobb angle ≥ 30 degrees, Chinese race, osteoporotic and increasing age have a higher risk for thoracolumbar fractures.

Hypothesis

The aim of this study was to investigate if scoliosis is a risk factor for development of spinal fractures.

Design

A retrospective cross-sectional study was conducted using spinal images obtained from DEXA scans of individuals aged 40 years to identify spinal fractures in a multi-racial Asian country.

Introduction

Scoliosis is known to be biomechanically less stable than a straight spine.

Methods

Patients with spinal fractures were divided into with and without scoliosis. Spinal fracture characteristics and location of spinal fracture (at scoliosis apex, upper end vertebra (UEV) and lower end vertebra (LEV) of scoliosis curve) were described. Risk factors for fractures were analyzed using SPSS.

Results

3% (202/7045) patients were identified to have spinal fractures. Average age of patients with fractures was 76 years. 55% were osteoporotic. 88.6% of fractures were found in Chinese patients. The average Cobb angle was 16° (10° - 66°). The most common fracture location was at the thoracolumbar junction (74.3%, 150/202). Fractures were found in 17% (110/645) of scoliotic patients. 30% of the fractures occurred around UEV, 19.4% at apex, and only 4.5% around LEV. Subgroup analysis showed that 66% of fractures occurred at T12 and L1 in scoliotic patients, while 72% of fractures occurred at T12 and L1 in non-scoliotic patients.

In multivariate analysis, scoliosis ($p=0.01$), increasing Cobb angle (10-20o: RR= 4.78, 95%CI: 2.63-8.68, 21-30o: RR=4.95, 95%CI: 1.60-15.27, >30o: RR=6.14, 95%CI: 1.06-35.51), Chinese race (RR=2.64, 95%CI: 1.07-6.55), osteoporosis (RR=1.68, 95%CI: 1.33-2.12) and increasing age (RR=1.12, 95%CI: 1.09-1.15) were identified as statistically significant risk factors for spinal fracture development.

Conclusion

This is the first report to demonstrate degenerative scoliosis as a risk factor for thoracolumbar spinal fractures development. The average fracture rate in Asian adults over 40 years is 3%. Patients with Cobb angle 30o, Chinese race, osteoporotic and increasing age have 6X, 2.6X, 1.7X and 1.1X higher risk for thoracolumbar spinal fractures development.

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71. DEVELOPMENT AND VALIDATION OF A NOVEL ADULT SPINAL DEFORMITY SURGICAL INVASIVENESS SCORE: ANALYSIS OF 464 PATIENTS

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Summary

We developed an adult spine deformity (ASD) invasiveness index which incorporates scores for specific components of ASD surgery, as previous spine indices are not able to account for the additional surgical complexity. The ASD invasiveness index (ASD-R) incorporating surgical and radiographic parameters was a better predictor of surrogates of invasiveness including estimated blood loss (EBL) and operative time (OPT) than an ASD invasiveness index without radiographic parameters (ASD-S); both performed better than a previously published generic spinal invasiveness index (Mirza).

Hypothesis

Including deformity-specific parameters in a surgical invasiveness index better predicts invasiveness in ASD patients compared to a generic spine invasiveness index.

Design

Retrospective review.

Introduction

Surgical invasive indices are useful in predictive modeling and point of care decision making. A published invasiveness index (Mirza) has been validated in general spine procedures but may be limited in grading ASD surgery due to inherent increased complexity. The purpose of this study is to evaluate the Mirza index in ASD surgery and to derive a new system that includes deformity-specific factors.

Methods

464 ASD patients were included (253 development; 211 validation). Multivariable models of EBL and OPT were created using deformity-specific surgical factors (Table 1). Beta coefficients derived from these models were used as guidelines to attribute points to each component. The resultant scoring system (ASD-S) was applied to a validation cohort. Scoring was iteratively refined to optimize the R2 of univariate models of EBL and OPT employing ASD-S as an independent variable. The same method determined weighting of postoperative change in radiograph parameters including SVA, PT and PI-LL which were incorporated into a second index (ASD-R). The ability of Mirza, ASD-S and ASD-R to predict EBL and OPT (adjusted for age, gender, CCI, BMI) was assessed.

Results

Mirza, ASD-S, ASD-R were significant independent predictors of EBL and OPT ($p < 0.001$). Multivariate analysis demonstrated that ASD-S and ASD-R explained more variability (higher R2) in EBL and OPT than did

Mirza (Table 1). The addition of postoperative change in radiographic parameters to the scoring system, ASD-R, explained 34% of the variation in EBL and 34% variation in OPT while Mirza only explained 22% and 18%, respectively.

Conclusion

Compared to the generic Mirza, the newly derived ASD-R which includes deformity-specific surgical factors leads to improved prediction of surrogates of surgical invasiveness including EBL and OR time.

Parameter in ASD-S	Points for each Variable Body Involvement	Parameter in ASD-R	Points for each Surgical Factor	R ² EBL	ASD-S	ASD-R
Pedicle	1	OP	1	0.22	0.21	0.34
Transpedicular	1	TLIF	2	0.22	0.21	0.34
Interpedicular	1	Alar-iliac	2	0.22	0.21	0.34
Transverse	1	System	1	0.22	0.21	0.34

72. BIOMECHANICAL EVALUATION OF LONG POSTERIOR SPINAL FUSION CONSTRUCTS WITH S2AI FIXATION

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Summary

The biomechanical performance of long posterior fusion constructs was assessed comparing L5/S1 support with axial interbody fusion (AIF), TLIF and S2 alar-iliac (S2AI) screws, +/- crosslinks and measuring L5/S1 ROM and rod strain and S1 screw strain. S2AI constructs were stiffer than other constructs and provided greater offloading of S1 screws, especially in lateral bending and axial torsion. Crosslinks improved performance in axial torsion.

Hypothesis

S2AI screws improve stiffness across L5/S1 and offload S1 screws in long posterior constructs, compared with pedicle screws alone and with TLIF or AIF.

Design

Cadaveric biomechanical analysis

Introduction

S1 screw failure and L5/S1 non-union are issues with long fusions to S1. Improved construct stiffness and S1 screw offloading can help avoid this. S2AI screws have been shown to provide similar stiffness to iliac screws when added to L3-S1 constructs. Comparison with L5/S1 interbody support, and analysis of S2AI effect on rod and S1 screw strain, have not previously been performed.

Methods

Two S1 screws and one rod with strain gages (at L5/S1) were used in L2-S1 screw-rod constructs in 7 L1-pelvis specimens (two with low BMD). ROM, S1 screw and rod strain were assessed using a pure-moment flexibility testing protocol. Specimens were tested intact and then in five instrumentation states consisting of 1) Pedicle Screws (PS) L2-S1, 2) PS + S2AI, 3) PS + TLIF, 4) PS + AIF, 5) PS + AIF + S2AI. The five instrumentation conditions were also tested with crosslinks at L2/3 and S1/2.

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Tests were conducted in flexion-extension, lateral bending and axial torsion with no compressive preload. Motion was tracked using a non-contact camera-based motion measurement system with simultaneous acquisition of strain data.

Results

ROM:

Flexion/extension: all stiffer than PS; S2AI, TLIF and AIF equivalent; combined S2AI/AIF stiffest.

Lateral bending: S2AI stiffer than all others.

Axial torsion: crosslinks greatest effect, some effect from S2AI.

Strain:

S1 offloading greatest with S2AI and AIF in flexion/extension.

Lateral bending: S2AI only construct that offloaded S1 screws.

Axial torsion: greatest offloading with crosslink and with S2AI.

Rod strain in flexion increased at L5/S1 with S2AI screws compared to other constructs.

Conclusion

S2AI screws provide improved stiffness and S1 screw offloading in all planes compared with constructs without S2AI screws. Adding crosslinks affects axial torsion stiffness.

Addition of S2AI screws to a long posterior construct increases stiffness and offloads S1 screws compared with constructs without S2AI screws +/- interbody support.



73. HARRINGTON REVISION SURGERY IN ADULTHOOD: LONG-TERM OUTCOMES

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Summary

Harrington operations lead to Flatback and distal adjacent segment disease. No previous outcome studies reported Harrington revision surgery (HRS) results using a 3rd generation fixation technique. A review of 36 patients

who underwent staged posterior-anterior HRS procedure with 7 years follow-up (FU) underlined the characteristics of the revision procedure, the significative postoperative improvement of quality of life scores, with minor complications.

Hypothesis

To assess long-term results, characteristics, functional outcome and complications of Harrington revision surgery in adulthood.

Design

Retrospective clinical and radiographic review of 36 patients with Harrington rod fusion undergoing Harrington revision surgery (HRS) with a minimum of 2-years follow-up (FU).

Introduction

Although the rate of spinal fusion to the sacrum in adult scoliosis has been reported, there have been no outcome studies of Harrington revision surgery using a modern segmental fixation technique.

Methods

A review of 36 patients (3 male, 33 female; mean age 52.5 ± 7 years) who underwent a staged posterior-anterior HRS in a single institution. Mean FU was 7.25 ± 4 years. The indication for surgery was Flatback and/or symptomatic distal adjacent segment disease. In all cases, after rod and hook removal, posterior extension of spinal fusion to the sacrum, bridging the fusion mass (FM) up to the newly instrumented proximal fused level, was combined to a staged anterior column support procedure. There were 7 primary pedicle subtraction osteotomies (PSO), and 29 posterior column osteotomies (PCO) including FM osteotomies. Seven secondary PSOs were performed for residual or progressive sagittal imbalance. Preoperative and last FU Oswestry (ODI) score, SRS-30 and SF-12 questionnaire values were analyzed by a paired t test

Results

HRS led to a significant decrease in ODI score, from $39.8 \pm 12.7\%$ preoperatively to $29.8 \pm 17.8\%$ at last FU ($p=0.005$). There was likewise improvement in SRS-30 (2.7 ± 0.7 to 3.7 ± 0.7 ; $p < 0.0001$) and the physical (32.8 ± 6.3 to 39 ± 10.6 ; $p=0.0005$) and mental (38.1 ± 11.8 to 43.6 ± 11.9 ; $p=0.057$) components of the SF-12 quality of life score. Despite 2 revision surgeries for distal implant failure and 1 for rod breakage in the first year of FU, all patients achieved solid fusion radiographically at last FU. There were 3 deep wound infections and 3 regressive radicular deficits

Conclusion

Combined posterior-anterior extension of spinal fusion to the sacrum appeared to be a safe and effective Harrington rod fusion revision procedure for flatback syndrome and all resultant residual or progressive spinal deformity issues.

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74. CLINICAL AND RADIOGRAPHIC PARAMETERS ASSOCIATED WITH BEST VS. WORST CLINICAL OUTCOMES IN MINIMALLY INVASIVE DEFORMITY SURGERY

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United States

Summary

This is a retrospective analysis of 104 patients who underwent cMIS deformity surgery and compared those who had the best and worst clinical results (as measured by ODI). While patients between the two groups did not differ preoperatively, we found that patients who did worst after surgery were the ones who had inadequate correction in their PI-LL mismatch and SVA.

Hypothesis

Patients with the best clinical outcomes after circumferential MIS (cMIS) deformity surgery have postoperative SVA < 5 cm and PI-LL matched within 10°, whereas those who do the worst have continued PI-LL mismatch and sagittal imbalance regardless of decompression of their stenosis.

Design

Multi-center retrospective review of MIS deformity cases.

Introduction

MIS deformity techniques have limited ability to restore sagittal balance and match the PI-LL. However, MIS techniques are effective for decompression and limit tissue disruption. This study compares best vs. worst outcomes after MIS surgery to identify variables that predispose postoperative success.

Methods

Retrospective study of a multi-center database with adult spinal deformity (Cobb>20°, SVA>5cm, PT>20, PI-LL>10, or Thoracic Kyphosis >60°) patients treated with cMIS. Radiographic and clinical outcomes were compared between "Best" and "Worst" patients. Best was defined as the top 20% improvement in ODI at 2 years from baseline, and Worst was defined as bottom 20%.

Results

426 patients were identified, 104 patients were included with 2 year data. There were no significant differences in age, BMI, pre- and postop Cobb angle, PT, PI, levels fused, O.R. time, and blood loss between the Best and Worst Groups. However, the preop ODI was significantly worse at baseline in the group that had the greatest change in ODI. There was no difference in preop PI-LL mismatch (12.8° Best vs. 19.5° Worst, p=0.298). Compared to patients who did Worst, patients who did Best after MIS fusion had lower postop SVA (3.4 cm Best vs. 6.9 cm Worst, p=0.043) and had matched PI-LL (10° Best vs. 19° Worst, p=0.027). The Best Group also had better postop VAS back and leg pain scores (p<0.05).

Conclusion

MIS deformity surgeons should focus on correcting a patient's PI-LL mismatch to within 10° and restoring SVA < 5cm. Restoration of these parameters seems to impact which patients will achieve the greatest degree of improvement in ODI outcomes, while patients who do worst are not appropriately corrected (fused into a fixed deformity), and were significantly worse clinically at postop.

		BEST (n=22)	WORST (n=21)	p-value
	Age (years)	64	63.1	0.918
	BMI	28.8	29.9	0.318
	OR time (minutes)	419.5	413.3	0.396
	Blood loss (cc)	494.2	511.2	0.251
	Levels fused	3.7	3.8	0.733
Pre-op	Cobb angle (degrees)	33.5	37	0.506
	PT (degrees)	22.8	27.8	0.244
	PI (degrees)	30.8	37.4	0.001
	LL (degrees)	37.1	37.9	0.47
	PI-LL (degrees)	12.8	18.5	0.298
	SVA (cm)	3.25	5.3	0.007
	ODI	58.2	69.7	<0.001
	VAS back pain	8.7	6.8	0.001
Post-op	Cobb angle (degrees)	21.9	21.2	0.931
	PT (degrees)	22.8	27.8	0.001
	PI (degrees)	31	37.4	0.001
	LL (degrees)	40.8	38	0.313
	PI-LL (degrees)	10.8	19.4	0.027
	SVA (cm)	3.4	6.9	0.043
	ODI	11.9	38.4	<0.001
	VAS back pain	7	4.8	0.001
VAS leg pain	7.27	5.5	0.006	

75. DEDICATED SURGICAL MEASUREMENT SOFTWARE (SMS) HELPS OBTAIN SAGITTAL AND PELVIC PARAMETERS MORE RELIABLY THAN PACS

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Summary

Accurate radiographic measurement of sagittal alignment is not only essential for evaluating adult spinal deformity but also for planning its treatment. Traditional PACS systems provide limited measurement capabilities. Measurements of spino-pelvic parameters are significantly more reliable in SMS (ICC: 0.810-0.996) vs. PACS (ICC 0.647-0.990) with significantly less variation across users. The superior reliability of SMS vs. PACS is augmented when compared exclusively among surgeons, demonstrating the clinical utility of dedicated, spine-specific software.

Hypothesis

Dedicated surgical measurement software (SMS) is more accurate and reliable than traditional picture archiving and communication systems (PACS) measurements.

Design

Comparison of radiograph measurement reliability between PACS and SMS.

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Introduction

Accurate radiographic measurement of sagittal alignment is essential for evaluating adult spinal deformity (ASD). PACS measurements often necessitate rudimentary techniques and estimations of anatomic landmarks and angles. Though SMS has been studied and validated, there are no direct comparisons PACS to SMS.

Methods

Eleven independent observers (7 surgeons, 4 researchers) digitally measured 20 ASD radiographs for pelvic incidence (PI), pelvic tilt (PT), lumbar lordosis (LL), PI-LL, thoracic kyphosis (TK), and sagittal vertical axis (SVA). Round 1 used PACS basic line/angle tools; Round 2 used a validated SMS that automatically calculates spino-pelvic parameters from 6 user-identified landmarks. Means, coefficient of variance (CV) and intra-class correlation coefficients (ICC) were analyzed.

Results

PACS measurements were significantly inflated compared to SMS (PI, PT, PI-LL: $P < 0.0001$) (Table). Excluding TK, the variations in measurement (CV) were significantly greater for PACS (14-34%) vs. SMS (11-23%). Reliability was greater in SMS than PACS for PI, PT, PI-LL, LL, and SVA. The greatest differences in ICC between PACS and SMS were in PI (PACS: 0.647; SMS: 0.810) and PI-LL (PACS: 0.921; SMS: 0.970). In surgeons only, the differences between PACS and SMS were greater, and SMS had higher ICC than PACS for all parameters (mean ICC 0.931 vs 0.861). Among surgeons, PI had the lowest reliability (PACS: 0.505; SMS: 0.752) and SVA had the highest (PACS: 0.985; SMS: 0.994).

Conclusion

SMS provides significantly more reliable measurements than PACS, especially among surgeons. Consistent use of SMS in the evaluation and surgical planning of ASD patients would be advantageous given the significant differences in values, variance, and reliability between PACS and SMS.

Parameter	PI	PT	PI-LL	LL	TK	SVA
PACS Mean	61.3	28.4	18.7	40.8	47.8	67.8
SMS Mean	58.5	28.3	18.4	40.1	44.0	67.7
P (mean)	<0.0001	<0.0001	<0.0001	0.228	0.328	0.478
PACS Mean SD	8.1	3.8	3.8	7.8	7.2	8.1
SMS Mean SD	8.0	2.1	3.8	3.1	6.7	8.0
P (standard deviation)	<0.0001	<0.0001	<0.0001	0.412	0.489	<0.0001
PACS CV	14%	17%	34%	24%	34%	23%
SMS CV	13%	11%	23%	21%	31%	23%
P (CV)	0.0002	<0.0001	0.0002	0.381	0.0010	0.413
PACS ICC	0.647	0.801	0.921	0.931	0.935	0.985
SMS ICC	0.810	0.807	0.970	0.942	0.940	0.994
PACS ICC (surgeons)	0.505	0.811	0.891	0.922	0.947	0.991
SMS ICC (surgeons)	0.752	0.875	0.977	0.958	0.951	0.994

Table Comparison of radiographic parameters, variance, and ICC between PACS and SMS

76. A NEW ANTEROLATERAL RETROPERITONEAL APPROACH FOR LUMBAR INTERBODY FUSION FROM L1 TO S1:

A Prospective Series with Clinical Outcomes

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Summary

We describe a novel anterolateral retroperitoneal approach, which is safe and reproducible to access the disc spaces from L1 to S1 inclusive, obviating the need for a separate direct anterior approach to L5/S1.

Hypothesis

To report a novel lateral psoas-preserving surgical approach to the lumbar spine, avoiding the approach related complications of the traditional lateral transpsoas approach and allowing access to L5/S1, and to evaluate clinical and radiologic outcomes from use of this alternative surgical technique in a prospective series of L1 to S1 anterior lumbar interbody fusions.

Design

A prospective series of patients (n=44).

Introduction

A variety of different surgical approaches have been utilized for cage insertion in lumbar interbody fusion surgery. A direct anterior (transperitoneal or retroperitoneal) approach facilitates access to L5/S1, however, access to the adjacent lumbar disc spaces requires mobilization of the great vessels. The lateral transpsoas approach is useful for accessing L1 to L5, with the L4/L5 level being most difficult and L5/S1 being inaccessible.

Methods

Data collected included surgical blood loss, perioperative complications and need for secondary/revision procedures. Preoperative and postoperative radiologic parameters and clinical outcome measures were assessed.

Results

Mean blood loss was <200 mls from this anterolateral approach. There were no permanent neurological, vascular or visceral injuries. One revision procedure was required on a patient with rheumatoid arthritis and advanced systemic disease that sustained a sacral fracture and required revision ALIF (anterior lumbar interbody fusion) at L5/S1. Mean VAS back pain score improved from 8.4 ± 1.25 preoperatively to 1.4 ± 0.2 at 2 years. Mean VAS leg pain score improved from 5.8 ± 3.8 preoperatively to 1.8 ± 0.9 at 2 years. Mean ODI score improved from 64.3 ± 31.8 preoperatively to 12.4 ± 11.8 at 2-year follow-up.

Conclusion

The technique described is a safe, muscle-splitting, psoas-preserving, one-incision approach to provide access from L1-S1 for multilevel anterior or oblique lumbar interbody fusion surgery. This operative approach minimizes the need to mobilize the great vessels.



77. LARGER GLOBAL SAGITTAL CORRECTION WITH PEDICLE SUBTRACTION OSTEOTOMY IS ASSOCIATED WITH INCREASED PJK AND MAJOR COMPLICATIONS, BUT BETTER CORRECTION AND HRQL SCORES

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Canada

Summary

The importance of restoring sagittal alignment in adult spinal deformity (ASD) has been established, leading to larger corrections in the sagittal plane. This study examined the impact of magnitude of correction in patients undergoing Pedicle Subtraction Osteotomy, and found that larger global sagittal correction, as measured by the T1 Pelvic angle (TPA), lead to increased major complications and Proximal Junctional Kyphosis (PJK). However despite this, these patients also had improved post-operative alignment and improved HRQL.

Hypothesis

Larger sagittal correction leads to better alignment but is associated with increased complications.

Design

Retrospective analysis of a multicenter database.

Introduction

In recent years, emphasis has been placed on restoring sagittal alignment when performing adult spinal deformity (ASD) surgery. This study examines the impact of the magnitude of sagittal correction on complications and health related quality of life outcomes (HRQL) in ASD patients.

Methods

Retrospective review of a multicenter database of surgical ASD patients undergoing PSO. Patients with severe sagittal deformity (SVA>9.5, PI>20, PI-LL>10) who reached 1-year follow up were included. Magnitude of correction was assessed using the T1-pelvic angle (TPA). Outcomes included complications (major, intra&postop,

blood loss>4L, PJK), unplanned return to the OR, postop alignment, and 1-year HRQL. Multivariate linear, logistic and poisson regression was performed, adjusting for age, gender, BMI, revision surgery, and curve types.

Results

184 patients met inclusion criteria. HRQL measures were available on 96 patients. Larger TPA correction was associated with increased major complications (IRR 1.32 per 10°, p=0.002), increased post-operative complications (IRR 1.31 per 10°, p=0.024), increased PJK rates (OR 1.57 per 10°, p=0.025), and more frequent unplanned return to the OR (OR 1.91 per 10°, p=0.037). Larger TPA correction did not impact intra-operative complications, revision due to PJK, or EBL>4L. Angular correction though the PSO did not correlate with complications. Larger TPA correction led to better postop sagittal alignment (SVA coef 18.22 p<0.001, PI-LL coef 4.62 p=0.001, PT coef 3.74 p=0.0001), and better improvement on the SRS22r (coef 0.4 p=0.0001).

Conclusion

In ASD patients with severe sagittal deformity, larger corrections lead to better post-operative alignment and greater improvement in SRS22r scores. However, this came at the cost of increased major complications, post-operative complications, and increased incidence of radiographic PJK. Revision rate due to PJK was not influenced by the magnitude of sagittal correction.

78. DEFINING NORMATIVE QUALITY METRICS IN COMPLEX HIGH-RISK DEFORMITY CASES: RESULTS FROM THE SCOLI-RISK 1 STUDY

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Summary

Quality metrics are important for comparative research. Normative standards for quality metrics are not established for complex deformity surgery in adults. Analysis of an international, multi-center, prospective, longitudinal, observational cohort (Scoli-Risk1) demonstrates that readmission rates are 16.5% and reoperation rates are 20.1% at 6 months after index surgery discharge. There is evidence that age is significantly associated with higher readmission rates, but not with the need for reoperation. Osteotomy type is not related to readmission or to reoperation rates.

Hypothesis

Readmissions and reoperations in complex spinal reconstruction are unaffected by age or procedure type.

Design

Secondary analysis of a prospective, multi-center, observational study.

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Introduction

Quality metrics are a component of the value calculation, and reflect the risk of care. The purpose of this study is to define normative quality metrics for complex, high-risk spinal deformity cases, and to provide a standard and baseline data that may guide quality improvement in comparative research.

Methods

Secondary analysis of a prospective, international, multicenter, observational study. The study cohort includes adults with spinal deformity in the cervicothoracic or thoracolumbar regions. Quality metrics include readmission and reoperation rates, wound infection, and Deep Venous Thrombosis rates. Logistic regression was used to determine the association of age and procedure type with readmission and reoperation.

Results

273 patients were included in the analysis. Cumulative readmission rates were 7.7, 13.2, 16.5% at 30, 90 and 180 days after discharge from index surgery. Reoperation rates were 14.7, 17.6, 20.1% at 30, 90 and 180 days. Age was found to be significantly associated with readmission during the first 180 days after surgery (OR per decade increased 1.39 (1.07;1.80)), whereas there was no significant association between age and reoperation (OR=1.11 (0.90;1.36)). Osteotomy type (PSO/VCR vs SPO) was not significantly related to the need for readmission (p=0.986) or reoperation (p=0.753). The overall infection rate was 7.0%. The rate of DVT was 3.7%.

Conclusion

Normative quality metrics are not established for complex deformity surgery in adult patients. This paper demonstrates that readmissions and reoperations in complex spinal reconstruction in adults occur at a higher rate than expected rates in less complex spine procedures. There is evidence that increasing age is significantly associated with higher readmission rate, but not with the need for reoperation. This data may provide normative data for comparative studies of surgical outcomes with similar magnitude of deformity treated with operations of comparable invasiveness.

Pathology	Readmission (N, %)	Reoperation (N, %)
Neural Injury		
Nerve Root	1 (0.4%)	9 (3.3%)
Spinal Cord	1 (0.4%)	1 (0.4%)
Wound Complication		
Deep Wound Infection	8 (3.0%)	11 (4.1%)
Superficial Wound Infection	2 (0.7%)	2 (0.7%)
Hematomas	0	13 (4.8%)
Distal Limb Complication		
Surgical Infection	1 (0.4%)	23 (8.4%)
Adverse Systemic Pathology	9 (3.3%)	11 (4.1%)
Unintentional Complications	25 (9.2%)	11 (4.1%)
Primary Complication		
Cardiovascular	22 (8.1%)	7 (2.6%)
Respiratory or Renal Dysfunction	1 (0.4%)	26 (9.5%)
Pain	1 (0.4%)	

79. THE INCIDENCE AND PREDICTORS OF EARLY MORBIDITY AND MORTALITY IN ADULTS UNDERGOING ELECTIVE FUSION FOR SPINAL DEFORMITY

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Summary

The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database was used to determine the incidence and risk factors for 30-day morbidity and mortality after adult spinal deformity surgery. Several clinical and patient variables were found to be predictive of morbidity. Such information may improve surgical planning strategies and reduce postoperative complications in adults.

Hypothesis

We hypothesized that the incidence of 30-day postoperative complications will be low but associated with patient and surgical factors.

Design

Retrospective cohort analysis using a prospectively collected database.

Introduction

Prior studies have investigated potential risk factors related to complications following spinal surgery, but few have utilized a large-scale, multi-institutional database. The predictors for morbidity and mortality of this study population have not been well quantified.

Methods

The ACS NSQIP database is a multi-center registry that prospectively collects data, including morbidity and mortality within 30 days of surgery. Current Procedural Terminology codes were used to query the database for adults who underwent fusion for spinal deformity 2005-2012. Univariate and multivariate analyses were performed.

Results

4,793 patients were included. The rate of 30-day complication was 24.8%. This included a mortality rate of 0.4%, morbidity of 22.8%, unplanned readmission rate of 4.8%, unplanned reoperation rate of 2.9%, and extended hospital stay of 0.4%. While primary and revision anterior fusions were associated with lower morbidity rates (<0.0001), combined approaches, posterior fusion, osteotomy, and fusion to pelvis were significantly associated with higher complication risk (<0.0001). Independent risk factors for morbidity included low hematocrit, high total RVU, extended operative time, prolonged length of stay, and primary posterior fusion.

Conclusion

The 30-day incidence for complication was 24.8%. Preoperative and intraoperative variables were predictive of morbidity. These data may assist in developing future quality improvement activities and saving costs through measurable improvement in patient safety.

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Frequency of Complications in Adults Undergoing Extensive Spinal Deformity Surgery (1000 Cases = 4,750)			
Complication	Number	Rate	
Deep Postoperative Wound Dehiscence	118	24.8%	
Manometry	19	0.4%	
Respiratory Infection (N=2432)	136	5.6%	
Septicemia (N=2432)	30	1.2%	
Return to OR	113	2.4%	
Urinary Tract Infection (within 30 days)	17	0.4%	
Mortality	1291	27.2%	
Postoperative Pain (N=1000)	102	2.1%	
Septic Shock	33	0.7%	
Deep Infection (N=1000)	271	27.1%	
Brain Injury (N=1000)	11	0.1%	
Wound Dehiscence	11	0.1%	
Paralysis	44	0.9%	
Urinary Incontinence	26	0.5%	
Postoperative Infection	39	0.8%	
Intubation > 48 hours	32	0.7%	
Postoperative Blood Transfusion	4	0.1%	
Acute Renal Failure	1	0.0%	
Urinary Tract Infection	89	1.9%	
Stroke (NVA) Intraoperative	12	0.3%	
Postoperative Stroke	21	0.4%	
Cardiac Arrest Postoperative (N=1000)	10	0.1%	
Mortality (N=1000)	14	0.1%	
Intubation > 48 hours	345	7.3%	
Acute Postoperative Pain (N=1000)	1	0.0%	
IVC Thrombocytopenia	41	0.9%	
Stroke (N=1000)	39	0.8%	
Stroke (N=1000)	11	0.2%	

Independent Risk Factors for Mortality as Identified by Multivariate Logistic Regression			
Variable	Adjusted OR	95% CI	P Value
Preoperative Hemorrhage	0.5	0.3 - 0.9	<0.001
Total FVU	1.1	1.0 - 1.1	<0.001
Operative Time > 4 hours	0.3	0.2 - 0.4	<0.001
LOS > 3 days	0.4	0.3 - 0.5	<0.001
Primary Posterior Fusion	0.3	0.2 - 0.4	<0.001

Independent Risk Factors for Mortality as Identified by Multivariate Logistic Regression			
Variable	Adjusted OR	95% CI	P Value
Preoperative Hemorrhage	0.2	0.1 - 0.4	0.001
Preoperative PFI	1.1	1.0 - 1.2	0.012
LOS > 3 days	0.4	0.3 - 0.5	0.001
Posterior Vertebral Fusion	0.3	0.2 - 0.4	0.001
Preoperative Injury	0.3	0.2 - 0.4	0.001
Stroke (N=1000)	0.1	0.0 - 0.1	0.001

80. COMPLEX RECONSTRUCTION FOR PERSISTENT PSEUDOARTHROSIS AND CORONAL IMBALANCE IN AN ADULT PREVIOUS TREATED WITH HARRINGTON ROD INSTRUMENTATION AND MULTIPLE REVISION SURGERIES.

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United States

Summary

Correction of coronal imbalance in a previously fused spine can be challenging. We report the case of a 57-year-old female with Harrington rod fusion performed as a teenager, who presented with pain and radiculopathy and substantial coronal deformity forty years after the index procedure and multiple revision attempts involving fusion to the sacrum. Two-stage revision surgery was performed to restore sagittal and coronal alignment, as well as function after surgery.

Hypothesis

Careful preoperative planning, while extending the fusion to the sacrum, is crucial to avoid inducing coronal malalignment in a patient with a previously fused thoracic or thoracolumbar spine.

Design

We report on a single case, with clinical and radiographic follow-up.

Introduction

A 57-year-old female judge presented to us with the sensation of leaning to her right, pain, and significant limitations of function. She had undergone posterior spinal fusion T6 to L2 with Harrington instrumentation for correction of scoliosis, with multiple ensuing surgeries including removal of Harrington rods, and revision fusion to the sacrum. Radiographs demonstrated a residual 58 degree left thoracolumbar curve T6 to L4, a 6 cm coronal malalignment, and positive SVA of 3.2 cm. CT confirmed a nonunion at the L5-S1 segment.

Methods

Instrumentation from L1-sacrum was removed and the patient underwent posterior spinal fusion from T8 to sacrum with Ponte osteotomies at L4-L5 and L5-S1, and an asymmetric pedicle subtraction osteotomy performed at T12 utilizing a lateral extracavitary technique. Six weeks later, an L5-S1 anterior discectomy was performed via a retroperitoneal approach with femoral allograft utilized as graft for the L5-S1 space.

Results

By one and six months post-operatively, she had resolution of her preoperative pain and symptoms. Good global spinal alignment was regained with no evidence of instrumentation failure or junctional problems.

Conclusion

Patients with complex deformities and a history of multiple revision procedures may be challenging. Close attention should be paid with extension of a prior thoracic or thoracolumbar fusion so as not to induce coronal malalignment requiring complex fusion.



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81. PREDICTORS OF LENGTH OF HOSPITAL STAY AND 30-DAY READMISSION IN ADULT SPINAL DEFORMITY SURGICAL PATIENTS: AN ANALYSIS OF 963 PATIENTS USING THE AMERICAN COLLEGE OF SURGEONS DATABASE

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United States

Summary

Adult spinal deformity (ASD) surgery is associated with a high rate of complications which may require reoperation. Increased scrutiny is being placed on length of hospital stay (LOS), readmission, and reoperation. Efforts to optimize surgical outcomes with respect to these variables are highly warranted. This study was a retrospective review of ASD patients in the American College of Surgeons (ACS) database. This study identified risk factors for increased LOS, readmission, and reoperation for ASD patients who underwent corrective surgery.

Hypothesis

Certain operative variables will be associated with and predict LOS, readmission, and reoperation in ASD surgical patients.

Design

Retrospective review of a prospective database.

Introduction

ASD surgery can relieve pain and improve function, but complications may occur. This study aimed to identify risk factors for increased LOS and readmission in ASD surgical patients.

Methods

Inclusion criteria were ASD surgical patients between 2010 and 2012. Demographic and operative variables were collected for patients with normal LOS (<8 days) and extended LOS (≥8 days) and with readmission data in the ACS NSQIP database. Readmitted patients who underwent reoperations were sub-analyzed. Univariate and multivariate regression analyses identified predictors.

Results

963 ASD patients were identified (mean age 57.3, BMI 27.5 kg/m², 69.7% female). Average overall LOS was 6.95 days (range: 0-64 days); mean LOS for normal and extended LOS groups were 4.11 and 12.93 days, respectively. Univariate analysis associated extended LOS with older age (p=0.010), higher ASA class (p<0.001), ASA class≥3 (p<0.001), hypertension (p=0.028), pulmonary comorbidities (p=0.028), and op time≥426 minutes (p<0.001). Multivariate analysis identified independent predictors of extended LOS: major prior op within 30 days of index (OR 5.45, p<0.001) op time (OR 1.005 per 1 min increase, p<0.001), pre-op transfusion use (OR 5.73, p=0.005) and number of bleeding transfusions (OR 2.77, p<0.001). 2.6% of patients were readmitted. Multivariate analysis identified infections (OR 8.76 p<0.001) and

intra-op bleeding transfusions (OR 3.61, p=0.024) as readmission predictors. Readmitted patients requiring reoperations had higher incidence of an operation within 30 days prior to index surgery (p<0.05).

Conclusion

Surgical risk factors for extended LOS were increased op time and pre- and intra-op transfusions. Surgical risk factors for readmission were infections and intra-op transfusions. Baseline factors, such as history of a major operation within 30 days prior to index ASD surgery, increased odds for extended LOS and reoperation.

82. DEFINING THE ROLE OF LOWER LIMBS IN COMPENSATING FOR SAGITTAL MALALIGNMENT

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United States

Summary

The role of the lower limbs in sagittal deformity surgical planning is not well understood. This study evaluated 2,124 full body xrays of patients presenting to a single spine center. The antero-posterior translation of the pelvis permits T9 to remain in line with the ankles, independent of Sagittal Vertical Axis (SVA) values. Lower limb compensatory mechanisms also permit an increase in recruitment of PT and therefore do not need additional consideration in the setting of surgical planning.

Hypothesis

The role of lower limbs is to permit larger recruitment of pelvic tilt (PT) and counteract anterior sagittal malalignment by maintaining center of gravity above ankles.

Design

Retrospective review.

Introduction

While lower limbs compensatory mechanisms are an established response to progressive sagittal malalignment, their specific role and impact on surgical planning has not been evaluated. This study evaluates ability of knee flexion (KF) and pelvic shift (P.shift) to counteract high SVA and defines the relationship between lower limb compensatory apparatus and PT.

Methods

Single center retrospective review of full body xrays was performed in patients (pts) >20 yrs. Parameters were measured with dedicated software. Population was stratified by 50mm intervals of SVA and one-way ANOVA was performed to compare P.shift. (P.Shift=antero-posterior translation of the pelvis versus the feet) across SVA groups. Antero-posterior offset of each vertebra versus vertical line erected from distal tibial metaphysis

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(TM) was investigated. Linear regression was performed to predict PT using KF and P.Shift while controlling for pelvic incidence minus lumbar lordosis mismatch (PI-LL) and SVA.

Results

2124 pt visits were included (PI $55.1 \pm 14.1^\circ$, PT: $21.0 \pm 11^\circ$, PI-LL: $6.3 \pm 17.3^\circ$, SVA: 29 ± 51 mm). With progressively increased SVA, P.shift decreased from 30 to -100mm (all $p < 0.005$). Analysis of vertebrae offsets from the distal tibial metaphysis revealed that T9 was aligned with TM line across all SVA groups. (Fig) Prediction of PT based on PI-LL and SVA yielded $R^2 = 0.76$ ($p < 0.001$); addition of KA and P.shift as independent parameters using hierarchical multiple regression led to significant improvement in R^2 , demonstrating the independent role of lower limbs parameters in PT prediction. KA and P.shift had a positive standardized coefficient (all $p < 0.05$).

Conclusion

Lower limb compensatory mechanisms increase with progressive sagittal malalignment. Antero-posterior translation of pelvis allows T9 vertebra to remain in line with the ankle ("conus of economy"). Lower limb compensatory mechanisms are positive predictors of PT and do not need additional consideration for surgical realignment planning.

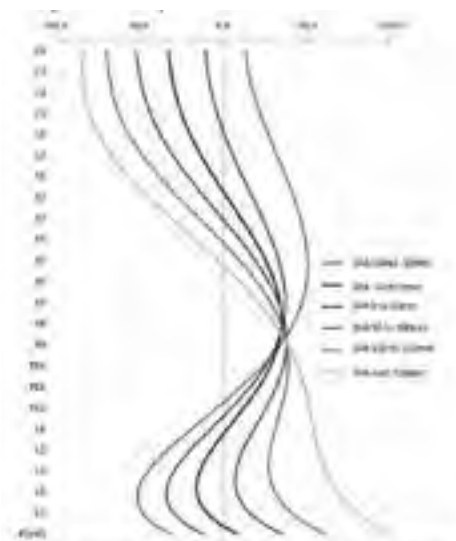


Figure 1: Antero-posterior vertebra specific offset from distal tibial metaphysis among anterior malalignment progression groups

83. THE IMPACT OF RESIDENT INVOLVEMENT ON POSTOPERATIVE COMPLICATIONS FOLLOWING ADULT DEFORMITY SURGERY (ADS)

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United States

Summary

A retrospective analysis of the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) found that resident involvement was associated with an increased rate of complications, longer operative time, and longer length of stay (LOS) following ADS.

Hypothesis

Resident involvement would be a significant risk factor for complications in patients following ADS.

Design

Retrospective analysis of prospectively collected data.

Introduction

The literature has shown conflicting reports with regard to the impact of resident involvement on post-operative complications and intraoperative factors. Our objective was to analyze resident involvement as a risk factor for complications within 30 days following ADS.

Methods

This was a retrospective analysis of prospectively collected data from the NSQIP database of patients > 18 years old undergoing ADS between 2005 and 2012. Resident involvement was identified based on CPT coding. Complications and mortality within thirty days from the surgical procedure were analyzed using multivariate logistic regression analysis with significance defined as $p < 0.05$. Odds ratio (OR) was calculated with a 95% confidence interval.

Results

4,277 cases met inclusion criteria and resident involvement was 41.9%. 35.8% of cases were anterior fusion and 45.6% were posterior fusion. Rate of resident involvement was consistent throughout the year by academic quarter (mean 41.0%) and no difference in complication rates was noted when comparing academic quarters of the year ($p > 0.05$). Resident involvement was associated with increased rates of any complication, major complication, wound complication, reoperation, increased operative time and longer length of stay (LOS) > 5 days (all $p < 0.02$) (see table 1).

Conclusion

Resident involvement was associated with increased risk of complications, reoperation and longer operative time and LOS following ADS. These factors may be due to institutional variables, though should be considered during surgical planning and resident education.

Table 1. Post-operative complications following adult deformity surgery	No Resident Involvement	Resident Involved	P Value
Any Complication	2538 (16.97%)	1749 (29.62%)	<0.0001
Major Complication	5.20%	7.38%	0.0021
Wound Complication	1.58%	3.74%	0.0005
Reoperation	2.53%	3.83%	0.0153
Mortality	38.00%	46.00%	0.6044
Operative Time > 4 hours	23.97%	42.05%	<0.0001
LOS > 5 Days	23.69%	25.50%	<0.0001

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84. THE IDEAL LUMBAR LORDOSIS ANGLE FOR RESTORING AN OPTIMAL PELVIC TILT IN ELDERLY PATIENTS WITH ADULT SPINAL DEFORMITY

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Japan

Summary

The ideal lumbar lordosis (LL) angle for restoring optimal pelvic inclination in patients with adult spinal deformity was identified. In a prerequisite study, we determined the optimal alignment which include pelvic tilt (PT) and LL according to the pelvic incidence (PI). Second, we predicted the postoperative PT from corrective LL. Based on these studies, the ideal LL angle was determined to be $0.45 \times \text{PI} + 31.8$, which can be used as a reference during surgical planning.

Hypothesis

We determined the ideal lumbar lordosis (LL) angle for restoring an optimal pelvic tilt in adult spinal deformity (ASD) surgery.

Design

Two different subjects were investigated, a prospective cohort study and retrospective multi-center case series.

Introduction

In order to achieve successful corrective fusion in ASD patients with sagittal imbalance, it is essential to not only correct the sagittal spinal alignment, but also obtain a suitable pelvic inclination. The objective of this study is to identify the ideal LL angle for restoring the optimal PT in ASD patients.

Methods

Two groups were included in this study. The prerequisite group included 184 elderly volunteers (age, 51 to 70 years; mean, 64 years) with an Oswestry Disability Index score less than 20%. The relationship between PT or LL and PI in normal individuals was investigated using single regression analysis. The second group included 116 ASD patients (age, 37 to 84 years; mean, 66 years) who underwent thoraco-lumbar corrective fusion in 4 spine centers. The postoperative PT value was calculated from collected parameters using multiple regression analysis. Based on these studies, an ideal LL angle was determined.

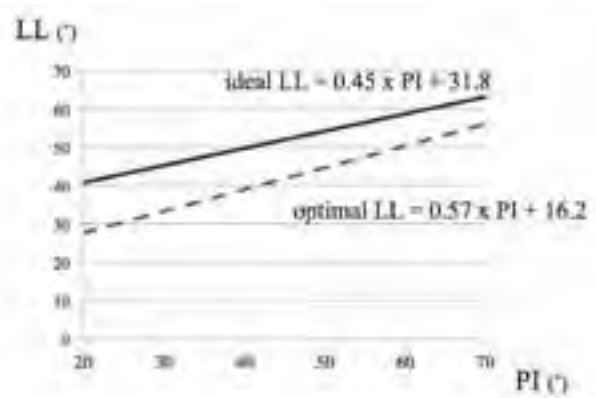
Results

In the prerequisite study, the linear regression equation for optimal PT and LL according to PI was found to be "optimal PT = $0.47 \times \text{PI} - 7.5$ " and "optimal LL = $0.57 \times \text{PI} + 16.2$ ", respectively. In the second study, the postoperative PT was determined according to PI and corrected LL by multiple regression analysis, using the equation "postoperative PT = $0.7 \times \text{PI} - 0.5 \times \text{corrected LL} + 8.1$ ". The ideal LL angle was determined based on these 2 equations (mathematically equalize each of PTs), as follows: "ideal LL = $0.45 \times \text{PI} + 31.8$ ". This equation reveals

that the ideal LL is approximately 10 degrees larger than the optimal LL determined from volunteers. Using this formula, a corrected LL of 54.3° is required to obtain optimal pelvic inclination in a patient with a PI of 50° .

Conclusion

The ideal LL angle can be determined to be $0.45 \times \text{PI} + 31.8$, which can be used as a reference during surgical planning in ASD cases.



85. ACETABULAR ANTEVERSION CHANGES IN SPINAL DEFORMITY CORRECTION – IMPLICATIONS FOR HIP AND SPINE SURGEONS

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United States

Summary

Sagittal spinal deformity (SSD) correction changes acetabular anteversion. Patients with SSD have a high incidence of excessively anteverted acetabular total hip arthroplasty (THA) components. Conversely, changes in anteversion may predispose patients to dislocate a previously stable THA. Acetabular anteversion is significantly reduced in this series of patients following SSD correction. Patients with concomitant symptomatic hip arthritis and SSD should preferably have their spinal procedures prior to THA to allow correct acetabular component positioning.

Hypothesis

Surgical correction of Sagittal Spinal Deformity (SSD) will reduce acetabular anteversion by reducing pelvic tilt.

Design

Retrospective review of prospective database.

Introduction

Hip osteoarthritis often co-exists with SSD. Debate exists whether to perform SSD correction or total hip arthroplasty (THA) first. Hip extension and pelvic tilt are important compensatory mechanisms in SSD. In theory, spinal deformity correction may cause reciprocal changes in acetabular position.

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Methods

SSD patients who underwent surgical realignment were reviewed and included if they had a THA on baseline x-rays. Patients were excluded if they had, large metal-on-metal bearings or revision THA in the study period. Acetabular anteversion (AV) was calculated via the ellipse method (Lewinneck) on a standing PA 36" x-ray with a well-centered pelvis. AV was measured preoperative, and on the 6-week or 3-month post-operative x-ray. Spinopelvic parameters measured included Pelvic Incidence, Pelvic Tilt (PT), Sacral Slope (SS), Lumbar Lordosis (LL), T1-Pelvic Angle (TPA), Sagittal Vertical Axis (SVA), Truncal Tilt (T1SPi) and Thoracic Kyphosis (TK). Their relationship was assessed by correlation coefficient and linear regression.

Results

Forty-one hips (33 patients) were identified. AV reduces after SSD correction by a mean 4.9° (range +2 to -23). The change in AV was significantly correlated with the changes in PT (R=0.80), SS (-0.693), LL (-0.682), PI-LL (0.7237), SVA (0.561) and TPA (0.696). There was a weak correlation with TK and T1SPi. AV was decreased by 1° for each of the following iatrogenic changes in spinopelvic parameters (p<0001): 1.1° PT, -1° SS, 3.2° LL, 1.67° TPA and -11mm SVA.

Conclusion

SSD correction results in reduction in AV, with potential implications for THA stability. SSD correction, when indicated should be performed prior to THA to enable accurate acetabular positioning and minimize potential for dislocation. This study provides an algorithm for the sequence of THA and SSD correction in the patient with concomitant pathologies.

86. DOUBLE LEVEL DEGENERATIVE SPONDYLOLISTHESIS: WHAT IS DIFFERENT IN THE SAGITTAL PLANE?

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France

Summary

This study aims at analyzing patients with double level DS and comparing this population with single level DS patients in terms of demographic and radiographic data. 78 patients were included in double_DS group and 576 patients in uni_DS group. Patients with double DS were significantly older than unilevel DS. In double DS, patients had larger PI and sagittal malalignment is more important with larger anterior tilt, loss of lumbosacral lordosis and they recruited more compensatory mechanisms with pelvic retroversion.

Hypothesis

Patients with double degenerative spondylolisthesis (DS) have greater sagittal malalignment with larger anterior shift and pelvic retroversion

Design

Retrospective multicenter (13 hospitals) study.

Introduction

Numerous studies have described the spinal sagittal malalignment and instability in DS population and therefore, the surgical consequences with correction and posterolateral or interbody fusion. However, there is no study reporting sagittal alignment analysis in double level DS. This study aims at analyzing patients with double level DS and comparing this population with single level DS patients in terms of demographic and radiographic data.

Methods

Adult patients with one (uni_DS) or two levels DS (double_DS), only primary cases were included. Demographic data and clinical outcomes (SF 36 and ODI) were recorded. Sagittal radiographic parameters were measured such as pelvic, spinal and global parameters with C7 sagittal tilt (C7tilt, angle between the center of the vertebral body of C7 and the middle of the sacral endplate with the vertical reference line). After a descriptive analysis, radiographic and demographic data were compared between single and double levels DS.

Results

78 patients were included in double_DS group and 576 patients in uni_DS group. Patients with double DS were significantly older than unilevel DS (70.2 ±9.4 vs 66.9 ±10.6 years, p=0.009). C7tilt was significantly greater in double_DS group (6.2° ±5.3 vs. 4.8° ±3.8, p=0.003). Multi_DS patients had a significantly greater Pelvic incidence (62.4° ±11.3 vs. 58.3° ±11.1, p=0.002). Pelvic tilt was significantly larger in multi-DS group (26.0° ±7.5 vs. 22.6° ±8.1, p=0.001) as well as PT/PI ratio (42% vs. 37%, p=0.033). L4S1 lordosis represented 40.4% of the LLmax in double_DS group and 45.8% in uni_DS group (p=0.013).

Conclusion

Double DS have different sagittal alignment than single DS with greater PI. In double DS, malalignment is more important with larger anterior tilt, loss of lumbosacral lordosis and they recruited more compensatory mechanisms with pelvic retroversion. These findings highlight the need for an adapted surgical correction to these older patients with greater sagittal malalignment

87. EVALUATION OF NITINOL ROD CORROSION PERFORMANCE IN SPINAL CONSTRUCTS WITH TITANIUM PEDICLE SCREWS

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Summary

The aim of this study was to investigate the corrosion of Nitinol rods locked in Ti pedicle screws. We retrieved several rods from patients, measured Ni content in tissues around the junction with the pedicle screw and in patient's blood. Within 2.5 years follow-up no evident signs of corrosion were found.

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Hypothesis

Development of corrosion between Nitinol rods and Ti pedicle screws would result in the damage of the rods, their premature fatigue fracture, increasing of Ni content in the tissues around rod/screw junction and in patient's blood.

Design

Analysis of retrieved Nitinol rods and measurement of Ni ion content in tissues around rod/screw junction and in patient's blood.

Introduction

The use of Nitinol rods in spinal pedicle screw constructs might provide less rigid fixation. However, corrosion of Nitinol rods locked in Ti pedicle screws is a potential complication. The junction between Nitinol and titanium pedicle screws may promote fretting and galvanic corrosion.

Methods

Up to 2.5 years follow-up have been achieved for 132 adult patients operated for degenerative disease or scoliosis using a fusionless stabilization technique with 2 superelastic Nitinol rods and Ti6Al4V pedicle screws (age 40-82, 2-5 levels from L1 to S1). The surface of 8 rods from 4 revisions were analyzed using SEM and EDAX. The content of Ni in tissues was measured by ICP-MS (Nexion 300D). Content of Ni ions in the blood of 10 patients was measured before the surgery, 1 day, 7 days and 3 months after the operation.

