WELCOME TO THE 2017 SUMMER SPINE MEETING IN SAN DIEGO

We are very excited to present research and discuss topics that will ultimately enhance the care of our patients.

Throughout this meeting, abstract presentations will address the current science on the cervical spine, thoracolumbar surgery and basic science. Faculty will cover topics such as Cervical Myelopathy, Workup of Mimicking Pathology, Spine Deformity and Lumbar Stenosis/Spondylolisthesis during symposia.

There also is a technical exhibition and ePoster viewing to round out the meeting.

And, you have the afternoons free to get outside and enjoy the San Diego attractions.

Thank you for attending. We look forward to your participation and interaction during this meeting.

Clinton J. Devin, MD, Chair
Jason W. Savage, MD, Co-chair
2017 SUMMER SPINE MEETING REVIEWERS
NASS thanks the following volunteers who spent numerous hours reviewing abstracts:

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LEARNING OBJECTIVES

Upon completion of this meeting, participants should gain strategies to:
• Promote discussion of new scientific developments and best practices within spine care organizations;
• Demonstrate the application of current techniques, procedures and research;
• Practice evidence- and value-based medicine relative to spine care;
• Provide an environment for the exchange of ideas in spine care with experts and peers from around the globe;
• Provide opportunities to strengthen professional relationships worldwide.

CONTINUING MEDICAL EDUCATION (CME) CREDIT

This activity has been planned and implemented in accordance with the Essentials and Standards of the Accreditation Council for Continuing Medical Education (ACCME). The North American Spine Society is accredited by the ACCME to provide continuing medical education for physicians and takes responsibility for the content, quality and scientific integrity of this CME activity.

The North American Spine Society designates this live activity for a maximum of 14.25 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The American Medical Association has determined that physicians not licensed in the U.S. who participate in this CME activity are eligible for AMA PRA Category 1 Credits™.

Physician Assistants: The American Academy of Physician Assistants (AAPA) accepts Category 1 credit from AOACCME, prescribed credit from the American Academy of Family Physicians (AAFP) and AMA PRA Category 1 CME Credit™ for the Physician’s Recognition Award from organizations, such as NASS, accredited by the ACCME.

Nurses: For the purpose of recertification, American Nurses Credentialing Center (ANCC) accepts AMA PRA Category 1 Credit™ from organizations accredited by the ACCME.

Nurse Practitioners: The American Association of Nurse Practitioners (AANP) accepts AMA PRA Category 1 Credit™ from organizations accredited by the ACCME.

Requirements vary for other allied health and advanced practice providers; please contact your licensing organization for their requirements.

CME CERTIFICATES

After the meeting, attendees can submit evaluations electronically and print CME certificates directly from the NASS website. Visit www.spine.org/CME to claim education credit and to print CME certificates. Contact the NASS education department at education@spine.org with questions.

ABOUT NASS

The North American Spine Society (NASS) is a multidisciplinary organization with 8,000 members in North America and abroad. The membership consists of orthopedic surgeons, neurosurgeons, physiatrists, other medical/interventional physicians and affiliated healthcare professionals involved in spine care.

The leading multidisciplinary organization in the field of spinal disorders, NASS’ mission is to foster the highest quality, ethical, value- and evidence-based spine care for patients.

STOP BY REGISTRATION TO LEARN ABOUT FREE NASS MEMBERSHIP!

Not already a member of NASS? Visit the registration area to complete an application for a complimentary membership for the remainder of 2017!

This exclusive offer for nonmember attendees of the meeting includes access to many essential benefits for spine care providers including subscriptions to the #1 spine journal, The Spine Journal (TSJ), and SpineLine, access to SpineConnect online, pricing discounts on education and products and much more!
SESSION RECORDINGS ON DEMAND
Order the Summer Spine Meeting 2017 session recordings and receive 24/7 access to all conference content. These web-based, fully synchronized audio, video and slide presentations are available anywhere with internet access. Purchase at the registration desk or online at www.spine.org.