Results

No rods breakage was recorded after 132 fusionless surgeries (2.5 years follow-up). All revisions were carried out 12-13 months after the primary surgery. Discoloration on the rods surface containing Ti, Ni, C, O and Fe were observed in all regions of rods. However, they were not associated with locked titanium screws. The content of Ni ions in the tissues collected around rods/screw junction at the revisions was 0.11-0.98 microgram/g, which was not statistically different from control patient without implants (n=8, Ni content 0.12-0.99 microgram/g). 2 of 10 patients had between 2 and 5 fold increased content of Ni ions in the blood 1-7 days after the surgery. 3 months after surgery the level of Ni in patient's blood had returned to normal.

Conclusion

Follow-up of 130 patients with Nitinol rods did not reveal any corrosion between Nitinol rods and Ti screw. Longer follow-up periods are however required to determine the longer term performance.

88. PALLIATIVE SURGERY IN SPINAL METASTASIS PATIENTS WITH INSTABILITY PAIN: THE ROLE OF MINIMALLY INVASIVE SPINAL STABILIZATION (MIST) USING FLUOROSCOPIC GUIDED PERCUTANEOUS SCREWS TECHNIQUE.

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Malaysia

Summary

This prospective study reports the outcome of 50 spinal metastasis patients underwent MIST with/without minimally invasive decompression. Pain reduced from 7.9+/-1.4 to 2.5+/-1.2. 75.0% had neurological recovery of ≥ 1 Frankel grade with a mean survival 11.3 months. Average time to ambulation was 3.4 +/- 1.8 days. There is no major complications documented. MIST also offers a new treatment option for patients with advanced metastatic disease i.e. Tomita score ≥ 8 who are traditionally treated non-operatively.

Hypothesis

MIST can be used as a form of palliative surgery in patients with spinal metastasis with significant instability pain.

Design

Prospective Cohort Study.

Introduction

The advent of minimally invasive percutaneous pedicle screw stabilization system had revolutionized the treatment of spinal metastasis.

Methods

In between 2008 and 2013, 50 cases of spinal metastasis with pathological fracture(s) with/without neurology deficit were treated with MIST. The patients were assessed for Tomita score, pain score, operation time, blood loss, neurological recovery, time to ambulation and survival.

Results

MIST provided a statistically significant reduction in pain score (VAS) with mean pre-operative score of 7.9+/-1.4 which reduced to 2.5+/-1.2 postoperatively (p=0.000). (Table 1) 37 patients (74.0%) required minimally invasive decompression in addition to MIST. The mean operating time was 2.3+/-0.5 hours for MIST alone and 3.4+/-1.2 hours for MIST with decompression with the mean blood loss was 0.4+/-0.2L and 1.7+/-0.9L respectively. Those with neurological deficit, 70% had improvement of 1 Frankel grade and 5% had 2 Frankel grades improvement. None of the patient was bed ridden post-operatively with the average time to ambulation of 3.4+/-1.8 days. The overall mean survival was 11.3 months (range, 2 to 51 months). The group with the Tomita score <8 has a significant longer survival as compared to the group with the Tomita score ≥ 8 with the mean survival of 14.1+/-12.5 months and 6.8+/-4.9 months respectively (p=0.019). There was one case of implant failure that did not require any revision surgery.

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Conclusion

MIS^t offers a new option of treatment for spinal metastatic patients. It provides good relieve of instability back pain with no major complications. It improves the quality of life, even in those with Tomita score ≥ 8 who are traditionally treated non-operatively.

	Tomita-1 (n=21)	Tomita-3 (n=17)	P value
Age (year)	55.3 \pm 10.2	57.8 \pm 15.9	0.490
Gender			
Male	18, 41.9%	12, 83.2%	0.143
Female	13, 58.1%	7, 36.8%	0.143
Pain (VAS)			
Pre Op	7.5 \pm 1.4	8.6 \pm 1.3	0.013*
Post Op	2.7 \pm 1.2	3.1 \pm 1.8	0.005*
No Neurological Deficit	2, 9.7%	7, 36.3%	0.020*
Neurological Improvement			
0 grade	5, 16.1%	3, 26.3%	0.382
1 grade	22, 71.0%	6, 31.6%	0.006*
2 grade	1, 4.2%	1, 7.9%	0.721
Neurological Worsening	0, 0%	0, 0%	n.s.
Time to ambulation (day)	3.4 \pm 1.3	3.9 \pm 2.4	0.371
Survival (month)	14.1 \pm 11.3	6.8 \pm 4.9	0.019*

* Indicates statistical significance

89. TEMPORARY INTRAOPERATIVE INSTRUMENTATION OF LOWEST INSTRUMENTED VERTEBRA +1: A NOVEL TECHNIQUE TO HELP MINIMIZE EXTENT OF ARTHRODESIS IN AIS

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Canada

Summary

Limiting the extent of arthrodesis remains a fundamental goal of AIS surgery, particularly for Lenke 3,5, and 6C curves. To date, no firm guidelines exist for consistently ending fusions at the end vertebra (EV) with considerable variability among surgeons on choosing the lowest instrumented vertebra (LIV). We present a novel technique that predictably results in shorter fusions, impressive curve correction, and minimal residual angulation of the LIV or disc below LIV in structural lumbar curves.

Hypothesis

Temporary instrumentation of LIV+1 allows for predictably shorter fusions of lumbar curves than traditional techniques.

Design

Retrospective case series.

Introduction

Fusion level selection in AIS is traditionally based on CSVL relation to LIV, bending films, or traction xrays, which may not necessarily optimize the extent of the arthrodesis. Limiting the arthrodesis in structural lumbar curves particularly to L3 has reported advantages, however, L4 at times is deemed necessary when selecting levels using traditional methods. Our aim was to evaluate the effectiveness of a novel intra-operative technique in predictably allowing shorter fusions than traditional methods in treating structural lumbar curves in AIS.

Methods

3 independent spine surgeons blinded to the study question analyzed pre-op xrays on 10 consecutive patients to determine their selection of LIV. Their responses were compared to actual LIV of these patients post-op. In all patients, a temporary pedicle screw was placed at the concave LIV+1 to help with deformity correction, particularly apical translation, leveling LIV and minimizing disc angulation below LIV. Following placement of rods, this temporary screw was removed intra-op. Patient demographics were obtained through chart review and pre-op and most recent follow-up radiographic outcomes were analyzed.

Results

All patients were female with a mean age of 16.1 years, pre-op mean major Cobb of 64.3° (range 40°-75°), and mean follow-up of 22 months (range 15-34). L4 was suggested LIV from the independent surgeons in 56.7% of cases, whereas L3 was suggested in 43.3%. LIV for all cases (100%) in this series was L3 utilizing the LIV+1 temporary fixation technique. % curve, apical translation, and rib/lumbar prominence corrections were 80.6%, 85.9%, and 67.4%/57.1%, respectively at final follow-up. Table 1 summarizes pre- and post-op parameters.

Conclusion

Temporary instrumentation of LIV+1 allows for predictably shorter fusions of lumbar curves than traditional techniques. Significant correction of the EV angulation along with significant improvement in the disc angulation below LIV is achieved without compromising curve correction.

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Table 1

Mean	Pre-operative	Post-operative
Levins Curve	30.9, 31.1, 31.0, 31.0	
C7-12 Kyphosis	12.3, 12.5, 12.4	
Major Cobb (°)	64.1 ± 8.8	55.9 ± 8.8
NFI	31.1 (13.8-23.3)	
Independent Thoracic Rotated LIV	13, 43.7%; L4, 34.7%	
Actual LIV		13, 100%
C5-12 Kyphosis	29.1 ± 11.3	24.9 ± 8.7
T12-S1 Lordosis	42.3 ± 12.4	52.1 ± 11.3
Apical Vertebral Translation	11.6 mm ± 2.6 mm	12.8 mm ± 2.8 mm
C7-12 Angle (°)	28.9° ± 9.8°	
LIV Angle (°)		4.1° ± 4.2°
Dist Angle below LIV (°)		1.7° ± 1.3°
Thoracic RA Transverse (°)	33.8 ± 4.8	4.5 ± 1.2
Lumbar Flexion (°)	14.4 ± 3.5	4.5 ± 1.9

Figure 1: Example of Technique



90. NOVEL CERVICAL ANGULAR MEASURES ACCOUNT FOR BOTH UPPER CERVICAL COMPENSATION AND SAGITTAL ALIGNMENT

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United States

Summary

Current cervical deformity measures like C2-C7 plumbline (cSVA) focus on subaxial cervical alignment. Two novel cervical deformity measures are described: the Craniocervical Angle (CCA) combines McGregor's slope with cervical tilt; the C2-Pelvic Tilt (CPT) does not vary with pelvic retroversion or lower extremity compensation (Figure). These novel cervical angular measures correlate with both upper cervical compensation and cervical sagittal alignment in patients (pts) with cervical sagittal deformity (CD).

Hypothesis

Cervical measures can account for upper cervical compensation and cervical sagittal deformity.

Design

Prospective cohort and retrospective review of prospective database.

Introduction

Current descriptions of CD like C2-C7 plumbline (cSVA) do not account for upper cervical compensation. Thoracolumbar deformity (TLD) angular measures like the T1 Pelvic Angle (TPA), can account for both global

and pelvic tilt and are less affected by lower extremity compensation. Such advantages are lacking in established cervical measures. The craniocervical angle (CCA) combines the slope of McGregor's line and the inclination from C7 to the hard palate, thus it accounts for cervical alignment and upper cervical compensation (C0-2A). The C2-Pelvic Tilt (CPT) is an angle that combines C2 tilt and pelvic tilt, thus, like TPA, it is less affected by lower extremity and pelvic compensation.

Methods

Novel and existing CD measures were correlated in 781 pts from a TLD database and 61 pts from a prospective CD database. CD pts were subanalyzed by region of deformity driver: cervical (C), and cervico-thoracic junction (CT). TLD pts were grouped if they had cervical deformity (cSVA > 4cm or TS-CL > 20) or not.

Results

TLD cohort: Mean cSVA was 31.7° ± 17.8mm. In pts with cervical deformity, mean CCP = 56.0° ± 7.4 and CPT = 33.6° ± 15.8 were significantly different than nonCD pts (p < 0.001). CCA and CPT correlated with cSVA (r = 0.49/r = 0.42, p < 0.001) and C0-2A (r = 0.63/r = 0.29, p < 0.001). CD cohort: mean cSVA was 47.3° ± 32.2mm. CCA and CPT correlated with cSVA (r = 0.71/r = 0.66, p < 0.001) and C0-2A (r = 0.66/r = 0.61, p < 0.001). Correlation of cSVA and C0-2A was weaker (CT pts were significantly more deformed by cSVA (71.3mm vs 24.0, p < 0.001), CCA (47.1° vs 59.1°, p < 0.001), and CPT (63.3° vs 43.8°, p = 0.002). Using linear regression analysis, cSVA of 4cm corresponded to CCA of 53.2° (r² = 0.5) and CPT of 48.5° (r² = 0.4).

Conclusion

CCA and CPT account for both cervical sagittal alignment and upper cervical compensation. These novel parameters can be utilized in pre and postoperative assessments of cervical sagittal alignment. Future studies should gauge their clinical relevance with health measures relevant to cervical deformity.



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91. "DISTRACTION FAILURE" IN MAGNETICALLY-CONTROLLED GROWING RODS: PREVALENCE AND RISK FACTORS

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Hong Kong

Summary

"Slippage" (i.e. distraction failure) of the rods during distraction may occur in EOS patients undergoing treatment with the magnetically controlled growing rod (MCGR). The current study assessed the occurrence and potential determinants associated with slippage of the MCGR during distraction in a series of patients. In 168 distraction episodes, slippage was noted in 25%, mainly occurring in the offset rod. Further studies are needed to assess if this occurrence is a complication or a physiological, fail-safe mechanism for such patients.

Hypothesis

Rod slippage can occur but gain in implant length still occurs with no effects upon clinical outcome.

Design

A prospective case series.

Introduction

Recently, the use of "magnetically" controlled growing rods (MCGR) has advanced the surgical treatment of children with early onset scoliosis (EOS), providing non-invasive and outpatient distractions. Sometimes during the distraction procedure, the rod may fail to distract, which is manifested as a audible or palpable "clunking". This is due to slippage of the internal mechanism. The current study assessed the occurrence and potential determinants associated with slippage during distraction.

Methods

Four EOS patients who underwent implantation of dual MCGR were assessed. Each underwent monthly outpatient distractions. Rod slippage was noted if a "clunking" noise occurred during distraction. Pre- and post-distraction AP/lateral radiographs were obtained of each patient until the last follow-up. Various radiographic parameters and demographics were analysed.

Results

The mean time period from operation to the first slippage was 11 months. Overall, in 168 distraction episodes, slippage was noted in 25%. Offset rod (35%) had higher slippage compared to the standard rod (17%). Early slippage (within one year of surgery) occurred in 50% of the patients. Based on the sample size, demographics, number of vertebral levels involved, distance between magnets, and curve alignment/flexibility parameters were not distinctively involved. Despite this slippage, there was overall gain in the length of the implant and spine. Throughout follow-up, all patients had no pain, had good functional outcome, and were satisfied with the procedure.

Conclusion

In MCGR patients, a "clunking phenomena" or rod slippage can occur within the first year since rod implantation and may continue thereafter, and is more prevalent in the offset rod. This is the first study to identify this observation, which may help predict distraction potential. Larger studies are needed for validation and to determine if it is related to potential rod breakage, revision surgery, loss of correction, improper spinal growth, or a naturally occurring, physiological fail-safe mechanism.

92. VALIDITY, RELIABILITY AND RESPONSIVENESS OF SRS-7 AS A FUNCTIONAL OUTCOME MEASURE FOR OPERATIVELY TREATED ADULT SPINAL DEFORMITY (ASD) PATIENTS

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Summary

In this study, we compared the Scoliosis Research Society-22r (SRS-22r) instrument against an item-response theory derived 7-question short-form questionnaire (SRS-7) in operatively treated adult spinal deformity patients. We found that SRS-7 is a valid, reliable, responsive and unidimensional instrument that can be used as a short form alternative to SRS-22r for global assessment of functional outcomes in operatively treated adult spinal deformity patients.

Hypothesis

SRS-7 is a valid, reliable, responsive and unidimensional instrument for assessing operatively treated adult spinal deformity (ASD) patients.

Design

Retrospective analysis of a prospective ASD registry.

Introduction

The aim of our study was to compare Scoliosis Research Society-22r (SRS-22r) against an item-response theory derived 7-question short-form instrument (SRS-7) in operatively treated ASD patients. SRS-7 has theoretical advantages of being short, unidimensional, and an interval scale, which has been previously validated in operatively treated adolescent idiopathic scoliosis patients.

Methods

A prospective database of operatively treated ASD patients ≥ 18 years (N=345) was queried for all patients who answered all preop and 2-year postoperative questions in the SRS-22r instrument (207 pts, 60%). Corresponding SRS-7 scores were calculated from answers to questions 1, 4, 6, 10, 18, 19, 20 in the SRS-22r. The two instruments were compared with respect to their concurrent validity, internal consistency, responsiveness, and unidimensionality. Significance was set at $P < 0.001$.

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Results

SRS-7 and SRS-22r had a high preoperative ($r=0.901$, $P<0.001$), and 2 years postoperative ($r=0.849$, $P<0.001$) correlation. Pre- and postoperative SRS-7 and SRS-22r had Cronbach α of 0.85 and 0.94, and 0.83 and 0.94, respectively, indicating good to excellent internal consistency. SRS-7 was found to be more responsive than SRS-22r with respect to all measures of effect size: Cohen's d (0.773 vs. 0.735), Hedge's g (0.771 vs. 0.733), and effect size correlation r (0.361 vs. 0.345). Iterative principal factor analysis of pre- and postoperative scores demonstrated the presence of one dominant latent factor in SRS-7 (unidimensionality) and 4 latent factors (multidimensionality) in SRS-22r, respectively.

Conclusion

SRS-7 is a valid, reliable, responsive and unidimensional instrument, which can be used as a short form alternative to the SRS-22r for global assessment of functional outcomes in ASD patients.

93. THE VALUE OF BONE BIOPSY DURING PERCUTANEOUS VERTEBROPLASTY IN TREATMENT OF PRESUMED OSTEOPOROTIC VERTEBRAL COMPRESSION FRACTURES

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Summary

Bone biopsy in presumed osteoporotic vertebral compression fractures (VCF) treated via percutaneous vertebroplasty (PV) plays a significant role in the diagnosis of etiology.

Hypothesis

A variety of malignant conditions may be responsible for vertebral fractures.

Design

Retrospective.

Introduction

The most common cause of VCF is osteoporosis. Malignant conditions (metastasis, multiple myeloma (MM), lymphoma) also may be responsible for vertebral fractures. We have reviewed the biopsy results of patients treated via PV. The aim of this study is to determine the value of performing a routinely applied bone biopsy during PV.

Methods

Between 2009-2013, 136 patients older than 50 y/o were included. Biopsies were performed during PV procedure. Pre-operative imagings were evaluated second time by a radiologist with the pathological results of the biopsies. Six patients with diagnosis of osteoporotic VCF presenting with abnormal blood tests were consulted with hematologist and the biopsy specimens of these patients were re-analyzed with CD-138 marker by the same pathologist.

Results

187 biopsies were obtained from 136 patients (85F,51M). The mean age was 70.1 (50-96). In 17 patients (12.5%) pathologic process underlying the fracture was MM, metastasis and lymphoma. MM was diagnosed in 13 patients (9.5%). In 6 of 13 (46%) patients with osteoporotic biopsy results, MM was diagnosed by re-analyzing the specimens with CD-138 marker. Metastasis was found in 3 patients (2.2%). Lymphoma was found in 1 patient (0.7%).

Conclusion

This study found a 12.5% incidence of malignancy (mostly MM) in patients with presumed osteoporotic VCF. Even the pathologic result is normal in 46% of MM pts (6 of 13) at initial evaluation, consulting patients with abnormal blood test with hematologist and re-analyzing the pathology specimens with CD-138 marker diagnosed MM. We believe that routine vertebral body bone biopsy can play a significant role to assist in initiating concurrent medical treatment especially patients with multiple myeloma and metastasis. As a result, we recommend routine obtainment of bone biopsy during every PV procedure and also analyzing the biopsy specimens with CD-138 marker for MM.

94. DOES MIS SURGERY ALLOW FOR SHORTER CONSTRUCTS IN THE SURGICAL TREATMENT OF ASD?

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United States

Summary

Two multicenter databases, one involving minimally invasive (MIS) and other OPEN surgeries for Adult spinal deformity (ASD) were propensity matched for clinical and radiographic parameters with a minimum 2 year follow-up, to examine the effect of the number of fusion levels on surgical outcomes. MIS Techniques might potentially decrease construct length, fusion levels, reoperation rates, blood loss and length of stay without affecting the clinical and radiographic outcomes when compared to a similar ASD patients treated with OPEN techniques.

Hypothesis

MIS spinal surgery for ASD can potentially decrease the fusion levels and construct length, providing a positive clinical impact.

Design

Two multicenter databases, one retrospective involving MIS and the other prospective with OPEN surgeries for ASD with similar deformity were propensity matched for clinical and radiographic parameters with a minimum 2 year follow-up. Outcomes were evaluated and compared.

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Introduction

Length of construct can potentially increase risks in adult spinal deformity (ASD) surgery. The objective of this study was to examine the effect of the number of fusion levels on surgical outcomes in a group of patients with similar ASD comparing MIS to OPEN approaches.

Methods

Two large multicenter ASD databases were queried for MIS and OPEN patients with minimum 2-year follow-up. Patients were propensity matched for max Cobb, pelvic incidence-lumbar lordosis (PI-LL), and baseline ODI. Independent T-test and chi square were used for analysis.

Results

A total of 1,215 patients were identified in both databases, with 84 patients matched in each group. There were no statistical differences in baseline demographics or preoperative radiographic parameters (table 1). OPEN patients on avg had 10.1 levels fused while MIS 4.8 levels ($p < 0.001$). MIS patients had significantly more interbody fusions (IBF; 3.6 MIS and 2.4 OPEN, $p < 0.001$). Length of stay was significantly less for MIS (6.7 v 9.7 days; $p = 0.003$). Both groups showed significant HRQOL improvement from baseline, with no differences between MIS and OPEN.

Conclusion

When treating mild to moderate ASD, MIS techniques achieve similar clinical and radiographic results with the exception of PI-LL correction. Additional benefits include shorter construct, decreased blood loss, and length of stay. Longer follow up is required to assess fusion and durability of the MIS techniques.

	MIS	OPEN	p
N/Age	84/52	84/57.5	0.143
Total IBL	488.5	1762.5	<0.001*
Total LGS	6.7	9.7	0.003*
Pre/Post Op Cobb	36.5/32.5	28.5/22.5	0.276/0.985
Pre/Post Op PI	24.2/24.1	23/21.8	0.888/0.247
Pre/Post Op PI-LL	13.6/10.8	14.6/12.3	0.543/0.212*
Pre/Post Op VAS	36.1/34.8	32.8/31.7	0.307/0.889
Posterior Levels Fused	4.8	10.1	<0.001*
IBF Levels	3.6	2.4	<0.001*
Pre/Post Op ODI	47/28.5	41.8/24.8	0.885/0.223
Pre/Post Op VAS Back	6.5/2.2	7.3/3.4	0.009*/0.892
Pre/Post Op VAS Leg	3.8/3.8	3.1/2.3	0.276/0.08
Reoperation*	11 (13.1%)	14 (16.0%)	0.294

95. IS L1S1 LORDOSIS MEASUREMENT STILL THE RELEVANT PARAMETER TO ASSESS LUMBAR CURVE MAGNITUDE?

Radiographic Study of Sagittal Lumbar Spine Alignment in 296 Healthy Volunteers

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France

Summary

This study presents a database for the sagittal lumbar spine alignment of 296 normal subjects. Results suggest that, considering the arcs of lumbar lordosis (LL), global LL angle was more accurate than L1S1 angle in assessing lumbar spine variation in the sagittal plane. The number of vertebrae involved in the lordotic curve correlated significantly with sacral slope (SS) and pelvic incidence (PI).

Hypothesis

To describe and quantify general fluctuations in the sagittal alignment of the lumbar spine and pelvis.

Design

Prospective radiographic study of 296 healthy volunteers without spinal pathology.

Introduction

L1S1 lordosis measurement is considered as a gold standard for assessing lumbar curve magnitude. However, the Roussouly classification showed the geometric definition of LL and the relationships between LL arc and SS. Enhancing its statistical significance, in an asymptomatic population, remains relevant.

Methods

PI, SS and the lumbar parameters L1S1 lordosis, inflexion point (InP), global LL and total number of lordotic vertebra (LL verteb) were evaluated in 296 healthy volunteers (126 male, 170 female; mean age, 27 years; range, 18-48 yrs). Comparison between the 4 types of sagittal spinal shape on the Roussouly classification used Student, ANOVA and Tukey tests for quantitative variables and χ^2 , Fischer and Holm tests for qualitative variables.

Results

Mean LL verteb was (2.9) for type 1, (4.2) for type 2, (4.5) for type 3, and (5.4) for type 4 ($p < 0.0001$). The more the InP was proximal to the thoraco-lumbar junction, the greater was SS and PI (Table 1). There were significant differences between the 4 types in terms of LL (51° for type 1, 48° for type 2, 58° for type 3, and 69° for type 4 $p < 0.001$) and of L1S1 (46° for type 1, 45° for type 2, 56° for type 3, and 67° for type 4 $p < 0.001$). However, LL was found significantly different between type 1 and type 2 ($p < 0.04$) while L1S1 was not ($p = 0.7$).

Conclusion

Spinal sagittal alignment of normal volunteers varied significantly. The shape of the lumbar spine has been assessed more precisely by global LL angle by enhancing the difference of transition between lordotic and kyphotic curves in the thoraco-lumbar junction.

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96. BIPORTAL ENDOSCOPIC SPINAL SURGERY (BESS) FOR TREATMENT OF SPINAL STENOSIS ; INTRA- AND EXTRAFORAMINAL APPROACH

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Korea*

Summary

Innovative new endoscopic surgical technique using BESS is introduced, which allows preservation of multifidus muscle, minimal bone resection maintaining spinal integrity under more clear vision and wider angle view. It also permits application of microscopic spinal surgical instruments just as open procedures. By this procedure more effectively and safely circumferential and extraforaminal decompression were possible, which was difficult by conventional uniportal endoscopic spinal surgery systems.

Hypothesis

Various kinds of minimal spinal surgeries including endoscopic spinal surgery systems, mainly with unilateral approach, have been introduced to preserve spinal structures. But most approaches sacrifice medial multifidus with injury to the muscle fibers which are innervated only by the medial branch of the dorsal ramus. Even small salvage of this muscle may result in atrophy of the adjacent muscle groups and back muscle dysfunction. We tried preservation of this important muscles by operating through spatium intermusculare with biportal endoscopic spinal system. Furthermore wider angle and more clear view can be obtained by this procedure.

Design

We could get wider view of uni- and contralateral side of the intraspinal canal using biportal endoscopic spinal system. Preservation of paraspinal muscles was possible with this procedure going through potential intermuscular space.

Introduction

Many kinds of endoscopic minimally invasive surgeries have been introduced to manage spinal stenosis. But still there are many limitations in practice. We tried biportal endoscopic approach to obtain wider range of access angle and more clear view preserving paraspinal muscles.

Methods

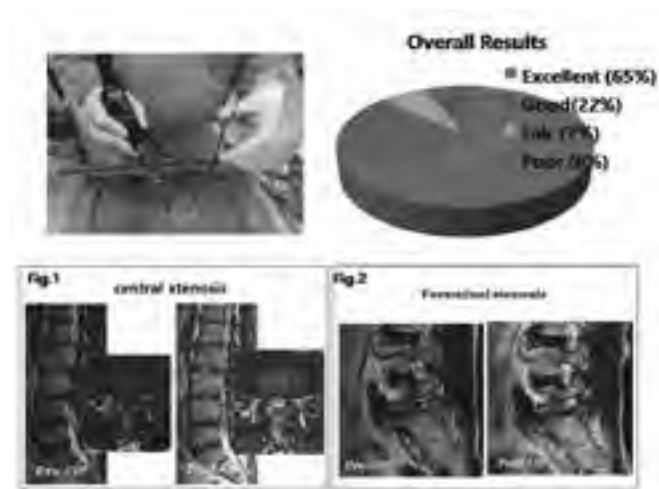
This study was composed of 36 consecutive patients with lumbar stenosis with or without herniated nucleus pulposus who underwent laminotomy and foraminotomy with posterior lumbar and extraforaminal approach respectively.

Results

Effective circumferential and extraforaminal decompression were possible with this approach. Sixty-nine percent of patients had at least 75% of improvement in Oswestry Disability Index(Oswestry) and Visual Analog Scale(VAS) scores. The surgery-related complications were identified : dural tear(3), transient neuralgia(2), and missed level(1) especially in early cases.

Conclusion

Biportal Endoscopic Spinal Surgery (BESS) technique was supposed to be a safe and innovative approach which allows not only wider angle of anatomical view and more clear vision but also preservation of paraspinal back muscles.



97. AGE-ADJUSTED ALIGNMENT GOALS HAVE THE POTENTIAL TO REDUCE PJK

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Summary

This study revisits the concept of under vs. over-correction in the setting of PJK analysis following realignment surgery using age-adjusted thresholds. Sagittal alignments between patients with and without PJK were compared across the whole population, as well as between 3 sub-groups divided by age range. Overall, PJK rate increased with age across the 3 sub-groups. Comparisons on the offset vs. the age-adjusted alignments demonstrate an over-correction of PI-LL and SVA on PJK patients.

Hypothesis

Over-correction of the sagittal plane based on age-specific threshold of ideal alignment is not a risk factor for PJK.

Design

Retrospective cohort.

Introduction

Age and under-correction have often been cited as risk factors for PJK. Recent ASD studies show that alignment targets are age-specific. This study explores PJK as a function of age-adjusted surgical correction goals.

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Methods

ASD patients with fusions to the pelvis were included. Age stratification was defined as young adult (YA<40yo), middle age (MA: 40-65yo), Elderly (ED>65yo). ANOVA analysis was carried out to compare the 3 groups in terms of 1yr post-operative alignment and 1yr offset from age-specific alignment targets.

Results

The cohort consisted of 679 patients (61yo, 77F, BMI=28.1); at 1-year post-op there was a significant decrease in PT (29 to 23°), spino-pelvic mismatch [PI-LL] (28 to 5°), and SVA (110 to 37mm), and a 45.1% overall incidence of PJK. The stratification by age (YA, n=28; MA, n=389; ED, n=262) revealed an increase in PJK incidence with age: YA=17.9%, MA=43.8%, and ED=50.2% (p<0.001). Post-operatively, patients who developed PJK had smaller PI-LL mismatches (ED 0.8 vs. 9.8°, MA 3.1 vs. 7.3°), without significant differences in PT or SVA. The analysis of the post-operative offset from age-specific norm revealed that the overall, undifferentiated cohort and the two older sub-groups that developed PJK were over-corrected in terms of PI-LL mismatch versus the norm (All: 2.8 vs. -5.2°, MA:-1 vs. +4°, ED: -11 vs. -2°), as well as SVA versus the norm (All: 7 vs. -10mm, MA: 10 vs. -3mm, ED: -18 vs. -6mm). The coefficients of correlation between the magnitude of the PJK angle and the offsets from age-adjusted objective were 0.320 for PI-LL, 0.114 for PT and 0.136 for SVA.

Conclusion

Overall, this study suggests that patients with PJK were overcorrected versus age-adjusted alignment objectives. Certainly, elderly patients have risks for PJK such as osteoporosis, and other co-morbidities that are difficult to mitigate. On the other hand, optimizing alignment is a variable that can be controlled. This emphasizes the need for surgeons to incorporate age-specific alignment targets into the standard pre-operative planning process.

	N	Post-operative alignment			Post-op Offset from Norm		
		No PJK	PJK	p	No PJK	PJK	p
Overall	PI-LL	8.7 ± 16.8	1.9 ± 14.1	<0.001	2.8 ± 17.1	-5.2 ± 14.9	<0.001
	PT	23.6 ± 10.4	23.1 ± 9.8	0.759	3.4 ± 10.8	0.7 ± 10.8	0.039
	SVA	41.2 ± 41.0	32.9 ± 36.9	0.014	7.1 ± 42.7	-9.9 ± 37.5	<0.001
Young Adults	PI-LL	7.8 ± 20.2	-10.0 ± 14.7	0.094	15.7 ± 20.8	-3.0 ± 13.1	0.030
	PT	21.4 ± 14.1	43.0 ± 11.4	0.471	6.7 ± 10.8	-2.0 ± 12.2	0.122
	SVA	42.8 ± 38.1	44.7 ± 29.0	0.694	12.0 ± 40.7	-1.0 ± 18.2	0.000
Middle Age	PI-LL	7.4 ± 18.9	2.1 ± 13.4	0.009	4.2 ± 17.1	-6.7 ± 13.0	0.001
	PT	22.2 ± 10.3	23.0 ± 9.1	0.700	2.0 ± 10.3	2.8 ± 9.1	0.046
	SVA	33.1 ± 40.2	23.9 ± 39.1	0.001	-9.7 ± 40.2	-1.1 ± 39.6	0.017
Elderly	PI-LL	8.8 ± 19.1	0.8 ± 14.8	0.001	-2.0 ± 14.4	-11.1 ± 14.7	<0.001
	PT	24.7 ± 9.2	23 ± 10.3	0.109	-1.1 ± 9.6	-2.8 ± 10.3	0.131
	SVA	35.1 ± 41.5	41.0 ± 34.4	0.107	-3.1 ± 41.0	28.5 ± 35.6	0.000

98. ROLE OF ETHNICITY IN ALIGNMENT COMPENSATION: PROPENSITY MATCHED ANALYSIS OF DIFFERENTIAL COMPENSATORY MECHANISM RECRUITMENT PATTERNS FOR SAGITTAL MALALIGNMENT IN 288 ASD PATIENTS FROM JAPAN, KOREA AND UNITED STATES

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United States

Summary

Adult spinal deformity patients from three nationalities were matched based on their age, gender and pelvic morphology and recruitment of compensatory mechanisms was compared. For the same degree of sagittal malalignment, Japanese patients had more pelvic extension and Korean patients more thoracic hypokyphosis and greater loss of lumbar lordosis compared to patients from the United States.

Hypothesis

Recruitment of compensatory mechanisms in sagittal deformity varies among ethnicities.

Design

Retrospective review of ASD patients in multi-ethnic database.

Introduction

While investigating the impact of age, gender and pelvic morphology on the ability to compensate for sagittal malalignment is crucial, role of ethnicity in compensatory recruitment pattern is poorly understood.

Methods

Patients from United States (USA: 85% White) > 25 yrs were propensity matched by age, gender, and pelvic incidence (PI) with patients from Korea and Japan (100% Asians). Only primary patients and those with existing fusion below T12 were retained for analysis. Groups were further sub-classified by deformity severity (aligned; sagittal vertical axis (SVA): < 50, moderate malalignment; SVA:50-100, severe malalignment; SVA>100mm).

Radiographic measurements; pelvic retroversion (PT), thoracic kyphosis (TK), loss of lumbar lordosis (LL/PI-LL), cervical lordosis (CL) and cervical SVA were compared between the groups,

Results

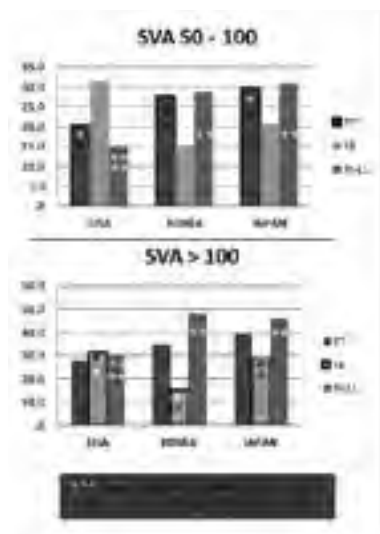
288 patients (96 each). Similar age (64-67yrs), and PI (49-53°). USA had less PI-LL in every alignment group (p<0.05, Fig). In moderate malalignment, JPN had more pelvic retroversion than USA (30 vs. 20°), and KOR had more thoracic hypokyphosis than USA (15 vs. 31°). In severe malalignment, JPN had more pelvic retroversion than USA (39 vs. 27°), and KOR had more thoracic hypokyphosis than USA (15 vs. 31°). KOR had less cSVA in both aligned

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(11 vs. 27mm) and moderate (19 vs. 31mm) malalignment compared to USA. In the severe malalignment, KOR had less CL (13 KOR vs. 15 USA vs. 27° JPN). $P < 0.05$ for all differences.

Conclusion

Sagittal profile varies among nationalities. Asians have more ability to compensate for higher loss of lumbar lordosis. Recruitment of compensatory mechanisms for sagittal malalignment is ethnicity dependent, with Korean favoring thoracic compensation by hypokyphosis, and Japanese favor pelvic compensation by hip extension. Patient ethnicity should be considered while evaluating the sagittal plane and correction strategies.



99. SAGITTAL SPINOPELVIC ALIGNMENT IN 654 DEGENERATIVE SPONDYLOLISTHESIS

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France

Summary

Degenerative spondylolisthesis (DS) is a common degenerative spinal disease. Recent studies highlighted relationship between DS and high pelvic incidence. We aimed at describing sagittal spinopelvic parameters in DS patients, comparing them with asymptomatic volunteers, and determining a classification of DS patients. Demographic and radiographic parameters of DS patients were compared to 709 asymptomatic, age-matched volunteers. 654 DS patients were included. They had greater PI and C7tilt. LLmax and lumbosacral lordosis were significantly smaller in the DS group.

Hypothesis

DS patients have sagittal malalignment with global sagittal malalignment or compensatory mechanisms involvement.

Design

Retrospective multicenter study of prospectively collected data.

Introduction

Degenerative spondylolisthesis (DS) is common degenerative spinal disease. Recent studies highlighted relationship between DS and high pelvic incidence (PI). Moreover, impact of spinopelvic alignment on clinical outcomes has been emphasized. We aimed at describing epidemiologic and sagittal spinopelvic parameters in patients with DS, comparing them with asymptomatic volunteers, and determining a classification of DS patients.

Methods

Any adult patients treated for lumbar DS were included. Demographic data were recorded, as well as radiographic parameters such as PI, pelvic tilt (PT), maximal lumbar lordosis (LLmax), lumbosacral lordosis, thoracic kyphosis, and C7tilt. C7tilt was measured between the vertical reference line and the line between the center of C7 vertebral body and the middle of the sacral endplate. DS patients were compared to 709 asymptomatic, age-matched volunteers. Cluster analyses were used to classify patients in homogenous groups.

Results

654 patients were included (72% female, 67 years). DS patients had greater PI (58.8° vs 53.2° , $p < 0.001$) and C7tilt ($p < 0.001$). LLmax and lumbosacral lordosis were significantly smaller in the DS group. Cluster analysis allowed for the identification of 2 groups of patients according to C7tilt: 159 patients with anterior C7tilt and 495 with normal C7tilt. In each group, 3 subgroups were found with different PI and sagittal spinopelvic parameters.

Conclusion

Predominance of high PI and female gender was emphasized in DS population. Moreover, these findings highlighted the importance of sagittal alignment analysis in DS with 24% of patients with anterior malalignment and in the remaining 76% (normal C7Tilt), more than 50% had pelvic retroversion. Consequently, DS sagittal malalignment should lead to specific surgical correction adapted to each subgroup of patients.

100. THE IMPACT OF DEPRESSION ON 2-YEAR OUTCOMES AFTER ADULT SPINAL DEFORMITY SURGERY

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United States

Summary

A retrospective multivariate analysis from a prospective multicenter database of 267 adult spinal deformity (ASD) patients demonstrated that a subjective pre-operative medical history of depression does not significantly impact 2-year clinical outcomes. Alternatively, the mental health tool that best predicts 2-year clinical outcomes

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is the Distress and Risk Assessment Method (DRAM)'s Modified Somatic Perception Questionnaire (MSPQ). Increases in MSPQ score decrease the probability of reaching 2-year Oswestry Disability Index (ODI) minimally clinically important difference (MCID).

Hypothesis

Two-year outcomes after ASD surgery can be predicted by a subjective history of depression and DRAM scores.

Design

Retrospective review of prospective, multicenter ASD database.

Introduction

Subjective pre-op depression in ASD was previously associated more with "worst" than "best" outcomes 2 years post-op. As this correlation may be due to pain and disability, we aim to evaluate which mental health screening tool best predicts post-operative ASD outcomes and to isolate whether depression's effect on outcome is a consequence of associated physical disability or a primary psychiatric condition.

Methods

Effects of DRAM subgroup and self-reported pre-op depression on post-operative HRQoL and the probability of achieving ≥ 1 ODI MCID based on MSPQ were assessed.

Results

Of 267 eligible patients, 114 had completed the DRAM questionnaire. Compared to the Normal group ($n=22$), Distressed Somatics ($n=11$) had higher ODI (23.5 points) and lower PCS (-10.9), SRS Activity (-0.9), and SRS Total (-0.8) ($p<0.01$). Distressed Depressives ($n=25$) had lower PCS (-8.4 points) and SRS Total (-0.5) ($p<0.05$). For each additional MSPQ point there was a 0.8-point ODI increase ($p=0.03$). The probability of ≥ 1 ODI MCID improvement ranged from 77-21% for MSPQ scores 0-20, respectively (Table 1).

Of the entire cohort, 66 self-reported depression pre-operatively. These patients had worse pre-op back pain, higher Charlson Comorbidity Indices, BMI, more severe spinal deformity, greater disability (ODI 55vs39) and lower baseline scores of SRS (2.3vs3), PCS (28vs34), and MCS (35vs48) ($p<0.001$). After adjusting for all these differences with a multivariate linear regression analysis, subjective pre-op depression did not correlate with worse 2-year ODI, PCS/MCS, and SRS scores ($p>0.05$).

Conclusion

A subjective history of pre-operative depression does not correlate with worse 2-year outcomes after ASD surgery when controlling for baseline differences in comorbidities, HRQoL, and spinal deformity severity. The DRAM's MSPQ was more predictive than MCS or SRS mental for 2-year outcomes, and should be obtained at baseline as a valuable tool for surgical screening.

MSPQ	Improvement probability of ≥ 1 MCID of ODI (%)
0	77.3
9	52.3
15	34.3
20	21.5

101. ADULT SPINAL DEFORMITY: NATIONAL TRENDS IN THE PRESENTATION, TREATMENT, AND PERI-OPERATIVE OUTCOMES FROM 2003-2010

Peter G. Passias, MD; Cyrus Jalai, BA; Nancy Worley, MS; Bryan Marascalchi, BS, MD; Virginie Lafage, PhD; Thomas J. Errico, MD

United States

Summary

Few studies have investigated postsurgical outcomes for the surgical management of adult spinal deformity (ASD), and even fewer studies have analyzed trends on a nationwide scale. This study revealed changes in surgical approach (decrease in anterior, increase in combined) as well as increased charges, length of hospital stay, and complications with no change in mortality between 2003 and 2010. This study provides clinically useful data for surgeons to educate patients and direct future research to improve patient outcomes.

Hypothesis

Changes in ASD surgical approach and patient outcomes have occurred in the past decade.

Design

Retrospective review of a prospective database.

Introduction

Few studies examine national trends in ASD surgical outcomes. This study investigates outcomes for ASD surgical management, and analyzes these trends on a nationwide scale using data from the Nationwide Inpatient Sample (NIS) from 2003-2010.

Methods

Inclusion criteria were patients diagnosed with ASD between 2003-2010 undergoing an anterior, posterior, or combined surgical approach, age ≥ 25 , and represented in NIS. Patients with fractures, 9+ levels fused, or any cancer were excluded. Measures included patient demographics, hospital system-related data, and total procedure-related complications. Yearly trends were analyzed using univariate analysis and linear regression modeling.

Results

10966 discharge cases (1952 anterior, 6524 posterior, 1106 combined) were identified. Total surgical ASD cases increased by 112.5% ($p=0.029$) from 2004-2010. Number of surgical ASD patients >65 y/o significantly increased from 2003-2010 ($p=0.009$). Yearly trend analysis shows that anterior case number decreased by 13.7% ($p=0.019$), posterior trend increased by 38.9%, though insignificantly ($p=0.084$), and combined increased by 22.7% ($p=0.047$). Total charges for all approaches increased ($p<0.001$).

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Total hospital length of stay for all approaches decreased over the time interval ($p < 0.005$). Overall morbidity for all procedures increased by 22.7% ($p < 0.001$), while mortality didn't significantly change ($p = 0.817$). The most common morbidities in 2003 were hemorrhagic anemia, puncture laceration, and device-related complications, which persisted in 2010 with the exception of increased ARDS and Pulmonary related complications.

Conclusion

For ASD surgery from 2003-2010, anterior procedures decreased, posterior didn't change, and combined increased. Hospital charges increased for all procedures, and length of hospital stay decreased. For all approaches, morbidity increased while mortality didn't change. Given the current healthcare environment, future study is required to develop innovative methods to reduce morbidity and costs.

102. IMPORTANCE OF PATIENT REPORTED INDIVIDUALIZED GOALS WHEN ASSESSING OUTCOMES FOR ADULT SPINAL DEFORMITY (ASD): INITIAL EXPERIENCE WITH A PATIENT GENERATED INSTRUMENT (PGI)

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Summary

A free text patient centered tool in which patients create their own specific outcome measures has been developed (Patient Generated Instrument, PGI). PGI was administered to ASD patients and compared with ODI, SF36, and SRS22r Total for preop and post op correlations and text frequency matching. PGI offers additional information about the patients' individual perspective and does not correlate to baseline ODI and PCS. Patient free text responses overlapped with SRS 22r only 29.8% of time.

Hypothesis

Standardized HRQOL instruments do not adequately represent a patient's individual experience of their disability, nor expression of individualized goals for surgery.

Design

Prospective single center.

Introduction

Current metrics to assess a patient's HRQOL may not reflect a true change in a patients' specific perception of what's most important to them. This study aims to describe the initial experience of an HRQOL instrument (PGI) in which the patients (pts) create and score their own outcome domains.

Methods

Single center prospective study of consecutive ASD pts (>18yr). ODI, SF36 (PCS/MCS) and PGI were administered pre-, and postop at 6wks, 6mos, and 1yr. Pts assigned a pre-treatment score (0[worst]-100[best]) to 6 areas of their lives affected by their spinal condition, and then allocated 60 points across the items they hoped to improve following surgery with a final score of 0(worst)-100(best). PGI correlations with ODI, SF36, SRS22r Total score and text frequency analysis of PGI exact response with text in ODI/SRS22r questionnaires were analyzed.

Results

38 pts with 106 patient encounters were analyzed. PGI written response topics included affect/emotions, relationships, activities of daily life, personal care, work, and hobbies. Mean preop PGI score was 16.3 ± 10.5 and scores did not significantly correlate with preop ODI or PCS, but did with SRS Total ($r = 0.55, p < 0.01$), and MCS ($r = 0.51, p < 0.01$). Postop PGI correlated with all the HRQOL measures ($p < 0.0001$ for all): ODI ($r = -0.66$), PCS ($r = 0.46$), MCS ($r = 0.53$), SRS Total ($r = 0.54$). From 238 PGI written patient goals, these responses exactly matched with ODI and SRS22r text 47.9% and 29.8%, respectively, and 58.8% and 60.9% respectively for categories.

Conclusion

PGI offers additional information about the patients individual perspective. PGI free text responses overlapped with SRS22r only 29.8% of time, and the lack of pre-op correlation with ODI and PCS suggest that these metrics do not adequately reflect individualized patient perceptions of the key determinants of their deformity related disability, nor target areas for surgical improvement.

103. EARLY RECOVERY KINETICS PREDICT 3-YEAR OUTCOMES IN OPERATIVELY TREATED ADULT PATIENTS WITH SPINAL DEFORMITY

Amit Jain, MD; Khaled M. Kebaish, MD; Daniel M. Sciubba, MD; Brian James Neuman, MD; Justin K. Scheer, BS; Frank J. Schwab, MD; Virginie Lafage, PhD; Themistocles S. Protopsaltis, MD; Douglas C. Burton, MD; Justin S. Smith, MD,PhD; Christopher I. Shaffrey, MD; Richard Hostin, MD; Chessie Robinson, MS; Christopher P. Ames, MD; International Spine Study Group United States

Summary

The aim of our study was to analyze the evolution in patient reported outcomes over time in operatively treated ASD patients. We hypothesized that the incremental improvements in patient reported outcomes over the first year may predict the final outcomes at the 3-year follow-up. We found that most significant changes in the ODI and the SRS-22r total scores occurred between the 6-week and the 1-year follow-up. Incremental changes over the first year predicted final outcomes at the 3-year follow-up.

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Hypothesis

In operatively treated adult patients with spinal deformity (ASD), the incremental improvements in patient reported outcomes over the first year after surgery may predict the final outcomes at the 3-year follow-up.

Design

Retrospective analysis of multicenter database.

Introduction

The aim of our study was to analyze the evolution in patient reported outcomes over time in operatively treated ASD patients.

Methods

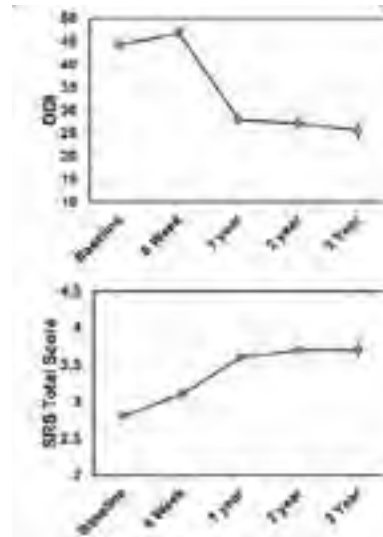
564 patients had operative treatment for ASD; 141 patients had a 3 year follow-up. Total 87 patients (61.7%) had complete ODI data at all intermediate time points and were used for analysis. Multivariate regression models were constructed to assess the relationship between incremental improvements over the first year after surgery, and those at the 3-year follow-up. Significance was set at $P < 0.001$.

Results

Between baseline and the 3-year follow-up, the ODI improved from 38.4 to 25.7 ($P < 0.001$), and the SRS-22r from 2.94 to 3.72 ($P < 0.001$). At the 6-week follow-up, the ODI worsened by 3.1 ($P < 0.001$), while the SRS total score improved by 0.30 ($P < 0.001$). Between the 6-week and 1-year follow-up, the ODI improved by 18.6 ($P < 0.001$), and the SRS-total score improved by 0.55 ($P < 0.001$). There were no significant changes in the ODI or in the SRS total score between the 1-year to 2-year, and the 2-year to 3-year follow-up. There was a significant correlation between the actual improvements in the ODI over the 3-year follow-up (compared to baseline), and the improvement predicted from a multivariate model consisting of baseline to 6-week change and 6-week to 1-year change; correlation coefficient: 0.608 ($P < 0.001$), model adjusted R-squared: 0.357. Similarly, there was a significant correlation between the actual improvements in the SRS total score over the 3-year follow-up, and the predicted improvement; correlation coefficient: 0.604 ($P < 0.001$), model adjusted R-squared: 0.351.

Conclusion

Most significant improvements in the ODI and the SRS-22r total scores occurred between the 6-week and the 1-yr follow-up. A model consisting of incremental improvements from baseline to 6-weeks, and 6-weeks to 1-yr can be used to predict final outcomes at the 3-yr follow-up.



104. DISTAL ILIAC SCREW (DIS) FIXATION TECHNIQUE: AN ALTERNATIVE ILIOPELVIC FIXATION TECHNIQUE IN ADULT DEFORMITY SURGERY

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Turkey

Summary

Distal iliac screw (DIS) fixation technique which has a more distal starting point than traditional iliac screw fixation provided rigid stability for lumbosacral fusion with very low rate of implant related complications even in osteoporotic patients.

Hypothesis

DIS fixation is a good alternative iliopelvic fixation in adult patients undergoing long fusion down to sacrum.

Design

Retrospective study

Introduction

We start to use a freehand distal iliac screw (DIS) fixation with a more distal starting point (posterior inferior iliac spine) as an alternative lumbopelvic fixation technique in adult deformity surgery. DIS fixation does not require any cortical bone resection for entry and has low profile than traditional iliac and S2AI fixation. DIS fixation biomechanically provided greater insertional torques, axial-pull out and toggle forces than traditional iliac fixation in our cadaveric study. The main disadvantage of the technique is the additional distal soft tissue exposure for the placement of the screw. The purpose of this study is to evaluate the clinical outcomes of DIS fixation in adult deformity surgery.

Methods

61 pts (43F,18M) who underwent a long fusion (>5 levels) to the sacrum with DIS fixation were reviewed. Preop, postop, f/up standing AP/L, pelvis AP were reviewed for radiological data.

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Results

Mean age was 61.8 yrs (47-84), mean f/up was 28.8 months (24-38). Ave instr. level was 9.6 levels (5-16). In 42 pts (69%) with BMD<-2.5 T score, cement augmented fenestrated pedicle fixation technique (except S1 and DIS) was performed to augment posterior fixation. Mean iliac screw length was 95.2mm (80-100mm). Iliac screw diameters were 7,5mm in 11 pts, 8,5mm in 26 pts and 9.5mm in 4 pts. In addition to lumbopelvic fixation, interbody fusion for L5-S1 level was performed in 70% (43 pts.) of the patients. Posterior instr. was augmented with multi-rod fixation in 41 pts (67%). Complications related to DIS were ; 6 screws (4.9%) had loosening > 2mm in 3 pts. There were no pseudoarthrosis or implant failure related to lumbosacral joint. ODI showed a significant decrease from 75.6 to 28.4 and VAS scores improved 7.8 to 4.2 postoperatively.

Conclusion

DIS fixation provided the required stability for lumbosacral fusion and demonstrated very low rate of complications even in osteoporotic patients. DIS fixation technique is a good alternative for lumbosacral fixation in adult deformity surgery.



105. SELECTING CAUDAL FUSION LEVELS: 2 YEAR FUNCTIONAL OUTCOMES WITH MATCHED PAIRS ANALYSIS IN MULTILEVEL FUSION TO L5 VERSUS S1

Heiko Koller, MD; Michael Mayer, MD; Oliver Meier, MD; Alec Gabriel Contag, BS; Alan H. Daniels, MD; D.Kojo Hamilton, MD; Justin S. Smith, MD, PhD; Shay Bess, MD; Eric O. Klineberg, MD; Christopher P. Ames, MD; Frank J. Schwab, MD; Robert A. Hart, MD; International Spine Study Group

Germany

Summary

A retrospective analysis of a validated stiffness measure (LSDI) among ASD patients with multilevel thoracolumbar fusions with caudal fixation ending at L5 or S1 was performed. Patients were matched by ODI, SVA, age and number of fusion levels with 40 patients in each group. At 2-year minimum follow-up there was no significant

difference in stiffness related limitations between the L5-group or S1-group. Lumbosacral fusions with caudal fixation ending at L5 vs. S1 result in comparable lumbopelvic function.

Hypothesis

Fusions to L5 will preserve greater function compared to patients with fusions to sacrum.

Design

Retrospective, matched-pairs study with 2 year follow-up (F/U).

Introduction

Controversy persists on whether to end multilevel fusions caudally at L5 or S1. Some argue that stopping at L5 may preserve greater function, but there are few data comparing functional limitations due to lumbar stiffness in patients with fusion to L5 vs S1. This study evaluates this question using 2 year retrospective data.

Methods

Patients undergoing thoracolumbar fusion ≥ 5 levels to L5 or S1, with solid healing ≥ 2 years F/U, were included. 40 patients with distal stopping point of L5 from a single center were matched with a subset of 40 patients with a distal endpoint of S1 +/- pelvic fixation. S1 patients were selected from a multi-center database of 197 patients. The L5- and S1-groups were matched for ODI, Sagittal Vertical Axis (SVA C7-S1), number of fusion levels, and age. Impacts of lumbar stiffness on function as measured by the Lumbar Stiffness Disability Index (LSDI) were compared using a Wilcoxin test.

Results

After matching, there were no significant baseline differences between the L5-group and S1-group for final ODI (29 ± 22 vs. 29 ± 22), SVA (34 ± 38 vs 30 ± 40 mm), patients with age >50yrs (75% vs 88%), and number of fusion levels (9 ± 3 vs 10 ± 3 levels). Final LSDI scores were not significantly different between the L5-group (29 ± 22) and S1-group (28 ± 21 ; $p=.8$). Functional limitations due to pain (ODI) and stiffness (LSDI) both showed significant correlation with sagittal imbalance (SVA, $p<.01$ / $p<.01$) and age ($p=.03$ / $.04$). ODI and LSDI scores also demonstrated a significant positive correlation ($r=0.7$, $p<.0001$).

Conclusion

Analysis of patients with multilevel lumbar fusions demonstrated that after minimum 2 year follow-up, self-reported functional impacts of lumbar stiffness were not significantly different between patients having fusion to L5 versus fusion to S1. Matching according to baseline ODI and SVA suggest that residual pain and spinal sagittal imbalance may have larger influence on perceived stiffness than selection of caudal fusion level.

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106. EFFICACY AND SAFETY OF RILUZOLE IN ACUTE SPINAL CORD INJURY (SCI). RATIONALE AND DESIGN OF AOSPINE PHASE III MULTI-CENTER DOUBLE BLINDED RANDOMIZED CONTROLLED TRIAL. (RISCIS).

Michael G. Fehlings, MD, PhD, FRCSC; Branko Kopjar, MD, PhD, MS; Robert Grossman, MD

Canada

Summary

This abstract describes the rationale and design for ongoing multi-center double-blinded randomized controlled trial of efficacy and safety of riluzole in patients with acute spinal cord injury.

Hypothesis

The working hypothesis is that the riluzole treated subjects will experience superior motor, sensory, functional, and quality of life outcomes as compared to those receiving placebo, with an acceptable safety profile.

Design

Multi-center, international double-blinded phase III RCT.

Introduction

There is convincing evidence from the preclinical realm that the pharmacologic agent riluzole attenuates certain aspects of the secondary injury cascade leading to diminished neurological tissue destruction in animal SCI models. The safety and pharmacokinetic profile of riluzole have been studied in a multicenter pilot study in 36 patients. Efficacy of riluzole in acute human SCI has not been established.

Methods

This ongoing multi-center, international double-blinded phase III RCT will enroll 351 patients with acute C4-C8 SCI and ASIA Impairment Grade A, B or C randomized 1:1 to riluzole and placebo. Primary outcome is the change in ASIA Motor Score (AMS) between baseline and 180 days. Other outcomes include ASIA Upper and Lower Extremity MS; ASIA Sensory Score; ASIA grade; SCIM); SF-36v2; EQ-5D and GRASSP. Two-stage sequential adaptive trial statistical design has 90% power to detect 9 points difference in the ASIA Motor Score at one-sided alpha = .025.

Results

A matched cohort analysis performed in the Phase I study showed that riluzole treated cervical SCI patients experienced an additional 15.5 points in AMS recovery at 90 days post injury. Although the phase I study was underpowered to investigate efficacy the current phase II/III study is poised to definitively address this question. Subject enrollment for this trial began on October 1, 2013 in 11 international centers.

Conclusion

This is a Phase III study of riluzole in acute SCI.

107. INCIDENCE OF COMPLICATIONS AFTER THERAPEUTIC ANTICOAGULATION IN THE POSTOPERATIVE SPINE TRAUMA PATIENT

Ehsan Jazini, MD; Brian Shiu, MD; Elizabeth Le, MD; Timothy Costales, MD; Nicholas Caffes, MD; Ebrahim Paryavi, MD, MPH; Daniel E. Gelb, MD; Eugene Koh, MD; Bizhan Aarabi, MD; Steve Ludwig, MD

United States

Summary

This represents the first attempt to quantify complications secondary to therapeutic doses of anticoagulation after spine surgery. We found a relatively high rate of complications requiring reoperation, including a 3% incidence of spinal epidural hematoma compared to a historical epidural hematoma rate of 0.2%. Initial anticoagulation using a heparin infusion compared to low molecular weight heparin may increase the rate of reoperation.

Hypothesis

We hypothesize a high complication rate following therapeutic anticoagulation in the postoperative spine trauma patient.

Design

Retrospective clinical study.

Introduction

There have been numerous studies on prophylactic anticoagulation after spinal surgery but none have investigated the risks of therapeutic anticoagulation for treatment of a thromboembolic event.

Methods

Patient selection criteria included those who: 1) underwent spinal surgery and 2) sustained a thromboembolic event (pulmonary embolism, deep vein thrombosis or myocardial infarction). Patients were excluded if: 1) the thromboembolic event was sustained before spinal surgery, 2) anticoagulation was sub-therapeutic (PTT < 60, INR < 2), or 3) medical records were not available. Of 1,712 patients at a level-1 trauma center, 63 patients met these criteria (2001-2014).

Results

Initial anticoagulation was obtained by a heparin infusion, LMWH, and warfarin in 50.7%, 46.0%, and 3.2% patients, respectively. After postoperative initiation of therapeutic anticoagulation, 17.5% of patients sustained complications requiring return to the operating room with 10/11 patients returning within the first 26 days. 3% of patients underwent re-exploration due to the development of epidural hematomas causing neurologic decline; both patients were initially anticoagulated by heparin infusion. Remaining patients required reoperation due to wound infection, hemorrhage from tracheostomy site, and pseudoarthrosis. Our multivariate model demonstrated a 13.3 times higher odds (p=0.039) for reoperation due to a spinal surgery complication and a 17.9 times higher odds (p=0.048) for reoperation for any reason.

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with the initial use of a heparin infusion compared to LMWH. Thromboembolic complications and subsequent anticoagulation occurred at an average of 10.3 and 12.5 days after surgery, respectively.

Conclusion

To our knowledge, this represents the first attempt to quantify complications secondary to therapeutic doses of anticoagulation after spine surgery. We found a relatively high rate (17.5%) of complications requiring reoperation, including a 3% incidence of spinal epidural hematoma compared to a historical epidural hematoma rate of 0.2%.

108. IS THERE A ROLE OF SPINAL CORD MONITORING IN SURGERIES FOR PATIENTS WITH TRAUMATIC SPINAL INJURIES?

May Lin Yin; Gabriel Liu, FRCSC; Wei Ket Yang, BS; Naresh Satyanarayan Kumar, FRCSC; Leok-Lim Lau, MD; Joseph Shanthakumar Thambiah, FRCSC, MBBS; Hee Kit Wong, MD
Singapore

Summary

This study retrospectively reviewed the usefulness of spinal cord monitoring in emergency surgeries in patients with traumatic spinal injury. No SSEP, MEP and EMG were recordable in all ASIA A and most ASIA B pts pre, intra, and post-operatively. There was no false+ve or false-ve identified in ASIA A and B pts. The results suggest that routine use of spinal cord monitoring is not required.

Hypothesis

Spinal cord monitoring is not always necessary in surgeries performed on patients with ASIA score A and B.

Design

Retrospective review.

Introduction

Spinal cord monitoring is a standard of care for pts undergoing routine spinal deformity surgeries. However there is no published data on its usefulness during surgery for pts with spinal cord injury. There is no statistical difference between patients from all categories.

Methods

Retrospective review of spinal cord monitoring in emergency surgeries performed between Nov 2010 to Dec 2014 in a university hospital were examined. Pts are classified according to the type of spinal injuries as well as American Spinal Injury Association (ASIA) scores. Pre-operative and intra-operative somatosensory evoked potentials (SSEPs), transcranial motor evoked potentials (Tc-MEPs) and Electromyography (EMG) recorded were analyzed and compared to the clinical findings.

Results

126 consecutive pts are identified. The average age of the pts is 50 years (12~83). The injury levels include cervical (n=50), thoracic (n=56) and lumbar (n=20) and the data were further classified according to the type of injury; chance fracture (n=5), burst fracture (n=19), fracture dislocation (n=28), pathological fracture (n=36) and cord compression without fracture (n=38). 24, 8, 22, 43, and 29 pts are classified as ASIA A, B, C, D and E respectively.

Preoperative SSEP and MEP were unrecordable in all pts with ASIA A and 6 pts of ASIA B. 2 ASIA B pts had normal SSEP baseline but no MEP. All baselines remained unchanged intraoperatively and postoperatively in both ASIA A and B pts. Postoperative sensory recovery was found in all studied pts except ASIA A pts as no functional recovery was recorded upon hospital discharge. An average of one grade motor power improvement was seen in pts with ASIA B, C, and D upon hospital discharge. No false+ve was noted. 1 true+ve in an ASIA E pt and 1 false-ve in ASIA D pt were found.

Conclusion

Based on this study, the author does not recommend the routine use of spinal cord monitoring in pts with ASIA A and B. This will ease the cumbersome logistics in emergency surgeries and improve cost savings for pts with traumatic spinal injury.

109. ROLE OF BISPHOSPHONATES AS ADJUVANTS IN GCT OF SPINE

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India

Summary

Bisphosphonates are established adjuvant in treatment of GCTB of extremities but its role in spinal GCTB is still under investigation. We retrospectively evaluated Spine GCTB cases operated at our center and divided them in two groups depending on presence and absence of administration of bisphosphonates postoperatively. Results of two groups were compared. Presence of sclerosis in all patients on post operative CT scans and absence of recurrence in patients who received bisphosphonates established that they are effective adjuvant treatment modality.

Hypothesis

Bisphosphonates are effective treatment modality as adjuvant in spinal GCT.

Design

Retrospective Study.

Introduction

Spinal Giant Cell Tumour of Bone (GCTB) accounts for 2.7% - 6.5% of all GCTBs. Many challenges are involved in treatment of spine GCT, such as complete excision is associated with increased morbidity, chemotherapy is not effective and radiotherapy can cause complications like myelitis and malignant transformation. Role of bisphosphonates is well established in GCTBs of extremities but its role in spine GCTBs is still not established.

Methods

Retrospective analysis of all the patients of Spine GCT operated at All India Institute of Medical Sciences (AIIMS), New Delhi was done from July 2005 to Jan 2015. Patients were divided in two groups depending on the absence or presence of administration of bisphosphonates

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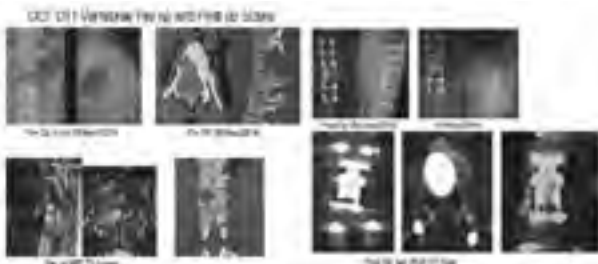
postoperatively in dose of 70mg Alendronate once a week. Pre and post operative radiographs and CT scans were studied and evaluated for the presence of the sclerosis. Results of two groups were compared statistically. Bisphosphonates were considered to be effective if either sclerosis or new bone formation was present with no tumour tissue.

Results

13 cases of Spine GCT were operated from July 2005 to Jan 2015 at AIIMS, New Delhi. Out of 13 cases, 6 patients received bisphosphonates postoperatively. Eight patients were female and five patients were male with age ranging from 13 to 55 years and average age of 29.5 years. Six patients were of GCT Sacrum and one patient each of D9, D11, L2, L4 and two patients of L5 vertebrae. Average follow up period was 36.84 months. Post operative sclerosis was present in all 6 patients in whom bisphosphonates were given. Mean VAS score and Mean ODI score were comparable in both groups both pre and post operatively. No recurrence of tumour was present in bisphosphonate group but two patients had recurrence in patients who didn't receive bisphosphonates and one of them died.

Conclusion

Bisphosphonates are effective and safe adjuvant therapy alongwith appropriate surgical intervention in Spinal GCTBs and may have role in decreasing the recurrence of the tumour although studies with larger sample size are required to put it on firm footing.



110. SURVIVAL AND CLINICAL OUTCOMES IN PATIENTS WITH METASTATIC EPIDURAL SPINAL CORD COMPRESSION: RESULT OF THE A AOSPINE PROSPECTIVE MULTI-CENTRE STUDY OF 142 PATIENTS

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Canada

Summary

This study aimed to prospectively evaluate surgical outcomes in terms of survival, neurological, functional, and QoL using outcome measures suitable for MESCC patients.

Hypothesis

Surgery improves pain, neurological, functional, and overall quality of life in selected MESCC patients.

Design

Prospective Multi-Centre Study.

Introduction

Management of MESCC is palliative and seeks to promote quality of life (QoL) at an acceptable risk. Although more patients undergo surgical treatment, the impact of surgery on QoL is not well known.

Methods

142 surgically treated patients for a single symptomatic MESCC lesion enrolled in a prospective North American multi-center study were followed up for 12 months. Clinical data were obtained pre- and postoperatively and included ASIA scores, SF-36, Oswestry Disability Index (ODI), and EQ-5D.

Results

Indications for surgery were: neurological deficits (40%), intractable pain (39%), and spinal instability (21%). Surgeries involved a median of 5 spinal levels (1 - 18 levels); 94% of patients had spinal reconstruction. The median survival was 7.7 months. Lung and breast cancer had the shortest and longest median survival (4.5 vs. 12.3 months). The 30-day and 12-month mortality rate were 9% and 62%, respectively. Overall, surgery improved ambulatory status (73% vs 87%), bladder (17% vs 8%) and bowel dysfunction (13% vs 4%). Overall, 67.5% of ASIA B, C, or D patients gain at least 1 grade after surgery, 25% remained stable, and 7.5% deteriorated, while 94% of ASIA E patients remained neurologically intact. ODI, EQ-5D, pain severity and pain interference scores were significantly improved at each follow-up ($p \leq 0.01$). SF-36 scores were generally higher after surgery for mental and physical components, and for physical functioning, physical role limitation, general status and social functioning, but not for the energy domain. The incidence of wound complications was 7% and 2 patients required a second surgery for screw malposition and epidural hematoma.

Conclusion

Surgical treatment provides immediate and maintained improvement in pain, neurological, functional, and quality of life with acceptable risks in selected MESCC patients.

111. EWING'S SARCOMA OF THE SPINE: SURVIVAL AND LOCAL CONTROL IN SURGICALLY TREATED PATIENTS

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United States

Summary

An ambispective multicenter database of surgically treated patients with Ewing's sarcoma of the spine was analyzed to investigate whether Enneking appropriate surgery (en bloc resection with negative margins) impacts patient survival and local control.

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Hypothesis

Enneking appropriate surgical management of Ewing's sarcoma of the spine decreases local recurrence and increases survival.

Design

The AOSpine Knowledge Forum Tumor performed a multicenter ambispective cohort study of surgically treated patients with primary Ewing's sarcoma of the spine.

Introduction

Primary Ewing's sarcoma of the spine is a rare and challenging tumor to treat because of its high rate of local recurrence. The role of surgery is not clearly defined. The aim of this study was to evaluate the influence of Enneking classification on survival and local control in surgically treated patients diagnosed with primary Ewing's sarcoma of the spine.

Methods

Patient demographic, diagnosis, treatment, cross-sectional survival, and local recurrence data were collected. Patients were divided into two cohorts: Enneking appropriate (EA) and Enneking inappropriate (EI) based on surgical margins. They were categorized as EA when the final pathological assessment of the margin matched the Enneking recommendation (en bloc resection with negative margins). Otherwise, they were categorized as EI.

Results

Between 1981 and 2012, 59 patients diagnosed with primary Ewing's sarcoma of the spine underwent surgery. Enneking appropriateness of surgery was known for 55 patients; 25 (45%) treated were EA and 30 (55%) treated were EI. The 5-year postoperative survival was 76% (N=19) for EA patients and 50% (N=15) for EI patients. A significant difference in favor of longer survival for EA-treated patients was found (P=0.033). In addition to surgery, most patients received chemotherapy treatment. Timing of chemotherapy was significantly associated with increased survival (P=0.007). Local recurrence occurred in 25% (N=6) of patients with an EA procedure versus 39% (N=11) of patients with an EI procedure. The rate of local control was not significantly different between Enneking cohorts (P=0.235).

Conclusion

Primary spinal Ewing's sarcoma requires multidisciplinary treatment. An EA surgical procedure is associated with longer survival and better local control, and when feasible, should be the surgical treatment of choice.

112. PREOPERATIVE EMBOLIZATION IN SURGICAL TREATMENT OF SPINAL METASTASES: A RANDOMIZED CLINICAL TRIAL OF EFFICACY IN DECREASING INTRAOPERATIVE BLOOD LOSS

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Denmark

Summary

An increasing number of patients undergo surgical treatment for symptomatic spinal metastasis. In this randomized study patients undergoing preoperative embolization had a reduction in intraoperative blood loss; however not significant; 618 ml. vs. 735 ml (P = 0.270). In the embolization group, however, the duration of surgery was significantly reduced; 90 minutes vs. 124 minutes (P = 0.031).

Hypothesis

The hypothesis of the present study was that pre-operative embolization significantly reduces the peri-operative blood loss in surgical treatment of patients with spinal metastasis.

Design

Single-blind, one-center, randomized, controlled trial.

Introduction

Substantial blood loss and allogenic blood transfusion is associated with an increased risk of complications in oncological patients undergoing surgical treatment. The role of pre-operative embolization in patients with spinal metastasis has not been assessed in a prospective, randomized study.

Methods

This randomized, controlled, single-center trial was approved by the national committee on biomedical research ethics and preregistered. Informed consent was obtained and the study period was from May 2011 until March 2013.

All participants were scheduled for decompression and posterior instrumentation and were randomly assigned to either 1) preoperative arteriography and embolization the embolization group or 2) preoperative arteriography the control group.

Primary outcome: intraoperative blood loss. Secondary outcomes: perioperative blood loss, allogenic RBC transfusion and duration of surgery. Analyses were by intention-to-treat (ITT).

Results

Forty-five randomized patients were available for the ITT. Mean intraoperative blood loss did not differ significantly (P = .270) between the embolization group (618 ml [SD, 282 ml]) and the control group (735 ml [SD, 415 ml]). Neither did perioperative blood loss and allogenic RBC transfusion. The duration of surgery, however, was significantly shorter in the embolization group (P = .031): median 90 minutes (range, 54-252) vs. 124 minutes (range, 80-183). Thirty-four of 45 metastases (76%) were hypervascular.

Conclusion

Preoperative embolization does not result in a reduction of intraoperative blood loss, perioperative blood loss and blood transfusion, but reduces the duration of surgery for symptomatic metastatic spinal cord compression.

113. Mobile Spine Chordoma: Results of 166 Patients from the AOSpine Knowledge Forum Tumor

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United States

Summary

The goal of this study was to review the outcomes of surgically treated patients with mobile spine chordoma at multiple international centers.

Hypothesis

Enneking appropriate surgical management of primary mobile spine chordoma decreases local recurrence and increases survival.

Design

The AOSpine Knowledge Forum Tumor performed a multicenter ambispective cohort study where data were collected between 1988 and 2012 about prognosis-predicting factors including various clinical characteristics and surgical technique for mobile spine chordoma.

Introduction

Chordomas are primary spinal tumors that grow via an indolent course, but have devastating effects on the lives of patients. En bloc surgical resection remains the preferred treatment to maximize patient outcomes, yet there have been few large-scale studies about chordoma of the mobile spine.

Methods

Tumors were classified according to Enneking principles and analyzed in two treatment cohorts: Enneking appropriate (EA) and Enneking inappropriate (EI). Patients were categorized as EA when the final pathological assessment of the margin matched the Enneking recommendation, and otherwise, they were categorized as EI. All factors were evaluated according to local recurrence and survival. Univariate and multivariate analyses were performed.

Results

A total of 166 patients (55 female; 111 male) with mobile spine chordoma were included. The median patient follow-up was 2.6 years. Fifty-eight (41%) patients were EA and 84 (59%) patients were EI. The type of biopsy ($P<0.001$), spinal location ($P=0.018$), and whether the patient received adjuvant therapy ($P<0.001$) were significantly different between the two cohorts. Altogether, 58 (35%) patients suffered a local recurrence and 57

(34%) patients died. Median survival was 7.0 years postoperative; 8.4 years postoperative for EA patients and 6.4 years postoperative for EI patients ($P=0.023$). Multivariate analysis showed the EI procedure was significantly associated with an increased risk of local recurrence compared to the EA procedure (HR: 7.02; 95% CI: 2.96, 16.6; $P<0.001$); although, no difference for survival was observed.

Conclusion

Enneking appropriate surgical resection plays a major role in decreasing the risk for local recurrence for patients with chordoma of the mobile spine.

114. REVISION SURGERY AFTER INCOMPLETE RESECTION OF CHORDOMA OF THE CERVICAL SPINE

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Switzerland

Summary

The available literature suggests significantly worse outcomes after revision surgery than after primary surgery for chordoma of the cervical spine.

We achieved a 5-year progression-free survival rate of 72.6% after revision surgery for cervical chordoma.

Hypothesis

With thorough preoperative planning, appropriate surgical techniques and the addition of adjuvant radiation therapy, one can achieve results similar to those for primary surgery.

Design

A retrospective cohort study of 24 patients treated for cervical spine chordoma remnant or recurrence.

Introduction

Chordomas rarely metastasize but due to the high local recurrence rate prognosis is not good. There is a paucity of literature regarding the outcome after treatment of recurrent chordomas. This study reports on survival rate and complications in patients treated with chordoma remnants or tumor recurrence at the cranio-cervical junction or in the cervical spine.

Methods

24 patients with cervical spine chordoma remnant (Rc) or remnant-recurrence (RRc), treated in our department between 1999 and 2012, were reviewed retrospectively at an average 37.5 mo (range, 4 to 102 mo) follow-up. All patients had undergone at least one previous surgery. The average time between the latest surgery and admittance to our department was 4 mo (range, 2 to 6 mo) in Rc-group and 12.1 mo (range 4 to 21 mo) in RRc-group. Average age was 44.3 years (range, 5 to 86). The chordomas were located at the cranio-cervical junction (N=13), mid-cervical levels (N=9) and the low-cervical spine (N=2). X-ray, CT, MRI and angiography were performed to determine the extent of the tumor, signs of instability and encasement/displacement of vertebral arteries. All patients underwent single- or multi-staged tumor removal. Postoperatively, 4 patients received

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adjuvant proton beam radiation therapy and 12 patients had additional combined photon- and proton beam radiation therapy. We analyzed the surgical margins, spinal stability, short- and long-term complications, local tumor recurrence rate and morbidity rate.

Results

R0 resection was achieved in 17 cases. Dehiscence of the pharyngeal wall was the most common long-term complication (7 cases). No instability was observed. The 5-year progression-free survival rate was 72.6 %.

Conclusion

With thorough preoperative planning, appropriate surgical techniques and the addition of adjuvant radiation therapy, one can achieve results similar to those for primary surgery.

115. EFFECT OF INCLUSION OF ASYMPTOMATIC SPONDYLOTIC LEVELS ON ADJACENT SEGMENT DISEASE FOLLOWING ACDF

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United States

Summary

The present study examines rates of adjacent segment disease following anterior cervical discectomy and fusion in a review of a large prospectively collected database. In the present study the overall rate of adjacent segment disease was low with no association with disease rate and number of levels fused.

Hypothesis

The application of neuroradiology, evolving technology, and differing clinical decision making with inclusion of asymptomatic spondylotic levels will be associated with a decreased incidence of symptomatic adjacent segment disease following ACDF.

Design

Database Review.

Introduction

This study examined the incidence of symptomatic adjacent segment disease with new radiculopathy or myelopathy referable to a motion segment adjacent to the site of a previous anterior arthrodesis of the cervical spine.

Methods

A consecutive series of 570 patients who had a total of 603 anterior cervical arthrodesis for the treatment of cervical spondylosis with radiculopathy or myelopathy, or both, were followed for a maximum of thirteen years after the index operation. The annual incidence of symptomatic adjacent-segment disease was defined as the percentage of patients who had been disease-free at the start of a given year of follow-up in whom new disease developed in that year leading to subsequent surgical intervention. The prevalence was defined as the percentage of all

patients in whom symptomatic adjacent-segment disease developed within a given period of follow-up. Kaplan-Meier survivorship analysis was used to characterize the natural history.

Results

Symptomatic adjacent-segment disease occurred at a relatively constant incidence of 1.6 percent per year (range, 0.0 to 2.8 percent per year) during the ten years after the index operation. Survivorship analysis predicted that 14.5 percent of the patients (95 percent confidence interval, 7.3 to 21.7 percent) who had an anterior cervical arthrodesis would have new disease at an adjacent level within ten years after the operation. In the present study no statistically significant difference was observed in rates of adjacent segment disease between groups based on number of levels fused.

Conclusion

Inclusion of asymptomatic spondylotic levels was associated with lower rates of adjacent segment degenerative disease in the presented study population.

116. THE EFFECT OF LOCAL INTRAOPERATIVE STEROID ADMINISTRATION ON THE RATE OF POST-OPERATIVE DYSPHAGIA FOLLOWING ACDF: A NATIONAL DATABASE STUDY OF 245,754 PATIENTS

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United States

Summary

A national health-insurance administrative database was utilized to compare rates of postoperative dysphagia following short and long ACDF in patients who received intraoperative local steroids and those who did not. Steroid administration in patients undergoing long ACDF significantly reduces the rate of postoperative dysphagia, with no difference in postoperative infection rates between groups. Additionally, use of local steroid was associated with significantly reduced length of stay in both ACDF groups.

Hypothesis

We hypothesize that intraoperative administration of steroids is associated with decreased rates of postoperative dysphagia in patients undergoing ACDF, without any increase in infection.

Design

Retrospective review.

Introduction

Literature on the effectiveness of intraoperative local steroid administration following ACDF has been limited to small institutional studies describing conflicting results.

Methods

A national health-insurance administrative database was utilized to characterize and compare rates of dysphagia within 90 days postoperatively in patients who received intraoperative local steroid following short (1-2 level) ACDF (n=1,310) and a control group of short ACDF

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patients that did not (n=198,690); patients who received intraoperative steroids following long (3 or more level) ACDF (n=257) and a control group without local steroid (n=45,497). Subsequent 90-day postoperative dysphagia rates, 90 day infection and wound complication rates and average length of stay (LOS) were then evaluated and compared. Odds ratios (OR), 95% confidence intervals (CI) and P values were calculated using SPSS.

Results

Use of intraoperative local steroid was associated with a significantly lower rate of postoperative dysphagia in patients who underwent long ACDF (9.3% versus 14.6%, OR 1.7, p = 0.022), but not in patients who underwent short ACDF (7.3% versus 8.4%, OR 1.1, p = 0.195) [Table 1]. The mean difference in average LOS was 1 day less for patients who received intraoperative local steroid for both short and long ACDF (p < 0.0001) [Table 1]. The combined rate of infection/wound complications was not significantly different between those patients who received local steroids and those who did not (1.5% vs 1.6%, OR 0.9, 95% CI 0.6-1.4, p = 0.811).

Conclusion

Use of local intraoperative steroid is associated with a significantly reduced rate of postoperative dysphagia after long (3 level or greater) ACDF and a reduced average length of stay for both long and short (1 to 2 level) ACDF. No association between local intraoperative steroid and postoperative infection or wound complications was noted.



117. POLYURETHANE ON TITANIUM UNCONSTRAINED CERVICAL DISC ARTHROPLASTY VERSUS ANTERIOR CERVICAL DISCECTOMY AND FUSION FOR THE TREATMENT OF CERVICAL DISC DISEASE. A REVIEW OF LEVEL I-II RANDOMIZED CLINICAL TRIALS INCLUDING CLINICAL OUTCOMES

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Spain

Summary

A review of 10 level I-II RCTs comparing clinical and radiological outcomes of patient undergoing cervical arthroplasty with polyurethane on titanium unconstrained cervical disc (PTUCD) and ACDF was performed. A total of 562 patients were randomly assigned into the cervical arthroplasty group and 539 into the ACDF. The impact of both surgical techniques on the cervical spine (radiological deterioration and/or complications) was more severe in patients undergoing ACDF. However, the surgical revision rate at any cervical level was equivalent for ACDF and PTUCD arthroplasty.

Hypothesis

To date, a compilation of the clinical and radiologic outcomes and adverse events of anterior cervical discectomy and fusion (ACDF) compared with a single cervical disc arthroplasty (CDA) design, such as the polyurethane on titanium unconstrained cervical disc has partially accomplished.

Design

Review of randomized clinical trials with evidence level I-II

Introduction

The controversy concerning the benefits of unisegmental CDA over ACDF is still open because (RCTs) comparing ACDF with cervical arthroplasty have been highly inconclusive. Most of these studies mixed disc prosthesis with dissimilar kinematic characteristics.

Methods

Only RCTs reporting clinical outcomes were included in this review. After a search on different databases including PubMed, Cochrane Central Register of Controlled Trials, and Ovid MEDLINE, a total of 10 RCTs out of total 51 studies were entered in the study. RCTs were searched from the earliest available records in 2005 to December 2014

Results

Five studies were Level I, and five were Level II. A total of 562 patients were randomly assigned into the PTUCD group and 539 patients into the ACDF group. The mean follow-up was 30.9 months. Patients undergoing CDA had lower Neck Disability Index, and better SF-36 Physical component scores than ACDF patients. Patients with CDA had less radiological degenerative changes at the upper adjacent level. Overall adverse events were twice more frequent in patients with ACDF. The rate of revision surgery including both adjacent and index level showed no statistically significant differences.

Conclusion

This review of evidence level I-II RCTs comparing clinical and radiological outcomes of patient undergoing PTUCD arthroplasty or ACDF indicated a global superiority of the disc arthroplasty. The impact of both surgical techniques on the cervical spine (radiological spine deterioration and/or complications) was more severe in patients undergoing ACDF. However, the rate of revision surgeries at any cervical level was equivalent for ACDF and PTUCD arthroplasty

118. NEW TECHNIQUE OF C2 DECOMPRESSION WITH PRESERVING C2 ATTACHED MUSCLES FOR CERVICAL MYELOPATHY DUE TO OPLL OF CERVICAL SPINE

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Japan

Summary

Our C2 decompression method (DD from caudal side and TDD from cranial and caudal sides) with preserving C2 attached muscles produced enough decompression of C2 for OPLL patients that has OPLL exceeding the C2 level.

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We could safely perform decompression of C2 without C2 laminectomy or dissection of C2 attached muscles. Key point of DD and TDD is to perform C3 complete decompression after C2 decompression.

Hypothesis

To evaluate our C2 decompression method preserving muscles attached to C2.

Design

Retrospective study.

Introduction

C2 laminectomy has generally been done for C2 OPLL. However, C2 occupies a pivotal position for cervical alignment and stability. So, proper methods to preserve the C2 spinous process should be selected.

Methods

31 patients with an average age of 63.5 years were retrospectively reviewed with an average follow-up period of 5.3 years (>2 years). All patients underwent C2 decompression including C3-6 (7) laminoplasty for OPLL. Our C2 decompression methods involve two methods. First is C2 dome decompression (DD) from caudal side of C2 for OPLL in the C2 level, and second is C2 tunneled dome (TDD) from cranial and caudal sides of C2 for OPLL in more than C2 level. 25 patients had C2 DD and 6 patients had C2 TDD. Radiographic parameters included cervical range of motion (ROM), cervical lordotic angle (LA, C2-7 angle) and MRI findings after decompression. Clinical parameters included recovery rate using JOA score, neck pain and activities of daily living (ADL) disturbance that involves 4 items (full score: 8 points) of neck motion (look up, down and back) and shoulder stiffness (severe 0, slight 1, normal 2 point).

Results

The average pre and post-operative follow-up ROM were 33.7 degrees and 19.0 degrees. The average pre and post-operative LA were 20.9 degrees and 19.2 degrees. MRI revealed enough decompression at C2 level. ADL disturbance was observed in 20 cases with an average of 5.9 points. Of those cases, 3 cases had severe limitation of look down. 14 cases had shoulder stiffness and 2 cases had slight neck pain. The average pre and postoperative JOA score were 11.1 points and 14.2 points. Recovery rate was 54.2%. There was no difference on the postoperative ROM, LA and ADL disturbance between this study and C3-7 laminoplasty group (22 cases, >10 years follow-up) that we underwent.

Conclusion

Our TDD and DD methods without dissecting C2 attached muscles produced enough decompression and clinical outcomes. Our methods are useful and safety procedures for OPLL exceeding C2 level.

119. FULL BODY DYNAMIC RADIOGRAPHIC ANALYSIS OF LAMINOPLASTY VERSUS POSTERIOR CERVICAL DECOMPRESSION AND FUSION PATIENTS CORRELATED TO HRQOL

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United States

Summary

Cervical laminoplasty (LP) and posterior cervical decompression and fusion (CDF), are both utilized in the treatment of cervical myelopathy. In CDF patients, C2-C7 plumbline (CPL) greater than 4cm is associated with worse health related quality of life scores (HRQOL). Little is known about how dynamic motion of the spine differs in CDF and LP patients. CDF patients had more cervical deformity, more cervical stiffness, less cranial motion and they had to recruit more pelvic motion to generate neck flexion/extension.

Hypothesis

CDF patients will have less motion than LP patients with no difference in HRQOL.

Design

Retrospective.

Introduction

Postoperative cervical deformity is associated with poor outcomes after cervical surgeries. Little is known about how regional and global spinal alignment and dynamic motion affect neck pain and function.

Methods

Full body standing radiographs were obtained in neutral and cervical flexion/extension in CDF and LP patients. HRQOL included NDI and mJOA. Established cervical parameters included C2-C7 angle (CL), C2-C7 plumbline (CPL), C2 slope (C2S), cranial slope (C0 slope), T1 slope (TS), TS-CL, C0-C2 angle (COC2A), and a range of these parameters in flexion/extension. Global alignment parameters and spinopelvic measures included novel ones: CTPA and TPA (Figure), and established ones: pelvic tilt, thoracic kyphosis and lumbar lordosis. Dynamic and static radiographic parameters were correlated to HRQOL and group comparisons were made.

Results

36 patients (mean age 61) were included with 56% male and mean follow-up 34 months. Mean NDI and mJOA were 13.2±11.4 and 15.0±2.7. mJOA correlated with C2S ($r=-0.340$, $p<0.05$) and CTPA ($r=-0.390$, $p<0.05$). Flexion/extension range for CL, C2S, CTPA and McGregor's Slope correlated with mJOA ($r=-0.496$, 0.409 , 0.355 , 0.376 , all $p<0.05$). Differences in CDF and LP were found in TS-CL (30.0° vs. 19.1° $p=0.028$), C2S (30.7° vs. 19.9° , $p=0.033$) and the flexion/extension range for CL (11.1° vs. 26.7° , $p=0.002$) and Pelvic Tilt (2.2° vs. 0.7° , $p=0.039$). No differences existed in age, sex or follow up time between

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LP and CDF. LP patients had a larger arc of cranial motion in flexion/extension (60.4° vs. 29.5° , $p < 0.05$). CTPA correlated with C2-C7 plumbline ($r = 0.92$, $p < 0.05$) and TS-CL ($r = 0.77$, $p < 0.05$) as a measure of cervical sagittal alignment.

Conclusion

Cervical sagittal deformity as defined by larger CTPA and C2 slope correlated with lower mJOA. While the groups did not differ in CTPA or cervical plumbline, the CDF group had a larger TS-CL, a marker of cervical deformity, more cervical stiffness and less cranial motion. CDF had to recruit more pelvic motion for cervical flexion/extension.



120. STAND-ALONE ANTERIOR MULTIPLE LEVELS CERVICAL CAGE

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Egypt

Summary

A retrospective study of patients with cervical spondylotic radiculopathy and or myelopathy surgically treated in the same institution with a three to four levels anterior Cervical discectomy and fusion using stand-alone cages

Hypothesis

To assess the clinical and radiological efficacy of standalone multiple level cervical cages in treatment of degenerative cervical disc disease.

Design

Retrospective study.

Introduction

Anterior Cervical discectomy and fusion is common surgical procedure for treatment of cervical spondylotic radiculopathy and or myelopathy after failure of conservative management. Previous studies multilevel cervical discectomies and fusion have shown decrease in fusion rates with increase number of surgical levels fusion.

Methods

Thirty three patients 18 males 15 female with cervical spondylotic radiculopathy were treated with multiple levels anterior Cervical discectomies and fusion using stand-alone cages filled with Allograft. Total number of

levels 114 eighteen patients operated for three levels and fifteen patients operated for four levels. Clinical evaluation and patient satisfaction scales were used. Cervical fusion and complications were assessed.

Results

Improvement of the clinical outcome and the radiological parameters were detected.

Conclusion

Three and four levels anterior stand-alone cages filled with Allograft is very good option for treatment of degenerative cervical disc disease with low complication rate good clinical and radiological outcomes.

121. ASSOCIATION BETWEEN T1 SLOPE AND KYPHOTIC ALIGNMENT CHANGE AFTER LAMINOPLASTY IN PATIENTS WITH CERVICAL OSSIFICATION OF POSTERIOR LONGITUDINAL LIGAMENT (OPLL)

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Korea

Summary

Patients with higher T1 slope had more lordosis before surgery and showed the more loss of cervical lordosis after surgery at 2-year follow-up. However, there was no difference in the incidence of postoperative kyphosis between higher and lower preoperative T1 slope. Therefore, laminoplasty for cervical OPLL patients with higher T1 slope should be carefully monitored for development of kyphotic alignment change.

Hypothesis

Cervical laminoplasty is one of the major surgical methods for the patients with cervical OPLL. Few patients develop postoperative kyphosis despite preoperative enough lordosis. Recently, the impact of T1 slope as a predictor of kyphotic alignment change after laminoplasty has been considered.

Design

A retrospective case study.

Introduction

To analyze the association between T1 slope and kyphotic alignment change after laminoplasty in cervical OPLL.

Methods

From 2011 to 2012, consecutive 64 patients who underwent cervical laminoplasty for OPLL were enrolled. Cervical spine lateral radiographs were taken before surgery and at 2-year follow-up. The authors measured C2-7 Cobb angle, cervical range of motion, T1 slope, T1-CL, neck tilt and C2-7 sagittal vertical axis. Clinical outcomes (JOA, NDI) were compared.

Results

Preoperative T1 slope was divided into 2 groups based on 50th percentiles (%). High T1 group (higher than 50th%) was slope 23.2° to 38.7° . Lower T1 group was T1 slope 8° to 22.9° . There were no differences in age, sex, the presence and type of OPLL, and operation level between the 2 groups. There was a significantly higher preoperative cervical lordosis in higher T1 group

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($P=0.001$). There were no significant differences in preoperative both cervical ROM and C2-7 SVA between the 2 groups. Patient with higher preoperative T1 slope showed the more occurrence of loss of lordosis ($P=0.03$). In multiple linear regression analysis, higher T1 slope ($B=0.414$, $P=0.04$) and lower T1S-CL ($B=-0.412$, $P=0.03$) were significantly associated with loss of lordosis. However, incidence of postoperative kyphosis in higher T1 group was similar to lower T1 group. Also, clinical outcomes (JOA, NDI) were not significantly different in both groups.

Conclusion

Patients with higher T1 slope had more lordosis before surgery and developed higher loss of lordosis after surgery at 2-year follow-up. Although, there was no difference in the incidence of postop kyphosis between high and low T1 slope. Laminoplasty for cervical OPLL patients with higher T1 slope should be carefully monitored for development of kyphotic alignment change.

122. FULL SPINE RADIOGRAPHIC ANALYSIS OF CERVICAL LAMINOPLASTY VERSUS POSTERIOR CERVICAL DECOMPRESSION AND FUSION CORRELATED WITH HRQOL

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United States

Summary

Cervical laminoplasty (LP) and cervical decompression and fusion (CDF) are common posterior surgeries utilized in the treatment of cervical myelopathy. Studies show that regional cervical sagittal deformity after CDF is associated with poor outcomes. Little is known about the effect of global alignment on health related quality of life measures (HRQOL) and function. Cervical deformity was associated with worse mJOA scores among all patients. CDF patients had worse cervical deformity and worse NDI.

Hypothesis

Global and regional spinal alignment affects disability and function in patients undergoing LP and CDF surgery.

Design

Retrospective.

Introduction

Few studies have directly compared LP and CDF in terms of regional cervical as well as global spinal alignment and HRQOL. T1 slope minus cervical lordosis (TS-CL), the cervical answer to pelvic incidence minus lumbar lordosis (PI-LL), is a marker of cervical sagittal deformity. Novel global angular measures, cervico-thoracic pelvic angle (CTPA) and T1 pelvic angle (TPA) that define relative

proportions of cervical and thoracolumbar deformities respectively, have been described (Figure). Standing cervical and global alignment in LP and CDF patients are compared and correlated to HRQOL

Methods

LP and CDF patients with full spine standing radiographs and HRQOL (NDI, mJOA) were analyzed. Established cervical parameters included C2-C7 angle (CL), C2-C7 plumbline (CPL), C2 slope (C2S), T1 slope (TS), TS-CL, C0-C2 angle (C0-C2A) and chin-brow vertical angle (CBVA). Global alignment parameters and spinopelvic measures included novel ones: CTPA and TPA (Figure), and established ones: sagittal vertical axis, pelvic tilt, thoracic kyphosis (TK), and lumbar lordosis. Radiographic parameters were correlated with HRQOL and group comparisons were made.

Results

54 patients (22 LP, 31 CDF) with mean age 59 and mean follow-up 34 months were included. No differences existed in age, sex or follow up time between LP and CDF. mJOA correlated with CBVA ($r=-0.56$, $p=0.024$), CTPA ($r=-0.35$, $p=0.02$), TS-CL ($r=-0.32$, $p=0.04$), and C2S ($r=-0.32$, $p=0.04$). CDF patients had worse regional cervical alignment by TS-CL (26.7° vs. 15.7° , $p<0.01$), C2-T3 plumbline (81.8mm vs. 66.1mm , $p=0.04$), and C2S (26.7° vs. 17.7° , $p=0.03$) and worse NDI (21.5 vs. 9.56 , $p<0.01$). CDF patients had more TK (-38.6° vs. -29.7° , $p=0.02$) and worse global alignment by TPA (18.4° vs. 12.5° , $p=0.04$).

Conclusion

Cervical sagittal deformity, as identified by larger CTPA and TS-CL, correlated with worse mJOA regardless of surgical technique. CDF patients had worse postoperative cervical sagittal alignment, and worse NDI scores.



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123. SCREW PERFORATION FEATURES IN 148 CONSECUTIVE PATIENTS PERFORMED COMPUTER-GUIDED CERVICAL PEDICLE SCREW INSERTION

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Japan

Summary

Cervical pedicle screw (CPS) fixation has been criticized for the potential risk of serious neurovascular injuries. Careful insertion of CPS is necessary, especially at C3 to C5 because of higher perforation rates.

Hypothesis

Careful insertion of CPS is necessary, even if we use navigation system.

Design

A retrospective study.

Introduction

CPS fixation has been criticized for the potential risk of serious injury to neurovascular structures. To avoid such serious risks, computed tomography (CT)-based navigation has been used during CPS insertion, but screw perforation can occur even with the use of a navigation system. This study aimed to clarify screw perforation features in 148 consecutive patients treated with computer-assisted CPS insertion and to determine important considerations for computer-assisted CPS insertion.

Methods

The records of 148 consecutive patients who underwent CPS insertion using a CT-based navigation system were reviewed. Postoperative CT images were used to evaluate the accuracy of screw placement. The screw insertion status was classified as grade 1, indicating that the screw was accurately inserted in pedicle; grade 2, indicating perforation of less than 50% of the screw diameter; and grade 3, indicating perforation of 50% or more of the screw diameter. We analyzed the direction and rate of screw perforation according to the vertebral level.

Results

Of the screws showing grade 3 perforation, 70.5% screws were laterally perforated. Furthermore, we evaluated screw perforation rates according to the vertebral level. Grade 3 pedicle screw perforation occurred in 4.8% of C2 screws; 6.5% of C3 screws; 12.8% of C4 screws; 7.1% of C5 screws; 2.8% of C6 screws; and 4.5% of C7 screws. Grades 2 and 3 pedicle screw perforations occurred in 11.9% of C2 screws, 21.0% of C3 screws, 31.2% of C4 screws, 23.0% of C5 screws, 14.6% of C6 screws, and 13.5% of C7 screws. C3-5 screw perforation rate was significantly higher than C6-7 ($p < 0.01$).

Conclusion

Careful insertion of CPS is necessary, especially at C3 to C5, even when using a CT-based navigation system. Pedicle screws tend to be laterally perforated.

124. OUTCOMES AND COMPLICATIONS OF FUSIONS FROM THE CERVICAL SPINE TO THE PELVIS: SERIES OF 46 CASES WITH AVERAGE 2.7 YEAR FOLLOW-UP

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United States

Summary

When indicated, fusions that extend from the cervical spine to pelvis can lead to excellent correction of deformity with a significant improvement in SRS outcome scores and an acceptable rate of complications. The greatest improvements were noted in the mental health and pain domains of the SRS-22r. This is the largest series on the outcomes of cervical to pelvis fusions reported in the literature.

Hypothesis

The SRS-22r Outcomes of Cervical Spine to Sacrum/Pelvis Fusions are poor.

Design

Retrospective Cohort Study.

Introduction

Revisions can result in fusions that extend from the cervical spine to the sacrum/pelvis. The purpose of this study is to determine the outcomes in this subset of patients utilizing the SRS-22r, ODI and NDI HRQOLs.

Methods

Patients from 2003-2014 with fusions resulting in a UIV from any level in the cervical spine and LIV of Sacrum/Pelvis were included in the study. Those with infectious or acute trauma related deformities were excluded. Pt demographics, medical history, diagnosis, operative procedure and HRQOLs were analyzed. Students T-test, a Kruskal-Wallis and X2 Test was used as appropriate; significance was set at $p < 0.05$ for all tests

Results

55 pts met inclusion for the study and 46 (84%) had sufficient data for analysis. The avg age was 44 and avg. fu time of 2.7 years. Proximal Junctional Kyphosis (PJK) was the most common indication for fusion to the cervical spine (28%), followed by kyphosis (21%) and kyphoscoliosis (15%). The most common UIV was C2 (28%) or C7 (28%). There was a significant improvement in radiographic outcomes with an average 31-degree correction in maximum kyphosis and a 3.3cm improvement in SVA.

Complications data was available in a subset of 28 patients. In these patients, the rate of all types of complications was 71%. The incidence of major complications was 39.3% and minor complications 53.6%. The rate of medical complications was 61% while the rate of surgical complications was 43%.

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There was an improvement of the SRS score from 3.0±0.7 pre-operatively to 3.5±0.9 at the most recent follow up visit (p<0.01). Improvement was greatest for the SRS Mental Health (ΔSRS Mental Health = 0.9, p<0.01) and Pain (ΔSRS Pain = 0.6, p<0.01) domains. There were no significant differences in pre and post-op scores for the NDI or ODI.

Conclusion

When necessary, fusions that extend from the C-Spine to the Pelvis can result in improvements in HRQOLs. Our data demonstrated a significant improvement in SRS-22r outcomes and radiographic parameters with operative intervention in this subset of patients.

125. ASSESSMENT OF SURGICAL TREATMENT STRATEGIES FOR MODERATE TO SEVERE ADULT CERVICAL DEFORMITY REVEALS MARKED VARIATION IN APPROACHES, OSTEOTOMIES AND FUSION LEVELS

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United States

Summary

Although previous reports suggest that surgery can improve the pain and functional impact of ACD, surgical approaches and techniques for a given deformity are not standardized. Based on a series of 18 ACD cases presented to 14 deformity surgeons, a broad range of treatment recommendations was produced, including for surgical approach(es), numbers of fusion levels and types of osteotomies. These findings suggest that further study is needed to assess whether specific surgical treatment approaches may be associated with better outcomes.

Hypothesis

There is a lack of consensus on recommended surgical plans for treatment of ACD.

Design

Survey-based study.

Introduction

Although previous reports suggest that surgery can improve the pain and functional impact of ACD, approaches and techniques for a given deformity are not standardized.