After purchasing, visit www.spine.org/presentations to view audio, video and PowerPoint® slides for podium and symposia presentations. PowerPoint® slides for ePosters also will be available on this webpage. Meeting content will be posted as it becomes available. All content will be posted no later than two weeks after the conference adjourns and will be available indefinitely. NASS members will receive the conference recordings free of charge.

SPEAKER INFORMATION CENTER
Bel Aire Foyer
Presenters can upload or amend their presentations by visiting the Speaker Information Center located in the Bel Aire Foyer at Registration. Speakers are not permitted to use their own laptops for their presentations. Mac users must convert their presentations to PowerPoint®. No exceptions will be made.

ePoster authors are not permitted to upload or amend their presentations on-site once the content review process has concluded.

Hours:
- Wednesday, July 26: 7:00 a.m.–6:00 p.m.
- Thursday, July 27: 6:30 a.m.–12:30 p.m.
- Friday, July 28: 6:30 a.m.–2:30 p.m.
- Saturday, July 29: 6:30 a.m.–12:00 p.m.

TECHNICAL EXHIBITION
Fairbanks A-C
Experience first-hand technology, products and services from vendors who can help you manage your professional goals and strategic objectives. Breakfast and breaks will be offered in the exhibit hall.

- Wednesday, July 26: Setup
- Thursday, July 27: 6:30 a.m.–12:00 p.m.
- Friday, July 28: 6:30–11:00 a.m.

OPENING RECEPTION
Join your colleagues at the Opening Reception on Thursday, July 27, from 5:00–6:00 p.m. in the Garden Terrace at the Sheraton San Diego Hotel & Marina. This is an opportunity to relax and discuss the day’s events.

SPINEPAC EVENT: PRESIDENT’S BASEBALL & BREWERY TOUR OUTING
Join your colleagues for an exclusive outing in San Diego. Attendees will visit a local favorite ‘Ballast Point Brewery’ before heading to Petco Park to see the San Diego Padres take on the New York Mets. Enjoy the game in a private box suite complete with food, drinks, and fun! This experience will be a carefree and luxurious event you will not want to miss. Spouses and guests of Summer Spine attendees are encouraged to attend.

Date: Thursday, July 27
Location: Ballast Point Brewery and Petco Park Western Metal Suite 3A
Departure: 2:30 p.m. (meet in front lobby of Sheraton San Diego Hotel & Marina)
Duration: Approx. 6 hours

Suggested SpinePAC contribution per attendee: $250
Transportation to and from the Sheraton will be provided.

DISCLAIMER
The material presented at the Summer Spine Meeting is made available by the North American Spine Society for educational purposes only. The material is not intended to represent the only, nor necessarily the best, method or procedure appropriate for the medical situations discussed; rather, it is intended to present an approach, view, statement or opinion of the faculty which may be helpful to others who face similar situations.

NASS disclaims any and all liability for injury or other damages to any individual attending the meeting and for all claims which may arise out of the use of the techniques demonstrated therein by such individuals, whether these claims shall be asserted by physicians or any other person.

This Final Program contains confirmed program content, faculty and presenters as of July 7, 2017. Any further changes from the published Final Program will be announced at the beginning of each session.
EMBARCADERO
Located adjacent to Downtown San Diego along the Big Bay, San Diego’s Embarcadero is a testament to the region’s colorful maritime history complete with historic ships, museums and harbor tours, as well as restaurants and shops.

Seaport Village/District has more than 50 shops featuring art, toys and souvenirs plus casual eateries and fine dining restaurants, many with views of the beautiful bay and harbor.

Museum of Contemporary Art provides an unprecedented variety of experiences, featuring an internationally recognized collection and a dynamic schedule of exhibitions including installations by artists Jenny Holzer and Richard Serra.

USS Midway Museum is one of America’s longest serving aircraft carriers. 60 exhibits with audio tours are narrated by the USS Midway sailors giving historic information and facts about the various exhibits. The USS Midway sailors also tell personal stories of their lives as bomber pilots aboard the USS Midway. Guests at the USS Midway Aircraft Carrier Museum are also welcome to climb aboard the aircrafts on deck.

Maritime Museum features historic ships that display exhibits onboard. See what it was like to live and work on these vessels. Look into the cabins where the ship’s crew slept, walk by the kitchen and dining areas to see where they had meals and satisfy your curiosity by seeing the very small bathrooms and showers.

GASLAMP QUARTER
In this historic heart of San Diego is the premier entertainment district with rich Victorian architecture and history, world-renowned chefs, and nationally-recognized nightlife venues. Tucked tightly into 16 ½ blocks, the Gaslamp Quarter is a walkable urban playground located in Downtown San Diego adjacent to the Convention Center, Petco Park, and Horton Plaza. The Gaslamp area is accessible via several trolley and bus lines.

BELMONT PARK
Located in Mission Bay, this historic oceanfront amusement park opened on July 4, 1925. The Giant Dipper and The Plunge pool remain as not only pieces of history, but the two main attractions to experience at Belmont Park. In addition to several restaurants, there is an athletic club.

THINGS TO DO
THINGS TO DO

BALBOA PARK

If you are interested in science, art and history, you can check out the museums at Balboa Park. The various gardens at Balboa Park are beautiful and there are cool rides for the kids, so everyone in the family can stay entertained.

See folk art at Mingei International Museum, images captured on camera at the Museum of Photographic Arts and mummies at the Museum of Man. Visit Centro Cultural de la Raza to immerse yourself in Chicano, Mexican, Indigenous and Latino art and culture. Marston House, originally the home of civic leader and merchant George W. Marston, welcomes visitors to explore it.

San Diego Automotive Museum celebrates the importance of automotive engineering in our culture and its transformation through history featuring vehicles ranging from 1909 to 1990, and Indian and Harley Davidson motorcycles.

The Air & Space Museum showcases the 1783 model of the Montgolfier brothers’ hot air balloon, which was the first manned aircraft to defy gravity, as well as the actual Apollo 9 Command Module. The 3D/4D theater invites guests to experience the multi-sensory and special effects during a showing of Fly Me to the Moon, Jetpack Adventure or Virtual Time Machine, while the three flight simulators include the F-35, Doron Transport 6 and the FS2000 two-seat flight. Galleries focus on the modern jet and space age, World War I, World War II and the golden age of flight.

San Diego Hall of Champions is the largest multi-sport museum in the United States. The museum acknowledges 133 San Diego outstanding athletes in 20 various sports categories including the well-known football, baseball and basketball players, but also the perhaps lesser-known competitors in horse racing, sailing and pole vaulting.

The San Diego Zoo makes an effort to entertain the youngest of kids and adults alike. One of the coolest animal exhibits at the Zoo is the giant panda exhibit. The San Diego Zoo is one of only four facilities in the United States to carry the giant pandas, which are a critically endangered species.

The Balboa Park Carousel is adjacent to the San Diego Zoo. The carousel features plenty of hand-carved animals. All but two of the hand-carved animals are original from 1910.