Methods

18 ACD cases ranging from moderate to severe deformity were assembled, including a clinical vignette, cervical imaging (x-rays, CT/MRI), and full-length standing x-rays. Cases were reviewed by a panel of deformity surgeons who were queried regarding recommended surgical plan. Plans were compared across surgeons and by deformity type.

Results

The panel included 14 surgeons (10 orthopedic, 4 neurosurgery) that had a mean of 11 yrs in practice, performed an average of 80 instrumented cervical cases/yr, including a mean of 20 ACD cases/yr. There was marked variation in treatment plans across all deformity types (Table). Even for the least complex deformities (moderate mid-cervical apex kyphosis), there was lack of agreement on approach (50% combined A-P, 25%, ant-only, 25% post-only), number of fusion levels: anterior (range: 2-6) and posterior (range: 4-16), and types of osteotomies. As the kyphosis apex moved caudally (CT junction/upper T-spine) and cases with chin-on-chest kyphosis, >80% of surgeons agreed on a post-only approach and >70% recommended a PSO or VCR, but the range in number of anterior (4-8) and posterior (4-27) fusion levels was exceptionally broad. Cases of cervical/CT scoliosis had the least agreement in approach (48% post-only, 33% combined A-P, 17% 540°, 2% ant-only) and had broad variation in number of anterior (2-5) and posterior (6-19) fusion levels, and recommended osteotomies (41% PSO/VCR).

Conclusion

Among a panel of experienced deformity surgeons, there is marked lack of consensus on recommended surgical approach, osteotomies and fusion levels for moderate to severe ACD. Further study is warranted to assess whether specific surgical treatment approaches may be associated with better outcomes.

Deformity Type	Approach	Ant Levels, mean (range)	Post Levels, mean (range)	Osteotomy
Moderate mid-cervical apex kyphosis (n=4)	+Ant 25% +Post 25% +A-P 50%	4.0 (2-6)	8.2 (4-14)	+Anterior facet releases and SOCs +3 surgeons use PSO in C/T spine
Cervical kyphosis with apex at C1-junction or upper T-spine	+Post 60% +A-P 10% +Ant 30%	4.7 (4-6)	11.4 (5-18)	+70% use PSO or VCR in C/T spine
Chin-on-chest cervical kyphosis (n=2)	+Post 32% +A-P 13% +Ant 55%	5.5 (4-7)	11.2 (7-21)	+72% use PSO or VCR in C/T spine +2 surgeons use PSO in T-spine
Mild cervical kyphosis with mid-thoracic kyphosis (n=2)	+Ant 17% +Post 48% +A-P 22% +Ant 13%	7.0 (2-9)	12.8 (4-22)	+42% use PSO or VCR in C/T spine
Cervical/CT scoliosis (n=2)	+Ant 7% +Post 48% +A-P 13% +Ant 32%	7.3 (5-9)	10.1 (6-19)	+41% use PSO or VCR in C/T spine

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126. FOCAL AND DYNAMIC CERVICAL ALIGNMENT PATHOLOGY CORRELATES WITH MYELOPATHY SEVERITY IN CERVICAL DEFORMITY PATIENTS

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Summary

In a prospective cervical deformity cohort, focal alignment parameters such as the maximum kyphosis and dynamic parameters such as the kinematic area were more highly correlated with myelopathy severity than were regional cervical parameters like cSVA. The NDI does not correlate with any cervical alignment parameters. These findings call into question the utility of the NDI when evaluating patients with cervical deformity.

Hypothesis

HRQOL scores in cervical deformity (CD) patients correlate with focal and dynamic alignments.

Design

Retrospective Review of Prospective cohort.

Introduction

While there are numerous studies on cervical sagittal alignment, few studies actually report HRQOL correlations. This study investigates correlations between established cervical outcomes and regional, focal and dynamic alignments.

Methods

In a retrospective review of prospectively collected CD patients, bi-variable correlations between HRQL scores and radiographic parameters were calculated using both the entire cohort and the driver of deformity (C=cervical, CT=cervico-thoracic). Radiographic parameters included cervical global alignment parameters (C2-C7 angle, cSVA, TS-CL, C0-C2 angle), focal parameters (number of kyphotic levels >5° (nK), maximum segmental kyphosis (maxK), number of listhesis >4mm (nL), maximum listhesis (maxL)) and dynamic parameters (C2-7 range of motion (ROM), kinematic area (kArea), C0-C2 ROM).

Results

62 patients were included (mean 61±7yo, 60%F, 32C and 29CT). Mean sagittal parameters for the cervical alignment were C2-C7 -5±30°, cSVA 47±34mm, TS-CL 35.9±26.7°, C0-C2 40±11.6°, nK 1.9±1, maxK -13.4±8.5°, nL 0.8±1.2, maxL 6±8mm. Mean HRQOL scores included NDI 48±18, mJOA 13.5±2.4, EQ5D 9.9±2.2 and VAS 61±24. There was no correlation between regional parameters and HRQOL, but mJOA correlated significantly with maxK (0.324, p=0.017) and kArea (0.321, p=0.023). The stratification by deformity driver revealed significant correlations between maxK and mJOA in the C patients, and between nK and mJOA in CT patients. In addition, radiographic parameters correlated with individual mJOA, EQ5D and NDI questions. (Table).

Conclusion

In cervical deformity patients, focal and dynamic parameters correlated more with mJOA than did regional cervical alignment. This suggests that focal and dynamic parameters play a larger role in the quality of life of these patients than regional cervical alignment. The NDI total score did not correlate with any cervical parameters. These findings call into question the utility of the NDI when evaluating patients with cervical deformity.

	Regionals	Focal	Dynamic
	cSVA	TS-CL	C0-C2
NDI			
mJOA			
EQ5D			
VAS			

127. PROSPECTIVE MULTICENTER ASSESSMENT OF EARLY COMPLICATION RATES ASSOCIATED WITH ADULT CERVICAL DEFORMITY (ACD) SURGERY IN 78 PATIENTS

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Summary

Surgery for ACD is associated with high early complication rates. Among 78 patients treated for ACD and prospectively followed, 52 early (<30 days of surgery) complications were reported (26 minor, 26 major), including 1 mortality. Overall, 34 (43.6%) patients had at least one complication and 24.4% had at least one major complication. Significantly higher rates of complications were associated with combined and posterior-only approaches compared with anterior-only approaches. These findings may prove useful in treatment planning and patient counseling.

Hypothesis

Surgery for ACD is associated with high early complication rates.

Design

Prospective multicenter cohort study.

Introduction

Although ACD can have profound impact, few reports have focused on the treatment of these patients. We present early complication rates associated with surgical treatment for ACD based on a prospective multicenter cohort.

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Methods

Prospective multicenter database of consecutive operative ACD patients was reviewed for early (<30 days from surgery) complications. Enrollment required at least one of the following: cervical kyphosis >10°, cervical scoliosis >10°, C2-7 SVA >4cm or chin-brown vertical angle >25°.

Results

78 patients (59% women) underwent surgical treatment for ACD and had a mean age of 60.7 yrs and previous surgery in 52%. Surgical approaches included anterior-only (A, 14%), posterior-only (P, 49%), anterior-posterior (AP, 35%) and posterior-anterior-posterior (PAP, 3%). Mean numbers of fused anterior and posterior vertebral levels were 4.7 and 9.4, respectively. A total of 52 early complications (Figure) were reported, including 26 minor and 26 major (Table) for an overall complication rate of 66.7%. 22 (28.2%) patients had at least one minor complication, and 19 (24.4%) had at least one major complication. Overall, 34 (43.6%) patients had at least one complication. The most common complications included dysphagia (11.5%), deep wound infection (6.4%), new C5 motor deficit (6.4%) and respiratory failure (5.1%). One mortality (1.3%) was reported. Overall early complication rates were significantly different based on approach: A (27.3%), P (68.4%) and AP/PAP (79.3%) (p=0.007).

Conclusion

Among 78 patients treated for ACD and prospectively followed, a total of 52 early complications were reported (26 minor, 26 major). Overall, 34 (43.6%) patients had at least one complication and 24.4% of patients had at least one major complication. Significantly higher rates of complications were associated with combined and posterior-only approaches compared with anterior-only approaches. These findings may prove useful in treatment planning and patient counseling.

Complication	Minor (%)	Major (%)	Total (%)
Dysphagia	7 (9.0)	2 (2.6)	9 (11.5)
Deep wound infection	0	5 (6.4)	5 (6.4)
New C5 motor deficit	0	5 (6.4)	5 (6.4)
Respiratory failure	1 (1.3)	3 (3.8)	4 (5.1)
New nerve root motor deficit (not C5)	0	3 (3.8)	3 (3.8)
New nerve sensory deficit	1 (1.3)	2 (2.6)	3 (3.8)
Superficial wound infection	3 (3.8)	0	3 (3.8)
Distal tear	2 (2.6)	0	2 (2.6)
Death	0	1 (1.3)	1 (1.3)
Pulmonary embolism	0	1 (1.3)	1 (1.3)
Cardiac arrest	0	1 (1.3)	1 (1.3)
Cardiac event (not arrest)	1 (1.3)	0	1 (1.3)
Arterial injury	0	1 (1.3)	1 (1.3)
Instrumentation malposition	0	1 (1.3)	1 (1.3)
Excessive bleeding (~4L)	0	1 (1.3)	1 (1.3)
Other	11 (14.1)	0	11 (14.1)
Total	26	26	52
Mean number of complications/patient	0.33	0.33	0.67
Number (%) of patients affected	22 (28.2)	19 (24.4)	34 (43.6)

128. TOWARDS A CERVICAL DEFORMITY OUTCOME INSTRUMENT: PRINCIPAL COMPONENT ANALYSIS OF 89 HRQL QUESTIONS IN 476 PATIENTS WITH CERVICAL DEFORMITY

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United States

Summary

Current health related quality of life (HRQL) measures do not correlate with measures of cervical deformity (CD). A principal component analysis of 89 questions from the NDI, mJOA, EQ5D, SWALQOL, ODI, SRS and SF36 yielded 13 item categories that correlated with cervical deformity measures among 61 patients (pts) from a prospective cervical deformity database and 415 patients with CD from a thoracolumbar deformity (TLD) database. These items should be considered in developing a CD specific outcome instrument.

Hypothesis

HRQL questions can be correlated with cervical alignment to identify essential elements for a new cervical deformity outcome.

Design

Retrospective analysis.

Introduction

No CD specific outcome measure exists and current HRQL are not tailored to the problems of CD. We analyze cervical alignment measures and individual questions from 7 HRQL instruments to identify items most relevant to CD.

Methods

CD measures and HRQL were analyzed in 415 pts meeting CD criteria (cSVA>4cm or TS-CL>20) from a TLD database and 61 pts from a prospective CD database. Total NDI, mJOA, EQ5D and SWALQOL scores and their individual questions were analyzed within the CD cohort and items from the ODI, SRS, and SF36 were analyzed in the TLD pts. With a principal component analysis (PCA) individual questions correlating the most with the principal components were retained and used as a new outcome instrument that was correlated to the alignment measures.

Results

CD cohort: No alignment measure correlated with any NDI/mJOA/EQ5D total score. SWALQOL domains correlated with some CD measures (best r=0.37, p<0.01). PCA identified 10 items from the NDI/mJOA/EQ5D/SWALQOL that account for 76% of the item variance. This new CDc score correlated with C0-C2Angle (r=0.40, p=0.005) C2Slope: r=0.37, p<0.05) and number of kyphotic discs (nK: r=0.31, p<0.05). TLD cohort: Total HRQL scores correlated nonspecifically with some CD measures in both CD and noCD patients (best r=0.22, p<0.05). PCA identified

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10 items from the ODI/SRS/SF36 that account for 75% of the item variance. This new CDt score correlated with cSVA ($r=0.24, p<0.001$) and nK ($r=0.15, p<0.05$) in TLD pts with CD.

The CDc and CDt scores included 13 item categories: swallowing, motor scores, sensory scores, reading, activity level, mental health, appearance, sleeping, general health, work, personal care, social life, and walking.

Conclusion

Existing total HRQL scores do not correlate with alignment measures in cervical deformity pts, thus a CD specific outcome measure is needed. Based on an analysis of 89 questions from existing HRQL, 13 item categories should be considered in a new CD disability measure.

Table correlation between HRQL total scores and alignment measures

HRQL	CP-C2 angle	C2 slope	P of kyphosis	Cranio-cervical angle (CCA)	C2-Peak-T19 (PTT)	ODI
Total score						
New CDt score	$r=0.208^*$	$r=0.188^*$	$r=0.309^*$	$r=0.401^*$		
New CDt score			$r=0.173^*$		$r=0.24^*$	$r=0.248^*$
NCS						
PHQ-9			$r=0.324^*$			
EQ-5D						
ODI			$r=0.280^*$			$r=0.188^*$
VAS			$r=0.184^*$			$r=0.112^*$
SF36 PCS			$r=0.224^*$			$r=0.140^*$

129. HIGH GRADE SPONDYLOLISTHESIS IN THE YOUNG – LONG-TERM FOLLOWUP RESULTS OF A PROGRESSIVE REDUCTION TECHNIQUE

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Summary

In spite of many published reviews on the subject, surgical options for management of high grade spondylolisthesis in the young remains a controversy. A retrospective review of 27 patients who underwent surgery at our center by a progressive reduction technique showed good functional and radiological outcomes and demonstrated a significant reduction of high grade spondylolisthesis, with restoration of lumbosacral alignment. Our technique of reduction gives satisfying outcomes in correction of this difficult spinal deformity.

Hypothesis

To determine the efficacy of the technique and assess the long term functional outcomes.

Design

Retrospective case series.

Introduction

Surgical management of high grade spondylolisthesis in the young is not only challenging but also controversial, from in-situ fusion to complete reduction. It is fraught with dangers such as neurological injury, pseudoarthrosis and

progressive deformity with subsequent global sagittal imbalance. We describe our experience of progressive reduction technique and restoration of lumbosacral alignment.

Methods

A retrospective review of patients who underwent surgery between 1998 and 2012. The surgical technique involved positioning the hips in extension with traction, pedicle screw fixation, correction of lumbosacral kyphosis with a specific distraction manoeuvre, wide decompression, and gradual reduction of the deformity and maintenance of reduction with interbody fusion. All patients were serially assessed at 1, 3, 6 months and yearly thereafter with clinical, radiological and outcome measures (ODI and VAS).

Results

27 patients with high grade spondylolisthesis at L5-S1 (3 Grade 3, 7 Grade 4, 17 Grade 5) with a mean age of 13.9 yrs were reviewed. Mean follow-up was 120 months (range 24-192). All patients presented a solid fusion at the 6 month visit; mean slip percentage was reduced from 89% to 23%, with all cases reduced to grade 2 or less. The slip angle improved from 45° to 3° postoperatively, with improvement in sacral slope from 13° to 35°. 4 spondyloptosis patients had concomitant scoliosis which corrected spontaneously and did not need further intervention.

All but one patient (96.2%) had good functional outcomes and returned to their full normal activities. One patient developed a deep infection necessitating implant removal, with eventual deformity progression leading to a poor outcome. Three patients (11.1%) suffered partial drop foot that resolved in full by 12 weeks.

Conclusion

Our technique demonstrated a significant reduction of high grade spondylolisthesis, with restoration of global sagittal balance via correction of the lumbosacral kyphosis. Though surgically demanding, it is safe and reproducible.

130. PREDICTION OF SURGICAL OUTCOMES AND COMPLICATIONS WITH REDUCTION OF HIGH-GRADE SPONDYLOLISTHESIS

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Summary

Study on 101 pts with high-grade spondylolisthesis (HGS) $\geq 3^\circ$ according to Meyerding (MD). Mean preop MD-grade was 3.8° (3-5°) and slip was 81±22.5%. Multivariate analysis identified risk factors for postoperative footdrop (FDR), complications, and revision surgery including the degree of deformity (MD-grade & slip), correction of lumbosacral kyphosis in terms of changes in lumbosacral angle(LSA) and L4-Slope(L4-S), and upper instrumented

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vertebra (UIV)>L5. Avoidance of overdistraction and reconstruction of lumbosacral lordosis are main parameters to prevent complications and achieve good clinical outcomes.

Hypothesis

Lumbosacral kyphosis influences outcomes.

Design

Retrospective.

Introduction

Controversy lingers on the need for reduction in HGS. This study thought to identify predictors of radiographic and clinical outcomes in HGS.

Methods

Age of pts was 62.6yrs. Strategy was 54°-approach in 61 pts and 360°-approach in 40 pts. 17 pts had L5-corpectomy (L5-CE). 45 pts had UIV>L5. End vertebra was S2 in 7, S1 in 94 pts. Fusion levels were 1.6±0.7. All pts had clinical and radiographic ≥1yr F/U (0.47mo, 1yr-GROUP). 46 pts had HRQL-queries (ODI, SF36-PCS, VAS) and ≥2yr F/U (≥105mo, 2yr-GROUP). Preop characteristics were not sig. different btw. 1yr- and 2yr-Group.

Results

For main results see table 1. Complete reduction (≤1 MD-grade/<20% slip) was achieved in 55/42 pts. 11 pts had preop imbalance (C7>hip axis) and 4 pts at F/U. Lumbosacral kyphosis (L4-S, LSA) sig. correlated w/ alignment (TK/LL) postop and at F/U. Clinical results sig. correlated w/ lumbosacral kyphosis (VAS-back&LSA, VAS-leg&LSA, SF36-PCS&LSA, ODI&LSA) and PI (SF36-PCS&PI, ODI&PI, and age (ODI, SF36-PCS, VAS-leg). 29 pts had a late complication. Risk increased w/ PI (p<.01) and change of L5-S1 height (p<.01). 40 pts had major complications. Risk increased w/ LSA preop (p=.04) and at F/U, PI (p<.05), smaller postop LL (p<.05), L5-CE (p<.01), and in the 540°-Group (p<.01). 30 pts had FDR. Pts w/ FDR had greater MD-grade/slip (p<.01), preop LSA (p<.01), more often UIV>L5 (p<.01) and L5-CE (p<.01). Preop L4-S (p=.02), LSA (p<.01) and L5-S1 height (p=.02) were sig. different, but postop L4-S, LSA and L5-S1 were similar, indicating increased 3D-correction in the FDR-group. A sig. risk model for FDR could be established incl. L4-S change and PI (NPV=82%, PPV=71%, p<.01). 26 pts needed revision, 17 for non-union. Pts w/ revision had larger preop deformity (MD-grade/slip, p<.01), PI (p=.02), postop L4-S (p<.01), age (p=.02), more often L5-CE (p<.01), and UIV>L5 (p<.01). Complete reduction was not protective against non-union (p=.08), but resulted in better correction of LL at F/U (p=.03).

Conclusion

Main risk factors for FDR seem to be the extent of lumbosacral kyphosis correction and distraction L4-S1. In HGS clinical outcomes correlate w/ correction of lumbosacral kyphosis.

Demographic Variable (n=121)	Preop	Postop	Follow-up	F-Level Preop/Follow-up	F-Level Postop/Follow-up
Meaning Score	5.0 (95% CI)	5.4 (95% CI)	5.4 (95% CI)	0.01	0.01
EQ-5D	0.7 (95% CI)	0.7 (95% CI)	0.7 (95% CI)	0.01	0.01
Visual Analogue Scale (VAS)	52 (95% CI)	47 (95% CI)	47 (95% CI)	0.01	0.01
Physical Function (PF)	52 (95% CI)	47 (95% CI)	47 (95% CI)	0.01	0.01
Health Status (HS)	52 (95% CI)	47 (95% CI)	47 (95% CI)	0.01	0.01
Overall Health (OH)	52 (95% CI)	47 (95% CI)	47 (95% CI)	0.01	0.01
Timed Up-and-Go (TUG)	28 (95% CI)	28 (95% CI)	28 (95% CI)	0.01	0.01
Lumbar Lordosis (LL)	37 (95% CI)	44 (95% CI)	44 (95% CI)	0.01	0.01
Back Pain (BP)	47 (95% CI)	47 (95% CI)	47 (95% CI)	0.01	0.01
Lumbar Angle (LA)	18 (95% CI)	18 (95% CI)	18 (95% CI)	0.01	0.01
L4-S1 LSA	28 (95% CI)	18 (95% CI)	25 (95% CI)	0.01	0.01
L5-S1 height	28 (95% CI)	45 (95% CI)	44 (95% CI)	0.01	0.01
C7-CO1	11 (95% CI)	17 (95% CI)	17 (95% CI)	0.01	0.01
Clinical results at F/U					
Severity Disability Index (SDI)	11 (95% CI)	17 (95% CI)	17 (95% CI)	0.01	0.01
VAS-leg	78 (95% CI)	78 (95% CI)	78 (95% CI)	0.01	0.01

131. MODELED COST-EFFECTIVENESS OF TLIF VERSUS PSF FOR SPONDYLOLISTHESIS USING N2QOD DATA

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United States

Summary

For patients with spondylolisthesis, using SF-6D based QALYs, TLIF would still be more cost-effective than PSF at an increased surgical cost of \$4,034. However, using EQ-5D based QALYs, TLIF would become cost-prohibitive compared to PSF at an increased surgical cost of \$696 over PSF. As with all cost-effectiveness studies, cost/QALY is dependent on the measure of health utility selected, durability of the intervention, readmissions and the accuracy of cost assumptions.

Hypothesis

Relative cost-effectiveness of TLIF vs PSF in patients with spondylolisthesis will depend upon variation in initial surgery cost and health utility measures.

Design

Modeled cost-effectiveness analysis.

Introduction

TLIF has become the most commonly used fusion technique for lumbar degenerative disorders. This suggests an expectation of better clinical outcomes that has not been validated consistently. How surgical variables and choice of utility measures drive the relative cost-effectiveness of TLIF versus PSF has not been established.

Methods

From the N2QOD database, 109 spondylolisthesis cases treated by PSF were propensity-matched to cases treated by TLIF. HRQOL measures and peri-operative parameters were compared. As utility values derived from SF-6D and EQ-5D may be different, especially in low back disorders, QALYs were derived using both the EQ-5D and SF-6D. Sensitivity analysis for the relative cost/QALY of TLIF versus PSF was assessed in a series of cost assumption models.

Results

OR time (201 mins vs 202 mins, p=0.982), EBL (406cc vs 474cc, p=0.213), hospital stay (4.1 days vs 4.2 days), readmissions at 30 days (1 in both groups) and 3 months post-op (4 in both groups), and return to work rates (82% vs 84%, p=1.000) were similar between TLIF and

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PSF groups. Both TLIF and PSF produced significant improvements in back pain, leg pain, ODI, EQ-5D and SF-6D at 3 and 12 months post-op. TLIF patients had a greater improvement in ODI (29.4 vs 20.8, $p=0.001$), SF-6D (0.17 vs 0.12, $p=0.004$) and EQ-5D (0.25 vs 0.24, $p=0.842$) compared to PSF patients at 12 months post-op. At a cost/QALY threshold of \$100,000, using SF-6D based QALYs, TLIF would still be more cost-effective than PSF at an increased surgical cost of \$4,034. However, using EQ-5D based QALYs, TLIF would become cost-prohibitive compared to PSF at an increased surgical cost of \$696 over PSF.

Conclusion

Analysis using the N2QOD registry showed that TLIF may potentially be more cost-effective than PSF in patients with spondylolisthesis. As with all cost-effectiveness studies, cost/QALY is dependent on the measure of health utility selected, durability of the intervention, readmissions and the accuracy of cost assumptions.

132. LLIF VERSUS MINIMALLY INVASIVE TLIF FOR DEGENERATIVE SPONDYLOLISTHESIS: RESULTS FROM A PROSPECTIVE MULTI-CENTER STUDY

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Summary

This prospective, multicenter, study aimed to compare indirect decompression via LLIF and direct posterior decompression via TLIF for treatment of low-grade spondylolisthesis with a focus on clinical and radiographic outcomes. LLIF afforded reduced blood loss when and greater stability in flexion/extension at early follow-up. TLIF resulted in fewer patients with postoperative weakness and a greater increase in foraminal and canal dimensions. Surgical metrics, patient-reported outcomes, remaining radiographic measures and neurologic function were similar for both treatment groups throughout follow-up.

Hypothesis

Symptomatic low-grade spondylolisthesis can be effectively treated with either direct or indirect decompression.

Design

Prospective, multicenter, comparative, IRB-approved study.

Introduction

TLIF allows for direct posterior element decompression and interbody fusion with supplemental fixation through the same approach. When combined with percutaneous pedicle fixation, LLIF does not provide direct decompression, but allows for better visibility and more complete discectomy, better endplate preparation, and insertion of a larger cage for better indirect decompression.

Methods

Adult patients with low-grade degenerative spondylolisthesis at one or two levels were treated with either minimally invasive TLIF or LLIF. Patient reported outcomes, radiographic measurements and motor/sensory evaluations were collected pre-op and at subsequent follow-up visits up to 24-months.

Results

Fifty-five patients were treated, 29 (36 levels) in the LLIF group and 26 (26 levels) in the TLIF group. Mean patient age was 63 years. Mean procedure time per level and length of hospitalization were similar between groups. Correction of spondylolisthesis, increase in disc height and increase in disc anglet from pre- to post-op was comparable between groups. Estimated blood loss was lower in the LLIF group ($p<0.001$). In the perioperative period, 9 LLIF patients had hip flexion weakness, one patient had weakness in the entire lower extremity, and three patients had decreases in sensory function. Two TLIF patients experienced a decrease in sensory function. All weakness and decreases in sensory function resolved within 12 months. Patient-reported outcomes for surgical satisfaction, back and leg pain, as well as Oswestry disability index were comparable at all follow-up visits. LLIF complications included 2 cases of ileus. TLIF complications included 3 dural tears, and one incident of pseudarthrosis with revision at 18 months.

Conclusion

Only subtle difference are noted between LLIF and TLIF during the early post-operative period. Long term patient-reported outcomes and radiographic stability are comparable, suggesting that both are realistic treatment options for low-grade degenerative spondylolisthesis.

133. OUTCOMES OF MINIMALLY INVASIVE LUMBAR FUSION (MILIF) IN PATIENTS WITH STENOSIS: A SUBGROUP ANALYSIS OF THE MASTERS-D STUDY

Paulo M. Pereira, MD, PhD; Wolfgang Senker, MD; Ulrich Hubbe, MD; Neil Manson, MD; Kai Scheufler, MD; Joerg Franke, MD Portugal

Summary

To investigate the outcomes of MILIF for DLD in the MASTERS-D study subset, comparing: 1. Patients with/without stenosis (S/NS) and 2. Patients with stenosis and with/without decompression (S+ND).

Hypothesis

To investigate the outcomes of MILIF for DLD in this study subset, comparing: 1. Patients with/without stenosis (S/NS) and 2. Patients with stenosis and with/without decompression (S+ND).

Design

Multicenter 1-year prospective observational study (NCT01143324).

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Introduction

Our multicenter 1-year prospective observational study (NCT01143324) showed significant and rapid improvement following MILIF with low complications rates. Stenosis was diagnosed in 71.4% of the patients.

Methods

From 252 DLD patients: 1- (83%) or 2-level (17%) MILIF (TLIF: 95%; PLIF: 5%) treated of predominant leg pain (52.0%), back pain (38.9%) or claudication (9.1%), including spondylolisthesis (52.8%), stenosis (71.4%), and/or disc pathology (93.7%). Outcomes measured: Time (days) to first ambulation (TFA) and study-defined postsurgical recovery (TPSR), VAS back/leg pain, ODI pre-/post-surgery (4 weeks, 12 months), changes from baseline [all variables: medians and (interquartile ranges) Mann-Whitney U-test] were compared between S:(N=180)/ (NS:N=72) and (S+D:N=142)/ (S+ND:N=38) patients.

Results

All groups demonstrated statistically significant improvement in all outcome measures. TFA was similar for all subgroups [S/NS 1.0 (0.5)/1.0 (1.0) $p=0.0702$; S+D/S+ND 1.0 (0.0)/1.0 (1.0) $p=0.9473$]. TPSR was higher for S vs NS [3.0 (2.5)/2.0 (1.0) $p=0.0021$] and lower for S+D vs S+ND [2.0 (2.0)/4.0 (3.0) $p=0.0017$]. At baseline, VAS Leg pain higher in S vs NS [7.0 (3.0)/5.0 (4.0) $p=0.0014$] but similar at 4w [2.0 (5.0)/1.0 (4.0) $p=0.3805$] and at 12m [1.0 (4.0)/1.0 (5.0) $p=0.6425$] due to a more pronounced drop from baseline in S (4w: 3.9 vs 3.0, $p=0.0784$; 12m: 5.0 vs 3.0, $p=0.0185$). ODI improved slightly more (non-significant) in S vs NS and VAS back pain was equal in these groups. VAS leg pain, ODI and VAS back pain pre-/post-surgery as well as changes from baseline were similar in S+D compared to S+ND.

Conclusion

Stenosis patients need longer times for surgery recovery, show more leg pain at baseline but better improvement after MILIF. Non-stenosis patients present similar outcomes at 4w and 12m. Decompressed stenosis patients recover sooner from surgery than non-decompressed patients.

134. EXPANDABLE TECHNOLOGY IN MINIMALLY INVASIVE TLIF: A MULTICENTER CLINICAL AND RADIOGRAPHIC ANALYSIS OF 202 PATIENTS WITH TWO-YEAR FOLLOW-UP

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United States

Summary

A review of clinical and radiographic outcomes using an interbody device which can be expanded in situ.

Hypothesis

Controlled interbody implant expansion following insertion provides an optimal long term clinical results and serves to help restore and maintain intervertebral disc height.

Design

The 202 patients included in this multicenter, retrospective analysis presented with clinical evidence of degenerative lumbar disc disease at 1 or 2 level(s) and were followed for 24 months postoperatively. Patient demographics and intraoperative measures were quantified. Patient outcomes including radiographs, Visual Analog Scale (back and legs) (VAS), Oswestry Disability Index (ODI), and Odom's Criteria and complications were recorded preoperatively and at 6, 12 and 24 months postoperatively.

Introduction

Static interbody cages require impaction for insertion which may cause endplate damage. This study served to document the clinical and radiographic outcomes in patients who had a minimally invasive transforaminal lumbar interbody fusion (TLIF) with a device which offers controlled in situ expansion.

Methods

Retrospective analysis of 202 patients using an expandable spacer combined with transpedicular posterior stabilization. Device-related complications were defined as implant breakage, migration, subsidence, and revision surgery at the index level.

Results

Mean VAS and ODI scores decreased significantly from preoperative to the 24 month postoperative interval ($p<0.05$). Intervertebral disc heights (0.6 ± 0.1 vs 1.1 ± 0.2 cm) and neuroforaminal heights (1.7 ± 0.4 vs 2.0 ± 0.3 cm) increased significantly and were maintained throughout 24 months ($p<0.05$). There were no cases of device failure. Asymptomatic migration or subsidence was present in 12 (5.9%) patients and the overall reoperation rate at the index level was 2.97% ($n = 6$), which was secondary to pedicle screw failure and pseudoarthrosis.

Conclusion

The current study documented the use of expandable interbody implant for treatment of lumbar discogenic pathology. Significant improvements were observed in ODI /VAS scores and intervertebral disc height restoration.

135. ARE THE OUTCOMES OF MINIMALLY INVASIVE LUMBAR FUSION (MILIF) AFFECTED BY AGE AND OBESITY?

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Portugal

Summary

Investigate whether outcomes of MILIF for degenerative lumbar disorders (DLD) are affected by age or weight using data from the MASTERS-D trial (NCT01143324).

Hypothesis

Can age and/or weight affect the outcomes of patients with DLD treated by MILIF in the MASTERS-D study?

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Design

Multicenter 1-year prospective observational study (NCT01143324).

Introduction

The two major public health issues are obesity and aging. Many patients with DLD treated by MILIF are either obese and/or aging.

Methods

A total of 252 DLD patients underwent 1- (83.3%) or 2-level (16.7%) MILIF (TLIF: 95.0%; PLIF: 5.0%) for treatment of predominant leg pain (52.0%), back pain (38.9%) or claudication (9.1%), including spondylolisthesis (52.8%), stenosis (71.4%), and/or disc pathology (93.7%). Outcomes measured: time (days) to first ambulation (TFA) and postsurgical recovery (TPSR), VAS back/leg pain, ODI and EQ5D (baseline, 4 weeks, 6 and 12 months) [all variables: medians and (interquartile ranges), Kruskal-Wallis test]. Age (≤ 50 yrs: N=102; 51-64 yrs: N=102; ≥ 65 yrs: N=48) and weight groups (min BMI to 25.0: N=79; 25.1 to 29.9: N=104; 30.0 to max BMI: N=69). Baseline to 12 months was compared for all clinical outcome variables within age group/weight class (Mann-Whitney U-test). Linear regression analyses were performed to better understand the relationship between TFA/TPSR and age or BMI.

Results

All groups showed improved clinical outcome measures at 12 months compared to baseline ($p < 0.0001$). TFA was similar for all subgroups [age groups: 1.0 (1.0)/1.0 (1.0)/1.0 (0.5) $p = 0.8707$; weight classes: 1.0 (1.0)/1.0 (1.0)/1.0 (0.0) $p = 0.1013$]. TPSR was higher for older and heavier patients [age groups: 2.0 (1.0)/2.0 (2.0)/3.0 (3.0) $p = 0.0662$; weight classes: 2.0 (1.0)/3.0 (2.0)/3.0 (3.0) $p = 0.1591$] with a significant linear relationship between TPSR and age ($p = 0.0028$) and TPSR and weight ($p = 0.0024$). Clinical outcome measures ODI, VAS back and leg pain and EQ5D were similar in all subgroups at every time point.

Conclusion

Heavier and older patients need more time to recover from MILIF surgery, however the additional time needed on average remains acceptably below 24h. The MILIF approach for spine surgery gives improved results for subjects of all age groups and weight classes with no significant differences in clinical endpoints between subgroups.

136. ARE MINIMALLY INVASIVE ROBOTIC-GUIDED TLIFs MORE SAFE AND ACCURATE THAN FREEHAND OPEN TLIFs?

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India

Summary

The need to do minimally invasive surgery entailing radiation hazards to the operating room personnel and increased demand on the operating surgeon to be safe and accurate necessitates a system to guide screw placement safely, accurately and with reduced radiation exposure. We aim to analyse the efficacy, safety and accuracy of the robotic guidance system in pedicle screw placement with freehand technique as a control.

Hypothesis

Freehand, open TLIFs are more accurate and safer than percutaneous, robotic-guided TLIFs. The study refutes this null hypothesis on accuracy, but not for safety (p value was $> 5\%$).

Design

Retrospective case control analysis.

Introduction

Freehand placement of TLIFs and pedicle screws by exposing the bony landmarks in a midline approach is the most common spinal fusion technique. Robotic-guidance facilitates performing such cases in a percutaneous paramedian approach. We compare one surgeon's experience with both approaches.

Methods

Medical files of two consecutive patient cohorts were reviewed retrospectively. Patients in the study arm (RO) underwent robotic-guided percutaneous instrumentation. An open, freehand technique was used in the control arm (CO). Screw accuracy was assessed on post-op CTs, using a 2 mm breach as a threshold between accurate screws and misplacements.

Results

Each arm included 102 patients (Table 1). No differences in age, gender-ratio or BMI were noted between the 2 cohorts. Of the 444 screws placed in the RO arm 99.5% were accurate, while the CO arm had 440 screws of which 94.1% were placed accurately ($p < 0.0001$). Despite the RO being percutaneous and the CO open, the procedure times and utilization of intraoperative fluoroscopy were similar. There was one revision in the RO arm due to one of the 2 misplaced screws. There were 6 complications in the CO arm, 4 of which resulted in revision surgeries.

Conclusion

In our study there were 2 variables between the cohorts: robotic guidance vs. freehand; and a minimally invasive approach vs. an open midline incision. The reduction in the infection rate is likely due to the percutaneous

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approach, but this is enabled by the use of the robot. While the differences in complication and revision rates did not reach statistical significance between the 2 cohorts, it is substantial clinically, and merits further study.

	Robotic	Freehand	p
Patients	102	102	
Female	49	49	
Age	58.3	57.6	0.737
BMI	27.8	28.3	0.574
Total Procedure Time (mins)	136.7	136.4	0.850
Total Fluoro Time (sec)	8.6	8.4	0.774
Fluoro per screw	2.1	2.0	0.894
# Dissected Screws	444	440	
# Accurate Screws (%)	442 (99.5)	434 (94.3)	
# Missplaced Screws (%)	2 (0.5)	6 (1.9)	0.0007
Implant related			
Discontinuity	0	0	
Deep wound infection	0	3	
New neurological deficits	1	1	
Instrumentation failure	0	1	
Complications	1	6	0.12
Surgical revisions	1	4	0.37

137. PSEUDOARTHROSIS RATE IN MINIMALLY INVASIVE TRANSFORAMINAL LUMBAR INTERBODY FUSION(M-TLIF): TWO-YEAR OUTCOMES VERSUS OPEN TLIF

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United States

Summary

This study compared the pseudarthrosis rates between a two consecutive cohorts of patients that had either undergone mTLIF or open TLIF. Statistical analysis identified only revision surgery as a relevant risk factor for pseudarthrosis.

Hypothesis

Differences in the rate of pseudarthrosis may be seen between open & mis-TLIF.

Design

Retrospective clinical cohort.

Introduction

MIS-TLIFs has shown similar long-term clinical outcomes with decreased perioperative morbidity and earlier return to work as compared to open TLIFs. However, the rate of pseudarthrosis and the impact of various demographic or comorbid factors have not been evaluated.

Methods

Between 2006-2012, 230 consecutive pts underwent one or two-level mTLIF or open TLIF at a single institution. Clinical & radiographic data was reviewed. Pts with complete medical records & minimum 2 yrs f/u were included in the analysis. Demographic data, medical comorbidities, surgical and radiographic data as well as pt assessed outcomes scores (ODI, VAS) were quantified. Binomial continuous & categorical tests were used for statistical comparison between cohorts. Pseudarthrosis was determined by 2-D computed tomography at >1yr f/u.

Results

184 pts were included in the analysis. mTLIF had 80 pts, 35 females/45 males. Mean age 51.5(23-75), 6 revisions. TLIF had 104 pts, mean age 51yrs(14-74), 62 males/42 females, 12 revisions. No significant differences were seen between the two cohorts with respect to mean age(51.5 vs 51.0 yrs), sex, medical comorbidities, number of levels fused, or revision procedures. Respective pseudoarthrosis rates were 13.7% & 11.7%(p=0.07). There was a significantly higher percentage of pseudoarthrosis in pts undergoing revision procedures (p=0.02). No statistical differences were seen between choices of interbody bone graft material. No statistical differences were seen with ODI or VAS scores at 2yrs.

Conclusion

mis-TLIF & open TLIF demonstrated comparable outcomes with regards to pseudarthrosis rates. Revision surgery was the only identifiable risk factor for pseudarthrosis.

138. POSTOPERATIVE PATIENT-REPORTED OUTCOMES AND REVISION RATES IN NORMAL, OVERWEIGHT AND OBESE PATIENTS FIVE YEARS FOLLOWING LUMBAR FUSION

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United States

Summary

In a propensity matched case control study, overweight and obese patients achieved similar improvements in outcomes and have similar rates of revision to normal-weight patients five years after posterior instrumented lumbar fusion. Obesity should not be considered a contraindication to surgery in patients with appropriate surgical indications.

Hypothesis

Patient-reported outcomes and revision rates five years after instrumented posterior lumbar fusion are similar between normal, overweight and obese patients.

Design

Propensity-matched case-control study.

Introduction

Obesity is a growing problem in healthcare. Studies have demonstrated similar functional outcomes but higher complication rates after surgery in obese patients.

Methods

Eighty-two patients with a BMI>30 (obese) who had posterior instrumented lumbar spinal fusion from 2001 to 2008 with complete pre-operative and five-year postoperative outcome measures were identified. Two comparison groups, one with BMI<25 (normal) and another with BMI between 25 and 30 (overweight) were created using propensity matching techniques based on demographics, baseline clinical outcome measures and surgical characteristics. Five-year postoperative outcome measures and revision rates in the three groups

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were compared. One way ANOVA was used to compare continuous variables and exact test was used to compare categorical variables between the groups. Significance was set at $p < 0.01$.

Results

Age, number of levels fused and preoperative outcomes were similar in the normal, overweight and obese groups. Estimated blood loss (440cc vs 702cc vs 798cc, $p=0.000$) and OR time (234" vs 263" vs 275", $p=0.003$) was significantly greater in the overweight and obese patients. Improvements in ODI (14.2 vs 9.6 vs 10.4, $p=0.226$), SF-36 PCS (5.9 vs 2.9 vs 3.5, $p=0.361$), back pain (3.0 vs 2.0 vs 2.1, $p=0.028$) and leg pain (3.0 vs 2.3 vs 2.3, $p=0.311$) scores were similar between the three groups. Revision rates (14 vs 15 vs 13, $p=0.917$), time between index and revision surgery ($p=0.990$) were similar between the three groups as well.

Conclusion

Overweight and obese patients achieve similar improvements in outcomes and have similar rates of revision to normal-weight patients following lumbar fusion. Obesity should not be considered a contraindication to surgery in patients with appropriate surgical indications.

139. BACK PAIN IMPROVEMENT AFTER DECOMPRESSION WITHOUT FUSION IN PATIENTS WITH LUMBAR SPINAL STENOSIS AND CLINICALLY SIGNIFICANT PRE-OPERATIVE BACK PAIN

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United States

Summary

From the N2QOD database, 726 patients with lumbar stenosis and back pain scores $\geq 5/10$ underwent decompression without fusion. There were significant improvements from baseline at both three and 12 months post-operative for back pain (7.6 to 3.2 to 3.7), as well as leg pain (7.2 to 2.9 to 3.1), EQ-5D (0.55 to 0.76 to 0.75) and ODI (49.1 to 27.2 to 26.4).

Hypothesis

Patients with lumbar stenosis and substantial back pain can obtain significant reductions in back pain after decompression.

Design

Longitudinal cohort.

Introduction

In patients with lumbar stenosis, conventional wisdom teaches that relief of back pain should not be an expected outcome of decompression and that substantial back pain may be a contraindication to decompression only. We hypothesized that patients with lumbar stenosis and clinically significant back pain can obtain substantial reductions in back pain after a decompression procedure.

Methods

Analysis of the N2QOD registry database identified 726 patients with lumbar stenosis and a baseline back pain score of $\geq 5/10$ who underwent a decompression procedure without fusion. Standard demographic and surgical variables, patient outcomes, including back and leg pain scores, ODI and EQ-5D at baseline, 3 and 12 months post-op were collected.

Results

The mean age of the cohort was 65.6 years; 407 (56%) were male. Mean BMI was 30.2kg/m²; 50% (326) reported never smoking; 30% (221) were former smokers, 18% (129) were current smokers. The majority of patients (294, 40%) had a two-level decompression, 208 (29%) had a three-level, 177 (24%) had a one-level, and 47 (6%) had a four-level decompression. Mean EBL was 130cc. Mean operative time was 100.85 minutes. The vast majority (88%) were routine home discharges. At three months and twelve months post-operative, there were significant improvements from baseline for back pain (7.6 to 3.2 to 3.7), leg pain (7.2 to 2.9 to 3.1), EQ-5D (0.55 to 0.76 to 0.75) and ODI (49.1 to 27.2 to 26.4).

Conclusion

Patients with lumbar stenosis and clinically significant back pain can obtain improvement in back pain after decompression only surgery. Additional studies are needed to clarify the impact of patient specific characteristics, as well as, the durability of the back pain improvement.

140. CAN THE EQ-5D ANXIETY DOMAIN AND SF-36 MENTAL HEALTH ITEMS PREDICT OUTCOMES AFTER SURGERY FOR LUMBAR DEGENERATIVE DISORDERS?

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Summary

Patient response to SF-36 item "Have you felt downhearted and depressed?" account for 20% of the variability of one-year ODI and EQ-5D scores and can be used by clinicians to screen for anxiety or depression in patients prior to lumbar fusion surgery. Clinicians may offer psychological support to these patients pre-operatively to improve treatment outcomes.

Hypothesis

The EQ-5D Anxiety Domain and SF-36 Mental Health Items can predict outcomes after surgery for lumbar degenerative disorders.

Design

Longitudinal cohort.

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Introduction

Several studies have shown that patients with anxiety or depression may have poorer outcomes after surgery for lumbar degenerative disorders. These conclusions were drawn from questionnaires specifically designed to measure anxiety and depression such as the DRAM, HADS or the BDI, which are not routinely administered in the spine surgery clinic.

The purpose of this study is to determine if patient responses to the EQ-5D Anxiety/Depression domain or the items used to calculate the Short-Form-36 Mental Composite Summary (SF-36 MCS) can predict outcomes after lumbar fusion surgery.

Methods

Patients locally enrolled in N2QOD who had one-year follow-up were identified. Apart from the standard patient reported outcomes collected as part of N2QOD, the SF-36 was administered as well. Linear Regression modeling was performed to predict one-year ODI scores using the EQ-5D Anxiety/Depression domain and the 14 items used to calculate the SF-36 MCS. To control for confounders, other known predictors such as indication for surgery, educational level, ASA grade, workers' compensation, insurance and symptom duration were included in the model.

Results

Complete data was available in 313 (89%) of 353 eligible patients. Mean age was 58.5 years, 175 (56%) were women and 52 (17%) were smokers. After controlling for other factors, the item in the SF-36 that asks "Have you felt downhearted and depressed?" is the strongest predictor of one-year ODI score (r -square=0.191, p =0.000) and one-year EQ-5D (r -square=0.205, p =0.000). Neither the EQ-5D Anxiety/Depression domain or the diagnosis of anxiety were predictors of one-year outcomes.

Conclusion

Patient response to SF-36 item "Have you felt downhearted and depressed?" account for 20% of the variability of one-year ODI and EQ-5D scores and can be used by clinicians to screen for anxiety or depression in patients prior to lumbar fusion surgery. Clinicians may offer psychological support to these patients preoperatively to improve treatment outcomes.

141. DOES LORDOTIC ANGLE OF CAGE DETERMINE LUMBAR LORDOSIS IN POSTERIOR LUMBAR INTERBODY FUSION?

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Korea

Summary

We evaluated radiological results of posterior lumbar interbody fusion using 4° lordotic angle cages in 65 patients, 8° cages in 49 patients, and 15° cages in 63 patients. Lumbar lordosis and segmental lordosis was restored much more in patients using 15° lordotic angle cages although all patients showed loss of correction after surgery regardless of cage lordotic angles.

Hypothesis

We hypothesize that cage angle in posterior lumbar interbody fusion influences the radiological results.

Design

Retrospective, radiographical analysis.

Introduction

To compare the radiological results of posterior lumbar interbody fusion (PLIF) using 4° cages, 8° cages, and 15° cages in degenerative lumbar spine diseases

Methods

We evaluated 177 patients after PLIF and pedicle screw instrumentation at single or two levels with at least 1 year follow-up. PLIF using 4° lordotic angle cages (4° group) was performed in 65 patients, 8° cages (8° group) in 49 patients, and 15° cages (15° group) in 63 patients. Lumbar lordosis angles, segmental lordosis angles, disc height, bony union rate were evaluated in the radiographs.

Results

The lumbar lordosis was 36.7° before surgery, corrected to 42.4° after surgery, and changed to 34.2° at the last follow-up in the 4° group. In the 8° group, it was 33.3° preoperatively, improved to 39.7° postoperatively and decreased to 35.1° at the latest follow-up. In the 15° group, it was 31.1° preoperatively, improved to 42.9° postoperatively and decreased to 36.4° at the latest follow-up. These changes showed statistical significances (p <0.001). The segmental lordosis was 6.9° before surgery, 9.5° after surgery, and 6.2° at the last follow-up in the 4° group. It was 6.7°, 9.8°, and 8.1° in the 8° group, and 5.9°, 10.3°, and 9.4° in the 15° group respectively (p <0.001). The disc height was 10.9 mm-13.9 mm-11.7mm preop-postop-at the last follow-up in 4o group, 9.2 mm-12.3 mm-9.8mm in the 8o group, and 7.3 mm-15.3 mm-11.4mm in the 15o cage group respectively (p <0.001). The bony union was achieved in 90.7% of patients in the 4° group and 93.9% in the 8° group and 93.7% in the 15° group without significant differences (p =0.087).

Conclusion

The lordotic angle of cage has determined restoration of lumbar lordosis after instrumented posterior lumbar interbody fusion. Cages with sufficient lordotic angle showed better restoration of lumbar lordosis as well as prevention of loss of correction.

142. RADIOLOGICAL OUTCOMES OF PEEK VERSUS TITANIUM TRANSFORAMINAL LUMBAR INTERBODY CAGES.

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United Kingdom

Summary

Titanium cages due to their material properties are inherently stiff materials restore better posterior disc height but have higher subsidence rates when compared with PEEK cages.

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Hypothesis

Titanium and PEEK Lumbar cages have similar radiological outcomes.

Design

Retrospective analysis of Prospectively collected data. A cohort of 54 consecutive patients operated by single surgeon from 2007 to 2011.

Introduction

TLIF (Transforaminal Lumbar Interbody Fusion) is a common procedure for low back pain with radicular symptoms. Interbody cages are used to restore disc height and foraminal height. These cages are made of different materials like Titanium and PEEK (Poly Ether Ether Ketone). Titanium has a higher modulus of elasticity when compared with PEEK which has a modulus similar to bone. Due to these differences in the materials used the stress at implant bone interface is varied. This study aims to analyze the radiological outcomes between the two implants used by a single surgeon.

Methods

54 consecutive patients had TLIF (Transforaminal Lumbar Interbody Fusion) procedure at single lumbar level were included in the study. 26 titanium cages and 28 PEEK (Poly Ether Ether Ketone) cages appropriate for the patients were used. An independent radiological analysis was performed measuring both pre and postoperative disc / foraminal heights, global / segmental lordosis and evidence of subsidence.

Results

Average age was 45 years at the time of surgery and mean follow up was 71 months. Statistical analysis was performed using SPSS 21. 2-tailed unpaired t-test was used and there was a statistically significant difference between titanium and PEEK cages in disc height (mean titanium = 0.046, PEEK = 1.36, mean difference 1.31 mm, $p=0.0272$), foramen height (mean titanium = 1.36, mean PEEK = 0.41, mean difference 0.95mm, $p=0.43$) and global lordosis (mean titanium = 5.62, mean PEEK = 0.59, mean difference 5.03, $p=0.09$) but not in anterior disc height (mean titanium = 1.52, mean PEEK = 2.52, mean difference 0.85mm, $p=0.30$). There was significant difference in the frequency of subsidence between the 2 groups of cages (Fishers exact test, $p=0.0003$, titanium 20 cases vs PEEK 6 cases).

Conclusion

Titanium cages restore better posterior disc height but have higher subsidence rates.

143. BLOOD LOSS, TRANSFUSION, AND CONSERVATION TRENDS IN SCOLIOSIS SURGERY OVER THE PAST 10 YEARS. META-ANALYSIS OF SRS MEETING ABSTRACTS BY THE HISTORICAL COMMITTEE

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Summary

Blood conservation strategies such as cell saver and antifibrinolytics are used to decrease blood loss and associated risk of blood transfusion. Studies differ in the stated benefits of these strategies. Meta-analysis of all SRS meeting abstracts related to these strategies shows minimal impact on blood loss and transfusion volume. Trend analysis shows lower blood loss in earlier studied years, however, decreased transfusion volume in later studied years. Transfusion rate is slightly, but insignificantly increased in the treatment group.