The Balboa Park Miniature Railroad is a family fun journey across four acres. The whole trip is quite enjoyable and only takes three minutes.
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<td>WEDNESDAY, JULY 26</td>
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<td><strong>Registration</strong></td>
<td><strong>Speaker Information Center</strong>&lt;br&gt;Bel Aire Foyer</td>
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<tr>
<td></td>
<td>7:00 a.m.—6:00 p.m.</td>
<td><strong>Spine Foundation Course:</strong> Biologic Interventions for Spinal Pathologies: Stem Cells, Growth Factors, and Novel Therapeutics</td>
<td><strong>Bel Aire Ballroom</strong>&lt;br&gt;<strong>Non-CME; additional fee</strong></td>
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<td>7:30 a.m.—3:45 p.m.</td>
<td><strong>Biologic Interventions for Spinal Pathologies:</strong> Stem Cells, Growth Factors, and Novel Therapeutics</td>
<td><strong>Bel Aire Ballroom</strong>&lt;br&gt;<strong>Non-CME; additional fee</strong></td>
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<tr>
<td>THURSDAY, JULY 27</td>
<td>6:30—8:00 a.m.</td>
<td><strong>Breakfast</strong></td>
<td><strong>Fairbanks A-C</strong></td>
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<td>6:30 a.m.—12:00 p.m.</td>
<td><strong>Technical Exhibition</strong></td>
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<td>7:10—7:15 a.m.</td>
<td><strong>Opening Remarks</strong></td>
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<td><strong>Advocacy Presentation</strong></td>
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<td>7:30—9:00 a.m.</td>
<td><strong>Symposium:</strong> Workup of Mimicking Pathology</td>
<td><strong>Bel Aire Ballroom</strong></td>
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<td>9:30—10:30 a.m.</td>
<td><strong>Abstract Presentations:</strong> Cervical Spine</td>
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<td>11:00 a.m.—12:30 p.m.</td>
<td><strong>Symposium:</strong> Cervical Myelopathy**</td>
<td><strong>Bel Aire Ballroom</strong></td>
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<td>12:30 p.m.</td>
<td><strong>General Meeting Adjourns</strong></td>
<td><strong>Bel Aire Ballroom</strong></td>
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<td>2:30-8:30 p.m.</td>
<td><strong>SpinePAC President’s Baseball and Brewery Event</strong></td>
<td><strong>Meet in Front Lobby</strong></td>
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<td>5:00—6:00 p.m.</td>
<td><strong>Opening Reception</strong></td>
<td><strong>Garden Terrace</strong></td>
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<td>FRIDAY, JULY 28</td>
<td>6:30—8:00 a.m.</td>
<td><strong>Breakfast</strong></td>
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<td>6:30 a.m.—2:30 p.m.</td>
<td><strong>Registration</strong></td>
<td><strong>Speaker Information Center</strong>&lt;br&gt;<strong>Bel Aire Foyer</strong></td>
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<td><strong>Opening Remarks</strong></td>
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<td>7:30—9:00 a.m.</td>
<td><strong>Symposium:</strong> Spine Deformity</td>
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<td><strong>Break/Technical Exhibition</strong></td>
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<td>9:30—10:30 a.m.</td>
<td><strong>Abstract Presentations:</strong> Thoracolumbar Surgery</td>
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<td>11:00 a.m.—12:30 p.m.</td>
<td><strong>Symposium:</strong> Cervical Radiculopathy**</td>
<td><strong>Bel Aire Ballroom</strong></td>
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<td>12:30—2:30 p.m.</td>
<td><strong>Lunch Symposium:</strong> Korean Spinal Neurosurgery Society MISS Suggestion for Pure Lumbar Foraminal Stenosis Management</td>
<td><strong>Bel Aire Ballroom</strong></td>
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<td>2:30 p.m.</td>
<td><strong>General Meeting Adjourns</strong></td>
<td><strong>Bel Aire Ballroom</strong></td>
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MEETING-AT-A-GLANCE

SATURDAY, JULY 29

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<td>Opening Remarks</td>
<td>Bel Aire Ballroom</td>
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<td>7:30–9:00 a.m.</td>
<td>Symposium: Lumbar Stenosis/Spondylolisthesis</td>
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<td>9:00–9:30 a.m.</td>
<td>Break</td>
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<td>9:30–10:30 a.m.</td>
<td>Abstract Presentations: Basic Science</td>
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<td>10:30 a.m.–12:00 p.m.</td>
<td>Symposium: Oncology</td>
<td>Bel Aire Ballroom</td>
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<tr>
<td>12:00 p.m.</td>
<td>General Meeting Adjourns</td>
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THANK YOU FOR YOUR SUPPORT

The North American Spine Society would like to express its sincere appreciation to the following companies for their support of the Biologics Interventions for Spinal Pathologies: Stem Cells, Growth Factors and Novel Therapies course preceding the Summer Spine Meeting.

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**WEDNESDAY, JULY 26**

7:00 a.m.–6:00 p.m.  
Registration  
Speaker Information Center  
Bel Aire Foyer

7:30 a.m.–3:45 p.m.  
Biologic Interventions for Spinal Pathologies: Stem Cells, Growth Factors and Novel Therapeutics  
Bel Aire Ballroom  
Chair: Wellington K. Hsu, MD

Spine Foundation Course (Non-CME; additional fee)

**THURSDAY, JULY 27**

6:30–8:00 a.m.  
Breakfast  
Fairbanks A-C

7:10–7:15 a.m.  
Welcome/Opening Remarks  
Bel Aire Ballroom  
Clinton J. Devin, MD, Chair, Summer Spine Meeting  
Yong Eun Cho, MD, PhD, President, Korean Spinal Neurosurgery Society

7:15–7:30 a.m.  
Advocacy Presentation  
Bel Aire Ballroom  
Chair: John G. Finkenberg, MD

7:30–9:00 a.m.  
Symposium: Workup of Mimicking Pathology  
Bel Aire Ballroom  
Chairs: David J. Kennedy, MD; Byron J. Schneider, MD

Successful management of spine versus large joint (hip or shoulder) pathology is underpinned by accurate diagnosis. There is overlay in the presentation and pain referral patterns of the cervical spine and shoulder and similarly of the lumbar spine and hip. Physical exam in conjunction with diagnostic tests can help differentiate. Diagnostic injections can further clarify the diagnosis. At times, concomitant pathology exists necessitating both issues be addressed. This session will provide an evidence-based approach using history, exam, imaging, and diagnostic injections to determine accurate diagnosis.

Upon completion of this session, participants should gain strategies to:
- Discuss what similarities exist in the presentations of cervical spine and shoulder pathology and then how to differentiate between the two;
- Clinically apply these concepts in the setting of a multidisciplinary practice that utilizes collaboration between surgical and non-surgical providers.

**Agenda**

- **Introduction: Prevalence and Diagnostic Confidence**  
  Byron J. Schneider MD
- **Neck and Shoulder Pain: Presentation, Diagnosis, and Conservative Treatment**  
  David J. Kennedy, MD
- **Surgical Perspective to Neck and Shoulder Pain with Case Presentation**  
  Clinton J. Devin, MD
- **Hip Spine Syndrome: Presentation, Diagnosis, and Conservative Treatment**  
  Byron J. Schneider, MD
- **Surgical Perspective to Hip Spine Syndrome with Case Presentation**  
  Clinton J. Devin, MD
- **Questions and Answers**

9:30–9:30 a.m.  
Break/Technical Exhibition  
Fairbanks A-C
9:30–10:30 a.m.
Abstract Presentations: Cervical Spine
Bel Aire Ballroom
Moderator: Clinton J. Devin, MD