Hypothesis

Use of antifibrinolytics decreases blood loss and risk of transfusion in all ages and diagnoses.

Design

Meta-analysis of all SRS annual meeting abstracts from 2004-2013.

Introduction

Use of antifibrinolytics in scoliosis surgery is common and is believed to decrease EBL and transfusion. However, studies tend to show varying results. The purpose of this study was to carry out a meta-analysis to test the effectiveness of blood conservation strategies.

Methods

1137 SRS abstracts from 2004-2013 were reviewed. Keyword search using "EBL", "transfusion" and blood conservation terms returned 41 abstracts. These were individually reviewed to meet inclusion criteria: scoliosis surgery, EBL, transfusion rate/volume, and blood conservation strategy. 13 studies were organized into control and treatment groups and the effect size; Hedges'd computed. Effect size is the standardized difference between two groups. Each study was weighted by the inverse of its variances and then weighted mean effect sizes and 95% confidence intervals (C.I.) were calculated. To analyze transfusion & EBL trends, studies before/ after 2008 were compared.

Results

3287 patients were included. Odds ratio for transfusion rate between the treatment group and controls was 1.2 (C.I. 0.91-1.56). There was no significant difference in EBL between younger and older patients (Effect Size, -0.255, -0.249); however, transfusion volume was significantly lower in younger patients (-1.18, -.80). In AIS and Non-AIS, treatment reduced EBL similarly (-0.658, -0.685).

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After 2008 EBL was higher despite treatment (-0.649, -0.151), but transfusion volume was lower. Although paradoxical, antifibrinolytics may be effective in decreasing post-op EBL as against intra-op EBL. Pre 2008, availability of aprotinin likely reduced EBL.

Conclusion

Blood conservation strategies are marginally effective in decreasing EBL, but seem more effective in decreasing transfusion volume. Treatment strategies for lowering transfusion volume are more effective in younger patients, but do not significantly decrease the likelihood of requiring a transfusion.

144. IMPLANT COMPLICATIONS AFTER MAGNETIC-CONTROLLED GROWING RODS FOR EARLY ONSET SCOLIOSIS: A MULTICENTER RETROSPECTIVE REVIEW

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United States

Summary

Traditional growing rods are known to have high complication rates. Early results demonstrate that the magnetic-controlled growing rods have a lower infection rate but have similar implant related complications as compared to traditional growing rods.

Hypothesis

Magnetically controlled growing rods have low rates of wounds and implant related complications.

Design

Multicenter retrospective study.

Introduction

Traditional growing rods have a reported wound and implant complication rate as high as 58%. It is unclear whether the use of magnetic-controlled growing rods (MCGR) will affect this rate. This study was performed to characterize surgical complications following MCGR in early onset scoliosis (EOS).

Methods

A multicenter retrospective review of MCGR cases was performed. Inclusion criteria was: 1) diagnosis of EOS of any etiology; 2) <11 years at time of index surgery; 3) pre-op major Cobb >30 degrees; 4) pre-op thoracic spine height <22cm. Complications (COMP) were categorized as wound-related and instrumentation-related. COMP were also classified as early (< 6 months) versus late. Distraction technique and interval of distraction was surgeon preference without standardization across sites.

Results

54 MCGR pts met inclusion criteria. 24 (16 primary and 8 conversion) had a min 2-year follow-up. There were 30 primary and 24 conversion procedures. Mean age at initial surgery was 7.3 years (SD=2.3, range 2.4 to 11 years), and mean duration of follow-up 19.4 mo (SD=7.9).

21 of 54 patients had at least 1 COMP. 15 of those had revision surgeries. 6 had broken rods (2- 4.5 and 4- 5.5 mm rods); two 5.5 mm rods failed early (4 mo) and 4 late (mean = 14.5 mo). 6 experienced 1 episode of lack or loss of lengthening of which 4 lengthened on subsequently. 7 had either proximal or distal fixation-related CMP at avg of 8.4 mo. 2 had infections requiring I&D, one early (2 wks) with wound drainage and one late (8 mo). The late case required explantation of one of the dual rods

Conclusion

This learning curve experience found that compared to traditional growing rods, early to intermediate follow-up results demonstrate a lower infection rate (3.7%) with MCGR. MCGR does not appear to prevent common implant related complications such as rod or foundation failure. The lack of lengthening seen at some visits is unique to MCGR. The long term implication of this remains to be determined.

145. COMPLICATIONS ASSOCIATED WITH SURGERY FOR HIGH GRADE SPONDYLOLISTHESIS-PATIENT AND SURGERY RELATED FACTORS: A SINGLE CENTER LONG TERM FOLLOW-UP OF 49 PATIENTS.

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India

Summary

49 high-grade spondylolisthesis from 2003-2014 were studied retrospectively for associated postoperative complications. Subgroup analysis was done for patient (age, sex, type of listhesis) and surgery (fusion type, fusion level) related variables. There is higher incidence of complications among dysplastic type and all are seen in L5/S1 level. Complications were observed mostly in L4-S1 fusion group (p=0.03) and there is no difference between the type of fusion.

Hypothesis

Complications associated with Surgery for high grade spondylolisthesis (HGS) are dependent on various patient related variables like age, sex, type of listhesis (lytic/dysplastic) as well as surgery related variables like (fusion type/fusion level).

Design

Retrospective Study from a single spine center.

Introduction

It is well established that surgery for High Grade Spondylolisthesis (HGS)(grade III/IV) is associated with more complications. However, the rate and type of complications varies with patient and surgery related variables. The objective of this study is to analyze the complication rates associated with the surgical treatment of HGS and identify factors associated with increased complication rates.

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Methods

49 patients (19 dysplastic, 30 spondylolytic) of operated HGS in our institution from 2003-2014 were analysed. Case sheets and X-rays/MRIs were retrieved from PACS(Picture Archiving and Communication System). Patient variables including age, sex, type (dysplastic/spondylolytic), level of HGS(L4/L5 or L5/S1) and surgical variables including type of fusion (TLIF/PLF),level of fusion (L4-S1/L4-L5/L5-S1) were tabulated. Complications were then compared with said variables and Statistically analyzed using Microsoft Excel Data Analyzer Tool Pack.

Results

Average follow-up of the patients was 55 months (6 - 140 m). 3 types of complications were found in 9 patients, New Neurological Deficit (NND) in 4(8.2%), wound healing problems in 4(8.2%) and implant related complication in 2(4.1%) {1 patient had both NND and implant related complications}. There is a higher incidence of complications among dysplastic type (7 out of 9) ($p=0.03$) and all are seen in L5/S1 level HGS. Complications were observed mostly in L4-S1 fusion group (8 out of 9) ($p=0.03$) and there is no difference between the type of fusion. All except one of the NNDs improved.

Conclusion

Surgery for HGS is significantly associated with various complications. The rate of complications is higher in dysplastic type and in L4-S1 fusion group and is not dependent on the type of fusion.

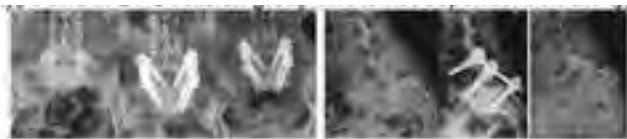


Figure 1: Three X-rays illustrating pedicle placement and the transverse AP and LAM views.

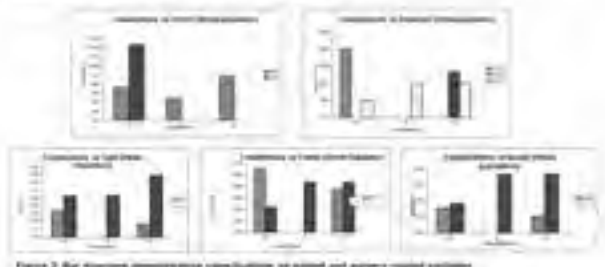


Figure 2: Bar graphs illustrating complications in pedicle and surgery related variables.

146. THE SAFETY OF PERCUTANEOUS PEDICLE SCREWS USING FLUOROSCOPY IN THE LUMBOSACRAL JUNCTION AND LUMBAR SPINE.

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Malaysia

Summary

This study reviewed 880 percutaneous screws placed in the lumbosacral junction and lumbar spine. The total perforation rate was 9.9% (87) with 7.4% grade 1, 2.0% grade 2 and only 0.5% grade 3 perforations. We found that the clinical safety profile of percutaneous pedicle screws technique is comparable to the conventional open technique in the current literature.

Hypothesis

To assess the clinical safety profile of percutaneous pedicle screw placement using fluoroscopy in the lumbosacral junction and lumbar spine.

Design

Retrospective review of CT scan.

Introduction

Percutaneous pedicle screws in the lumbosacral junction and lumbar spine had been used for various spinal conditions. Recent literature showed a varied safety profile.

Methods

This was a retrospective study to investigate the accuracy and safety of percutaneous pedicle screws placed using fluoroscopic guidance in the lumbosacral junction and lumbar spine. Computerized tomography scans of consecutive patients were recruited between January 2008 and December 2012. Screw perforations were classified according to Rao et al (2002) into grade 0, grade 1, grade 2 and grade 3.

Results

A total of 880 percutaneous pedicle screws from 203 patients were analysed. The mean age was 58.8 (16-91) with 103 male and 100 female patients. The total perforation rate was 9.9% (87 screws) with 7.4% grade 1, 2.0% grade 2 and 0.5% grade 3 perforations. One patient with medial grade 3 perforation developed postoperative radicular symptoms which subsided with conservative pharmacological treatment. The other 2 lateral and 1 anterior grade 3 perforations did not produce any complications. The perforation rate was the highest in S1 (19.4%, 13 perforations/67 screws) followed by L5 (14.9%, 17 perforations/114 screws).

Conclusion

Percutaneous pedicle screws placement has the accuracy and safety comparable to the open method of pedicle screw placement reported in the current literature. A higher caution must be taken during insertion of L5 and S1 percutaneous pedicle screws due to their more angulated pedicles, anatomical variations of their vertebral bodies and the morphology of their spinal canals.

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	Total	Rate (%)
Number of screws	880	
Screws with perforation	87	9.9
Screws with Grade 1 perforation	65	7.4
Screws with Grade 2 perforation	18	2.0
Screws with Grade 3 perforation	4	0.5

147. TIMING OF SURGERY FOR COMBAT-RELATED SPINE INJURY AFFECTS COMPLICATION RATES

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United States

Summary

The optimal timing for combat-related spine fractures is currently unknown. Therefore, we reviewed all operative cases of combat-related spine fractures managed operatively in the acute and delayed periods at our institution. We found higher rates of postoperative complications, reoperations and revisions in the acutely treated patients.

Hypothesis

There may be more postoperative complications in patients treated acutely for combat-related spine fractures.

Design

Retrospective review.

Introduction

There is no current consensus regarding optimal timing for surgical intervention for combat-related spinal injuries. We set out to report the immediate postoperative outcomes of service members with operatively managed spine fractures in the acute (<14 days) and delayed (>14 days) periods.

Methods

A retrospective analysis of patients undergoing spine surgery designated as engaged in Operations Enduring and/or Iraqi Freedom between 01JUL2003 and 01JUL2013 at our institution. Medical records and radiographs were reviewed for all patients.

Results

A total of eighty-eight patients met inclusion criteria. Fifty-seven (65%) underwent index spine procedure in the acute period (mean 6.6, \pm 3.9 days after injury), while 31 (35%) patients underwent delayed spinal fixation (mean 150.9, \pm 319.5, range 15-1600 days after injury). The most common mechanisms of injury in the acute group were mounted improvised explosive device (IED) and gunshot wound (44% and 23%, respectively). The most common mechanisms of injury in the delayed treatment group were mounted and dismounted IED (52% and 16%, respectively). The acute treatment group had fewer total vertebrae injured (3.4, \pm 2.0 versus 8, \pm 9.9, $p=$

0.12) and fewer spinal levels injured (1.6 versus 1.8, \pm 0.9, $p=$ 0.32). The two groups had an equal proportion of patients with spinal cord injuries (42%). The delayed treatment group had higher mean injury severity scores (ISS, 23.0, \pm 16.7 vs. 16.4, \pm 12.4, $p=$ 0.57), higher rates of pulmonary embolism (23% vs. 4%) and deep venous thrombosis (23% vs. 4%) ($p=$ 0.009), but a lower proportion postoperative complications (10% vs. 25%, $p=$ 0.09), additional surgeries (6% vs. 26%, $p=$ 0.02), and hardware revisions (3% vs. 16%, $p=$ 0.08).

Conclusion

The optimal period for operative intervention on combat-related spinal fracture remain unknown. We found that patients treated acutely had lower rates of venous thromboembolism but a higher complication rate, more additional surgeries, and fewer vertebrae and spinal levels injured, despite a lower average ISS.

148. PREDICTING EXTENDED LENGTH OF HOSPITAL STAY IN AN ADULT SPINAL DEFORMITY SURGICAL POPULATION

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United States

Summary

Complications can occur following adult spinal deformity surgery. This study identified risks associated with ASD surgery and extended hospital length of stay (LOS) and the effect of LOS on Health Related Quality of Life (HRQL) scores. Predictors for extended LOS were higher Charlson Comorbidity Score and increased number of intra-operative, but not peri-operative, complications. All patients improved in all HRQLs, but extended LOS patients improved less in all HRQLs except MCS.

Hypothesis

Increased length of hospital stay is associated with major complications and worse HRQL scores.

Design

Retrospective review of prospectively collected multi-center database.

Introduction

Surgery for adult spinal deformity (ASD) is complex and may result in various types of complications. This study identifies baseline and operative variables associated with extended length of hospital stay (ExtLOS) and this impact on health related quality of life (HRQL) scores.

Methods

Inclusion criteria were ASD surgical patients (age > 18 yrs, scoliosis \geq 20°, SVA \geq 5cm, PT \geq 25° and/or TK > 60°). Demographic, radiographic and HRQL data at baseline, 6 weeks, and 2 years following initial ASD surgery were reviewed. ExtLOS was based on 75th percentile, defined as \geq 9 days. Univariate and multivariate analyses identified

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predictors and evaluated effects on outcomes. Repeated measures mixed models analyzed impact of ExtLOS on HRQL [ODI; SF-36 PCS and MCS; SRS22r Activity (AC), Pain (P), Appearance (AP), Satisfaction (S), Mental (M) and Total (T)].

Results

380 patients met inclusion criteria: 105 (27.6%) had ext. LOS (≥ 9 days), 275 (72.4%) did not. Average LOS was 8 days (range: 1-30 days). Charlson Comorbidity Index Score (CCI) predicted ExtLOS (OR 3.92, $p=0.027$); ExtLOS was seen in 22.4% CCI 0-1, 31.3% CCI 2-4, and 56% CCI 5+ ($p<0.002$). Number of intra-op complications predicted ExtLOS (OR 3.56, $p=0.038$). ExtLOS patients had more intra cardiopulmonary (pleural effusion: 1.9% vs. 0%), and operative complications (dural tear: 13.3% vs. 5.1%; excessive blood loss: 18% vs. 5.8%) ($p<0.022$). Peri-op complications had no effect on LOS. At 2 years, both groups of patients experienced overall improvement in all HRQL scores (ODI, PCS, MCS, SRS22r AC, P, AP, S, T $p<0.001$). However, patients with ExtLOS had significantly less overall improvement in all HRQLs ($p<0.01$) except for MCS ($p=0.17$) and SRS M ($p=0.08$).

Conclusion

Extended LOS of ASD patients is affected by comorbidities (higher CCI) and number of intra-operative, but not peri-operative, complications. All patients improved overall in HRQL scores, but extended LOS patients improved less overall at 2 years in comparison.

149. DEVELOPMENT OF A PREOPERATIVE PREDICTIVE MODEL FOR INTRA- OR PERI-OPERATIVE MAJOR COMPLICATIONS WITH HIGH ACCURACY VALIDATED WITH 558 ASD PATIENTS

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United States

Summary

A predictive model (87.6% correct, AUC of 0.89) using 45 baseline demographic, radiographic, and surgical variables for sustaining a major intra- or perioperative complication was constructed with 558 ASD patients. Top 20 predictors were: age, leg pain, ODI, #decompression levels, #interbody fusion levels, PCS, SRS-Schwab coronal curve type, Charlson comorbidity index, SRS Activity, T1PA, ASA grade, presence of osteoporosis, PT, SVA, primary vs revision, SRS pain, SRS total, use of BMP, use of iliac crest graft, and PI-LL.

Hypothesis

A model based on baseline demographic, radiographic, and surgical factors can predict patients sustaining an intra- or periop major complication.

Design

Retrospective review of prospective multicenter ASD database

Introduction

The operative management of patients with ASD has a high complication rate and it remains unknown whether baseline patient characteristics and surgical plans may predict early complications (intraop and periop <6 wk). The development of an accurate preoperative predictive model can aid in patient counseling, shared decision making, and improved surgical planning.

Methods

Inclusion criteria: age ≥ 18 , ASD. 45 variables were included in the initial training of the model and included demographic data, comorbidities, modifiable surgical variables, baseline HRQOL, and coronal and sagittal radiographic parameters. Patients were grouped as either having at least 1 major intra- or periop complication (COMP) or not (NOCOMP). An ensemble of decision trees was constructed using the C5.0 algorithm with 5 different bootstrapped models. Internal validation was accomplished via a 70:30 data split for training and testing each model, respectively. Overall accuracy, and the area under a receiver operator characteristic curve (AUC) were calculated.

Results

558 patients were included, NOCOMP: 410(73.5%), COMP: 148(26.5%). The overall model accuracy was 87.6% correct with an AUC of 0.89 indicating a very good model fit. 20 variables were determined to be the top predictors (importance ≥ 0.90) and included (in decreasing importance - Figure): age, leg pain, ODI, #decompression levels, #interbody fusion levels, PCS, SRS-Schwab coronal curve type, Charlson comorbidity index, SRS Activity, T1PA, ASA grade, presence of osteoporosis, PT, SVA, primary vs revision, SRS pain, SRS total, use of BMP, use of iliac crest graft, and PI-LL.

Conclusion

A successful model (87% accuracy, 0.89 AUC) was built predicting major intra- or periop complications. This model can provide the foundation toward improved education and point-of-care decision making for patients undergoing ASD surgery.

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150. RISK FACTORS FOR VENOUS THROMBOEMBOLISM FOLLOWING THORACOLUMBAR SURGERY: ANALYSIS OF 43,777 PATIENTS FROM ACS-NSQIP 2005-2012

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United States

Summary

Using ACS-NSQIP, a review of 43,777 patients who underwent thoracolumbar surgery was performed to determine the incidence, timing, and risk factors for postoperative venous thromboembolism.

Hypothesis

The rate and timing of thromboembolism would vary across procedures. Multiple independent risk factors would be identified.

Design

Retrospective study of patients from a prospectively collected national database.

Introduction

The incidence of venous thromboembolism (VTE) following spine surgery is poorly understood. American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) is a validated database that collects 30-day complication data from over 400 institutions. We report a comprehensive examination of the incidence, timing, and risk factors for VTE following thoracolumbar surgery.

Methods

ACS-NSQIP identified 43,777 patients who underwent thoracolumbar surgery from 2005-2012. Multiple patient characteristics were identified. The incidence and timing of deep vein thrombosis (DVT) and pulmonary embolus (PE) were determined. Multivariable logistic regression analysis was performed to identify risk factors.

Results

Overall, 202 cases of PE (0.5%) and 311 cases of DVT (0.7%) were identified. VTE rates were highest in patients undergoing corpectomy with a 1.7% PE rate ($p < .001$) and a 3.8% DVT rate ($p < .001$). (Table 1) In 2011-2012, 28.0% of patients with VTE were readmitted. Independent risk factors for VTE included length of stay six days or greater (OR 4.07, $p < .001$), disseminated cancer (OR 1.77, $p < .001$), WBC > 12 (OR 1.76, $p < .001$), paraplegia (OR 1.75, $p = .003$), albumin < 3 (OR 1.73 $p = .012$), ASA class 4 or greater (OR 1.54, $p = .035$), BMI > 40 (OR 1.49, $p = .030$), and operative time greater than 193 minutes (OR 1.43, $p = .050$). Length of stay less than three days was protective (OR .427, $p < .001$). In the spinal deformity cohort, bleeding disorders were predictive of VTE (OR 5.86, $p = .008$).

Conclusion

We report an overall 30-day PE rate of 0.5% and DVT rate of 0.7% following thoracolumbar spine surgery. This resulted in a 28% readmission rate. Patients undergoing corpectomy were at highest risk for VTE. Patients with

longer hospital admissions and bleeding disorders had an increased VTE risk. Further studies are needed to develop algorithms to stratify VTE risk and direct prophylaxis accordingly.

Table 1. VTE rates following Thoracolumbar Spine Surgery

Procedure	N	PE (%)	OR (95% CI)	DVT (%)	OR (95% CI)	Days until DVT
Total	43,777	202 (0.5%)	1.0 ± 1.0	311 (0.7%)	1.0 ± 1.0	10.3 ± 7.4
Prophylaxis	38,529	98 (0.3%)	0.7 ± 0.5	149 (0.4%)	0.6 ± 0.4	10.5 ± 7.6
Disprophylaxis	5,248	104 (2.0%)	4.0 ± 3.1	162 (3.1%)	2.1 ± 1.7	10.2 ± 7.2
Procedure Types						
Corpectomy	3685	22 (0.6%)	1.7 ± 1.5	29 (0.8%)	1.7 ± 1.5	7.5 ± 6.4
PLF/PLP*	2189	13 (0.6%)	1.2 ± 0.8	11 (0.5%)	0.8 ± 0.6	9.8 ± 5.4
Discectomy	474	8 (1.7%)	3.8 ± 3.5	18 (3.8%)	3.8 ± 3.5	8.8 ± 7.5
Discectomy with discectomy	920	5 (0.5%)	0.8 ± 0.4	2 (0.2%)	0.2 ± 0.1	12.5 ± 8.6
Transpedicular discectomy	671	7 (1.0%)	2.0 ± 1.7	6 (0.9%)	1.0 ± 0.9	7.9 ± 6.7
Lateral minimally-invasive discectomy	194	1 (0.5%)	1.0 ± 0.5	2 (1.0%)	1.0 ± 0.5	15.0 ± 11.4
Other Approaches	170	3 (1.8%)	3.6 ± 3.1	1 (0.6%)	1.0 ± 0.6	6.0 ± 4.1
Spinal Deformity	1538	13 (0.9%)	1.8 ± 1.3	28 (1.8%)	1.8 ± 1.3	10.8 ± 7.3
Anterior Osteotomy	312	1 (0.3%)	0.3 ± 0.1	7 (2.3%)	7.5 ± 5.2	19.2 ± 15.2
Posterior Osteotomy	699	3 (0.4%)	0.8 ± 0.5	11 (1.6%)	1.1 ± 0.8	11.3 ± 7.1

*Minimally-invasive discectomy
*Minimally-invasive discectomy

151. DOES SINGLE- VERSUS TWO-STAGE PEDICLE SUBTRACTION OSTEOTOMY IN SPINAL DEFORMITY SURGERY INFLUENCE PERIOPERATIVE COMPLICATIONS?

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Thailand

Summary

We evaluated the rate of perioperative complications comparing single- versus two-stage PSO (SS/TS). 173 consecutive patients were identified that underwent PSO, with 103 pts meeting inclusion criteria and having complete data (59 SS and 44 TS). Single- versus two-stage PSO procedures did not have any difference in perioperative complications for adult spinal deformity patients. While two-staged PSO may result in greater EBL, there was no difference in total surgery time or # of intraop/postop blood transfusions.

Hypothesis

Perioperative complications would be similar between single- and two- stage pedicle subtraction osteotomy (PSO).

Design

Retrospective analysis of prospectively collected database.

Introduction

PSO for complex spinal deformity can be challenging with a high rate of perioperative complications. We evaluated the rate of perioperative complications comparing single- versus two-stage PSO.

Methods

Adult spinal deformity patients undergoing all-posterior PSO were retrospectively analyzed as two cohorts, single-stage (SS) vs. two- staged (TS). Perioperative clinical records were reviewed, and any complications occurring within the first two months postoperatively were recorded.

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Results

173 consecutive adult patients were identified that underwent PSO, with 103 pts meeting inclusion criteria and having complete data (59 SS and 44 TS). There were no differences in demographics (age, BMI, gender, ASA classification, Charlson Comorbid Index, smoking status, primary v revision surgery, preop diagnosis). We found no difference in total # of complications (SS 21,35.6% v TS 13,29.5%, $p=0.519$), or number of neuro deficits (SS 7 v TS 11, $p=0.082$). We found a difference in total EBL (SS 2632 v TS 3246mL, $p=0.019$), and total # of hospital days (SS 9.42 v TS 14.3 days, $p=0.00$). However, there were no statistical differences in total surgery time (SS 617 v TS 728min, $p=0.129$), total # of intraop pRBC transfusions (SS 4.66 v TS 5.25 units, $p=0.332$), or total # of postop pRBC transfusions (SS 1.47 v TS 1.86, $p=0.391$).

Conclusion

There were no differences in perioperative complications between single- versus two-stage PSO procedures for adult spinal deformity patients. Two-staged PSO resulted in greater EBL and increased hospitalization, but there was no differences in total surgery time or # of intraop/postop blood transfusions.

	Single-Stage	Two-Stage	P-Value
Demographics			
Age	51.1	51.2	0.20
BMI	29.7	29.2	0.80
Gender	21F, 38M	17F, 24M	0.40
ASA Classification	AAI=10 AAII=19 AAIII=30	AAI=10 AAII=19 AAIII=20	0.76
Charlson Comorbidity Index	2.1	2.0	0.12
Operative			
Primary Fusion	27 (45.8%)	47 (107%)	0.11
Revision Fusion	32 (54.2%)	37 (83%)	
# Pre-Operative Complications	7 (11.7%)	7 (16%)	0.80
# Post-Operative Complications	21 (35.6%)	13 (29.5%)	0.52
Neuro Deficit	7 (11.7%)	11 (25%)	0.08
Wound Healing Issues	0	0	
Wound Dehiscence	0	0	
Wound Infection	0	0	
Wound Drain	0	0	
Wound Stenosis	0	0	
Wound Abscess	0	0	
Wound Hematoma	0	0	
Wound Seroma	0	0	
Wound Necrosis	0	0	
Wound Fistula	0	0	
Wound Prolonged Healing	0	0	
Wound Reoperation	0	0	
Wound Mortality	0	0	
Complications			
Deep Wound Infection	0	0	
Neurologic Deficit	7	11	0.08
Reintubation	0	0	
Cardiac Arrest	0	0	
VTE	0	0	
Blood Transfusion	4.66	5.25	0.33
Death	0	0	

152. COMPLICATION RATES AFTER SPINAL SURGERY FOR ADOLESCENT IDIOPATHIC SCOLIOSIS VARY SIGNIFICANTLY BASED ON REPORTING METHODOLOGY: WHO TO BELIEVE?

Amit Jain, MD; Paul D. Sponseller, MD; Dolores Njoku, MD; Suken A. Shah, MD; Amer F. Samdani, MD; Patrick J. Cahill, MD; Randal R. Betz, MD; Peter O. Newton, MD; Michelle Claire Marks

United States

Summary

The aim of our study was to compare the rate of in-hospital major complications after spinal fusion surgery in patients with AIS using 3 large databases (AHRQ KIDS database vs. ACS NSQIP database vs. Harms Study Group AIS registry) with each utilizing different ascertainment methods. We found that the overall rate of serious complications after scoliosis surgery in AIS was low and varied significantly depending on the query source.

Hypothesis

The rates of perioperative complications after spinal surgery for adolescent idiopathic scoliosis (AIS) vary based on the ascertainment and coding methodologies.

Design

Retrospective comparison of 3 large databases.

Introduction

The aim of our study was to compare the rate of in-hospital major complications after spinal fusion surgery in patients with AIS using 3 large databases with each utilizing different ascertainment methods.

Methods

All patients with a diagnosis of AIS who underwent spinal fusion surgery in 2012 were identified in the following 3 databases: Agency for Healthcare Research and Quality Kids Inpatient Database (KID) (7,739 patients; relies on hospital billing data), American College of Surgeons National Surgery Quality Improvement Program (NSQIP; data entered by trained nurse abstractor) database (1,094 patients), and the Harms Study Group (HSG) AIS registry (222 patients; data entered by surgeon and research coordinator). Only in-hospital complications reported in each database were compared to allow for similar comparisons: deep wound infection (DWI), neurologic deficit, reintubation, cardiac arrest, venous thromboembolism (VTE), blood transfusion, and death.

Results

The rate of DWI varied from 0.18% to 0.45%, but was not significantly different. The rate of neurologic deficits varied significantly; compared to NSQIP, HSG reported a 1.7-fold rate. In the KID, the rate of postop re-intubations was 0.85% and of cardiac arrest was 0.34%, while no patients in the NSQIP or HSG were reported to have these complications. The reported rate of blood transfusion varied significantly among the 3 databases ($P<0.001$). Compared to the KIDS, transfusion rate was 2.4-fold in HSG, and 3.2-fold in NSQIP. NSQIP or HSG reported no inpatient mortality, while 7 patients in KIDS reportedly expired.

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Conclusion

The overall rate of serious complications after scoliosis surgery in AIS was low and varied depending on the query source. Administrative databases may suffer from coding errors but potentially capture rare events, while multicenter surgeon-reported registries may potentially provide access to more granular data.

	KIDS	NSQIP	HSG	P-Value
Deep Wound Infection	0.36%	0.18%	0.45%	0.507
Neurologic Deficit	0.0%	0.27%	0.45%	<0.001*
Re-intubation	0.85%	0%	0%	<0.001*
Cardiac Arrest	0.34%	0%	0%	0.12
DVT/PE	0.017%	0.0%	0%	1
Blood Transfusion	19.9%	63.0%	46.9%	<0.001*
Death	0.092%	0%	0%	1

153. OBESE CLASS III ADULTS HAVE SIGNIFICANTLY GREATER RISK OF MULTIPLE COMPLICATIONS AFTER ADULT DEFORMITY SURGERY: AN ANALYSIS OF 4,716 PATIENTS IN THE ACS NSQIP DATABASE

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United States

Summary

Patients with increased BMI appear to have increased complication rates following adult deformity surgery (ADS), with significantly greater risk of any complication for those with BMI >40 kg/m².

Hypothesis

Different grades of obesity influence complication rates differently in ADS.

Design

Retrospective cohort analysis of prospectively collected data using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database from 2005 to 2012.

Introduction

Previous studies have noted an association between obesity and increased risk of complications in idiopathic scoliosis surgery. The aim of this study was to analyze whether different grades of obesity influence complication rates in patients undergoing ADS.

Methods

Adult patients (>18 years) undergoing ADS (anterior fusion 2+ levels and/or posterior fusion 6+ levels) were categorized into four BMI groups: non-obese (18.5-29.9 kg/m²), Obese I (30-34.9 kg/m²), Obese II (35-39.9 kg/m²) and Obese III (>40 kg/m²). Obese I to III patients were compared to non-obese patients using chi-square test and analysis of variance. Multivariate logistic regression models were employed to adjust for preoperative risk factors.

Results

4,716 patients underwent ADS during the study period, with no significant differences between the groups in terms of patient demographics or surgical variables. Among all groups, 24.3% were in the Obese I group, 11.7% Obese II and 6.6% Obese III. On multivariate analysis assessing 30-day outcomes, only the patients in the Obese III group had a statistically increased risk of UTI (OR 2.8, 95% CI 1.5-5.2, p<0.001), return to OR within 30 days (OR 2.2, 95% CI 1.3-3.7, p=0.002) and increase risk of any complication (OR 1.4, 95% CI 1.1-1.9, p=0.014).

Conclusion

Obese III patients appear to have substantially increased complication rates following ADS. However, they do not appear to be at increased risk of postoperative mortality. Surgeons should be aware of the increased risk of multiple postoperative complications for patients with BMI >40 kg/m².

154. STUDY OF HYPERAMYLASEMIA AND PANCREATITIS FOLLOWING SPINAL SURGERY

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Japan

Summary

Between 2010 and 2012, 262 cases involving measurement of the serum amylase level following spinal surgery were examined. Hyperamylasemia at a level of >125IU/L was found in 92 cases. Hyperamylasemia at a level of >625IU/L was found in 6 cases and 1 case was involved hyperamylasemia caused by severe pancreatitis. Compared to the cases where serum amylase levels were normal, intraoperative blood loss was significantly higher in the cases where the serum amylase level was high (P<0.05).

Hypothesis

To investigate hyperamylasemia and pancreatitis following spinal surgery in the prone position.

Design

Retrospective clinical study.

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Introduction

Hyperamylasemia is a complication that can occur following spinal surgery in the prone position. A few previous studies have reported that it can be a very serious condition when it is caused by pancreatitis.

Methods

Between 2010 and 2012, 262 cases involving measurement of the serum amylase level following spinal surgery were examined. The mean age of the patients was 53.9 years (5 to 88). The relationship among serum amylase level, BMI, operative time, and intraoperative blood loss was investigated. Normal serum amylase level was considered to be less than 125IU/L.

Results

Hyperamylasemia at a level of >125IU/L following spinal surgery was found in 92 cases. Compared to the cases where serum amylase levels were normal, intraoperative blood loss was significantly higher in the cases where the serum amylase level was high ($P<0.05$). BMI and operative time were found to have no significant relationship with serum amylase level and intraoperative blood loss. Hyperamylasemia at a level of >625IU/L (one of the diagnostic criteria of postoperative pancreatitis according to previous reports) following spinal surgery was found in 6 cases. Asymptomatic hyperamylasemia was found in 5 cases, and 1 case involved hyperamylasemia caused by severe pancreatitis, but treated by intensive medical care.

Conclusion

In the present study, intraoperative blood loss was found to have caused a rise in the serum amylase level following spinal surgery. Therefore, whenever there is significant blood loss, the serum amylase level should be carefully monitored for changes. In addition, it is necessary to monitor for clinical symptoms of pancreatitis, such as abdominal pain and vomiting, following spinal surgery.

155. ANALYSIS OF COMPLICATIONS OF SURGICAL MANAGEMENT OF CERVICAL SPONDYLOTIC MYELOPATHY(CSM)-171 PATIENTS IN A SINGLE UNIT WITH AVERAGE FOLLOW-UP 47 MONTHS

Saumyajit Basu, MD; Tarun Suri, MS; Sri Krishna Chaitanya Kondety, MS; Amitava Biswas, MS; Kiran Tapal, MS; Vignesh Pushparaj, d ortho; Trinanjan Sarangi, MD

India

Summary

171 patients of CSM were retrospectively analyzed for postoperative complications and compared between different subgroups. Commonest complication was dysphagia & Dural leaks. Incidence of complications were higher in OPLL, multi-level surgery & ACDF compared to ACD but was independent of approach and cord signal changes.

Hypothesis

Complications after surgery for CSM dependent on disease variables like presence of OPLL, cord signal changes & surgery related variables like approach, no. of levels addressed & type of surgery

Design

Retrospective study of 171 surgically treated patients of CSM with mean follow up of 3.9 years (2.1 to 8.9 y).

Introduction

Complication of surgeries for CSM in existing literature varies from 39% but patient and surgery related variables have not been compared to identify patients who are more likely to have complications.

Methods

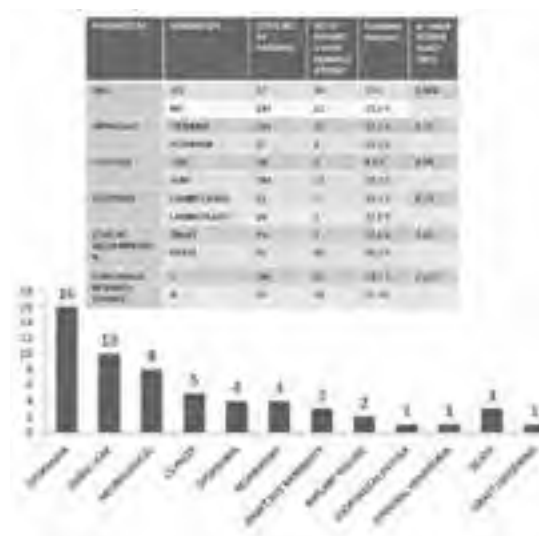
171 patients were grouped into pathology (OPLL vs Non OPLL), surgical approach (A/P), type of procedure, no. of levels of surgery, cord signal changes and subgroup analysis of complications were done using SPSS v16.0.

Results

132 patients were operated anteriorly (102 ACDF/ACCF, 30 ACD) and 37 posteriorly (21 laminectomy, 16 laminoplasty). Total 55 complications were found in 32 patients (18.7 %). Dysphagia was commonest (9.3%), followed by NNDs (4.8%) & dural leaks (4.8%). Others include dysphonia (2.4%), respiratory problems (2.4 %), C5 pals (1.79%), Esophageal fistula (EF)(0.6%), pseudomeningocele (1.19%), implant failure(1.19 %), graft extrusion(0.59%) and epidural hematoma(0.59%). Mortality rate was 0.6% (sole patient with EF). Significantly higher complications were found in OPLL group ($p=0.008$) & multilevel ACDF ($p=0.03$). It was not statistically significant in any approach, in laminectomy vs laminoplasty or with/without pre-operative cord signal changes.

Conclusion

Most common complications of surgery for CSM are dysphagia & dural leaks. Significant increase in complications in multilevel surgery and in patients with OPLL. No difference was found in Ant vs Post approach and laminectomy vs laminoplasty.



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156. PERI-OPERATIVE AND DELAYED MAJOR COMPLICATIONS FOLLOWING SURGICAL CORRECTION OF AIS IN 3530 PATIENTS

Carrie E. Bartley, MA; Burt Yaszay, MD; Tracey Bastrom, BS,MS; Suken A. Shah, MD; Baron S. Lonner, MD; Jahangir K. Asghar, MD; Firoz Miyanji, MD, FRCSC; Amer F. Samdani, MD; Peter O. Newton, MD

United States

Summary

From 1995 to 2014, there were 193 major complications following surgical correction of AIS in 3530 patients. The peri-operative complication rate was 2.6%. The majority of peri-operative complications were wound or neurologic related. For those patients with 2-year follow-up, the delayed major complication rate was 4.44% and the re-operation rate was 4.35%.

Hypothesis

Patients undergoing adolescent idiopathic scoliosis (AIS) surgery have a low rate of complications.

Design

Retrospective review of prospective data.

Introduction

Reporting accurate complications rates to patients and payers is important in the management of AIS. The purpose of this study is to report on the rate of major complications following surgically treated AIS both in the peri-operative period and at ≥ 2 yrs follow-up.

Methods

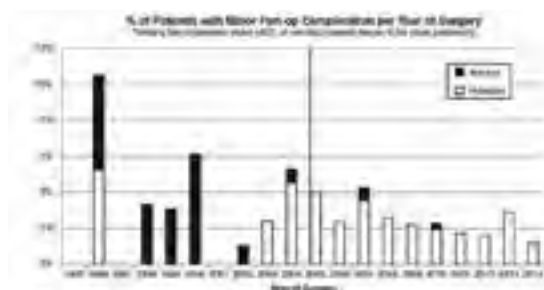
A prospectively collected (1995-2014), multicenter database of patients who had surgical correction of AIS was reviewed for all major complications. 3530 patients with pre-op and first post-op data were included. A subset of 2115 pts with ≥ 2 yrs f/u, made up the cohort for delayed complications. A complication was defined as major if it resulted in re-operation, was considered life-threatening, or resulted in spinal cord/nerve root injury. Overall complication rates were calculated, as well as percentage of complications by year of surgery and approach type.

Results

3530 patients (mean age 15 ± 2 years) were reviewed. Mean thoracic Cobb was $51 \pm 16^\circ$ and mean lumbar Cobb was $39 \pm 14^\circ$. There were 364 ASF and 3166 PSF (146 with anterior release). There were 193 major complications, 93 (2.6%) of which occurred peri-op (≤ 6 wks). The majority of peri-op complications were wound (1%), neurologic (0.5%), pulmonary (0.4%), instrumentation (0.4%), or gastrointestinal (0.2%) related. One patient died. The average peri-op complication rate based upon year of surgery ranged from 0-10.5% (Figure). The complication rate for each surgical approach was 3% ASF, 2.6% PSF (2.5% PSF only, 5.5% PSF with anterior release). The major complication rate for those with > 2 yr f/u was 4.4%; all but 2 had a re-operation (4.4%). The majority of these major complications were wound (2.1%) and instrumentation (0.9%) related.

Conclusion

After surgery for AIS, a 2.6% rate of major peri-op complications or a 4.4% rate of major complications at > 2 years post-op can be anticipated. This is critical information to guide patients and inform payers. Fortunately, the complication rate has decreased in the last decade with attention focused on safety and quality from all stakeholders.



157. 5-YEAR REOPERATION RISK AND CAUSES FOR REVISION AFTER IDIOPATHIC SCOLIOSIS SURGERY

Syed Imraan Ahmed, MD; Tracey Bastrom, BS,MS; Burt Yaszay, MD; Peter O. Newton, MD; Harms Study Group

United States

Summary

Limited data exists in characterizing the long-term risk of reoperation in scoliosis surgery. For 1435 idiopathic scoliosis surgical patients, the actuarial cumulative 5 year survivorship (no revision) rate was 93.9%. Infections were the most common cause for revision and had a bimodal distribution, peaking at < 3 mo and 2-5 yrs. The majority of problems related to implant misplacement occurred relatively early. Additional quality improvement efforts are required to further reduce the need for revision surgery.

Hypothesis

To define the rate and cause of surgical revision 5 years after scoliosis surgery.

Design

Actuarial survivorship analysis of primary scoliosis surgery, revision defined as α terminal event.

Introduction

Data on the mid-term revision surgery rates after idiopathic scoliosis surgery in the adolescent and young adult population is limited.

Methods

Patients enrolled in a multi-center observational prospective idiopathic scoliosis surgical registry from 1995-2009 were reviewed. Any spine re-operation was defined as a α terminal event. Actuarial survivorship analysis was performed to determine cumulative survival, which adjusts for patients lost to follow-up by censoring and counting half person years in each interval adjusting the denominator as necessary. Time intervals for the actuarial curve were defined as 0 to < 3 months, 3 mo to < 1 yr, 1 to < 2 yrs, 2 to < 5 yrs, and 5 to 10 yrs. Registry data and radiographs were reviewed and five

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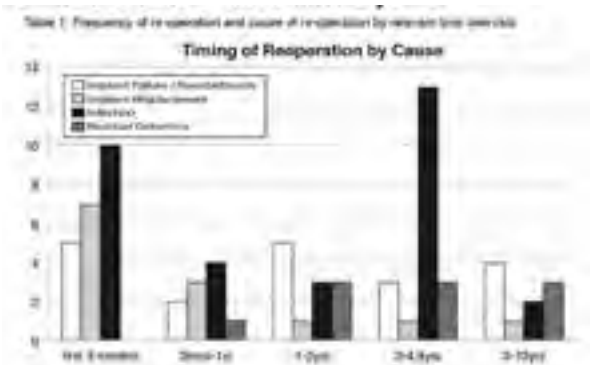
categories for reoperation assigned: 1) implant failure and/or pseudoarthrosis, 2) implant misplacement and/or prominence, 3) wound complication and/or infection, 4) residual deformity and/or progression, and 5) other.

Results

1435 patients from 12 sites were included. The majority were female (80%), with major thoracic curves (76% Lenke 1-4), and average age of 15±2 years (10-22) at surgery. Most had posterior spinal instrumentation and fusion (81%). At this time, 75 (5.2%) patients required re-operation. 23 occurred within 3 mo post-op, 10 more before 1 year, 11 more before 2 years, another 20 by 5 yrs and 10 more after 5 yrs. This corresponded to an actuarial cumulative survival of 98.3% at 3 months, 97.5% at 1 year, 96.6% at 2 years, 93.9% at 5 years, and 89.8% at the final interval (5-10 yrs). One patient who had an unplanned staged procedure due to loss of neuromonitoring was categorized as other and is not in the figure.

Conclusion

Revisions for scoliosis continue to occur well after 2 years with a 5 year survivorship of 93.9%. Reasons for re-operation are not uniformly distributed with time; with implant related issues and infection the cause early, while late infection is the most common cause after 2 years.



158. THE INCIDENT TRENDS, EPIDEMIOLOGY, MORTALITY, & ECONOMIC EVALUATION OF VERTEBRAL OSTEOMYELITIS IN THE UNITED STATES: A NATIONWIDE INPATIENT DATABASE STUDY OF 283,022 CASES FROM 1998 TO 2010

Kimona Issa, MD; Matthew R. Boylan, BS; Michael J. Faloon; Qais Naziri, MD; Ki Soo Hwang, MD; Kumar Sinha, MD; Arash Emami, MD; Carl B. Paulino, MD

United States

Summary

Review of the nationwide inpatient database revealed changing rates of Vertebral Osteomyelitis (VO) from 1998-2010 compared to previous reports. This study reports associated descriptive factors for these trends.

Hypothesis

Incidence of VO & associated risk factors have evolved over the study period.

Design

Retrospective Epidemiological Database Review

Introduction

VO represents 3 to 5% of all cases of osteomyelitis. The associated 1-yr cumulative mortality rate is approximately 11%. The purpose of this study was to attempt to assess the incidence & epidemiology of VO in the United States & over a 13 year period.

Methods

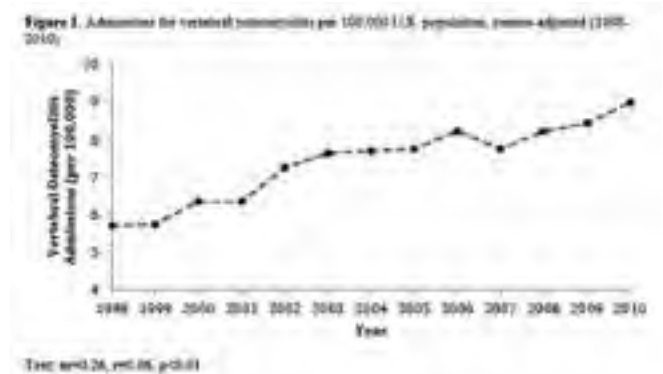
The Nationwide Inpatient Sample (NIS) database was carefully evaluated to identify all patients who were admitted for a diagnosis of vertebral osteomyelitis in the United States from 1998 to 2010 using related ICD-9 codes (730.28, 730.08, 730.2, 730.00, 722.90, 722.91, 722.92, 722.93). National trends in incidence, patient demographics, mortality during the hospital stay, length-of-stay(LOS), & total admission costs were further evaluated. The impacts of various contributing factors to these outcomes were further evaluated using adjusted multivariable linear & logistic regression analyses.

Results

Between 1998-2010, 283,022 pts were admitted for VO. Incidence increased from 15,400 cases (6.5 per 100,000 US population) to 27,710 (9 per 100,000 US population). Model estimates the incidence of VO to reach 32,500 in 2015 ($R^2=0.91$). Mean LOS significantly increased 9.5 to 11 days ($p<0.01$). Of all cases, 39% were treated operatively during the same admission. 55% pts were <60 yrs, 54% male, 28% non-white, & 43% Medicare. Mortality during the hospital stay reduced from 2.1% to 1.4%. Mortality rate was > w/ older age, male gender, > Deyo comorbidity score (DC), & urban teaching hospitals. Race had no affect on mortality. Admission costs & LOS were significantly higher > age, male, non-white, & > DC.

Conclusion

Incidence of VO has been increasing in the US, & various factors were identified to affect inpatient mortality rate, LOS, & admission costs. The findings of this study can be used for future comparative studies.



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159. NEONATAL SPONDYLODISCITIS: CASE SERIES AND LITERATURE REVIEW.

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Brazil

Summary

Pyogenic spondylodiscitis (PS) affecting children under 12 months of age may present as a severe condition, distinct from all other ages. Diagnosis is difficult and often delayed due to the nonspecific clinical presentation. In this series we report 6 cases who showed similar patterns of disease with perinatal complications, neonatal sepsis, extensive vertebral destruction and neurological impairment. We propose the recognition of this "patient at risk" as the key for early diagnosis and appropriate treatment.

Hypothesis

Neonate and infant may present a severe form of PS. A specific pattern can be recognized allowing early diagnosis and appropriate treatment.

Design

Retrospective case series.

Introduction

PS often shows a benign evolution after the walking-age. Children under 12 months of age may present a distinct form of this pathology because of the vascular and immunologic peculiarities, which produces a favorable environment for involvement of adjacent levels and bony destruction.

Methods

We report the cases of 6 patients treated for subacute and chronic PS.

Results

Diagnosis delays were seen in all cases. Pathogens were identified by cultures in 3 of 6 patients. Irritability of patients when held in upright position was a major sign seen in all cases. Parents reported retarded motor milestones related to the gait onset and 4 of 6 patients presented neurological deficit. Medical records showed previous history of perinatal complications such as neonatal sepsis and long stays at intensive care unit (ICU). Image studies showed a very similar pattern: destruction of 2 to 3 vertebral bodies with major instability, sharp kyphotic deformity and spinal cord compression. As an example of a typical case, a 6-month boy whose parents observed an increased trunk tilt and a dorsal gibbus. Medical records showed premature birth, low weight (1,420g) and a 75-day hospitalization at ICU for treatment of respiratory sepsis. Physical examination showed motor function asymmetry between upper and lower limbs and irritability when held in upright position. Destruction of T6, T7 and T8 vertebral bodies was seen on image studies with gross instability, sharp kyphotic deformity and signs of cord compression. He underwent surgical treatment

with anterior decompression and circumferential arthrodesis. Two years after the procedure, he showed partial recovery of lower limbs motor function and good maintenance of deformity correction.

Conclusion

Pyogenic spondylodiscitis affecting the neonate and infant must be seen as a severe condition. Diagnosis is often difficult and depends on a high grade of suspicion. Recognition of the "patient at risk" is the key for the appropriate treatment.



160. IS A DRAIN TIP CULTURE AFTER SPINAL SURGERY NECESSARY?

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Japan

Summary

Bacteria detected in drain tip cultures and SSIs were examined in 329 cases of spine surgery performed between 2010 to 2012 (excluding cases with preoperative infection). In cases with indigenous bacteria such as *Staphylococcus epidermidis* and *Propionibacterium acnes* detected on the drain tip, the infection rate was only 15% and was thought to be due to contamination. In contrast, in cases with methicillin-resistant bacteria such as MRSA and MRSE in the drain tip culture, the infection rate was 60%.

Hypothesis

To examine the validity of use of a wound drain tip culture in spinal surgery and clarify the relationship of findings with infection.

Design

Retrospective clinical study.

Introduction

Closed suction drainage of wounds is established as a principle of management following orthopaedic surgery. In spinal surgery, postoperative wound drains are commonly used to decrease the incidence of epidural hematoma. The wound drain tip culture may be useful for early detection of SSIs.