9:30–9:36 a.m.
1. Demographic and Surgical Risk Factors for Dysphagia Associated with ACDF Surgery: A 7-Year Study of 732 Consecutive Surgeries
Dennis E. Bullard, MD; Sarah A. Evans, BS; Andrew Seaman, BS, Triangle Neurosurgery, Raleigh, NC, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:36–9:42 a.m.
2. Comparative-Efficacy of Single-Level Anterior Cervical Discectomy and Fusion versus Posterior Cervical Foraminotomy for Patients with Cervical Radiculopathy: Analysis from Quality Outcome Database
Silky Chotai, MD1; Anthony L. Asher, MD2; Clinton J. Devin, MD3; Ahilan Sivaganesan, MD4; Mohamad Bydon, MD1; Matthew J. McGirt, MD1; Kristin Archer, PhD, DPT1; Steven D. Glassman, MD4; Christopher I. Shaffrey, MD3
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:42–9:48 a.m.
3. The Outcomes of Posterior Arthrodesis for Atlantoaxial Subluxation in Down Syndrome Patients: A Meta-Analysis
Joseph Scollan, BS1; Abduljabbar Alhammoud, MD2; Douglas Hollern, MD2; Qais Naziri, MD, MBA3; Carl Paulino, MD4; Bassel G. Diebo, MD4
1SUNY Downstate, Brooklyn, NY, US; 2Hospital Universitario, Valladolid, Valladolid, Spain; 3Thessaloniki, Greece; 4Centre Hospitalier Universitaire Pellegrin, Bordeaux Cedex, France
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:48–9:54 a.m.
4. One- or Two-Level Treatment by Arthroplasty of Cervical Degenerative Disease: Preliminary Results after Five Years Postoperative Controls
Patrick Fransen, MD1; David C. Noriega, PhD3; Athanasios Chatzizotiriou, MD, PhD1; Vincent Pointhillart, MD, PhD4
1IM2S, Monaco, Monaco; 2Hospital Universitario, Valladolid, Valladolid, Spain; 3Thessaloniki, Greece; 4Centre Hospitalier Universitaire Pellegrin, Bordeaux Cedex, France
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:54–10:00 a.m.
5. Prospective Clinical and Radiographic Assessment of the Cervical Spine in Professional Rodeo Riders after Exposure to Greater than 10G Linear Acceleration
Alexander A. Theologis, MD1; Jeremy D. Shaw, MD2; Jeffrey Mulvihill, MD3; Jeremie Larouche, MD, FRSC2
1University of California San Francisco, Department of Orthopaedic Surgery, San Francisco, CA, US; 2University of California San Francisco, San Francisco, CA, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:00–10:06 a.m.
6. Effect of Neck-Related Disability Scores on Satisfaction with Outcomes 12-Months after Elective Surgery for Cervical Spine Degenerative Disease
Silky Chotai, MD1; Ahilan Sivaganesan, MD1; Anthony L. Asher, MD2; Mohamad Bydon, MD1; Clinton J. Devin, MD1
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:06–10:12 a.m.
Korean Spinal Neurosurgery Society
The Radiologic and Clinical Results of Multilevel Anterior Cervical Discectomy and Fusion (ACDF) with Stand-Alone Cages
Jung-Kil Lee, MD, PhD, Sang-Deok Kim, MD, Department of Neurosurgery, Chonnam National University Hospital

10:12–10:30 a.m.
Discussion

10:30–11:00 a.m.
Break/Technical Exhibition
Fairbanks A-C
Friday, July 28

6:30–8:00 a.m.
Breakfast
Fairbanks A-C

6:30–11:00 a.m.
Technical Exhibition
ePoster Kiosks
Fairbanks A-C

6:30 a.m.–2:30 p.m.
Registration
Speaker Information Center
Bel Aire Foyer

7:25–7:30 a.m.
Opening Remarks
Bel Aire Ballroom
Jason W. Savage, MD

7:30–9:00 a.m.
Symposium: Spine Deformity
Bel Aire Ballroom
Chair: Jason W. Savage, MD

The goal of this session is to discuss the general principles of evaluating and treating patients with adult spinal deformity. Faculty will review the important radiographic parameters and alignment objectives in adult spinal deformity (ASD), with a focus on preoperative planning, and discuss when and why to use different types of osteotomies to achieve adequate correction. Faculty also will review the minimally invasive options to treat ASD, and discuss the management and mitigation of potential complications that often occur in these complex surgical procedures.

Upon completion of this session, participants should gain strategies to:
• Determine the important radiographic parameters and alignment objectives in ASD;
• Highlight the importance of preoperative planning and review the types of osteotomies used to correct ASD;
• Review the indications and limitations of minimally invasive options to treat ASD;
• Discuss the potential complications involved in deformity correction surgery and how to minimize the risk.

11:00 a.m.–12:30 p.m.
Symposium: Cervical Myelopathy
Bel Aire Ballroom
Chair: Wellington K. Hsu, MD

Cervical myelopathy is a common condition that can be debilitating if unrecognized and untreated. Advances in surgical technique have evolved the way spine specialists approach this problem. Keeping up to date with the most recent literature regarding neurological and patient reported outcomes after surgical intervention is important in offering an individualized treatment plan for each patient with myelopathy.

Upon completion of this session, participants should gain strategies to:
• Evaluate the risks and benefits of the surgical approach to decompress the cervical spinal cord;
• Assess the indications of surgical treatment for cervical myelopathy;
• Apply outcomes from evidence-based literature in the surgical decision making for case studies of cervical myelopathy.