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Methods

The subjects were 329 patients who underwent spinal surgery at our institution between 2010 and 2012. Wound drains were used and drain tips were subjected to bacteriological tests.

Results

Suction tip cultures were positive in 34 cases and there were 19 SSIs. Ten of the 34 tip culture-positive wounds developed SSIs. Suction tip cultures had a sensitivity of 52%, specificity of 92%, positive predictive value (PPV) of 29% and negative predictive value (NPV) of 97% for detecting a wound infection. There was no significant correlation between wound infection and the period of drainage. However, the suction tip culture-positive rate and the incidence of wound infection showed a significant association ($P < 0.05$).

Methicillin-resistant bacteria (MRSE, MRCNS, MRSA) were detected in the drain tip culture in 10 cases, and 6 of these cases had SSIs. The PPV for prediction of SSIs was 60% in cases in which methicillin-resistant bacteria were detected in the drain tip. In contrast, of 24 cases in which non-methicillin-resistant bacteria were detected in the drain tip culture, only 4 had SSIs, and the PPV for prediction of SSIs was only 15%. There was a significant difference in SSIs between cases in which methicillin-resistant and non-methicillin-resistant bacteria were detected in the drain tip culture ($P = 0.01$).

Conclusion

In cases in which methicillin-resistant bacteria are detected on the drain tip, the PPV (60%) was significantly higher than that in cases with non-methicillin resistant bacteria. Therefore, SSI may be present if methicillin-resistant bacteria are found in a drain tip culture, and close monitoring of the wound behavior and early intervention is necessary in such cases.

161. THE INFLUENCE OF THORACOLUMBAR SPINAL CORRECTION FOR ADULT SPINAL DEFORMITY ON THE ESOPHAGEAL MUCOSAL DISORDER

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Japan

Summary

We investigated the esophageal mucosal changes in 24 adult spinal deformity patients by pre and 3-6 months after operative. Deformity type included thoracolumbar kyphosis or kyphoscoliosis. We measured mucosal damage severity by using modified LA (Los Angeles) classification. Preoperatively, scope finding showed 16 (67%) of 24 patients had some esophageal mucosal damage. Post-operatively, 9 (56%) patients showed improvement by one or more grade. This study showed that the esophageal mucosal disorder in severe kyphosis patients does improve with spinal corrective surgery.

Hypothesis

Does stomach compression due to thoracolumbar deformity cause esophageal mucosal disorder? Can we cure the mucosal damage by spinal correction?

Design

Prospective case series.

Introduction

There are several reports on the influence of thoracolumbar kyphosis and lumbar vertebral fractures on GERD (gastroesophageal reflux disease) symptoms in middle-aged and elderly people. However their diagnosis for GERD was based upon questionnaires lacking real mucosal damage by using EGD (esophago gastroduodenscopy). Furthermore, there are no reports on the effect of spinal correction for GERD having the mucosal findings via EGD as an outcome.

Methods

During March 2010 to March 2013, 24 adult spinal deformity patients with or without digestive symptoms agreed to be examined by pre and post-operative EGD. They were reexamined by EGD at 3-6 months after operation. The patients consisted of 21 females and 3 males with the average age of 72.4y.o. Deformity type included 16 thoracolumbar kyphosis, 5 thoracolumbar kyphoscoliosis and 3 camptocormia due to Parkinsons disease.

We measured GERD severity by using modified LA (Los Angeles) classification in esophageal mucosal break. LA classification was defined as follows. N:Normal, M:color change only and A to D (A:less than 5mm mucosal break, D:more than 75% in circumference).

Results

Preoperatively, EGD finding showed N:8, M:9, A:2, B:1, C:4. 16 of 24 (67%) patients had some esophageal mucosal change. Post-operatively, EGD findings improved to N:11, M:9, A:2, B:2, C:0. 9 (56%) patients showed improvement by one or more grade. 6 patients showed no change in grade M. Only one patient showed worsening in grade. There were no patients requiring proton pump inhibitor medication or H2 blocker due to newly digestive symptoms occurring after the surgery.

Conclusion

This study shows that the esophageal mucosal disorder in severe kyphosis patients does improve with spinal corrective surgery giving them better alignment of the spine.



162. A NEW RADIOLUCENT DEDICATED CHAIR FOR SITTING-POSTURE RADIOGRAPHS IN NON-AMBULATORY CHILDREN: APPLICATION TO BIPLANAR DIGITAL SLOT-SCANNING (EOS) IMAGING.

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France

Summary

EOS imaging is a recent technology enabling 2D/3D imaging of patients in standing position. We designed a 360° rotating chair made of full-radiolucent polyethylene fitting the device dimensions to obtain EOS images in natural sitting postures. Out of 41 consecutive patients, 88% had a successful EOS. In most patients with severe neuromuscular trunk deformities the EOS system combined with our chair was useful to assess preoperative trunk collapse, pelvic obliquity and postoperative corrections in all planes.

Hypothesis

Assessing spinal balance in a daily functional position for non-ambulatory children with neuromuscular scoliosis is critical. The EOS system is currently not usable for non-ambulatory patients since their own chairs are too large to access the EOS acquisition area.

Design

Technical note and prospective cohort study.

Introduction

The EOS System is a low-dose biplanar stereoradiographic system, which simultaneously acquires orthogonal imaging of patients in standing position, and permits routine model-based 3D simulations. In neuromuscular patients, pelvic obliquity (PO) is commonly associated with scoliosis and impairs sitting position. PO in sitting position needs to be considered during spinal deformity management. We present a new custom-designed radiolucent chair fitting the EOS system dimensions. The feasibility of routine EOS 2D/3D images of non-ambulatory patients in sitting position is reported.

Methods

A full-radiolucent customized orthopaedic chair was designed and built according to the technical constraints of the EOS system (Figure 1). All patients benefited from a low-dose acquisition before further model-based 3D simulations.

Results

This protocol was used on 41 consecutive patients for whom an EOS spinal imaging was prescribed. We report an 88% success rate. However, five patients had severe neurological impairment and were not eligible to conventional EOS imaging protocols. Model-based 3D simulations were possible for all patients with no movement artifacts.

Conclusion

The use of this specific radiolucent chair was implemented with a high acceptance rate by caregivers, patients and families. We did not experience any adverse effects using this new customized device. The quality of the EOS images was not modified by the superimposition of radiolucent parts of the chair. In most patients with neuromuscular trunk deformities the EOS system combined with our radiolucent chair was useful to assess preoperative trunk collapse and PO in all planes.



163. DISTAL FUSION LEVEL SELECTION IN SCHEUERMANN'S KYPHOSIS: ARE WE FUSING TOO LONG?

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Netherlands

Summary

In a historic cohort of 30 surgically treated Scheuermann patients, distal junctional kyphosis greater than 10 degrees did not develop despite fusing short of the first lordotic disc or the sagittal stable vertebra.

Hypothesis

The sagittal stable vertebra will not predict re-alignment of the spine in selective thoracic fusion for Scheuermann's hyperkyphosis.

Design

Retrospective cohort study.

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Introduction

Selection of distal fusion levels in Scheuermanns kyphosis correction is determined by including the distal end vertebra (DEV), first lordotic disc (FLD) or sagittal stable vertebra (SSV).

Methods

In a historic cohort of surgically treated Scheuermann patients, we aimed to identify whether SSV, FLD and DEV can be related to the development of DJK.

Results

Measurements of 30/33 patients with on average 18 years follow-up were available (91%) 14 were operated posterior only, 16 via a combined approach. On average, 26% kyphosis was corrected. DJK defined as distal junctional angle greater than 10° and at least 10° greater than preoperative angle, between the lowest instrumented vertebra (LIV) and one vertebra below, was not observed. DJK defined as a kyphotic change at the lumbar disc space just below the LIV, was observed in 6 patients. 3 developed within 1 year, 1 after 7 years and 2 after 15 years.

No relation was found between distal inclusion of the SSV, FLD or DEV and the development of DJK. No relation was observed between functional outcome parameters (ODI) and the development of DJK. The results are shown in Table 1

Conclusion

No correlation was observed between development of DJK and the distal inclusion of generally accepted critical levels. Ending at the DEV resulted in a 0.7 levels shorter fusion than ending over the FLD, and a 1,3 level shorter fusion than ending at the SSV, which will lead to conservation of more spinal mobility in general. Further, no relation between long term functional outcome (Oswestry Disability Index) and the development of DJK was observed in our study. Based on these radiological observations we conclude that fusing to the SSV may lead to longer constructs than necessary, and does not result in better outcome. Ending at the DEV does not result in clinically relevant DJK. The clinical relevance of DJK is not clear in our observations and we argue that clinically relevant DJK should be defined.

	FLD included in fusion n= 21	fused short of FLD n= 9	SSV included n=7	fused short of SSV n=21	DEV included in fusion n= 29	fused short of DEV n= 1
ODI	5	1	3	4	6	0
No DJK	16	8	7	17	23	1

164. EVALUATION OF SURGICAL TREATMENT OF CONGENITAL SCOLIOSIS ASSOCIATED WITH SPLIT CORD MALFORMATION

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Summary

In this study, the outcomes of surgical treatment of congenital scoliosis associated with different type split cord malformation is evaluated. For the congenital scoliosis patients with split spinal cord malformation, prophylactic surgical intervention may not be necessary.

Hypothesis

To investigate the clinical outcomes of surgical treatment in congenital scoliosis patients associated with split cord malformation.

Design

A prospective study.

Introduction

To date, there is still some controversies about whether to perform prophylactic surgical intervention for intraspinal abnormalities is necessary.

Methods

From March 2000 to February 2014, 256 congenital scoliosis patients with SCM underwent spinal correction surgery at our centre. The patients who have no neurological deficit or stable neurological status at least two years were recruited in this study. And the patients who underwent vertebral column resection surgery were excluded. According to Pang's classification for SCM, a total of 247 patients were divided into type I SCM group (82 patients, 33.2%) and type II SCM group (165 patients, 66.8%). All these cases underwent correction without dealing with the intraspinal abnormalities.

Results

There were no significantly differences in preoperative characteristics, operation time, blood loss between two groups (P<0.05). In the type I SCM group, the major coronal curve Cobb angle was corrected from 72.1°±29.5° to 37.6° ±24.7° postoperatively with a correction rate of 50.1% ± 22.3%, and 44.3° ± 25.9° at the final follow-up with a correction rate of 38.9% ± 26.2%. For the patients in type II SCM group, the major coronal curve Cobb angle was corrected from 69.5°±26.8° to 33.9°±22.8° postoperatively with a correction rate of 56.2% ± 17.6%, and 37.5°± 23.9° at the final follow-up with a correction rate of 46.9% ± 22.2%. The correction rate was significantly lower in type I SCM group than that in type II SCM group (P <0.05). However, there were no statistically differences between two groups in the postoperative neurological complication rate (4.1% and 3.6% respectively, P>0.05).

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Conclusion

Compared with type SCM I group patient, the type SCM II group patient could obtain better spinal deformity correction without higher neurological complication rate. More importantly, for the congenital scoliosis patients with split spinal cord malformation, prophylactic surgical intervention may not be necessary.

165. THE EFFECT OF SPINAL OSTEOTOMIES ON SPINAL CORD TENSION AND DURAL BUCKLING: A CADAVERIC STUDY

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United States

Summary

Tension and dural buckling were measured during the closure of three different spinal shortening procedures in a cadaveric model of tethered cord syndrome. The SPO did not lead to appreciable tension reduction, while both the PSO and VCR showed a substantial response. The rate of tension reduction may be steeper for the VCR than the PSO. Buckling increased faster for the VCR than the PSO. Balance between these two factors seemed to be optimal with 12-16mm of posterior osteotomy closure.

Hypothesis

The primary aim of this study was to better define the range of tension reduction and dural buckling in a human cadaveric model.

Design

Cadaveric Study

Introduction

The application of spinal shortening procedures to recurrent tethered cord syndrome offers the potential of reducing tension on the recurrently tethered spinal cord while minimizing the difficulties inherent in traditional lumbosacral de-tethering revision. Although spinal shortening procedures have proven clinical benefit in patients with a recurrently tethered cord, it is unclear how much shortening is required to achieve adequate reduction in spinal cord tension or what impact these osteotomies have on dural buckling.

Methods

We averaged values from four human cadavers to evaluate the effect of three different spinal shortening procedures: Smith-Peterson Osteotomies (SPO), Pedicle Subtraction Osteotomies (PSO), and Vertebral Column Resections (VCR) on spinal cord tension and dural buckling. Two cadavers were dedicated to the measurement of spinal cord tension, while the other two cadavers were devoted to myelography for the purpose of measuring dural buckling parameters.

Results

The SPO was associated with a maximal decrease in spinal cord tension of 16.1% from baseline and no dural buckling with any degree of closure. The PSO led to a mean maximal decrease in spinal cord tension of 63.1% from baseline at 12mm of closure and demonstrated a

direct linear relationship between dural buckling and increasing osteotomy closure. Finally, VCR closure correlated with a mean maximal decrease in spinal cord tension of 87.2% from baseline at 10mm of closure and also showed a direct linear relationship between dural buckling and increases in osteotomy closure.

Conclusion

In this cadaveric experiment, the SPO did not lead to appreciable tension reduction, while both the PSO and VCR showed a substantial response. The rate of tension reduction may be steeper for the VCR than the PSO. Adequate tension relief while minimizing dural buckling may be optimal with 12-16mm of posterior osteotomy closure based on this cadaveric experiment.

166. MORPHOLOGICAL DIFFERENCES OF VERTEBRAE BETWEEN NEUROFIBROMATOSIS TYPE 1 ASSOCIATED SCOLIOSIS WITH AND WITHOUT PARASPINAL NEUROFIBROMAS

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China, People's Republic of

Summary

The incidence of rotatoryolisthesis, lamina destruction and costovertebral joint dislocation was significantly higher in NF1-S patients with paraspinal neurofibromas compared with those without neurofibromas. These morphological changes of vertebrae were mostly close to the site of neurofibromas which can lead to a more severe spinal deformity. Interestingly, the paraspinal neurofibromas were more likely to the concave side of the apical region.

Hypothesis

There may be morphological differences of vertebrae in NF1-S patients with and without paraspinal neurofibromas.

Design

A retrospective study.

Introduction

The morphological features of vertebrae affected by paraspinal neurofibromas in NF1-S patients have not been elucidated.

Methods

The patients with paraspinal neurofibromas were defined as the spinal tumor (ST) group, and the others without paraspinal neurofibromas were defined as the non-tumor (NT) group. The records and imaging data of these patients were evaluated to identify the radiological differences of vertebrae between the two groups

Results

There were 54 NF1-S patients in the ST group and 60 patients in the NT group. The Cobb angle of regional kyphosis was significantly larger in the ST group compared to the NT group (66.5° versus 52.9°, $p < 0.05$). There were significant differences between the ST and NT groups in the prevalence of rotatoryolisthesis (66.1% versus 36.7%), lamina destruction (48.1% versus 16.7%)

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and costovertebral joint dislocation (44.4% versus 13.3%). As for the paraspinal neurofibromas, 12 had plexiform neurofibromas; 24 had nodular neurofibromas and 18 patients with dumbbell tumors. In the ST group, 70.4% (49/54) of patients had paraspinal neurofibromas located at the apical region, 38 of whom were to the concave side. 70.9% of regional kyphosis, 76.6% of rotatoryolisthesis, 76.9% of lamina destruction, and 77.4% of costovertebral joint dislocation were adjacent to the site of paraspinal neurofibromas. In addition in the ST group, the patients whose paraspinal neurofibromas located at the apical region had a significantly higher degree of apical vertebral rotation than other patients.

Conclusion

The prevalence of paraspinal neurofibromas in patients with NF1-S was 47.3%. The NF1-S patients with paraspinal neurofibromas demonstrated more morphological changes of vertebrae including rotatoryolisthesis, lamina destruction and costovertebral joint dislocation. These morphological changes of vertebrae occurred more frequently adjacent to the site of paraspinal neurofibromas which can lead to a more severe spinal deformity.

167. LONG-TERM FOLLOW-UP AFTER POSTERIOR HEMIVERTEBRA RESECTION AND SHORT SEGMENT FUSION WITH PEDICLE SCREW FIXATION FOR CONGENITAL SCOLIOSIS IN CHILDREN UNDER AGE 10 YEARS

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Korea

Summary

This is the first long term follow-up on surgical outcomes of posterior hemivertebra resection and short segment fusion using segmental pedicle screw fixation in children under age 10 years with congenital scoliosis.

Hypothesis

To evaluate the surgical outcomes of posterior hemivertebra resection and short segment fusion with segmental pedicle screw fixation in congenital scoliosis in children under age 10 years.

Design

A retrospective study.

Introduction

Hemivertebra should be treated at the earliest patient age before the deformity extends and structural differentiation takes place in the adjacent segments. Early surgery in young children prevents the development of several local deformities and secondary structural curves, thus allowing normal growth in the unaffected parts of the spine.

Methods

Congenital scoliosis patients (n=18) under age 10 years at the time of the surgery were treated by posterior hemivertebra resection and bilateral pedicle screw fixation. The mean age at the time of surgery was 6.6 years (range, 2.6-9.8). They were retrospectively studied with a mean follow-up of 11.4 years (range, 7.1-17.3).

Results

The mean Cobb angle of the main curve was 34.4° before surgery, 8.6° after surgery, and 12.9° at last follow-up. In the compensatory cranial curve, the preoperative Cobb angle of 14.5° was corrected to 5.9° postoperatively and was 8.4° at last follow-up. In the compensatory caudal curve, the preoperative Cobb angle of 17.4° improved to 4° postoperatively and 6.6° at last follow-up. There were no crankshaft phenomena and no clinical and radiographic features suggestive of spinal stenosis during follow-up. There were no major vascular or neurological complications related to the pedicle screws.

Conclusion

Posterior hemivertebra resection following pedicle screw fixation in congenital scoliosis is a safe and effective procedure that can achieve rigid fixation, deformity correction and restore spinal balance. This study showed that early posterior hemivertebra resection of congenital scoliosis before structural changes occur above or below can reduce fusion length, prevent curve progression and effectively achieve a more satisfactory correction without hazardous iatrogenic spinal stenosis, crankshaft phenomena or neurologic complications.

168. SURGICAL RESULTS OF MAGNET DRIVEN GROWING RODS (MDGR) FOR EARLY-ONSET SCOLIOSIS (EOS) SECONDARY TO NEUROMUSCULAR (NMS) AND SYNDROMIC SCOLIOSIS (SS) AT ONE YEAR

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Summary

MdGR has revolutionised the surgical management of EOS esp. in neuromuscular and syndromic scoliosis by eliminating the need for repetitive anaesthesia and multiple surgeries. It has distinct advantages over conventional growing rods (CGR) with low infection rate and improvement in pulmonary function (PF). Surgical results from a prospective case series of 23 children operated at a single centre with a minimum follow-up of one year is presented. The complications encountered are discussed.

Hypothesis

What advantages does MdGR have over other growth guided systems in EOS secondary to NMS and SS.

Design

Prospective case series of 23 pts (clinical study LoE - IV).

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Introduction

MdGR is considered to be a new game-changer amongst distraction based devices for EOS and have recently been approved by USFDA and NICE-UK. Our objectives were to

1. Report surgical results of neuromuscular (NMS) and syndromic scoliosis (SS) at one year.
2. Report complications / adverse events unique to MdGRs.

Methods

23 children (10M & 13F) with EOS secondary to NMS and SS were prospectively recruited into the MdGR program after ethics committee approval. The most common etiologies were cerebral palsy (6), Prader-Wili(3), Ehler-danlos(2) & William's syndrome(2) and Spinal muscular atrophy-II(2). We evaluated the Cobb angle and T1-S1 length on serial radiographs taken at first visit, preoperative, postoperative and final follow-up of at least one year. Pulmonary function data of NMS was obtained in 9 pts. Adverse events causing unplanned return to the operating room and complications were recorded and managed appropriately.

Results

The patient demographics and radiological parameters are summarised in table 1. There was one MdGR graduate and key images from time of initial visit to definitive spinal fusion is illustrated in fig 1. There were 2 single rod (SR) and 1 dual rod(DR) breakages that needed revision surgery. There was one superficial infection and no deep infections in our series. There were three PJK and two DJK with positive sagittal balance. Two patients had progression of scoliosis warranting extension of instrumentation to pelvis in one. There was spectacular improvement in PFT esp. in Ehler-danlos and SMA-II patients. All patients had reduced incidence of chest infections and emergency admissions for pulmonary ailments.

Conclusion

MdGR was a boon to these group of vulnerable children with NMS and exotic scoliosis and had high caregiver satisfaction at one year post-surgery. Long-term studies until skeletal maturity is desired to define their true role in EOS surgeries.

Table 1: Summary of patient demographics

Parameters	Mean	Range
Age at 1 st visit	8.7 years	2.24 - 13.63 years
Age at MdGR insertion	8.9 years	3.6 - 12.9 years
Duration of follow-up	8.2 years	1.2 - 4.9 years
Thoracic kyphosis at 1 st visit	41.9°	20° - 65°
Mean postop Cobb °	71°	50° - 115°
Mean postop Cobb °	41°	12° - 77°
OSR final Rod E/L	58°	12° - 72°
T1 - S1 length gain @ final follow-up	27.2mm	-4 to + 68 mm



169. A NOVEL METHOD OF VERTEBRO-PELVIC FIXATION

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Summary

A novel method of vertebro-pelvic fixation was proposed. The fixation is performed using custom-made titanium plates which are manufactured based on CT-data and 3D models. The plates are shaped in such a way that it enables them to rest on the iliac alae and the plates are attached by special connectors to the instrumentation above. This method was applicable in 7 patients with spinal deformities and it seems to be an efficient way to achieve stable vertebro-pelvic fixation.

Hypothesis

We propose a novel method of vertebro-pelvic fixation. Our concept is based on the possibility to achieve a stable vertebro-pelvic fixation using custom-made titanium plates. The plates are manufactured based on CT-data and 3D models. The plates are shaped in such a way that it enables them to rest on the iliac alae. The plates are attached by special connectors to the instrumentation (rods) above.

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Design

Prospective clinical and radiographic study.

Introduction

Posterior fusion of the spine to the pelvis in paediatric and adult spinal deformity is still challenging. Traditional pelvic fixation with iliac screws, multiple screw/rod constructs are viable techniques for achieving pelvic fixation. However, sacropelvic fixation presents serious problems in patients with poor bone quality of the pelvis and sacrum, in cases of congenital deformities, neurofibromatosis and in previously operated patients with fixation failure. Major failures were defined as rod breakage and failure of S1 and iliac screws (breakage, halo formation, or pullout) and prominent iliac screws requiring removal.

Methods

The proposed technique was applied in 7 patients. The mean age was 23,5 yrs (range 10-46 yrs). There were 2 cases of neurofibromatosis, 2 cases of congenital deformity, 2 cases of neuromuscular scoliosis, and in one case a patient with neuromuscular scoliosis had iliac screw instability after previous surgery. The custom-made shape of the pelvic plates ensures that their application is safe and technically uncomplicated.

Results

The average follow-up is 10,4 months (4 - 19 mths). In 6 patients there was stable fixation and the patients were highly satisfied. In one case, due to retroversion of the pelvis, the fixation was unstable and the hardware had to be removed.

Conclusion

The proposed method of vertebro-pelvic fixation seems to be an efficient way to achieve stable vertebro-pelvic fixation in cases of severe spinal deformities when traditional sacro-pelvic fixation is questionable (impossible).



170. BACK PAIN IN CEREBRAL PALSY PATIENTS IS MARKEDLY REDUCED AFTER SPINAL FUSION FOR SCOLIOSIS

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Summary

Understanding the relationship between pain and scoliosis in the CP patient is important in the decision making process for surgical correction. As reported by their caregivers, CP patients with scoliosis experienced pain which appeared to influence their sitting tolerance. Postop, their pain improved along with their sitting ability.

Hypothesis

Pain is present in the majority of cerebral palsy (CP) scoliosis patients preoperatively and is improved after surgery.

Design

Retrospective analysis of prospectively collected data.

Introduction

The relationship between pain and spinal deformity in the CP patient is poorly understood. Understanding this relationship is essential in order to evaluate the cost/benefit ratio of undergoing operative correction, which is often accompanied by significant rates of complications.

Methods

A prospective multi-center database of CP patients was queried to identify patients with preop and 2 year postop pain assessments including visual analog scale (VAS) back pain scores. Radiographic and clinical demographics were recorded. Wilcoxon signed ranks test was used to compare change in VAS score.

Results

164 patients with preop pain assessments were identified, of which 61 had 2yr postop pain assessments. The average age was 14yrs (8-20yrs) and average pre-op Cobb was 85° (40-143°). When recorded, 75% of caregivers reported pain relief as one reason for surgery. Preop, patients with moderate to severe VAS scores had significantly decreased sitting tolerance compared to those with no pain ($p < 0.01$). The distribution of VAS scores prior to surgery was: 26% no pain (VAS 0), 16% mild (VAS 1-3), 26% moderate (VAS 4-6), and 21% severe pain (VAS 7-10). At 2yrs postop, the median pain score improved significantly from 3 to 0 ($p < 0.001$). All but 4 patients improved or remained in the no-mild pain group (VAS < 3) at 2yrs after surgery. Two of these patients experienced complications requiring revision (1 for PJK; 1 for broken rod with extension of fusion to pelvis). A correlation approaching a moderate effect size was observed, suggesting that improvements in sitting tolerance may be associated with decreased VAS following surgery ($r = -0.26$, $p = 0.08$).

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Conclusion

As perceived by their caregivers, the majority of CP patients experienced pain secondary to their scoliosis. Some of this may be inferred by their decreased tolerance for sitting. Following scoliosis correction, there was a significant improvement in pain with 96% of caregivers having reported no or only mild back pain.

171. CLINICAL RESULTS OF DYNAMIC STABILIZATION ADJACENT TO FUSION LEVEL: A NEW LUMBAR HYBRID INSTRUMENTATION

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Summary

New hybrid instrumentation with PEEK rod system provides rigid stability for fused levels and dynamic portion helps to prevent adjacent segment degeneration at the end of 2 years follow-up.

Hypothesis

Dynamic instrumentation adjacent to fusion level will prevent adjacent segment degeneration.

Design

Retrospective.

Introduction

Adjacent segment degeneration is a common (34%) problem following posterior spinal fusions in long term f/up. We have been using a new hybrid design which has a dynamic portion made of silicone and PEEK aiming motion preservation and fusion portion is entirely made of PEEK. The aim of this study is to evaluate the efficacy of dynamic portion of the PEEK rod system in preventing adjacent level problems in the surgical treatment of multilevel lumbar degenerative disease.

Methods

54 pts(28F,26M), mean age 48,2yrs(26-65) with 84 levels of TLIF's with more than 2 yrs of f/up were reviewed retrospectively. All surgeries were performed using with new hybrid lumbar instrumentation with PEEK rod. Preop,postop AP/L x-rays were measured for pelvic and sagittal parameters. Disc angles, ROM, anterior disc height(ADH) and posterior disc height(PDH) were measured for adjacent(AL) and supraadjacent (SAL) levels. All pts were evaluated with EOS images, dynamic x-rays and 3D CT scan at the final f/up. Clinical evaluation was done with ODI and VAS.

Results

Mean f/up was 26,3 months(24-38). Ave instr. levels was 3,33(2-5) and ave fused levels was 1,66(1-3). TLIF's were at L5-S1 in 42 pts, L4-5 in 35 pts, L3-4 in 6 pts and L2-3 in 1 ptn. TLIF's were single level in 10 pts, 2 levels in 28 pts and 3 levels in 6 pts. Preop LL was restored to 42.7° and 49.3° at final f/up. There were no significant differences in ADH,PDH and disc angles between preop and f/up for AL and SAL levels. Preop ave ROM for SAL of 5,85° changed

to 6,57°. Preop ave ROM of 6,72° was decreased to 5,07° at AL with a limitation of 24,6% postoperatively. 3D CT evaluation revealed solid fusions for all TLIF levels. Mean of 43,51% ODI was improved to 18,93 and preop VAS score 7,2 was improved to 2,2.

Conclusion

New hybrid lumbar instrumentation with PEEK rod system is effective in the treatment of multilevel degenerative lumbar disc disease. Dynamic portion of the hybrid system limits ROM by 24.6% at adjacent level. AL and SAL did not demonstrate any significant facet or disc degeneration at the end of min 2yrs f/up.

		Preoperative Mean (SD)	Postoperative Mean (SD)
Supra-adjacent Level	Flexion	4.29 (3.54)	3.0 (2.7)
	Neutral	6.01 (3.10)	5.26 (3.03)
	Extension	5.14 (2.91)	3.07 (2.01)
	ROM	5.42 (3.37)	5.72 (3.08)
Adjacent Level (Dynamic)	Flexion	5.34 (2.2)	3.84 (2.07)
	Neutral	6.94 (3.07)	5.47 (2.87)
	Extension	5.56 (4.11)	3.71 (3.4)
	ROM	6.72 (3.33)	5.07 (3.07)

172. TWO-LEVEL TOTAL DISC REPLACEMENT WITH LOW PROFILE CERVICAL DISC VERSUS ANTERIOR DISCECTOMY AND FUSION: A PROSPECTIVE, RANDOMIZED, CONTROLLED MULTICENTER CLINICAL TRIAL WITH 24 MONTH RESULTS

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United States

Summary

Cervical arthroplasty at two contiguous levels using the low profile cervical disc showed superior results to 2-level ACDF based on overall success criteria and NDI success.

Hypothesis

If the overall success rate for investigational cervical total disc replacement (TDR) is statistically non-inferior to the control ACDF at 2 years, TDR will be considered safe and effective.

Design

Prospective, randomized, controlled multicenter FDA IDE clinical trial.

Introduction

Cervical TDR is intended to treat symptomatic cervical disc disease (SCDD) while preserving motion. ACDF has been the standard treatment, but at the expense of lost motion. Few studies have focused on the safety and efficacy of cervical TDR at 2 levels. The primary objective of this study was to compare outcomes using the low profile cervical disc or ACDF for treatment of SCDD at 2 contiguous cervical levels.

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Methods

An FDA IDE trial of the low profile cervical disc was conducted at 30 centers in the US. 397 patients with 2-level SCDD from C3-C7 were randomized and treated with cervical TDR (n=209) or the control treatment, ACDF (n=188). Overall clinical success was defined as improvement in NDI \geq 15 points, maintenance or improvement of neurologic status, no implant or surgical related adverse events (AE), and no additional surgical procedures at the index level. NDI, numerical pain scales for neck and arm pain, SF36, radiographic outcomes and patient satisfaction were used to analyze clinical effectiveness.

Results

At 24 mos. both groups showed significant improvement vs baseline NDI, neck and arm pain, neurologic success and SF36 scores. TDR patients demonstrated statistical superiority over ACDF patients based on overall success (81.4% vs 69.4%, posterior probability of superiority (pps) = 99.3%) and NDI success (87.9% vs 79.2%, pps = 99.0%). Adverse event rates were lower for TDR vs ACDF (15.8% vs 20.7%). Subsequent index level surgeries were significantly lower for TDR vs ACDF (2.4% vs 8.0%). Range of motion in the TDR group averaged 6.92° and 6.85° at superior and inferior levels respectively. Overall patient satisfaction was higher for TDR (94.5%) vs ACDF (89.3%).

Conclusion

The results of this study represent Level I clinical evidence in support of cervical TDR at 2 contiguous levels using the low profile cervical disc.

173. A BIOMECHANICAL EVALUATION OF TWO DIFFERENT HYBRID INSTRUMENTATIONS AND THEIR EFFECTS ON INSTRUMENTED AND ADJACENT SEGMENTS

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Switzerland

Summary

Eighteen human lumbar spines (T11-L5) were instrumented from L1-L5 using a rigid and two different hybrid instrumentations. ROM for each spinal segment was then investigated. There was no significant difference in ROM among all three instrumentations.

Hypothesis

A Topping Off instrumentation can reduce hypermobility in adjacent segments compared to rigid Instrumentation.

Design

A biomechanical study.

Introduction

The development or progression of adjacent segment disease (ASD) after spine stabilization and fusion is seen as a major problem in spine surgery today. Apart from optimal balancing of the sagittal profile, dynamic instrumentation is often suggested to prevent or impede ASD. The use of hybrid instrumentation is often suggested to gain stabilization while allowing motion to avoid

hypermobility in the adjacent segment. In this study, the effect of two different types of hybrid instrumentation were evaluated on instrumented and adjacent segments of human cadaver T11-L5 spines.

Methods

Eighteen human cadaver spines (T11-L5) were instrumented with rigid fixation from L3-L5 and subdivided into three groups: rigid; dynamic; and hook comprising six spines each. For the rigid group, further rigid fixation from L1-L5 was applied. For the two hybrid instrumentation types, a dynamic Elaspine® system from L1-L3 was applied for the dynamic group, and the hook group was instrumented with additional laminar hooks at L1-L3. After application of a free bending load with 5° each of extension and flexion, the range of motion (ROM) for every single segment and step of the instrumentation was evaluated.

Results

Both the Elaspine® system and laminar hooks reduced the ROM in the instrumented levels close to that of the rigid instrumentation, while resulting in similar increasing mobility in the segments adjacent to the instrumentation. There was no significant difference in segmental stiffness or ROM among the three types of Instrumentation.

Conclusion

A rigid four-level instrumentation of the lumbar spine (L1-L5) leads to a compensatory hypermobility of the adjacent segments. A hybrid instrumentation with laminar hooks or the Elaspine® system showed no significant difference in ROM at the instrumented or adjacent segments compared to a rigid Instrumentation. In consequence, hybrid instrumentation with either of the devices cannot be recommended to prevent ASD.

174. 10-YEAR FOLLOW-UP WITH A SEMI-CONSTRAINED METAL ON METAL LUMBAR TOTAL DISC ARTHROPLASTY

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Italy

Summary

A few studies have been published about the long term results of lumbar total disc replacement (TDR). This study supports the safe and effectiveness in the long term although the benefit declined compared to the mid-term.

Hypothesis

To evaluate 10-year radiological and clinical outcome of a semi-constrained metal on metal lumbar total disc arthroplasty for the treatment of symptomatic one level degenerative disc disease (DDD).

Design

Prospective, non-randomised multicenter study.

Introduction

Mid-term effectiveness of lumbar TDR has been reported. To date, a few studies have been published about the long term results.

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Methods

10-year clinical and radiological outcome are reported and compared to the preoperative and 2-year follow up data.

Clinical outcome were evaluated using a visual analog scale (VAS) and Oswestry Disability Index (ODI 2.0). Clinical success, in terms of ODI improvement, was defined according to FDA criteria (> 15 points versus preoperative value). Radiographically, sagittal balance parameters and range of motion at the index level were assessed. MRI was performed to evaluate the facet joint degeneration at the index level and the degeneration at the level above at 10-year follow up.

Statistical significance was set at 0.05.

Results

51 Patients (33 F;18 M) were included; the average age was $43,4 \pm 7$ years.

Levels operated were the following: L3-4 (N=2), L4-5 (N=14) and L5-S1 (N=35). At 10 year follow up, the mean VAS and ODI 2.0 scores showed a significant improvement compared to the preoperative, although significantly lower compared to 2-year follow up. At the last follow up, clinical success was achieved in 77,4% of the patients.

The implant did not modify the sagittal balance parameters. 44 disc prosthesis (86.3%) were still mobile at 10-year follow-up.

MRI, at 10-year follow up, did not show a significant progression of disc degeneration at the level above the index level; on the contrary, 21,6% of the patients had a progression of the facet joint degeneration at the index level that was correlated with a worse clinical outcome.

Conclusion

At 10 year follow up, total disc arthroplasty resulted effective, although the benefit declined significantly compared to 2 year follow up. Progression of degeneration of facet joints at the index level was correlated with a worse long term clinical outcome.

175. CHANGES IN THE LUMBAR SPINE SAGITTAL ALIGNMENT AFTER OBLIQUE IMPLANTED TOTAL LUMBAR DISC REPLACEMENT: A 2-YEAR PROSPECTIVE STUDY OF 52 CASES

Eduardo Hevia, MD; Juan Solaz, MD; Carlos Barrios, MD, PhD; Alberto Caballero, MD; Jesus Burgos Flores

Spain

Summary

Prospective radiological investigation of 52 patients with L4/5 TDR inserted through an oblique approach. Only a 28.8% of cases showed a satisfactory placement of the implant. From 3 to 24 months of FU, there were differences in L1-S1 range of flexion, and in the overall range of total motion of the implant both improving significantly. TDRs showing unsatisfactory implantation demonstrated similar lumbar and segmental range of motion in comparison to properly implanted TDRs.

Hypothesis

Total disc replacement (TDR) at the L4-L5 level does not change the sagittal alignment and the range of motion of the lumbar spine when the implant is placed in accurate position.

Design

Prospective single-center radiological investigation of L4/5 TDR inserted through an oblique approach for the treatment of disc disease.

Introduction

Oblique implantable TDRs have been developed in an attempt to partially resect the anterior longitudinal ligament (ALL), together with additional partial resection of lateral annulus fibers. To date, the literature has not addressed the impact of the TDR oblique implantation on the lumbar spine sagittal alignment.

Methods

A series of 52 patients with a minimum of 2-year FU after oblique TDR at L4/L5 level was analyzed for radiological changes in sagittal alignment and range of motion of the lumbar spine. The total sagittal lumbar lordosis (TSLL), the segmental sagittal lumbar lordosis (SSLL) of the operated level, and the range of motion of the TDR implant were determined in pre- and postoperative functional X-rays. The accuracy of the implant position was also evaluated.

Results

A total of 52 patients (mean age, 42.7) were available. There were no revision surgeries for general and/or device-related complications. Only a 28.8% of cases (n=15) showed a satisfactory position. Off-center lateralized implants were the most common misplacements. Axial malrotated TDR accounted for the 28.1% of cases. From 3 to 24 months of FU, differences in range of motion were found in the total L1-S1 flexion, and in the mean range of motion of the implant both improving significantly. TDRs showing unsatisfactory implantation in the radiological studies (71,8%) demonstrated similar lumbar and segmental range of motion in comparison to properly implanted TDRs.

Conclusion

Oblique implanted L4/L5 TDR significantly increases total lordosis while retaining segmental lordosis, independently of the accuracy of its intervertebral position. Oblique TDR maintains antero-posterior segmental and total balance in most cases. Further studies should evaluate whether this finding has any implication for the long-term outcome.

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176. CLINICAL OUTCOMES OF TOTAL LUMBAR DISC REPLACEMENT IMPLANTED THROUGH AN OBLIQUE APPROACH: A PROSPECTIVE ANALYSIS WITH 2-YEAR FOLLOW-UP

Eduardo Hevia, MD; Juan Solaz, MD; Carlos Barrios, MD, PhD; Alberto Caballero, MD; Jesus Burgos Flores

Spain

Summary

In a prospective single-center investigation a series of 52 patients with total disc replacement inserted by an oblique approach were assessed 2 years after surgery. The overall results revealed a highly significant improvement in VAS and ODI levels at all postoperative FU stages. The 75% of patients reported highly satisfactory outcome and 15.9% satisfactory outcome. There were a low complication rate and no reoperations related with the implant. Further studies should evaluate whether these findings remain stable at long-term follow-up.

Hypothesis

The mid-term clinical efficacy, perioperative complications, and reoperation rates of L4/5 TDR using an oblique implant has been rarely reported.

Design

Prospective single-center investigation assessing the 2-year FU outcome of L4/L5 TDR with an oblique approach.

Introduction

Despite good clinical short and mid-term outcomes, the anterior TDR implantation entails technical difficulties especially above the segment L5/S1 due to the vessel configuration. Recently, oblique implantable TDRs have been developed primarily to facilitate the implantation of TDR, especially in the segment L4/L5. To date, the literature is very scarce concerning the clinical impact of the oblique implantation of TDRs.

Methods

A series of 52 patients with a minimum of 2-year FU was evaluated. Visual analog scale (VAS), Oswestry Disability Index (ODI), health quality of life (SF-12), and patient satisfaction rates measured clinical outcomes. The complication and reoperation rates were also considered. Patients were examined preoperatively, 3, 6, 12 and 24 months postoperatively.

Results

A total of 52 patients (mean age: 42.7 ± 9.5 years) with more than 2-year FU were available. The overall results revealed a highly significant improvement from baseline VAS and ODI levels at all postoperative FU stages ($p < .0001$). Patient satisfaction rates remained stable with 75% of patients reporting a highly satisfactory outcome and 15.9% a satisfactory outcome. The overall complication rate was 30.7%. There were no revision surgeries for general and device-related complications. TDRs showing unsatisfactory implantation in the radiological studies demonstrated similar improvement of VAS, ODI and SF-12 scores in comparison to properly implanted TDRs ($p < .05$).

Conclusion

Despite the fact that the current data comprises the early experiences and learning curve associated with the oblique implanted TDR technique, the results demonstrate satisfactory mid-term clinical results after 2-year FU. Patient safety was proven with a low complication rate and no reoperations related with the implant. Further studies should evaluate whether these findings remain stable at long-term follow-up.

177. CORRELATION BETWEEN CERVICAL SPINE SAGITTAL ALIGNMENT AND CLINICAL OUTCOME AFTER CERVICAL LAMINOPLASTY FOR OSSIFICATION OF THE POSTERIOR LONGITUDINAL LIGAMENT

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Korea

Summary

Cervical alignment after posterior cervical surgery has been considered important variable for explaining neck disability. Cervical laminoplasty increased the likelihood of cervical kyphotic alignment. However, current study demonstrates cervical sagittal alignment and clinical outcomes after cervical laminoplasty in OPLL patients were not clearly related. Only laminoplasty including C7 lamina is significantly associated with lower clinical outcome. Therefore, Surgeons should consider spinal alignment as well as extension of surgical level for decreasing postoperative clinical outcomes.

Hypothesis

Cervical alignment is one important factor for neck disability in postoperative patients with spondylotic myelopathy. Therefore, we hypothesized that kyphotic changes after laminoplasty in cervical OPLL patients would affect clinical outcome.

Design

Retrospective single center radiological and clinical outcome study.

Introduction

To determine the relationship between cervical spine sagittal alignment and clinical outcomes after cervical laminoplasty in patients with ossification of the posterior longitudinal ligament (OPLL).

Methods

Consecutive patients ($n=50$) who underwent a cervical laminoplasty for OPLL more than one year were enrolled in this study. Standing plain films of the cervical spine, CT, and MRI were obtained. Cervical spine alignment was assessed with the following three parameters: the C2-7 Cobb angle, C2-7 sagittal vertical axis (SVA), and T1 slope minus C2-7 Cobb angle. The change in cervical sagittal alignment was defined as the difference between the postoperative and preoperative C2-7 Cobb angles.

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Outcome assessments (Visual Analog Scale [VAS], Oswestry Neck Disability Index [NDI], SF-36, and Japanese Orthopedic Association score [JOA]) were obtained in all patients.

Results

Compared to the preoperative scores, the postoperative VAS and JOA scores improved. After laminoplasty, 34 patients had kyphotic changes, and 16 had lordotic changes. However, cervical sagittal alignment after laminoplasty was not significantly associated with clinical outcomes in terms of the postoperative improvement of the JOA, SF-36, VAS or NDI. Likewise, the change in cervical sagittal alignment was not related to the JOA ($p=0.463$), SF-36 ($p=0.403$), VAS ($p=0.359$) or NDI ($p=0.134$) scores. C7 involvement during the operation was associated with a significantly lower JOA score ($p=0.038$)

Conclusion

Cervical laminoplasty for ossification of the posterior longitudinal ligaments improved radiculomyelopathy. Cervical laminoplasty increased the likelihood of cervical kyphotic alignment. However, cervical sagittal alignment and clinical outcomes were not clearly related.

178. SPINAL CORD MRI SIGNAL CHANGE AT 1-YEAR AFTER CERVICAL DECOMPRESSION SURGERY IS USEFUL FOR PREDICTING MID-TERM CLINICAL OUTCOME: AN OBSERVATIONAL STUDY USING PROPENSITY SCORES

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Japan

Summary

We showed that spinal cord magnetic resonance imaging (MRI) signal improvement at 1 year after surgery predicted a good prognosis for cervical compression myelopathy (CCM) patients.

Hypothesis

Spinal T2HSC improvements at 1 year post-surgery positively impacted mid-term outcome.

Design

Observational study.

Introduction

There is little evidence concerning the relationship between MRI T2WI high signal change (T2HSC) at the spinal cord and surgical outcomes for CCM. Recently, an observational study using propensity scores was designed with an impact similar to a randomized controlled trial. We examined whether T2HSC improvement at 1 year post-surgery impacts the subsequent prognosis, adjusted for propensity scores as a potential confounding variable, which was a disadvantage of the observational study.

Methods

The subjects were 146 CCM patients who underwent surgery from 2007 to 2012. The mean age was 66 ± 11 years (34-87 years) at surgery. Based on spinal MRI at 1 year post-surgery, patients were divided into the following two groups: MRI improvement group (Imp. group, with a fading of T2HSC) or no improvement group (No-imp. group, with no change in or deterioration of T2HSC). Recovery rates of Japanese Orthopedic Association (JOA) scores at 1, 2, 3 and 5 years post-surgery were compared between groups using a t-test. We adjusted outcome scores for age, sex, and diagnosis by the inverse-probability weighting method using the propensity score. $P < 0.05$ was considered significant.

Results

The recovery rates (mean \pm standard error) were as follows: 1 year post-surgery, Imp. group, 44 cases, $49 \pm 6\%$; No-imp. group, 102 cases, $36 \pm 4\%$ ($P = 0.072$); at 2 years post-surgery, Imp., 42 cases, $50 \pm 6\%$; No-imp., 91 cases, $37 \pm 4\%$ ($P = 0.064$); at 3 years post-surgery, Imp., 31 cases, $55 \pm 6\%$; No-imp., 76 cases, $30 \pm 6\%$ ($P = 0.006$); and at 5 years post-surgery, Imp., 20 cases, $60 \pm 8\%$; No-imp., 41 cases, $31 \pm 7\%$ ($P = 0.014$).

Conclusion

Spinal T2HSC improvements at 1 year post-surgery positively impacted recovery rates starting at 3 years. We recommend confirming spinal MRI at 1 year post-surgery to predict the mid-term outcome.

179. OUTCOMES AND REVISION RATES FOLLOWING MULTILEVEL ANTERIOR CERVICAL DISCECTOMY AND FUSION

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United States

Summary

Patients undergoing three- and four-level ACDF for multilevel cervical disease demonstrate substantial improvement in outcomes. However, the two-year revision rate is relatively high at 35% with the majority of these patients requiring revision for non-union.

Hypothesis

Patients have improved clinical outcomes after multilevel (≥ 3 level) anterior cervical discectomy and fusion (ACDF) for symptomatic cervical radiculopathy and myelopathy.

Design

Longitudinal cohort.

Introduction

ACDF for cervical degenerative disease is an accepted treatment for symptomatic cervical radiculopathy and myelopathy. One- and two-level fusions are much more common and more widely studied. Outcomes and revision rates for three- and four-level ACDF has not been well described.

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Methods

Patients who underwent three- or four-level anterior cervical discectomy with plate fixation between 2006 and 2011 for symptomatic cervical degenerative disease were identified. Improvements in Neck Disability Index (NDI), neck and arm pain scores two years after surgery and revision rates were analyzed.

Results

Forty-six patients with a mean age of 55.9 years were included in the analysis. Twenty-one (46%) were male, 10 (22%) were smokers. Forty-one (89%) underwent three-level fusion and 5 (11%) underwent four-level fusion. NDI improved from 34.46 at baseline to 25.47 at two years. Neck pain improved from 7.04 at baseline to 3.95 and arm pain improved from 6.24 to 3.09 at two year follow up. Sixteen patients (35%) returned to surgery within two years with 11 of these patients (24%) returning for non-union. The average number of days to revision surgery was 750.6 ± 570.3 days.

Conclusion

Patients undergoing three- and four-level ACDF for multilevel cervical disease demonstrate substantial improvement in outcomes. However, the two-year revision rate is relatively high at 35% with the majority of these patients requiring revision for non-union.

180. ADJACENT SEGMENT PATHOLOGY CORRELATED WITH HRQL FOLLOWING LAMINOPLASTY VERSUS POSTERIOR CERVICAL DECOMPRESSION AND FUSION

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United States

Summary

Adjacent segment degeneration (ASD) has been described after anterior cervical fusion surgeries though ASD is not always clinically relevant. We expand the ASD definition with an analysis of radiographic adjacent segment pathology (RASP) by also assessing the progression of kyphotic alignment, and spondylolisthesis at adjacent segments in patients following laminoplasty (LP) and posterior cervical decompression and fusion (CDF). Both LP and CDF patients had adjacent level degeneration but there was a higher rate of developing adjacent segment spondylolisthesis in CDF.

Hypothesis

ASD and RASP are more common after CDF than LP.

Design

Retrospective.

Introduction

Hilibrand et al. described a grading system for ASD after anterior cervical fusion. The relative rates of ASD following cervical laminoplasty (LP) compared with posterior cervical decompression and fusion

(CDF) patients have not been characterized. We assess radiographic adjacent segment pathology (RASP) by also analyzing the progression of kyphotic alignment, and spondylolisthesis at the adjacent segments.

Methods

This is a retrospective analysis of RASP following LP and CDF. Preoperative and postoperative radiographs were analyzed for ASD, progression of adjacent level kyphosis and spondylolisthesis at proximal, distal or any segments. RASP was determined by combining proximal and distal ASD, and the adjacent level kyphosis and spondylolisthesis into one spectrum of disease. The presence and rate of development of adjacent segment pathology was compared for LP and CDF (Figure). HRQL included NDI and mJOA.

Results

64 patients were included (24 LP, 40 CDF) with mean age 59.9 years, 46.9% female, and 30.2 months mean follow-up. Spondylolisthesis at the adjacent segment was more prevalent in CDF (29.2% vs 4.5%). Both LP and CDF demonstrated a similar rate of RASP (LP 41%, CDF 44%). NDI correlated with proximal adjacent level degeneration ($r=0.34$, $p=0.024$) and kyphosis ($r=0.36$, $p=0.017$).

Conclusion

Both cervical laminoplasty and posterior cervical decompression and fusion are associated with adjacent level degeneration but there is a higher rate of adjacent segment spondylolisthesis after CDF. Motion preservation procedures may have less of a role in preventing adjacent level degeneration than previously thought. Adjacent segment degeneration correlated with NDI disability.



Figure. [A] Preop and [B] Postop patient from cervical decompression/fusion (CDF) group demonstrating progression of proximal adjacent segment degeneration (ASD)

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181. ARE BICORTICAL PURCHASE OF C1 LATERAL MASS AND C2 PEDICLE SCREWS SAFE FOR INTERNAL CAROTID ARTERY ASIANS?

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Malaysia

Summary

This study analyzed the CT scan of 180 Chinese, Indians and Malays to determine the safety of the internal carotid artery (ICA) during bicortical C1 and C2 screws insertion. About 45% of ICA could be at risk of injury if bicortical C1 lateral mass screws were inserted neutrally or laterally angulated. Medially angulated C1 screws and C2 pedicle screws were safe. Chinese patients had the shortest ICA-C1 cortex distance when compared to Indians and Malays ($p < 0.05$).

Hypothesis

Is there any difference in the relationship of internal carotid artery to C1 lateral mass and C2 pedicle screws among Chinese, Indians and Malays?

Design

Retrospective CT scan review.

Introduction

Injury to the internal carotid artery (ICA) injury during C1/C2 instrumentation scan cause devastating complications. Currently there is lack of ICA-C1/C2 studies for the Asian population and none had compared between racial groups.

Methods

3D computed tomography analysis of 180 subjects (60 each race) were performed with the male to female ratio of 1:1 and mean age of 50.6 ± 16.5 (20 - 92). The location, distance and angulations of ICA in relation to C1 and C2 screws were assessed and measured. Comparison was made among races statistically.

Results

For C1, 55.3% (199) of ICA were located in Zone 0, 44.7% in Zone 1 and none in Zone 2 according to the zone concept by Murakami et al. Its average location was at $8.5 \pm 6.4^\circ$ laterally from the Currier's C1 lateral mass screw entry point. The mean distance of ICA from C1 cortex was 3.7 ± 1.7 mm (0.6 -11.3mm). Chinese patients had the shortest ICA-C1 cortex distance when compared to Indians and Malays ($p < 0.05$). For C2, 98.1% (353) of ICA were located at Zone 0, 1.9% in Zone 1 and none in Zone 2. Its average location was $24.9 \pm 10.6^\circ$ laterally from the Harm's C2 pedicle screw entry point. The mean distance of ICA from anterior cortex of C2 was 5.2 ± 2.7 mm. Indian patients had the shortest ICA-C2 cortex distance when compared to Chinese and Malays ($p < 0.05$).

Conclusion

About 45% of ICA could be at risk of injury if bicortical C1 lateral mass screws were inserted neutrally or laterally angulated. Medially angulated C1 screws were generally safe. C2 pedicle screws were safe because of the inherent medially angulated pedicle axis.

182. CERVICAL FIXATION SURGERY FOR THE PATIENTS WITH CERVICAL INSTABILITY SECONDARY TO RHEUMATOID ARTHRITIS

Yoshihisa Sugimoto, MD, PhD; Masato Tanaka, PhD; Shinya Arataki, MD, PhD; Tomoyuki Takigawa, PhD; Toshifumi Ozaki, PhD

Japan

Summary

We performed cervical fusion for 46 patients with RA for the past 10 years. Three of 46 patients (7%) underwent surgery within 10 years after the onset. There were one vertebral artery injury, two dysphagia result from improper angle fixation and one screw perforation. Five of 46 patients (11%) died during follow-up. In the MRI study, 17 patients (30%) showed fluid which was located around the dens. Number of surgeries has decreased by 75% for the past 10 years.

Hypothesis

We expect Non-biologic DMARDs and/or biologic DMARDs to prevent the progression of cervical instabilities.

Design

Retrospective study.

Introduction

Rheumatoid arthritis (RA) is a systemic chronic inflammatory disorder that can compromise the cervical spine in up to 40% of the cases. The purpose of treatment for RA patients is clinical remission or low disease activity, no radiographic progression, and normal function. We expect Non-biologic DMARDs and/or biologic DMARDs to prevent the progression of cervical instabilities. We performed a retrospective review about RA patients who had been treated in our hospital.

Methods

We performed cervical fusion for 46 patients with RA for the past 10 years. There were 43 women and 3 men. Average follow-up periods were 2.5 years. Average duration of disease was 25 years (range 6 to 55 years). According to the Steinbrocker classification, there were one patient in stage II, 3 in stage III, and 42 in stage IV. There were 8 patients in class II, 18 in class III, and 20 in class IV.

Results

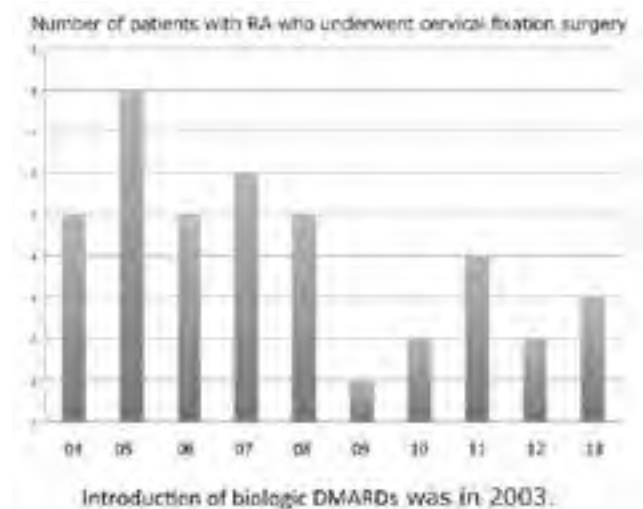
Three of 46 patients (7%) underwent surgery within 10 years after the onset. There were one vertebral artery injury, two dysphagia result from improper angle fixation and one screw perforation into the spinal canal. Five of 46 patients (11%) died during follow-up. Two of 5 patients had malignant RA.

Enhance CTs and MR angiographies were useful for screening for abnormality of vertebral artery. Twelve patients (26%) had unilateral vertebral artery stenosis. In the MRI study, 17 patients (30%) showed fluid which was located around the dens. Number of surgeries has decreased by 75% for the past 10 years.

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Conclusion

Three of 46 patients (7%) underwent surgery within 10 years after the onset. Number of surgeries has decreased by 75% for the past 10 years.



183. TREATMENT OF THE ADULT DEGENERATIVE SCOLIOSIS WITH SPONDYLOLISTHESIS GRADE III-IV (SPL). IS REDUCTION NECESSARY?

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Russian Federation

Summary

Adult degenerative scoliosis (ADS) is a common problem in the World, usually those over the age of 60. A retrospective study of 34 patients (age 60-83 years) with ADS with SPL. According to ODI, ASIA, SVA, VAS data, patients with ADS and SPL who were undergo spinal fusion have different clinical and X-ray outcomes in different operative technics.

Hypothesis

PSO with multilevel SPO and transpedicular screw fixation allow to achieve good clinical outcomes.

Design

A retrospective study of 34 patients (age 60-83 years) with ADS with SPL. Mean follow-up period was 4 years (2-5 years).

Introduction

There are not enough reports in the literature, describing the outcomes of pts with ADS and SPL operatively treated. Our study set out to compare clinical and radiographic outcomes in operative treated ADS pts with SPL with or without vertebra reduction.

Methods

A retrospective study of 34 patients (age 60-83 years) with ADS with SPL. Mean follow-up period was 4 years (2-5 years). Inclusion criteria: age >60 yrs, no prior surgery, and ADS (scoliosis ≥ 20 degrees, sagittal vertical axis (SVA) ≥ 6 cm, pelvic tilt (PT) ≥ 25 degrees, or thoracic kyphosis (TK) > 60 degrees). Demographic, radiographic and HRQOL data evaluated including: Oswestry Disability Index (ODI),

ASIA and VAS pain scale. Patients divided into 2 groups in depending on the applied surgical techniques: in the first group in 18 cases with transpedicular screw fixation, multilevel SPO+PSO, second group with transpedicular screw fixation, multilevel SPO+TLIF with vertebra reduction. There was no significantly difference between pre-op age, VAS, ASIA and ODI in both groups.

Results

In the first group a full restoration of the sagittal & coronal balance was achieved. In the second group, we did not achieve a full postoperative restoration of the sagittal & coronal balance. Post-op ODI, VAS and ASIA improvement in all groups but no significantly different between them. I group had significantly better SVA (≤ 4 cm) then II SVA (≥ 5 cm) ($p=0.03$).

At 3 years control showed, the I groups had significantly better ODI (36%) and VAS (3,1) then II (54%/4,9) ($p=0.04$).

Conclusion

PSO with multilevel SPO and transpedicular screw fixation allow to achieve good clinical outcomes. Deformities corrections without SPL reduction does not influence on sagittal balance restoration and fusion post-op. To confirm these the obtained results require more observations.

184. COMPARATIVE ANALYSIS OF RADIOLOGICAL, SURGICAL AND CLINICAL OUTCOME BETWEEN DIFFERENT 3 LUMBAR INTERBODY FUSION GROUPS (ALIF, DIRECT LATERAL INTERBODY DEVICE, PLIF) IN L4-5 SPONDYLOLISTHESIS.

Chul-Woo Lee, MD, PhD; Kang-Jun Yoon, MD, PhD
Korea

Summary

After lumbar interbody fusion, improvement of lordosis was significant for both the ALIF and LLIF groups, but not PLIF group. Intergroup analysis showed the ALIF group had significantly improved lordosis compared to both other groups. The ALIF and LLIF groups had significantly increased disc and foraminal height compared to the PLIF group.

Hypothesis

3 different fusion techniques show the different outcome.

Design

Retrospective comparative study.

Introduction

There has been no direct comparison of anterior lumbar interbody fusion (ALIF) with posterior lumbar interbody fusion (PLIF) and lateral lumbar interbody fusion (LLIF) in radiological, clinical, surgical perspectives. The objective of the study is to compare ALIF with PLIF and LLIF in their capacity to alter foraminal height, local disc angle, and lumbar lordosis by a retrospective radiographic analysis and investigate the clinical and surgical outcome in three groups.

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Methods

The medical records and radiographs of patients undergoing ALIF (53), PLIF (65) and direct lateral interbody device (48) in L4-5 single level from between January 2011 and December 2012 were retrospectively reviewed. VAS, ODI and radiographic measurements, including preoperative and postoperative foraminal and disc height, segmental and lumbar lordosis (SL, LL) and spondylolisthesis were obtained. Surgical outcome parameters (operative time, blood loss, hospital stay) and related complications were also reviewed and compared all these data between 3 different fusion groups.

Results

Average follow-up was 34.2 months (24-48mo), with no statistical difference between the groups. Our results indicated that ALIF and LLIF is superior to PLIF in its capacity to restore foraminal height and disc height. Intragroup analysis showed that the ALIF and LLIF groups significantly improved segmental and lumbar lordosis from preoperative to follow-up, while PLIF group did not. Intergroup analysis showed that the ALIF group significantly improved segmental and lumbar lordosis more than both the LLIF and PLIF groups. All three groups significantly reduced spondylolisthesis, with no difference between the groups.

Conclusion

ALIF and LLIF is superior to restore the foraminal and disc height than PLIF. ALIF is recommended to restore the segmental and lumbar lordosis than LLIF and PLIF.



185. DO INTRA-OPERATIVE RADIOGRAPHS PREDICT FINAL LUMBAR SAGITTAL ALIGNMENT FOLLOWING SINGLE LEVEL TRANS-FORAMINAL LUMBAR INTERBODY FUSION (TLIF)?

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Canada

Summary

We reviewed preoperative, intraoperative and postoperative radiographs in patients undergoing a single level TLIF to determine intra-op x-rays ability to predict post-op correction. Results suggest that much of the lordosis achieved intra-operatively is lost once the patient mobilizes. An improvement in the total lumbar lordosis postoperatively is likely to be due to the decompression.

Hypothesis

A primary single level TLIF does not affect the lumbar sagittal profile in patients with lumbar spine degenerative disease.

Design

Retrospective case series review.

Introduction

The variations in the reported outcomes of lumbar lordosis correction following a TLIF suggest a lack of clarity when using it to correct the sagittal profile.

Methods

Patients over the age of 16 who underwent a single-level TLIF for degenerative stenosis and/or spondylolisthesis without scoliosis over a period of 5 years were reviewed. Age, gender, surgical level, surgical approach, facetectomy (unilateral vs bilateral) were recorded. Standardized pre and early and 6 month postoperative upright radiographs as well as an intra-operative lateral radiographs were analyzed for the pelvic incidence (PI), segmental lordosis (SL) at the TLIF level and total lumbar lordosis (TL). Data is presented as mean (SD). p-value <0.05 was considered significant.

Results

69 patients were reviewed. Mean age was 58.6 (13.6) years, 39 males (56.5%), Wiltse approach was used in 30 (43.5%) while 39 had a midline posterior approach. Segments operated were L2/L3 (1 case), L3/L4 (6), L4/L5 (43), L5/S1 (19) and bilateral facetectomy was performed in 13 (18.8%). SL changed from 15.2° (7.3) preoperatively to 20.4° (7.7) intraoperatively (p-value <0.0001) but measured 17.9° (7.2) (p-value <0.0001) on early postoperative images and 17.2° (7.3) at 6 months follow up (p-value= 0.24). The total improvement in SL at 6 months was 2° (6.7), (p-value= 0.001). TL change was insignificant on the early postoperative X-rays (48.5° (12.4) to 47.2° (11.3), p-value= 0.37) but significantly increased to 53.1° (11.5) at six months (p-value <0.0001) with a total improvement of 4.6° (10) (p-value= 0.001). The mean pelvic incidence was 59.7° (11.2). The cage subsided in 11 (15.9%) cases and we had no metal work loosening.

Conclusion

At the level of the TLIF, much of the lordosis achieved intra-operatively is lost once the patient mobilizes. An improvement in the total lumbar lordosis at 6 months post surgery is likely to be due to the decompression component of the surgical intervention.

186. Sacro-Pelvic Parameter Changes after Surgery for High Grade Spondylolisthesis (HGS) Does Type of Fusion, Amount of Reduction and Type of Spondylolisthesis Matter?

Saumyajit Basu, MD; Sri Krishna Chaitanya Kondety, MS(Orth); Tarun Suri, MS(Orth); Amitava Biswas, MS(Orth); Kiran Tapal, MD; Trinanjan Sarangi, MD; Vignesh Pushparaj, D Ortho; Mainak Palit

India

Summary

Literature is sparse on Sacro-Pelvic changes in HGS with regards to type of surgery/type of listhesis. Present study compares changes of Sacro-Pelvic parameters in relation to Type of Spondylolisthesis, Type of Fusion & Amount of reduction. Retrospective analysis of 53 patients done with

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minimum follow up of 2 years. SA, SS, PI-LL difference were calculated for each group and changes tested for statistical significance. Changes are significantly more in Dysplastic listhesis, TLIF and near complete reduction.

Hypothesis

Sacro-pelvic parameter changes in HGS is significantly more in TLIF, Dysplastic Listhesis and near complete reduction groups comparing with PLF, Spondylyotic group and Partial reduction groups respectively.

Design

Retrospective study from a single center operated by same surgeon, with a minimum of 2 years (range 2.1 to 11.1 y - mean 5.2)

Introduction

There is a lot of data on sacro-pelvic parameters in HGS. The emphasis was over changes in relation to amount of reduction (reduction vs in-situ fusion). Classifications and treatment protocols are designed based on these. There is no evidence in relation to type of fusion and type of listhesis. In this study we compare the changes in relation to Type of listhesis, type of fusion & amount of reduction.

Methods

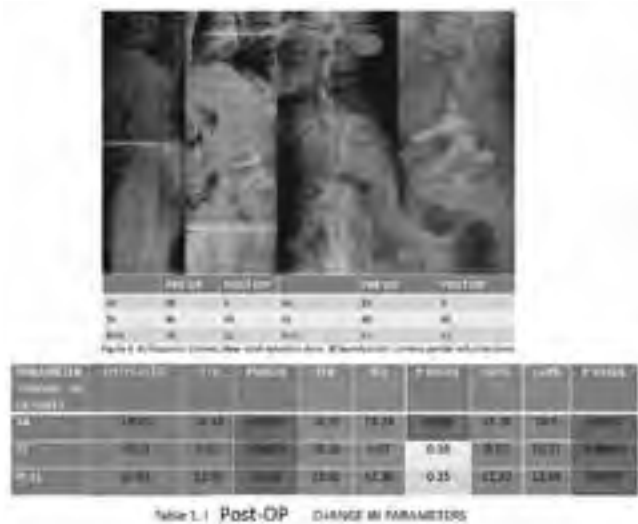
During 2003-2013, 53 patients of HGS (32 lytic & 22 Dysplastic) were included. Either Trans-foraminal Lumbar Inter-body Fusion (TLIF) or Postero-Lateral fusion (PLF) was done. 17 had partial (< 50%) and 36 had near complete (>50%) reduction. Patients were observed for minimum 2 years and resulting changes in Sacro-Pelvic alignment were observed and analyzed by Microsoft excel 2013.

Results

The mean intra-operative change (in degrees) in SA, SS, PI-LL difference in patients with Dysplastic and Spondylyotic listhesis are 18.60 & 18.24, 10.25 & 9.92, 12.93 & 12.30 respectively. (P<0.05 in all). The same in patients with TLIF and PLF are 18.550 & 18.24, 10.38 & 9.92, (P<0.05 in both) 13.02 & 12.30 (P>0.05) respectively. The same in patients with Partial and near Complete reduction are 18.24 & 18.60, 9.92 & 10.11, 12.30, & 12.68 respectively (P<0.05 in all).

Conclusion

Dysplastic type has a significant change in all sacro-pelvic parameters when compared to spondylyotic type. In TLIF there is significant change in SA when compared to PLF. SS and PI-LL difference is also more in TLIF group but not statistically significant. There is significant change observed in SS and PI-LL difference in patients with near complete reduction (>50%)



187. SACRO-PELVIC PARAMETER CHANGES AFTER SURGERY FOR HIGH GRADE SPONDYLOLISTHESIS (HGS) - DOES RADIOLOGICAL IMPROVEMENT CORRELATE WITH CLINICAL IMPROVEMENT?

Saumyajit Basu, MD; Sri Krishna Chaitanya Kondety; Tarun Suri, MS; Amitava Biswas, MS; Kiran Tapal, MS; Vignesh Pushparaj, d ortho; Mainak Palit; Trinanjan Sarangi, MD India

Summary

There are reports of postoperative sacro-pelvic parameter changes in HGS in Unbalanced and Balanced pelvis but these have not been correlated in relation to clinical improvement. We analyzed 53 patients of HGS grouped into balanced /unbalanced pelvis and tabulated the changes in sacro-pelvic parameters and ODI scores pre-op and 1 year post-op. Improvement was there in both - difference in radiological improvement was significant in the unbalanced group (p<0.05) but difference in clinical improvement was not significant (p>0.05).

Hypothesis

Sacro-Pelvic parameter and ODI score changes are significantly more in patients with unbalanced pelvis

Design

10 years Retrospective study of 53 patients, divided into unbalanced and balanced pelvis, pre and post-operative Slip Angle (SA), Pelvic tilt (PT), sacral slope (SS) were recorded and analyzed. ODI scores were recorded pre-op, 1 year post op and analyzed.

Introduction

There is lot of literature regarding changes in Sacro-Pelvic parameters in HGS. Most of these are in relation with unbalanced and balanced pelvis. There is scanty evidence correlating reduction with clinical improvement. The purpose of this study is to correlate the changes in these parameters with improvement in ODI (Oswestry disability index) scores and thus we can clinically support the radiological balance achieved.

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Methods

From 2003 to 2013, 53 patients with HGS (32 Spondylolytic & 22 Dysplastic) were treated in our unit. Instrumented Fusion was done -- either Trans-foraminal Lumbar Inter-body Fusion (TLIF) or Postero-Lateral fusion (PLF). Patients were divided into balanced (n=18) and unbalanced (n=35) pelvis groups and resulting changes in Slip Angle (SA), Sacral Slope (SS), and Pelvic Tilt (PT) are analyzed. ODI scores are calculated pre-op and 1 year post-op in each group and difference in percentage score is statistically analyzed.

Results

There were 9 male and 44 female patients with a mean age of 36.52 years (6-68) at presentation and mean follow up of 5.2 years (2.1 -11 .1).

The intra-operative difference in SA,SS,PT in balanced and unbalanced pelvis groups are 18.24 & 18.66,9.92&10.11,9.3&10.06 respectively-statistically significant difference (p<0.05).

Pre-operative and Post-operative ODI scores in balanced & Un-Balanced groups are 64.11 &20.4, 64 &20.2 respectively-not statistically significant (p=0.058).

Conclusion

There is more change in sacro-pelvic parameters in unbalanced pelvis group when compared to balanced group and these are statistically significant (p>0.05). The ODI score changes are more in unbalanced group but did not attain statistical significance (p>0.05).

Parameter	Balanced	Unbalanced	p value
SA	18.24	18.66	0.05
SS	9.92	10.11	0.05
PT	9.3	10.06	0.05

Group	Pre-op ODI	Post-op ODI	p value
Balanced	64.11	20.4	0.058
Un-Balanced	64	20.2	0.058

188. THE USE OF NITINOL RODS WITH DEGENERATIVE SPONDYLOLISTHESIS AND INSTABILITY OF THE LUMBAR SPINE.

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Russian Federation

Summary

The study was carried out in the Central Scientific Research Institute for Traumatology and Orthopedics named after N. Priorov Moscow, Russia. The outcomes of surgical treatment were compared. In the first group, lumbar fixation was performed using nitinol rods without fusion. In the II group, a standard lumbar fixation with titanium rods was performed.

Hypothesis

To determine the effectiveness of the use of nitinol rods in the treatment of the degenerative spondylolisthesis of the lumbosacral spine.

Design

Prospective randomized study.

Introduction

Nitinol is a unique alloy of nickel (55%) and titanium (45%) having the properties of shape memory and superelasticity. Nitinol is used in the superelastic state at body temperature (36-37° C), providing mechanical compatibility of transpedicular clamp with mechanical behavior of the spine.

Methods

The study included 54 patients with degenerative spondylolisthesis of degree I-II at age from 51 to 76 years. The patients were divided into two equal groups. The group I the nitinol rod is used as the retainer; the group II - standard titanium rods were implanted.

Before and after surgery all patients have completed questionnaires VAS, Oswestry, SF36, standard radiography in two projections was performed as well as functional radiographs in a standing position, MRI, CT.

The group I consisted of 27 patients. The installation of two nitinol rods was carried out. Fusion and bone grafting were not performed.

The group II consisted of 27 patients. The transpedicle screws were installed. If the segment L5-S1 appeared in the fixing zone the interbody fusion was performed at L5-S1 PLIF or TLIF technique using N age. All patients performed posterolateral fusion.

Results

After 2,5 years from the surgery the functional radiographs of patients of the patients from the I group is shown mobility of stabilized segments (7° ± 2.4°). In the Group II, the mobility in the fixed levels has not been detected.

VAS of the back and lower extremities decreased significantly in both groups, and remained at a comparable level in 2.5 years. ODI and SF-36 were statistically better in group I.

The Group I was not revealed instability of the implants on CT. In group II, it was marked suppuration at 1 patient. Pseudoarthrosis was at 4 patients. Adjacent segment disease identified in 2 cases; 2 cases required revision operations.

Conclusion

The use of nitinol rods at the lumbar spine without fusion showed good results after 2, 5 years after surgery. Nitinol rods keep mobility in 2, 5 years after surgery.

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189. EFFECTS OF FREQUENCY OF DISTRACTION IN MAGNETICALLY-CONTROLLED GROWING ROD LENGTHENING ON OUTCOMES AND COMPLICATIONS

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Summary

This is a retrospective review of prospectively collected data from a multicentre study of early-onset scoliosis treated by the magnetically-controlled growing rod with a minimum of 2-year follow-up. Higher distraction frequency was associated with an increased incidence of re-operations due to failure of rod distraction but lower rate of implant-related complications.

Hypothesis

More frequent distractions were less likely to be associated with re-operations and implant-related complications.

Design

Retrospective review of prospectively collected data.

Introduction

Magnetically-controlled growing rods (MCGR) are an alternative to traditional growing rods in skeletally immature patients by providing non-invasive, outpatient distractions mimicking a patient's physiological growth. However, the ideal frequency of MCGR distraction is currently not known. This study aimed to determine the effects of distraction frequencies on implant-related complications and re-operations.

Methods

Consecutive patients undergoing MCGR treatment with a minimum of 2-year follow-up from 6 centres were included. Clinical and radiographic data were collected prospectively.

Results

Thirty patients were included in this study. The mean age at the time of surgery was 7.3 years (range: 4 to 14 years) and the mean follow-up period was 35 months (range: 24 to 61 months). Patients were divided into 2 groups according to their distraction frequency: Group 1 (every 1 week-2 months), and Group 2 (every 3 - 6 months). There were 14 patients in Group 1, and 16 in Group 2. Patients in Group 1 had more re-operations due to failure of rod distraction (71% vs 25%) and a higher incidence of PJK (21% vs 13%) than Group 2. However, there were fewer incidences of implant-related complications including rod breakage and proximal foundation failure (14% vs 31%) in Group 1 compared with Group 2.

Conclusion

This is the largest series with the longest follow-up to date that examines the effect of distraction frequency in MCGR lengthening. Our study showed more frequent distractions were associated with increased incidence of rod distraction failure and PJK but lower incidence of implant-related complication. Clinicians should be aware

of a potential higher risk for re-operation if the interval between each distraction is less than 3 months. Further studies with a larger cohort are required to determine the critical threshold for distraction frequency and re-operations.

190. CAN A "NO FINAL FUSION" PRODUCE EQUAL RESULTS TO FINAL FUSION AFTER GROWING ROD TREATMENT?

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Summary

While final spinal fusion is often considered the standard endpoint for patients who complete growing rod treatment for early onset scoliosis, final fusion may not be necessary for specific group of growing rod patients who have satisfactory coronal curve correction and trunk height upon reaching skeletal maturity.

Hypothesis

Patients with satisfactory spinal alignment after completion of growing rod treatment who do not receive a final spinal fusion have similar radiographic outcomes compared to those who do receive a final fusion.

Design

Retrospective review of multicenter database.

Introduction

Final fusion is the common endpoint to growing rod treatment (GR) for early onset scoliosis (EOS). However, final fusion may not be necessary for a subset of EOS patients who have reached skeletal maturity with good alignment. Our aim was to characterize patients who completed GR treatment but received no final fusion (NF) and compare them to those who had final fusion (FF).

Methods

A multicenter EOS database was queried to identify 160 patients who received GR treatment and reached skeletal maturity (> Risser 3). 19 patients were identified as having completed GR surgery without final fusion. Clinical and radiographic characteristics of NF patients were compared against FF. All NF patients had minimum 2 year follow-up (F/U) after last surgery.

Results

There was no significant difference in NF and FF groups in: age at initial surgery, % female patients, or distribution of etiologies. There was no significant difference in the mean # of lengthenings (NF: 6.4±3.5 vs. FF: 5.6±3.9; P=0.36). All NF patients had rods retained at last surgery. There were no rod fractures at 2 year F/U. Mean F/U in the NF group after last distraction was 3.3±1.6 years. Mean age at last F/U was 14.5±3.1 yrs for NF and 15.22.8 yrs for FF. Final mean curve correction was similar between NF and FF groups: 46% (76±23 degrees to 41±21 degrees) and 37% (74±19 degrees to 46±18 degrees)

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($P=0.23$). Mean T1-S1 increase was 30% (270 ± 54 mm to 385 ± 30 mm) for NF and 25% (269 ± 54 mm to 361 ± 25 mm) for FF. Final T1-S1 in the NF group was significantly higher ($P<0.01$).

Conclusion

GR patients who did not receive final fusion had excellent final coronal correction and trunk height, and had no rod fractures. Due to progressive ankylosis, "No Final Fusion" at maturity is a viable option for GR patients in all C-EOS diagnostic groups who have satisfactory alignment.

191. THORACIC VOLUME MODELING OF GROWING SPINE INTERVENTIONS IN EARLY ONSET SCOLIOSIS

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United States

Summary

Early onset scoliosis can cause decreased thoracic volume and pulmonary insufficiency in children. CT scans are the gold standard to assess thoracic volume but radiation exposure limits their use, thus thoracic volume has not been adequately studied in EOS treatments. We have developed a novel methodology to evaluate thoracic volume and spinal deformity using three-dimensional thoracic modeling. The purpose of this study aims to assess the effect of growing rod treatment on thoracic volume in EOS using 3D computational modeling.

Hypothesis

We hypothesize that thoracic volume will increase over the course of growing rod treatment.

Design

The retrospective analysis included 6 children diagnosed with EOS (1-10 years old), who received growing rod treatment with a minimum of four lengthening procedures. All had pre- and post-op radiographs for each procedure. The enrollment period was 4 years and 6/6 patients reached 2 years of follow-up.

Introduction

Early onset scoliosis (EOS) can cause decreased thoracic volume and diminished cardiopulmonary function. Currently, thoracic volume is estimated using surrogate measures or CT scans, but neither is optimal due to limited accuracy and safety concerns from radiation exposure, respectively. We developed novel methodology to obtain thoracic volumes from conventional orthogonal radiographs using open-source 3D graphics and animation software (Blender 2.71). Prior validation studies demonstrated this method to be accurate within 3-4% of CT scans. This study aimed to evaluate the effect of growing rod treatment on thoracic volume in EOS patients.

Methods

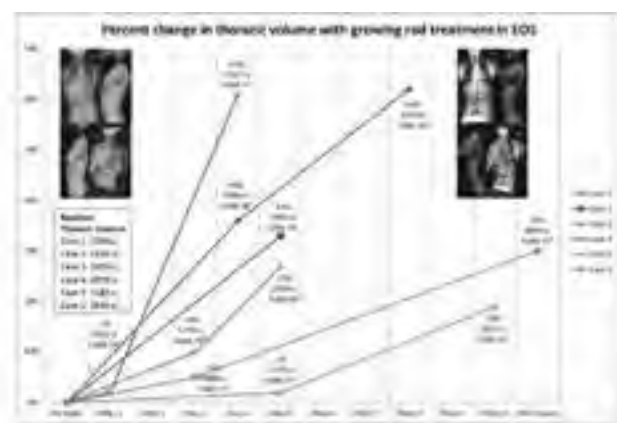
Blender software was used to create patient-specific 3D thorax models from coronal and sagittal radiographs and to calculate thoracic volume from the models. Thoracic volume was obtained for the pre-op index visit, at the midpoint of treatment and after the latest lengthening procedure.

Results

Initial thoracic volumes ranged 1384-2943 cc and increased 19-62% over the course of treatment. Pre-op Cobb angle ranged 42-87 degrees and corrected 13-71% based on latest post-lengthening radiographs. Strong correlation was observed between thoracic volume and coronal T1-T12 thoracic height ($r = 0.85$, 95%CI: 0.94, 0.62) and moderate inverse correlations with Cobb angle ($r = -0.59$, 95%CI: -0.84, -0.16), and kyphosis ($r = -0.53$, 95%CI: -0.81, -0.07).

Conclusion

Growing rod treatment increased thoracic volume with each lengthening, which correlated positively with coronal thoracic height and inversely with Cobb angle and kyphosis. Growing rod treatment provides a more suitable thoracic environment for lung expansion as the child grows.



192. 3D CORRECTION BY CB GROWTH ROD CONCEPT IN SEVERE DEFORMITIES OF THE IMMATURE SPINE (EOS)

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Denmark

Summary

A novel growth rod technique for 3D correction of severe EOS by MIS and 3 platform pedicle screw fixation of 3-4 growth tubes was developed. One active and 2 passive tubes were surgically lengthened every 6 months. 19 patients with mean 77° (47-129) Cobb angle were followed in 2.1-3.9 yrs. Results showed maintained 3D correction. Frontal correction was 43% (-4-81) and preserved truncal (T1-S1) growth 2.2 cm/year. Pulmonary function increased. Unintended reoperation rate was 32%.

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Hypothesis

Improved 3D correction and preserved truncal growth can be achieved by 3 platform hybrid growth rods in severe immature spinal deformities.

Design

Prospective cohort study.

Introduction

Management of severe spinal deformities in EOS should ensure a 3D correction with preserved pulmonary function and truncal growth. We have developed a triple growth rod concept with apical control based on three platforms. Aims of this study were to analyse 1) 3D curve correction, 2) pulmonary function, 3) truncal height and 4) to monitor adverse events.

Methods

34 patients have been treated with the new concept based on 4.5 mm pediatric implants since 2010. We excluded patients with less than 2 years follow-up (n=13) and complex salvage procedures (n=2). The study group of 19 patients with mixed pathologies has a mean follow-up of 3.0 years (2.1-3.9), mean age at index surgery 9.8 years (4-14) and mean scoliosis Cobb angle 77° (47-129). Etiologies: neuromuscular (n=9), idiopathic (n=4), and others (n=6). The system is mounted on pedicle screws in the cranial, apical and caudal platforms using MIS. Deformity correction is achieved by concave distraction, apical translation and derotation by applying apical compression. The sagittal contour is created outside the growth tube areas. Lengthening procedure every 6 months by concave distraction and locking, leaving convex growth tubes unlocked as a one day procedure until skeletal maturity.

Results

Index surgery decreased scoliosis Cobb angle by median 37° (15-68). Thoracic hyperkyphosis decreased, without significant change in lordosis. Torsion was corrected by 14% with partial loss over time. Truncal height assessed as T1-S1 on digital x-rays, increased by 2.2±1.0 cm per year. 11 out of 19 patients experienced 16 adverse events. Six complications lead to unintended reoperation (32%), mainly caused by rod breakage. One patient with severe trunk shift had poor frontal correction. Asymptomatic metal debris (6).

Conclusion

Our triple growing rod concept is the first to prove 3D correction in the surgical management of severe EOS. The concept needs further improvement on rotatory control and prevention of metal debris. Complication rate is 32%.

193. EVALUATION OF SAGITTAL PROFILE IN AMBULATORY CHILDREN WITH EARLY-ONSET SCOLIOSIS (EOS) TREATED BY MAGNET DRIVEN GROWING RODS (MDGR) AT TWO YEARS

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Summary

First study evaluating the sagittal profile in ambulatory children with EOS treated with MdGR with a minimum follow-up of two years is presented. Positive sagittal balances in three patients were addressed by revision surgery and coronal correction did not adversely affect the sagittal profile / spino-pelvic parameters at two years. There were four PJK and all but one needed extension of instrumentation. DJK was seen in one pt and long term studies till definitive spinal fusion / skeletal maturity is recommended.

Hypothesis

Does serial distractions of MdGR cause compromise in sagittal profile and balance in EOS.

Design

Case series of 11 ambulatory children with EOS treated by MdGR with a minimum follow-up of two years.

Introduction

MdGR is a novel implant approved by the USFDA and NICE for surgical management of EOS. It is considered to be a game-changer there is no study that has yet reported the effect of coronal correction gained with MdGRs on sagittal profile and balance. Our objectives were to

1. Evaluate the sagittal profile in all ambulatory children with a minimum postoperative follow-up of at least 2 yrs treated by MdGRs.
2. Report effect of complications / adverse events on sagittal balance in EOS treated with MdGR

Methods

Eleven children (6M & 5F) with EOS secondary to idiopathic(2), congenital(1), neuromuscular(1) and syndromic(7) treated by MdGR who had entire spine lateral x-ray at a minimum follow-up of two years formed the study group. They were evaluated for changes in sagittal radiographic parameters [thoracic kyphosis (TK), lumbar lordosis (LL), sagittal vertical axis (SVA) and sacral slope (SS)] on serial radiographs taken at first visit, preoperative, postoperative and final follow-up. Adverse events causing sagittal imbalance (implant / anchor failure and junctional kyphosis) were recorded and managed appropriately.

Results

There were five single rod(SR) and 6 dual rod(DR) insertions and three rod breakages (2SR & 1DR) that warranted revision surgery (RSx). The patient demographics and radiological parameters are summarised in uploaded table. An index case example showing correction in TK is depicted. There were four PJK

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and one DJK with positive sagittal balance and all but one had RSx. At the end of study, three patients had graduated from MdGR program and sagittal profile in all patients was in normal range.

Conclusion

Coronal correction did not adversely impact sagittal profile. Anchor and rod breakages seen with conventional growth rods were also seen in MdGR. Though lateral x-rays are seldom taken in an effort to reduce radiation, they are invaluable in evaluation of sagittal profile and fixation anchors.

Table 1: Pre- and Post-operative and T12-L1 correction with T1-L1 length gain

Parameter	Mean	Range
Age at IP cast	2.7 years	0.5-5.9 years
Age at MGR insertion	5.8 years	3.5-12.2 years
Duration of IP cast	2.3 years	1.0-4.2 years
Thoracic kyphosis at IP cast	42°	20°-63°
Percent correction at IP cast	28%	10°-50°
Thoracic kyphosis at MGR	22.8°	15°-30°
Thoracic kyphosis at final follow-up	21.4°	10°-30°
Lenzke correction at IP cast	26.9°	4°-50°
Lenzke correction at MGR	26.7°	5°-50°
Lenzke correction at final follow-up	22.4°	8°-40°
Lenzke correction at final follow-up	42.5°	15°-100°
T1-L1 length gain at final follow-up	27.2mm	7.8-48.8mm

Case 1: Showing T12 correction from 50° to 15° at one year

194. DOES INITIAL CAST CORRECTION PREDICT TREATMENT SUCCESS FOR INFANTILE SCOLIOSIS?

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United States

Summary

The success of casting treatment can be predicted by initial casting factors including age, Cobb angle, and percent correction in Cobb angle.

Hypothesis

Certain variables (Cobb, RVAD, percent correction) at initial casting can predict treatment success in idiopathic EOS.

Design

Multicenter, retrospective study.

Introduction

Casting treatment for idiopathic early onset scoliosis (EOS) results in varying amounts of Cobb angle correction. The aim of this study was to examine casting variables and identify which correlate with smaller Cobb angles at end of treatment.

Methods

Patients from two multicenter databases who underwent casting for idiopathic EOS between 2005 and 2013 were identified, with minimum 1-year follow-up. Cobb angles and rib-vertebra angle difference (RVAD) at presentation, initial casting, and at last follow-up were analyzed. Multivariable regression analysis was used to identify variables correlated with smaller Cobb angles at last follow-up.

Results

71 patients with a mean age at initial casting of 1.9 (range 0.5 to 5.9) years were identified. Mean follow-up after initial casting was 2.5 (± 1.03) years. Cobb angles improved from a mean of 46 degrees (± 14) to 23 degrees (± 12) demonstrating a 50% average correction in the initial cast. RVAD improved from 28 degrees to 18 degrees (36% average correction) in the initial cast. Overall, patients remained a mean of 15 months in a body cast and required an average of 5 casts (range 1 to 18) during the treatment period. Multivariable analysis determined that age, percent correction in Cobb from presentation to initial casting, and number of casts were significant predictors of most recent Cobb angle. Patients who were casted at a younger age, have a larger correction in initial cast, and require fewer casts during treatment have a smaller Cobb angle at follow-up. For each additional year in age at casting, the Cobb angle at follow-up increased by 5 degrees ($p=0.003$). For each 4% correction in Cobb at casting, the final Cobb angle decreased 1 degree ($p=0.01$). For each additional cast application, final Cobb increased by 1.5 degrees ($p=0.01$).

Conclusion

Early casting of idiopathic EOS patients is crucial to treatment success. Furthermore, percent correction in Cobb angle (which may represent curve flexibility and/or cast quality) can predict overall success of casting treatment.

195. NON-FUSION SURGICAL CORRECTION OF THORACIC IDIOPATHIC SCOLIOSIS USING A NOVEL BRAIDED UHMWPE TETHER DEVICE: 24-42 MONTHS RESULTS

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Singapore

Summary

Non-fusion scoliosis surgery was performed in skeletally immature patients via a novel tether-device specifically-designed for progressive thoracic scoliosis through a thoracoscopic technique. Sequential coronal and axial improvements were noted. Full scoliosis correction was

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seen at 2 years in 2 patients with unfused triradiate cartilage (TRC). The youngest patient progressed to over-correction with adding-on at 36 months. There were no device-related adverse events.

Hypothesis

Anterior tethering improves thoracic scoliosis.

Design

IRB-approved clinical trial for new device.

Introduction

Anterior tethering to effect scoliosis correction in a growing spine has been shown to be viable in animal models but with few clinical results. We describe non-fusion scoliosis surgery results in skeletally immature patients using a new device (UHMWPE tethers anchored to bone screws).

Methods

Five girls aged 9-12 (bone age=10-13, Risser 0) with thoracic scoliosis underwent thoracoscopic insertion of vertebral screws connected by braided UHMWPE tethers on the curve convexity. Xrays & MRIs were done pre-op and postop until at least 24 mos.

Results

Tether devices spanning end vertebrae (range 7-8 segments, T5 most proximal, T12 most distal) were implanted in 5 patients. Mean pre-op Cobb was 39.5° which improved to 23.7° at 12 mos (40% correction), 18.1° at 24 mos (52%), & 19.9° at 30 mos (50%). The mean Cobb was 22° at latest follow-up (mean 34months, range 24-42 months). Three patients with fused TRC had 26.3% correction at 12 mos and no further change by 24 & 30 mos (p=.42). Two patients with unfused TRC had better curve correction at 12 mos (63%) reaching full correction at 24 mos (100%) but with adding-on effect noted after TRC closure (13.5°). This was most marked in the youngest patient where over-all curve regressed to 24° w/ over-correction of tethered segments to -19° at 36 mos. Apical rotation assessed on MRI improved from 10° to 6° at 12 mos, and 5° at 4 mos (49%). Side-bending analysis showed preservation of curve flexibility up to 2 yrs in 4 patients. One patient had postop pleural effusion & another had community-acquired pneumonia 2 mos postop. There were no device-related complications.

Conclusion

Growth modulation using a novel device in progressive thoracic scoliosis showed deformity correction in coronal & axial planes that were maintained until 2 yrs with curve flexibility preserved. Maximum tethering was noted in those with unfused TRC. Over-correction & adding-on were seen in very young patients. Follow-up to maturity in more patients is needed to assess consistency of treatment effects of tether devices.

196. THE USE OF DYNAMIC SURGICAL GUIDANCE (DSG) SHORTENS PLACEMENT OF PEDICLE SCREW TIME WHILE IMPROVING ACCURACY, A TEACHING INSTRUMENT FOR RESIDENTS: A CADAVERIC STUDY

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United States

Summary

A DSG measures electrical conductivity at the tip and provides the surgeon with real-time audio and visual feedback based on differences in tissue-density between cortical and cancellous bone and soft tissue. The authors investigated the effectiveness of DSG for training residents and time to accurately place pedicle screws

Hypothesis

Participating residents when using DSG assistance will demonstrate shorter pedicle preparation time as well as will improve their screw placement accuracy.

Design

Cadaver study.

Introduction

Pedicle screw fixation commonly uses a manual probe technique for preparation and insertion of the screw. However, the accuracy of obtaining a centrally located path using the probe is often dependent on the experience of the surgeon and may lead to increased complications. Fluoroscopy and navigation improves accuracy but may expose the patient and surgeon to excessive radiation. DSG, provides real-time feedback without the use of radiation. The authors investigated the effectiveness of DSG for training residents on safe placement of pedicle screws.

Methods

Cadaveric thoracolumbar spine specimens were used for timing pedicle screw placement. Residents were randomized by pedicle side and order of technique for pedicle screw placement (free-hand versus DSG). Fluoroscopy was not used for pedicle preparation. Specimens were imaged using CT following insertion of all screws. Timing started when the probe was engaged and stopped when the last screw was placed.

Results

15 specimens were dissected in standard fashion to expose the thoracolumbar spine (T7-L5). 5 residents were randomized and assigned 3 specimens each to prepare bilateral pedicles from T8 to L5 (60 pedicles per resident) using either DSG or free-hand technique. A total of 249 pedicle screws were placed. Post-procedure CT scans demonstrated 214 (85.9%) screws within the pedicle. Breach rate for the DSG group was 8.2% and 19.7% for the DSG group, with an overall reduction of 58% (p=0.025)

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Conclusion

The assistance of Dynamic Surgical Guidance decreased screw placement time in residents and increased screw placement accuracy. This study demonstrates that DSG has the potential for resident education and refinement in operative technique to safely place pedicle screws in an expeditious manner.

197. POSTEROLATERAL DISKECTOMIES AS ALTERNATIVE TO ANTERIOR POSTERIOR SPINAL FUSION IN CHILDREN WITH SEVERE SPINAL DEFORMITIES

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United States

Summary

We present posterolateral diskectomies (PLD) at the apex of the deformity as an alternative to anterior releases and posterior spinal fusion (APSF). We compared 18 children with severe spinal deformities ($94\pm 21^\circ$ coronal, $63\pm 30^\circ$ sagittal) who underwent PLD, to 19 children ($106\pm 20^\circ$ coronal curve, $70\pm 36^\circ$ sagittal curve) who underwent APSF. PLD offers a single-approach alternative to APSF, and can achieve better coronal and equivalent sagittal correction with shorter operative time and a reduced risk of monitoring changes.

Hypothesis

Removal of the convex-side PLL, annulus and discs at the deformity apex facilitates spinal shortening and allows for posterior-only deformity correction for severe curves.

Design

Retrospective Case-Control.

Introduction

The aim of this study was to compare the results of posterolateral diskectomies (PLD) at the apex of spinal as an alternative to anterior releases and posterior spinal fusion (APSF) for significant thoracolumbar deformity.

Methods

18 children (mean age: 15.9 ± 3 years, 8F, 10M, $94\pm 21^\circ$ coronal Cobb, $63\pm 30^\circ$ sagittal Cobb) who underwent PLD were compared against 19 children (mean age: 14.5 ± 2.4 years, 14F, 5M, $106\pm 20^\circ$ coronal Cobb, $70\pm 36^\circ$ sagittal Cobb) who underwent APSF. There was no significant difference in the mean age ($P=0.11$), preoperative coronal ($P=0.09$) and sagittal ($P=0.53$) curve magnitudes, and number of posterior levels fused ($P=0.60$). In the PLD group, diskectomies were performed at apical levels on the convexity, removing the convex annulus, convex half of the posterior endplate, with rib head resection if it limited convex shortening. Radiographic results and clinical results, and complications were compared. Significance was set at $P<0.05$.

Results

PLD group had on average 2.6 ± 0.7 diskectomies, and APSF had on average 7.7 ± 2 anterior levels released ($P<0.01$). PLD group had a lower final coronal Cobb (28° vs 47° , $P<0.01$); there was no significant difference in final sagittal Cobb (34° vs 41° , $P=0.30$). There was

no significant difference in blood loss (1.65 vs $1.60L$, $P=0.87$). The PLD group had significantly shorter operative time (305 mins vs. 403 mins, $P=0.02$). There were no intraoperative neuromonitoring changes or neurologic complications in the PLD group. In the APSF group, 2 patients had intraoperative loss of signals requiring removal of implant. The PLD group had significantly shorter overall length of hospital stay (12 vs 25 days, $P=0.03$).

Conclusion

PLD offers a single-approach alternative to APSF for dealing with moderately large spinal deformities. It can achieve better coronal and equivalent sagittal correction with shorter operative time and a reduced risk of monitoring changes.



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198. CAN S2-ALAR-ILIAC (S2AI) SCREWS BE PLACED ACCURATELY WITHOUT FLUOROSCOPY?

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Thailand

Summary

Freehand S2AI screw insertion is a safe and reliable method. Our study found a 90.5% accuracy rate for acceptable screw position using the freehand S2AI screw insertion, with 5.8% minor and 3.2% major/critical cortical wall violations. Most pedicle wall violations occurred laterally and there were no S2AI screw related complications. We found freehand S2AI screw insertion has excellent accuracy, and obviates the use of fluoroscopic guidance.

Hypothesis

We hypothesized that freehand S2AI screw insertion is safe and accurate, with a high rate of acceptable screw placement and low rate of critically misplaced screws.

Design

Retrospective analysis of adult spinal deformity pts treated at one institution, single surgeon over 4 yrs (2010-14) with freehand S2AI screw placement, consecutively assessed with intraop computed tomography (CT) scan.

Introduction

S2AI screw insertion is most often performed with fluoroscopic guidance, however, the freehand S2AI screw insertion provides an alternative technique void of any fluoroscopic radiation. However, the accuracy and safety of the freehand S2AI screw technique has not been completely evaluated.

Methods

We analyzed intraop CT images of pts who underwent freehand S2AI screw fixation. Each CT image sequence was assessed by 3 spine surgeons, and any pedicle wall or screw violation of the cortical wall was confirmed/graded through consensus agreement. S2AI screw position was graded as acceptable (complete screw within the pelvic/iliac corridor), minor violation (≤ 6 mm) and major/critical violation (> 6 mm). Screws not adequately visualized on the CT images were excluded.

Results

Overall, there were 190 freehand S2AI screws inserted in 98 pts (n=93 L; n=97 R) and adequately visualized on intraop CT images. There were 5 pts with R S2AI/L Iliac (3 L lateral pedicle wall violations), 1 pt L S2AI/R iliac screw, and 5 pts with multiple (> 2) ipsilateral pelvic fixation points. Overall there was a 9.5% violation rate (n=8 L; n=10 R). The rate of minor violation was 5.8% (lateral n=9, 4.7%, avg 3.1mm; medial n=2, 1.1%, avg 2.5mm), and major/critical violation was 3.2% (lateral n=3, 1.6%, avg 10.8mm; medial n=4, 2.1%, avg 15.6mm). There were 12 pedicle wall violations, all were lateral (n=8 L; n=4 R). No pts had neurologic, vascular, or visceral complications related to S2AI screw placement.

Conclusion

Our study found a 90.5% accuracy rate for acceptable screw position using freehand S2AI screw insertion without fluoroscopy. There were no S2AI screw related complications, and most screw violations were minor and occurred laterally.

199. MIS IN AIS: LESSONS LEARNED AT 2-YEAR FOLLOW-UP

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Canada

Summary

Although previous reports have focused on positive early post-operative results of MIS in AIS, longer-term follow-up is critical to evaluate any true clinical benefits of MIS in this setting. We noted significantly lower blood loss, transfusion rates, and hospital stay in our MIS population, however this was at the expense of increased OR time, limited % curve correction, and a higher complication rate compared to standard open techniques. Despite these variations, there were no differences in SRS-22 scores at 2-years post-op.

Hypothesis

Long-term outcomes of MIS for AIS are no different to standard open PSIF techniques.

Design

Retrospective comparative case-matched control study.

Introduction

Minimally invasive surgery (MIS) is becoming popular in AIS. Previous reports have found favorable outcomes in the early post-op period, however, longer-term follow-up data is limited. Our aim was to compare peri-op outcomes as well as radiographic and clinical outcomes between MIS and standard open posterior spinal instrumentation and fusion (PSIF) at minimum 2-year follow-up.

Methods

A retrospective review of prospectively collected data of patients with AIS who underwent MIS was performed on all cases between 2009-2012. MIS cases were matched for age, sex, Lenke class, curve size, and single-surgeon with conventional PSIF from a multi-center longitudinal database. Pre-op, peri-op and 2-year follow-up data were evaluated. A priori defined peri-op variables included OR time (ORT), hospital stay (LOS), estimated blood loss (EBL), and transfusion rates (allogenic and cell saver). At 2-year follow-up, mean % curve correction, SRS scores, and complication rates were also compared.

Results

46 cases (23 MIS; 23 PSIF) with 2-year follow-up were analyzed. Both groups had comparable patient demographics. EBL, cell saver volume transfused, and LOS were all significantly reduced in the MIS group compared to PSIF ($p < 0.05$); however, ORT was significantly less in the PSIF group on average by 149.1 ± 2.39 ($p = 0.000$). At 2-year post-op, mean % curve correction was significantly better in the PSIF group ($58.1\% \pm 2.41\%$) compared to MIS

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(68%±1.45%) (p=0.000). A total of 5 reported complications (1 hardware failure, 3 delayed infections, 1 pseudarthrosis) were noted in the MIS group compared to 1 complication (delayed infection) in the PSIF group (p=0.080). SRS scores at 2-year follow-up were not significantly different between the groups (p=0.524).

Conclusion

Advantages of MIS relate to EBL, cell saver transfusion rates, and LOS; this needs to be carefully weighed against the significant increase in ORT, limited mean % curve correction and a higher noted complication rate of MIS in AIS compared to standard PSIF. Despite these variations, no clinical differences in SRS-22 scores were found at 2-years post-op.

Table 1: Patient demographics and results summary

Patient Demographics	MIS (n=21)	PSIF (n=25)	
Gender (M/F)	17/4	4/21	
Grade (Cobb (°))	11-29	17-32	
	0-2	3-4	
	4-1	5-5	
Mean Age (yrs)	16.3±0.40 (14-20)	16.4±0.28 (15-19)	
Mean Weight (kg)	59.1±1.74 (43-72)	56.4±1.97 (48.6-76.2)	
Mean Preop Major Cobb (°)	24.7±1.62 (19-27)	28.1±1.37 (16-34)	0.001
Mean Preop Lat (°)	22.3±2.06 (12-30)	23.6±1.45 (14-34)	
No. of Fusion Levels	18.2	12.2	
Outcome Variables of Interest			
Mean Postop Major Cobb at 2 year follow-up	21.6±1.68 (12-40)	18.7±1.62 (8-29)	0.017
Mean Postop Lat (T1-T12) at 2 year follow-up	22.6±1.96 (18-49)	21.6±1.31 (12-41)	0.332
% Major Cobb Correction	51.1±2.41 (38.8-73.9)	48.9±1.45 (31.8-64.4)	0.681*
Mean ODI (mm)	47.5±11.25 (28.8-61)	46.4±11.64 (22.1-61)	0.869*
Mean NRS (days)	4.41±0.15 (1-6)	5.98±2.14 (1-8)	0.000*
Mean EBL (ml)	261.2±25.68 (180-380)	491.7±30.68 (170-600)	0.000*
Mean volume of Cell Saver Blood Transfused (ml)	0	68.2±27.31 (0-100)	0.003*
Amount of Post Op Pain Medication (PRN)	1.0±0.18 (0-5)	1.7±0.21 (1-5)	0.118
Complications (n)	1/21 (4.8%)	1/25 (4%)	0.486
Mean Postop SRS-22 scores at 2 year follow-up	4.23±0.14	4.34±0.19	0.711

200. A CRITICAL ANALYSIS OF SAGITTAL PLANE DEFORMITY CORRECTION WITH MINIMALLY INVASIVE ADULT SPINAL DEFORMITY SURGERY: A 2-YEAR FOLLOW-UP STUDY

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Summary

A multicenter retrospective database of consecutive patients undergoing minimally invasive spinal deformity surgery was queried for patients with 2 year follow up and complete radiographic and HRQOL data. Patients were grouped by sagittal plane deformity according to the SRS adult deformity classification. Patient with only coronal

deformity or moderate sagittal plane deformity improved radiographically and clinically while those with severe sagittal plane deformities failed to achieve radiographic or clinical success and were effectively rendered as fixed sagittal plane deformities.

Hypothesis

Minimally invasive spine surgery is currently unable to achieve optimal sagittal plane correction among patients with significant sagittal plane deformity.

Design

Multicenter retrospective case series.

Introduction

Sagittal plane realignment is critical to achieve desired post-operative clinical outcomes. We aim to evaluate circumferential MIS (cMIS) techniques and their ability to treat the sagittal plane with 2-year follow up.

Methods

A retrospective multicenter database from 2009 to 2012 was queried for the following inclusion criteria: cMIS, 2yr followup, coronal Cobb ≥20°, SVA >5cm, or PT>25°. Patients were then stratified by SRS-Schwab global alignment modifier (GAM) as Scolio (coronal deformity; SVA<4), + (SVA 4-9.5), or ++(SVA>9.5) depending on their preoperative sagittal plane deformity, and analyzed at 2 yrs for demographic, radiographic and HRQoL measures (ODI and NRS back and leg).

Results

426 patients met inclusion criteria, 86 had complete 2yr data (n: Scolio=51, +=21, and ++=14). The Scolio group was significantly younger than ++ (57.6 v 70.5). There were no differences in baseline HRQoL and operative data. Preoperative radiographic parameters were consistent with GAM stratification (table 1). Postop, Scolio and + had improved ODI, NRS back and leg. Scolio had no differences radiographically while + saw improvement in PI-LL (21.1-15.4; p=0.025) and LL (33.6 - 39.9; p=0.016). ++ had improvement in NRS back but not in ODI, NRS leg, or PT, PI-LL, SVA, or LL. Of 52 pts in Scolio, 42 (81%) remained in Scolio, while 9 (17%) pts deteriorated (5 to +, 4 to ++). 13/21(61.9%) + pts remained + while 3 changed to ++, and 5 to Scolio. 9/14 (64.3%)++ pts remained ++, while 3 improved to + and 2 to Scolio.

Conclusion

Minimally invasive techniques successfully stabilized patients with SRS GAM of Scolio and + deformities and improved HRQoL at 2 years. Patients with substantial deformity ++ showed no improvement clinically after MIS surgery indicating that this group acquired a fixed sagittal plane deformity.

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SRS-23A Module (CAAS)	0	1	2+
N	51	21	10
Age	13.7 ^a	13.8	13.1
Gender - Female	44 (86.3%)	13 (61.9%)	9 (90.0%)
Total ERG	451.4	489	777.0
Total OR Time	419.8	362.8	302.8
Total LOS	7	7.1	6.1
Pre Op PT	21.8 ^a	26.7	28.5
Post Op PT	21.8	21.3	20.8
Pre Op P-LL	9.9 ^a	11.1	15.9
Post Op P-LL	8.0 ^a	11.4	20.8
Pre Op P-RL	8.1 ^a	10.9 ^a	22.7 ^b
Post Op P-RL	7.2 ^a	11.0 ^a	21.2 ^b
Pre Op LL	43.9 ^a	51.8	51.8
Post Op LL	44.7	39.0	39.5
Posterior Levels Fused	3.3	4.2	4.5
Pre Op ODR	43.1	51.3	49.1
Post Op ODR	26.5 ^a	29.6	41.0
Pre Op VAS Back	6.4	6.4	7
Post Op VAS Back	3 ^a	3.4	4.0
Pre Op VAS Leg	5.5	5.4	6
Post Op VAS Leg	3.3	3	3.4

201. 28% OF AIS PATIENTS REPORT CLINICALLY SIGNIFICANT PSYCHOPATHOLOGY

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United States

Summary

Of 82 patients with AIS, 28% scored in a clinically significant range for psychopathology. No significant differences were found between those undergoing observation, bracing, or surgery.

Hypothesis

Higher psychosocial pathology will correlate with more severe deformity and scores will differ between observation, bracing and surgery groups.

Design

Cross-sectional survey.

Introduction

We aimed to investigate the psychosocial manifestations of AIS using an extended behavioral and emotional assessment tool, the BASC-2. The BASC-2 is a validated 139-item survey tested on over 1 million children in the United States. It can detect clinical and subclinical levels of psychosocial problems in five domains: School Problems, Internalizing Problems, Inattention/Hyperactivity, Emotional Symptoms Index, and Personal Adjustment.

Methods

Patients aged 12-21 with a diagnosis of AIS were included. The BASC-2 self-report form was completed by 82 adolescents with AIS (mean age = 13 yrs; range 12-17) BASC-2 scale scores were compared to validated age-matched normative data. Comparisons were made between those undergoing surgery (n=28), bracing (n=27), or observation (n=27).

Results

In total, 28% (23/82) scored in the Clinically Significant range in at least one of the five domains. There were no significant differences in BASC-2 scale scores when stratified by age (p=0.36), Cobb angle (p=0.35), or treatment type (p=0.85).

Conclusion

More than 1 in 4 patients with AIS experience clinically significant emotional or behavioral distress. Patients undergoing observation, bracing, and surgery are all at risk for clinically significant symptoms.

Clinically Significant Range	School Problems (%) (N=82)	Internalizing Problems (%) (N=82)	Inattention/Hyperactivity (%) (N=82)	Emotional Symptoms Index (%) (N=82)	Personal Adjustment (%) (N=82)

202. THE FIRST 100 CONSECUTIVE ANTERIOR VERTEBRAL BODY TETHERING PROCEDURES FOR IMMATURE ADOLESCENT IDIOPATHIC SCOLIOSIS AT A SINGLE INSTITUTION: OUTCOMES AND COMPLICATIONS IN THE EARLY POSTOPERATIVE PERIOD

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United States

Summary

A retrospective review of the first 100 anterior vertebral body tethering (VBT) procedures at a single institution was performed. The average initial main curve correction was 49%. There were no major and few minor, transient complications. Operative time and blood loss have decreased with continued experience as the thoracic procedure is currently performed almost universally via an all-thoracoscopic approach. Short term results demonstrate VBT is a relatively safe, effective and minimally invasive treatment option for progressive immature idiopathic scoliosis.

Hypothesis

Anterior vertebral body tethering (VBT) is a viable option for the treatment of progressive immature adolescent idiopathic scoliosis (AIS).

Design

Retrospective review of a consecutive single institution case series.

Introduction

VBT has been described as a potential surgical treatment option for progressive immature AIS. This study evaluates the short term results and complications of VBT at a single large volume institution.

Methods

Institutional Review Board approval was obtained to retrospectively evaluate the clinical and radiographic outcomes of the first 100 VBT for AIS at a single institution. Radiographic and clinical perioperative and early postop (30 days) data was analyzed.

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Results

There were 82 females, average age of 12.3 years. Median preop Risser score=0, and Sanders Score=3. An average of 7.6 vertebrae were tethered (range: 5-11). Mean operative time was 246 minutes (pts 1-25: 294min vs. pts 75-100: 196min, $p<0.001$). Estimated blood loss mean 190mL (pts 1-25: 246mL vs. pts 75-100: 156mL, $p=0.2$), with 4% requiring a blood transfusion. The mean thoracic curve improved 49% from preop: 46° (range: 26° - 73°) to initial postop: 23° (range: 7° - 47°), $p<0.001$. The mean lumbar curve improved 41% (preop mean: 32° vs. initial followup: 18° , $p<0.0001$). 27 patients underwent concomitant contralateral thoracolumbar VBT or vertebral body stapling.

There were no major complications or early implant failures. Intraop, 2% were converted to an open approach after inability to tolerate single lung ventilation, and 1% had transient partial decrease in neuromonitoring that resolved prior to closure. Minor postop complications include: prolonged atelectasis requiring bronchoscopy ($n=1$), transient thigh pain/numbness ($n=5$), and unresolved intercostal neuralgia ($n=1$).

Conclusion

This is the largest series ($n=100$) of anterior vertebral body tethering (VBT) for immature idiopathic scoliosis. Initial curve correction was 49%. There were no major, and only few minor perioperative complications. Long-term study is required for definitive safety/efficacy assessment.

	Value	Range	p value
Preop Thoracic Coronal Cobb	46.1°	26°-73°	$p<0.01$
Initial Postop Thoracic Coronal Cobb	21.1°	7°-47°	
Percent correction	49%		
Preop lumbar Coronal Cobb	31.7°	10.2°-50.3°	$p<0.01$
Initial Postop lumbar Coronal Cobb	17.3°	0.5°-35.8°	
Percent correction	45%		
Preop Thoracic T5-T12 Sagittal Cobb	24.4°	0.5°-46.5°	$p<0.01$
Initial Postop Thoracic Sagittal Cobb	21.8°	3.5°-46.5°	
Preop Rib Prominence	6.7°	2°-17°	
Initial Postop Rib Prominence	5.1°	2°-10°	
Operative Time			<0.01
Pts: 1-25	294 min	117-700 min	
Pts: 26-50	237 min		
Pts: 51-75	231 min		
Pts: 76-100	196 min		
Estimated Blood Loss			0.2
Pts: 1-25	246mL	15mL-140mL	
Pts: 26-50	238mL		
Pts: 51-75	232mL		
Pts: 76-100	156mL		

203. A PROSPECTIVE, MULTICENTER, RANDOMIZED CONTROLLED TRIAL OF NONSURGICAL MANAGEMENT VS MINIMALLY INVASIVE FUSION FOR SACROILIITIS OR SACROILIAC JOINT DISRUPTION

David W. Polly, MD; Daniel Joseph Cher, MD; Peter G. Whang, MD; Clay Jamison Frank, MD; William Sanford Rosenberg, MD; Jonathan Nubla Sembrano, MD; Harry Lockstadt, MD, FRCSC; John Glaser, MD

United States

Summary

Minimally invasive SI fusion is clinically superior to non-surgical management (NSM) at 6 months.

Hypothesis

Minimally invasive SI fusion is more effective than NSM for sacroiliitis or SI joint disruption.

Design

Multicenter prospective randomized controlled trial.

Introduction

Sacroiliac (SI) joint pain is a prevalent but underdiagnosed cause of low back pain. Surgical fusion can relieve pain and improve quality of life in patients who fail nonoperative care. We report a prospective multicenter randomized clinical trial of minimally invasive SI joint fusion using triangular titanium implants or NSM in patients with chronic SI joint pain.

Methods

148 patients with SI joint dysfunction due degenerative sacroiliitis or SI joint disruption were randomly assigned to either minimally invasive SI joint fusion ($n=102$) or NSM ($n=46$). Crossover from NSM to SI joint fusion was allowed after the 6-month visit was complete. Pain scores and back disability (ODI) were collected at baseline, and 1, 3, and 6 months after surgery or assignment to NSM. Quality of life scores (SF-36 and EQ-5D) were collected at baseline and 6 months. Success rates (improvement of >20 mm on VAS and the absence of severe device-related or neurologic SI joint-related adverse events or surgical revision) were compared using logistic regression.

Results

Mean age was 51 years, 70% were women. Subjects were highly debilitated at baseline (mean VAS 82, mean ODI 62) and had pain for an average of 6 years. 6-month follow-up was obtained in $>95\%$. 6 months success was reached in 81% of the fusion group and 27.5% in the NSM group ($p<0.0001$). Mean pain decreased by 42 more points (0-100 scale) in the fusion group vs. the NSM group. Pain relief was greater in the fusion group at all postoperative visits. 48.6% and 11.4% of subjects in the fusion and NSM groups had a substantial (≥ 15 point) improvement in ODI. Quality of life improved more in the fusion group and satisfaction rates were high.

Conclusion

Compared to NSM, minimally invasive SI joint fusion using porous, coated triangular titanium implants is more effective in relieving pain, improving function and quality of life in patients with SI joint dysfunction due to degeneration or disruption of the SI joint.

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204. EARLY POSTOPERATIVE PAIN AND QUALITY OF LIFE FOLLOWING POSTERIOR INSTRUMENTED FUSION FOR LUMBAR DEGENERATIVE CONDITIONS: A PROSPECTIVE RANDOMIZED STUDY OF POSTOPERATIVE BRACING.

Hany A.G. Soliman, MD, PhD; Stefan Parent, MD, PhD; Soraya Barchi, BS; Gilles Maurais, MD, FRCSC; Alain Jodoin, MD; Jean-Marc Mac-Thiong

Canada

Summary

A prospective randomized controlled trial (RCT) of postoperative bracing following posterior spinal instrumented fusion (PSIF) in patients with lumbar degenerative conditions showed a decrease in early postoperative pain and improved quality of life for patients not wearing a brace compared to a brace wearing group.

Hypothesis

Postoperative bracing after posterior spinal instrumented fusion (PSIF) leads to better early pain relief and quality of life in patients with lumbar degenerative conditions.

Design

Prospective RCT comparing early pain and quality of life in 25 patients with postoperative brace and 18 patients without brace after PSIF for lumbar degenerative conditions.

Introduction

The decision to use a brace following lumbar spine surgery is mainly dependent on the surgeon's experience and training due to lack of evidence in the literature.

Methods

43 patients with PSIF for lumbar degenerative conditions were recruited and randomly assigned to the brace or non-brace group. Patients in the brace group were instructed to wear a rigid molded TLSO full time for 8 weeks except during hygiene and wound care followed by daytime wear for another 4 weeks. All patients completed Oswestry Disability Index (ODI) for back pain, and SF-12 General Health Survey preoperatively at baseline, and at 6 weeks and 3 months follow up. The non-parametric Mann-Whitney U test and a level of significance of 0.05 were used for statistical analyses.

Results

Both groups had comparable age, sex, weight, height, preoperative SF-12 and ODI scores (Table). The SF-12 and ODI scores were improved for both groups at 6 weeks and 3 months postoperatively. At 6 weeks postoperatively there was no significant difference in SF-12 and ODI scores between the two groups. At 3 months follow up, the ODI as well as all domains / component scores of the SF-12 (except for general health domain) were improved in the non-brace group when compared to the brace group (Table).

Conclusion

Postoperative bracing with a rigid TLSO did not improve the quality of life or the pain relief early after PSIF in patients with lumbar degenerative conditions.

Table: ODI and SF-12 (PCS) scores preoperative, at 6 weeks and 3 months follow up.

	Brace group (Mean ± SD)	No brace group (Mean ± SD)	P-value
Preoperative ODI score %	34.21 ± 14.91	46.52 ± 17.99	0.33
6 weeks follow up ODI score %	18.29 ± 20.29	29.28 ± 15.08	0.11
3 Months follow up ODI score %	17.76 ± 18.88	23.45 ± 16.90	0.01
Preoperative SF-12 PCS**	28.30 ± 9.77	30.85 ± 9.08	0.6
6 weeks follow up SF-12 PCS	32.67 ± 9.65	34.30 ± 9.87	0.7
3 Months follow up SF-12 PCS	35.94 ± 9.49	36.51 ± 7.44	0.201

**P-value calculated by Mann-Whitney U test.
**PCS [physical Composite Scores]

205. VARIATIONS IN SAGITTAL ALIGNMENT PARAMETERS BASED ON AGE: A PROSPECTIVE STUDY OF NORMAL PATIENTS USING FULL LENGTH LOW DOSE RADIATION

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United States

Summary

In this prospective cross-sectional study of 84 volunteer adults ranging in age from 22-77, normative measures of regional and global sagittal alignment were established; global sagittal angle (GSA, -0.6 ± 3.0) and T1-pelvis angle (T1PA, 7.8 ± 8.1). Age related changes were documented and emphasize the importance of correlating specific sagittal alignment parameters to patient age for pre and postop assessments. A novel parameter relating sagittal alignment to horizontal gaze, occipital slope (OS), is proposed and validated.

Hypothesis

EOS imaging can provide important insight into the changes in measures of occipitocervical and global sagittal alignment occurring with aging.

Design

Prospective Observational Study.

Introduction

EOS allows for simultaneous capture of coronal and sagittal standing images from the occiput to the lower extremity without stitching or vertical distortion. This provides an ideal method to evaluate measures of global alignment and relate measures of sagittal alignment to horizontal gaze.

Methods

Adults with no back or neck symptoms were recruited. Age, BMI, Neck Disability Index (NDI) and Oswestry Disability Index (ODI) scores were recorded. All radiographic parameters (Table 1) were measured by two reviewers. Occipital Slope (OS) was defined as the angle between a horizontal line and the line from the center of orbit to opisthion). Radiographs were used to calculate interobserver reliability (intraclass correlation coefficient,

Podium & Two-Minute Point Presentation Abstracts

ICC). ICC > 0.6 was considered acceptable and ≥0.9 was excellent. Comparisons of sagittal alignment parameters between different age groups were performed. A Pearson correlation was used to determine relationships.

Results

84 of the 100 pts had complete radiographs for evaluation. The avg age was 48.5 (range 22-77). The average value for T1PA was 7.8 ±81 and GSA was -0.6 ±3.0. KFA, a parameter that cannot be measured on "traditional" lateral spine radiographs, averaged -0.1 ±5.3. CL (r=-0.28, p=0.01), SVA (r=0.49, p<0.01), GSA (r=0.58, p<0.01), T1PA (r=0.42 p<0.01) and KFA (r=0.40, p<0.01) increased with age. ICC for OS was excellent (0.96). Average value for OS was 21 ±8 and OS was significantly correlated to important cervical alignment parameters: O-C2 angle (r=-0.42), CL (r=-0.27), and C2-7 SVA (r=-0.38). ICC was acceptable or better (range 0.64-0.97) for all other measured parameters.

Conclusion

This study on 84 adult volunteers presents normative values of sagittal regional and global alignment across age groups to be used as a reference for future studies in adult spinal surgery. In addition, OS is a novel radiographic parameter linking cervical sagittal alignment to horizontal gaze.

	Age 20-30		Age 31-40		Age 41-50		Age 51-60		Age 61-70		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
OS	21.1	7.1	20.1	8.1	18.1	9.1	17.1	10.1	16.1	11.1	18.1	9.1
OSI	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSIII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSIV	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSV	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSVI	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSVII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSVIII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSIX	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSX	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXI	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXIII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXIV	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXV	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXVI	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXVII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXVIII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXIX	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXX	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXI	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXIII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXIV	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXV	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXVI	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXVII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXVIII	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXIX	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
OSXXX	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	

206. LAMINECTOMY AND FUSION VERSUS LAMINOPLASTY FOR THE TREATMENT OF CERVICAL SPONDYLOTIC MYELOPATHY: RESULTS FROM THE AOSPINE NORTH AMERICA AND INTERNATIONAL PROSPECTIVE MULTICENTER CSM STUDIES

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Canada

Summary

The pooled analysis of the AOSpine North America and International prospective multicenter CSM studies revealed no difference in primary outcome measures (mJOA, Nurick, and NDI) between patients treated with laminoplasty versus laminectomy and fusion.

Hypothesis

Laminoplasty provides improved outcomes over laminectomy and fusion for CSM treatment.

Design

Pooled analysis of North American and International prospective multicenter CSM studies.

Introduction

There are a diversity of surgical options for the treatment of CSM and it remains unclear if there is superiority of one posterior surgical treatment over another. We present the results from the two largest prospective CSM studies to allow for a comparison of outcomes following laminoplasty and laminectomy and fusion.

Methods

The AOSpine North America and International prospective multicenter studies enrolled 757 patients undergoing surgical treatment for CSM spanning 2005-2007 and 2007-2011 respectively. 100 participants underwent laminoplasty and 166 participants underwent laminectomy and fusion. Inclusion into the study required radiologic and clinical evidence of CSM. 83% of included patients achieved follow up at 12 months. Primary outcomes included Nurick Score, mJOA, NDI. Outcomes were analyzed by 1-way ANOVA and ANCOVA adjusted for covariates: gender, age, smoking, # of operative level, region, and baseline scores.

Results

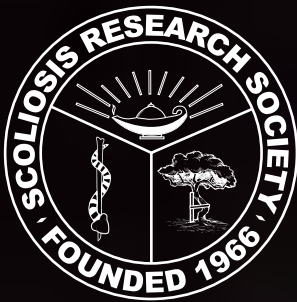
1 yr following surgery, laminoplasty patients achieved improvements in mean Nurick score of 1.00 (0.60, 1.41), mJOA 2.51 (1.78, 3.25), and NDI 9.72 (4.17, 15.26). The laminectomy and fusion group achieved improvements in mean Nurick score of 0.90 (0.57, 1.23), mJOA 2.45 (1.55, 2.71), and NDI 9.77 (5.07, 14.47). There was no statistical difference between groups once covariates were adjusted for.

Conclusion

There are no statistical differences in 1 year improvement of Nurick score, mJOA, and NDI in CSM patients who have undergone laminoplasty versus laminectomy and fusion. Both treatments remain comparably effective in the treatment of CSM.



Exhibits & Hands-On Workshops



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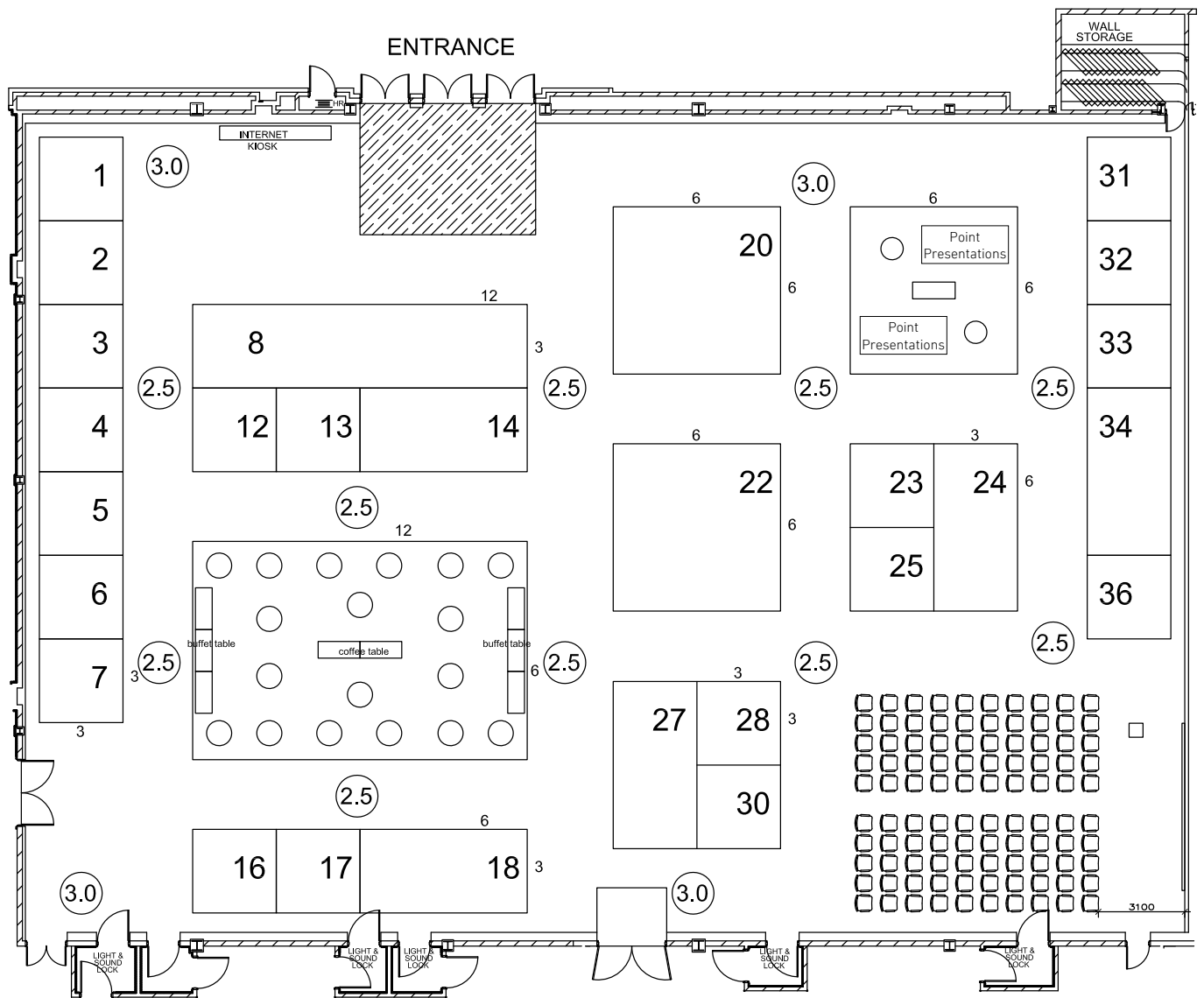
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Company	Booth Number
Alphatec Spine	30
Biomet Spine	12
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Medicrea International	34
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OrthoPediatrics	3
Scoliosis Research Society	31
Siemens	23
SpineCraft	20
SpineGuard	5
Stryker Spine	16
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Waston	2
Zimmer Spine	13

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NovaMedika is incorporated in Malaysia and operates its business in the capital city of Kuala Lumpur, Malaysia. The key personnel's of NovaMedika are very experience in the spinal business, having been in the industry since 1995. NovaMedika is representing Medyssey, an innovative young company from South Korea, that is specialising in spine products. Medyssey board members are made up of South Korean and International members whom have been in the orthopaedic and spine industry for over 20 years. Medyssey products are certified with CE Mark, Korea FDA and US FDA. It has an office in Chicago, United States of America, China and Egypt, besides a headquarter in South Korea. Medyssey heavily invested in state of the art technology, to design and develop spine implants. The latest being the ARCOM, electronic beam machine, which perform titanium 3D printing of spine and neuro implants. Medyssey is set to be a leader in spine technology in South Korea.

NUVASIVE

Corporate Headquarters
7475 Lusk Blvd.
San Diego, CA 92121
www.nuvasive.com

NuVasive® is a medical device company focused on developing minimally disruptive surgical products and procedures for the spine. The company, which offers more than 90 products spanning lumbar, thoracic and cervical applications, recently launched its integrated Global Alignment (iGA™) platform. iGA marks a significant advancement in the historical approach to spine surgery by integrating procedural technology and tools into one platform to help surgeons achieve more precise spinal column alignment. The iGA platform, which prioritizes the importance of proper alignment and its potential to impact positive patient outcomes, includes a collection of products, including next generation posterior fixation, anterior and posterior implants, updated neuromonitoring and computer-assisted surgical planning technology. Newly launched products in the iGA platform include ReLine™, NuvaMap™, Nuvaline™, NuvaMap O.R. and Bendini®. These products, which are seamlessly integrated across the surgical workflow, are designed to help the surgeon:

CALCULATE alignment parameters with NuvaMap and Nuvaline preoperative planning tools;

CORRECT the anterior and posterior columns with comprehensive implant solutions using real-time intraoperative assessment via NuvaMap O.R.; and

CONFIRM the restoration and preservation of global sagittal alignment postoperatively, again through NuvaMap and Nuvaline.

ORTHOFIX, INC

3451 Plano Parkway
Lewisville, TX 75056
Tel +1-214-937-2200
www.Orthofix.com

Orthofix International N.V. is a diversified, global medical device company focused on improving patients' lives by providing superior reconstructive and regenerative orthopedic and spine solutions to physicians worldwide. Headquartered in Lewisville, TX, the company has four strategic business units that include BioStim, Biologics, Extremity Fixation and Spine Fixation. Orthofix products are widely distributed via the company's sales representatives, distributors and its subsidiaries. In addition, Orthofix is collaborating on research and development activities with leading clinical organizations such as the Musculoskeletal Transplant Foundation, the Orthopedic Research and Education Foundation and the Texas Scottish Rite Hospital for Children. For more information, please visit www.orthofix.com.

Exhibitor Descriptions

ORTHOPEDIATRICS

2850 Frontier Dr
Warsaw IN 46582
Tel +1-574-268-6379
www.orthopediatrics.com

At OrthoPediatics® we have a cause to improve the lives of children with orthopedic conditions. As the only global medical device company focused exclusively on pediatric orthopedics, we have 16 surgical systems for Trauma, Limb Deformity, Spine, and Sports Medicine. OrthoPediatics is the true end-to-end provider for surgical solutions in pediatric orthopedics, and in collaboration with world-class pediatric orthopedic surgeons, we are dedicated to delivering the best products for children. We are committed to providing and supporting superior clinical education through partnerships with professional societies as well as training and educational initiatives globally to advance the field of pediatric orthopedics.

SIEMENS HEALTHCARE GmbH

Henkestr. 127, D-91052
Erlangen, Germany
Tel +49 0 9131 84 0
www.siemens.com/healthcare

Siemens Healthcare is one of the world's largest suppliers of technology to the healthcare industry and a leader in medical imaging, laboratory diagnostics and healthcare IT. All supported by a comprehensive portfolio of clinical consulting, training, and services available across the globe and tailored to customers' needs.

In fiscal 2014, Siemens Healthcare had around 43,000 employees worldwide and posted a revenue worth 11.7 billion euros, and profits of more than 2 billion euros. Further information is available on the Internet at <http://www.healthcare.siemens.com/>

SPINECRAFT

777 Oakmont Lane
Westmont, IL 60559
Tel +1-630-920-7300
TF: +1-877-731-SPINE (877-731-7746)
www.spinecraft.com

SpineCraft is a privately-held, US medical device company founded in 2004 by a group of medical professionals and spine executives. The company creates intelligent solutions by listening to surgeons. Surgeon input remains central to the way we approach improving existing products or work on new ideas: from our Medical Advisory Board to the individual surgeons who work with us on product development. We hear and see, first-hand, the concerns and obstacles surgeons encounter. This approach results in more practical devices that provide intraoperative efficiency for surgeons, cost-effectiveness for the hospitals and healthcare system, and superior outcomes for patients.

SpineCraft is large enough to be able to provide the most advanced spine technology while meeting growing surgeon demand, yet small enough not to be hampered by inflated design and manufacturing processes that often prolong new product development at bigger companies. SpineCraft's main focus has been deformity correction and complex spine instrumentation.

SPINEGUARD, INC

1388 Sutter Street
Suite 510
San Francisco, CA 94109
Tel +1-415-512-2500
www.spineguard.com

SpineGuard provides tools equipped with Dynamic Surgical Guidance (DSG) technology to enhance spinal surgery. Devices built with DSG technology give real-time audio and visual feedback to improve the accuracy of pedicle screw placement, without the need for ancillary equipment. The PediGuard probes are the only devices with built-in DSG capability. These devices have assisted spine surgeons in accurately placing pedicle screws in over 38,000 spinal procedures around the world. Please visit www.spineguard.com for more information.

Exhibitor Descriptions

STRYKER SPINE

2 Pearl Court
Allendale, NJ
Tel +1 201-760-8000
www.stryker.com

Stryker is one of the world's leading medical technology companies and together with our customers, we are driven to make healthcare better. The Company offers a diverse array of innovative products and services in Orthopaedics, Medical and Surgical, and Neurotechnology and Spine, which help improve patient and hospital outcomes. Stryker is active in over 100 countries around the world. Please contact us for more information at www.stryker.com.

SYNERGIC EVOLUTION SDN BHD

321, Jalan S2 B13, Uptown Avenue
70300, Seremban,
Negeri sembilan, Malaysia
Tel +60 6601 2260

SYNERGIC EVOLUTION SDN BHD supply high end and latest technology of spinal implants. Our company is an Authorized Representative for Cousin Biotech and Innov'Spine from France. Our main product is IntraSPINE®, a device for the interspinous space with laminar support. We market our product and service our customers throughout Malaysia.

WASTON MEDICAL APPLIANCE CO., LTD

9.Xihu Rd,Wujin Hi-Tech Industry Zone, Changzhou
,China.213164
Tel +86 18661214778
www.wastonmed.com

Changzhou Waston Medical Appliance Co., Ltd, one of China's most vigorous and innovative medical device manufacturers and related service providers, was founded in 2002. It consists of five divisions, including the Orthopedics Department, Surgical Stapler Department, Thoracic Surgery Department, Surgical Instruments Department and New Product Development Department. Our company has three R&D and production bases, located in National Changzhou Hi-tech Industry Zone of Jiangsu, National Wujin Hi-tech Industry Zone of Jiangsu, and Science and Technology Center of Changzhou separately.

ZIMMER SPINE

7375 Bush Lake
Minneapolis, MN 55439
Tel +1-800-655-2614
www.zimmerspine.com

Zimmer Spine develops, produces and markets high quality spine products and services that repair, replace and regenerate spine health. Zimmer constructs highly competitive fusion and non-fusion spine systems, instrumentation systems, cervical plates, allograft bone filler and Trabecular Metal™ Technologies. We value continuous surgeon education, building confidence and enhancing patient outcomes.

Hands-On Workshops

IMAST delegates are encouraged to attend the Hands-On Workshops (HOW) on Wednesday and Thursday afternoons, at lunch on Thursday and Friday and during breakfast on Thursday and Friday mornings. Each workshop is programmed by a single- supporting company and will feature presentations on topics and technologies selected by the company).

*Please note: CME credits are not available for Hands-On Workshops.

Wednesday	Thursday	Friday
	7:30-8:30	7:30-8:30
	Medtronic - 409	Alphatec - 406
	Biomet - 406	Medtronic - 409
	Misonix - 401	DePuy Synthes - 401
	12:30-13:30	12:05-13:05
	K2M - 404	K2M - 404
	NuVasive - 406	DePuy Synthes - 401
	Globus Medical - 401	Orthofix - 409
	Medtronic - 409	Biomet - 406
17:00-19:00	17:30-18:30	
NuVasive - 406	K2M - 404	
SpineCraft - 401	SpineCraft - 401	

Hands-On workshops are located on level 4 of the KLCC in rooms 401, 404, 406 and 409.

Hands-On Workshops

Wednesday, July 8, 2015 – 17:00-19:00

NuVasive

ROOM: 406

Global Spinal Alignment: It Matters

PRESENTERS: *Virginie LaFage, PhD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Juan Uribe, MD*

SpineCraft

Room: 401

Execution of Scoliosis Surgery: Implant Options, Rod Choices, Differential Rod Bending Techniques and Direct Vertebral Rotation

PRESENTER: *Kamal N. Ibrahim, MD, FRCS(C), MA*

Etiology and Surgical Management of Adjacent Segment Failure

PRESENTER: *Hani H. Mhaidli, MD, PhD*

Thursday, July 9, 2015 – 7:30-8:30

Medtronic

ROOM: 409

Treating Complex Posterior Cervical Pathologies with Fixation

PRESENTER: *Vincent Traynelis, MD*

Biomet Spine

ROOM: 406

Evaluation and Management of Cervical and Cervicothoracic Deformity

PRESENTERS: *K. Daniel Riew, MD; Christopher I. Shaffrey, MD*

Misonix

ROOM: 401

Ultrasonics in Spine Surgery: BoneScalpel Hands-On Workshop

PRESENTERS: *Peter O. Newton, MD; Juan Uribe, MD; Gregory M. Mundis, Jr., MD*

The Ultrasonics in Spine Surgery workshop showcases surgeon experiences using the BoneScalpel in deformity and minimally-invasive spine procedures. Surgeon presentations will feature the BoneScalpel techniques, case reviews and surgical benefits over traditional instruments and techniques. Attendees will have the opportunity for a hands-on demonstration and trial. There will also be an open discussion with the workshop faculty.

BoneScalpel Use in AIS Posterior Release Techniques

PRESENTER: *Peter O. Newton, MD*

BoneScalpel Applications in MIS Spine Surgery

PRESENTER: *Juan Uribe, MD*

Cervical Laminoplasty & Other Degenerative Surgeries with the BoneScalpel

PRESENTER: *Gregory M. Mundis, Jr., MD*

Hands-On Workshops

Thursday, July 9, 2015 – 12:30-13:30

K2M

ROOM: 404

Advanced Correction Techniques for Navigating the Curve in AIS

PRESENTERS: Laurel C. Blakemore, MD; John A. I. Ferguson, MD; Peter O. Newton, MD

NuVaisve

ROOM: 406

Anterior Column Realignment (ACR™): Techniques to Restore Global Alignment

PRESENTERS: Virginie LaFage, PhD; Frank J. Schwab, MD; Christopher I. Shaffrey, MD; Juan Uribe, MD

Globus Medical

ROOM: 401

Expandable Technology in Minimally Invasive TLIF: A MultiCenter Clinical and Radiographic Analysis of 202 Patients with Two-Year Follow Up

PRESENTER: Choll W. Kim, MD, PhD

Medtronic

ROOM: 409

Oblique Lateral Interbody Fusion: An Innovative Approach

PRESENTER: Hal Silcox, MD

Thursday, July 9, 2015 – 17:30-18:30

K2M

ROOM: 404

MIS Strategies for Treating Sagittal Alignment in Adult Degenerative Deformity

PRESENTERS: Robert Lee, MBBS, FRCS; Pierce Nunley, MD

SpineCraft

ROOM: 401

Techniques of Lumbopelvic and Sacral Fixation

PRESENTER: Hani H. Mhaidli, MD, PhD

Hands-On Workshops

Friday, July 10, 2015 – 7:30-8:30

Alphatec Spine

ROOM: 406

Effectiveness of the Direct Vertebral Rotation Technique in the Correction of Deformity in Adolescent Idiopathic Scoliosis

PRESENTER: Kevin B.I. Lim, MD, FRCS

Benefits of Minimally Invasive Lumbar Fusions

PRESENTER: Prof. Naresh Kumar

Percutaneous Treatment of Metastatic Spinal Diseases with Percutaneous Pedicle Stabilization

PRESENTER: Prof. Naresh Kumar

Medtronic

ROOM: 409

MAST Trauma: Minimally Invasive Reduction of Spinal Fracture with Sagittal Adjusting Screws (SAS™)

PRESENTER: Neel Anand, MD

DePuy Synthes

ROOM: 401

Advanced Techniques in Treating AIS

PRESENTERS: Peter O. Newton, MD; Amer F. Samdani, MD

AIS from an expert panel. This case based session will include an overview of the latest available technology and techniques for treating complex deformity in the adolescent population.

K2M

ROOM: 404

Advances in the Treatment of Adult Degenerative Deformity

PRESENTERS: Han Jo Kim, MD; John P. Kostuik, MD; Greg M. Mundis, Jr., MD

Hands-On Workshops

Friday, July 10, 2015 – 12:05-13:05

K2M

ROOM: 404

Spinal Tumor Care: Past, Present, & Future

PRESENTER: Stefano Boriani, MD; John P. Kostuik, MD

DePuy Synthes

ROOM: 401

Correction Techniques in Adult Deformity

PRESENTERS: Munish C. Gupta, MD; Baron S. Lonner, MD

This workshop is designed for surgeons experienced with open deformity procedures who want to learn new techniques for instrumented deformity correction utilizing the Favored Angle Screw. The session will include a technique discussion with case examples as well as hands-on demonstration.

Orthofix

ROOM: 409

Complex Deformity Correction and Complication Management: A Case-Based Discussion

PRESENTER: Munish C. Gupta, MD

This didactic session will feature a case base discussion on surgical planning and complication management for complex adult deformity. Our hands-on workshop will highlight the clinical advantages of utilizing the Firebird™ modular pedicle screw system and how that can provide greater intraoperative options for posterior approaches to spinal deformity correction.

Biomet Spine

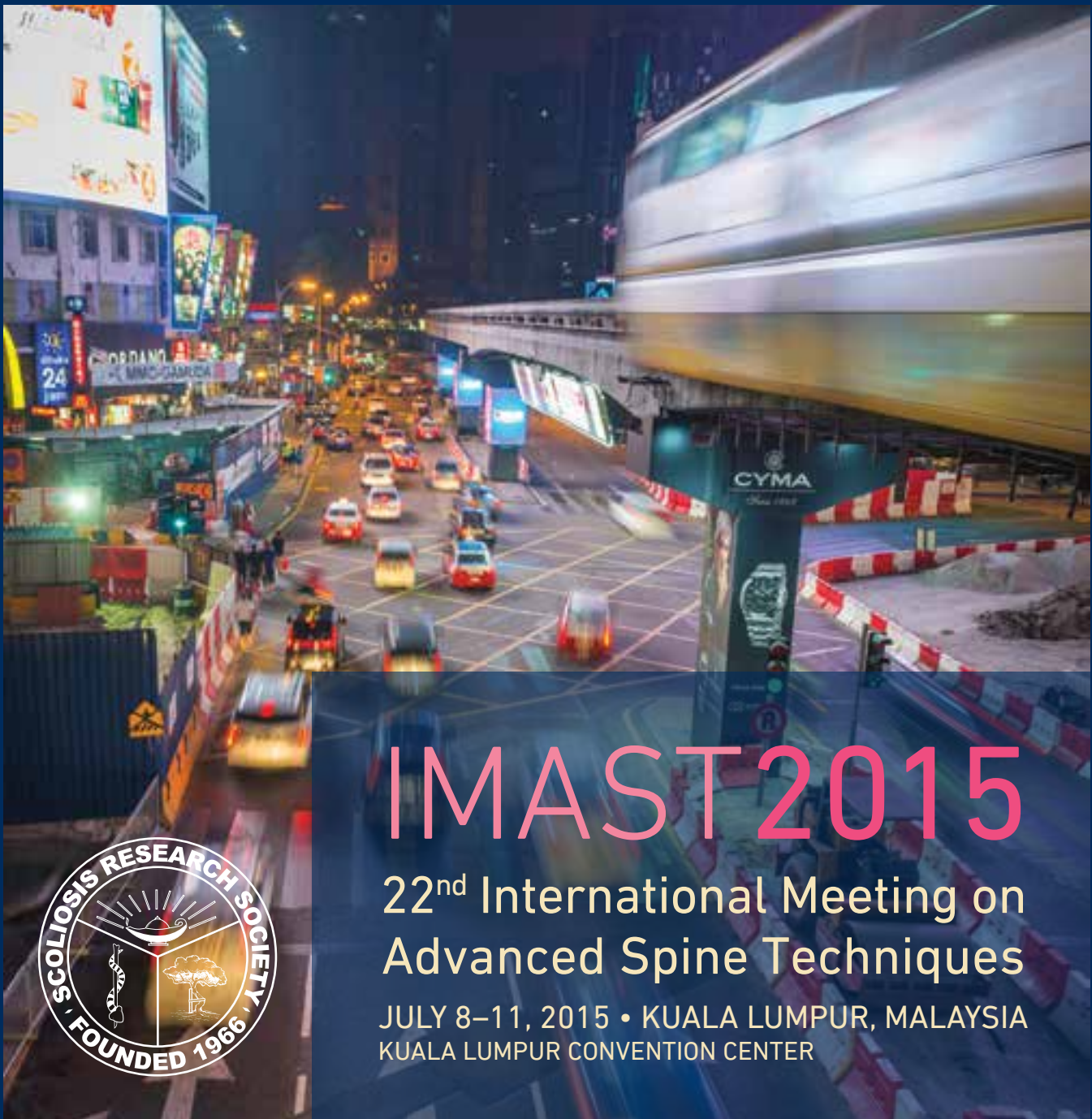
ROOM: 406

Successful Strategies for Revision Adult Deformity an Interactive Case Discussion

PRESENTERS: Han Jo Kim, MD; Frank J. Schwab, MD; Justin S. Smith, MD, PhD



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IMAST 2015

22nd International Meeting on
Advanced Spine Techniques

JULY 8–11, 2015 • KUALA LUMPUR, MALAYSIA
KUALA LUMPUR CONVENTION CENTER





The Scoliosis Research Society
gratefully acknowledges
SpineCraft for support of the
IMAST Welcome Reception

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Key:

RT= Roundtable Session
ICL= Instructional Course Lecture
DB= Debate Series
CP= Case Presentation
CS= Complication Series
LE= Lunch with Experts
S= Special Symposium (A or B)
VS= Video-Based Session

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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 35 orthopaedic surgeons to an international organization of more than 1,200 health care professionals.

Mission Statement

The purpose of Scoliosis Research Society is to foster the optimal care of all patients with spinal deformities.

Membership

SRS is open to orthopaedic surgeons, neurosurgeons, researchers and allied health professionals who have a practice that focuses on spinal deformity.

Active Fellowship (membership) requires the applicant to have fulfilled a five-year Candidate Fellowship and have a practice that is 20% or more in spinal deformity. Only Active Fellows may vote and hold elected offices within the Society.

Candidate Fellowship (membership) is open to all orthopaedic surgeons, neurosurgeons and to researchers in all geographic locations who are willing to commit to a clinical practice which includes at least 20% spinal deformity. Candidate Fellows stay in that category for five years, during which time they must meet all of the requirements and demonstrate their interest in spinal deformity and in the goals of the Society. After five years, those who complete all requirements are eligible to apply for Active Fellowship in the Society. Candidate Fellowship does not include the right to vote or hold office. Candidate Fellows may serve on SRS committees.

Associate Fellowship (membership) is for distinguished members of the medical profession including nurses, physician assistants, as well as orthopaedic surgeons, neurosurgeons, scientists, engineers and specialists who have made a significant contribution to scoliosis or related spinal deformities who do not wish to assume the full responsibilities of Active Fellowship. Associate Fellows may not vote or hold office, but may serve on committees.

See website for membership requirement details:
www.srs.org/professional/membership

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Friday, July 10, 16:45 - 17:00 at the Exhibit Hall

- How to Apply
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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.

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Meeting Overview

Wednesday, July 8, 2015

8:00 - 14:00	Board of Directors Meeting; Exhibit Set-Up
14:00 - 21:00	Registration Open
15:00 - 16:45	Special Symposia 1A-B
17:00 - 19:00	*Hands-On Workshops
19:00 - 21:00	Welcome Reception

Thursday, July 9, 2015

7:30 - 18:30	Registration Open
7:30 - 8:30	*Hands-On Workshops with Breakfast
8:15 - 8:45	Breakfast & Exhibit Viewing
8:45 - 10:15	General Session
10:15 - 11:00	Refreshment Break & Exhibit Viewing
10:20 - 10:50	*Exhibit Hall Case Presentation #1
11:00 - 12:15	Concurrent Sessions 2A-C: Abstract Session & Debate Series
12:30 - 13:30	Lunch & Exhibit Viewing / *Hands-On Workshops
13:45 - 14:45	Concurrent Session 3A-D: ICLs & Two-Minute Point Presentations
14:45 - 15:00	Walking Break & Exhibit Viewing
15:00 - 15:55	Concurrent Sessions 4A-D: Abstract Sessions, Complication Series & Two-Minute Point-Presentations
15:55 - 16:10	Refreshment Break & Exhibit Viewing
16:10 - 17:10	Concurrent Sessions 5A-D: Abstract & Roundtable Sessions
17:10 - 17:30	Walking Break
17:30 - 18:30	*Hands-On Workshops with Beverages & Snacks

Friday, July 10, 2015

7:30 - 16:45	Registration Open
7:30 - 8:30	*Hands-On Workshops with Breakfast
8:15 - 8:40	Breakfast & Exhibit Viewing
8:40 - 9:40	Concurrent Sessions 6A-D: Abstract Sessions, Debate Series & ICL
9:40 - 10:30	Refreshment Break & Exhibit Viewing
9:50 - 10:20	*Exhibit Hall Case Presentation #2
10:35 - 12:00	Concurrent Sessions 7A-C: Abstract Sessions & Video-Based Session
12:05 - 13:05	Lunch & Exhibit Viewing / *Hands-On Workshops
13:15 - 14:15	Concurrent Sessions 8A-E: Roundtable Sessions & Two-Minute Point Presentations
14:15 - 14:30	Walking Break & Exhibit Viewing
14:30 - 15:30	Concurrent Sessions 9A-D: Abstract Sessions, Debate Series & ICLs
15:30 - 15:45	Walking Break
15:45 - 16:45	Concurrent Sessions 10A-E: ICLs & Two-Minute Point Presentations
16:45 - 17:00	Membership Information Session
19:00 - 22:00	Course Reception

Saturday, July 11, 2015

7:45 - 12:30	Registration Open
7:45 - 8:15	Breakfast / Exhibits Closed
8:15 - 9:15	Concurrent Sessions 11A-C: ICLs
9:15 - 9:30	Walking Break
9:30 - 10:30	Concurrent Sessions 12A-C: Abstract Session, Debate Series & ICL
10:30 - 11:00	Walking Break & Lunch Buffet
11:30 - 12:30	Session 13: Lunch with the Experts
12:30	Adjourn

*Denotes Non-CME Session