Agenda
• Posterior Approaches
  Clinton J. Devin, MD

• Tricks and Pearls: Indications for Laminoplasty
  Yong Eun Cho, MD, PhD, Korean Spinal Neurosurgery Society

• Anterior Approaches
  Wellington K. Hsu, MD

• Complications
  Thomas E. Mroz, MD

• Discussion
  Panel

12:30 p.m.
General Meeting Adjourns

2:30–8:30 p.m.
SpinePAC President’s Baseball and Brewery Event
Meet in Front Lobby of Sheraton San Diego Hotel & Marina

5:00–6:00 p.m.
Opening Reception
Garden Terrace
9:00–9:30 a.m.
Break/Technical Exhibition
Fairbanks A-C

9:30–10:30 a.m.
Abstract Presentations: Thoracolumbar Surgery
Bel Aire Ballroom
Moderator: Jason W. Savage, MD

9:30–9:36 a.m.
7. Key Drivers of Patient Satisfaction in Lumbar Spine Surgery Setting
Jay M. Levin, BA1; Thomas E. Mroz, MD2; Michael P. Steinmetz, MD3
1University Hospital Case Medical Center, Department of Orthopaedic Surgery, Cleveland, OH, US; 2Cleveland Clinic Foundation Departments of Orthopaedic and Neurological Surgery, Cleveland, OH, US; 3Cleveland Clinic, Cleveland, OH, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:36–9:42 a.m.
8. 3D Printed Pedicle Targeting Guide Provide a Safe, Reliable and Accurate Method for Placement of Pedicle Screws
Asif Maknojia, MD
UT Health at San Antonio, San Antonio, TX, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:42–9:48 a.m.
9. Multilevel Posterior Column Osteotomies for Sagittal Plane Correction in the Management of Adult Degenerative Scoliosis
George M. Ghobrial, MD1; Joseph P. Gjolaj, MD2
1University of Miami, Miami, FL, US; 2Jackson Memorial Hospital, Department of Orthopaedic Surgery, Miami, FL, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:48–9:54 a.m.
10. Is there a Preoperative Morphine Equianalgesic Dose that Predicts Ability to Achieve a Clinically Meaningful Improvement Following Spine Surgery?
Joseph B. Wick1; Ahilan Sivaganesan, MD2; Silky Chotai, MD3; Kristin Archer, PhD, DPT3; Samuel Posey, BS3; Parker Evans, BS3; Clinton J. Devin, MD2
1Vanderbilt University, Nashville, TN, US; 2Vanderbilt University Medical Center, Nashville, TN, US; 3Nashville, TN, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:54–10:00 a.m.
Hamid R. Abbasi, MD
Tristate Brain and Spine Institute, Alexandria, MN, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:00–10:06 a.m.
12. Assessment of Damage to the Iliopsoas Muscle from the Oblique Lateral Interbody Fusion Approach
Masahiro Inoue, MD; Sumihisa Orita, MD, PhD; Kazuhide Inage, MD, PhD; Yasuhiro Shiga, MD, PhD; Hirohito Kanamoto, MD; Koki Abe, MD; Hideyuki Kinoshita, MD; Masaki Norimoto, MD; Tomotaka Ukimura, MD; Seiji Ohtori, MD, PhD
Department of Orthopedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
10:06–10:12 a.m.
13. Comparative Effectiveness Between Primary and Revision Foraminotomy for the Treatment of Lumbar Foraminal Stenosis

Emily Hu, BA1; Jianning Shao, BA2; Heath Gould, BS3; Roy Xiao3; Colin M. Haines, MD4; Don K. Moore, MD5; Thomas E. Mroz, MD6; Michael P. Steinmetz, MD7

1Cleveland, OH, US; 2Cleveland Clinic, Cleveland, OH, US; 3Cleveland Clinic Foundation, Cleveland, OH, US; 4Virginia Spine Institute, Reston, VA, US; 5Norwalk, OH, US; 6Cleveland Clinic Foundation, Departments of Orthopaedic and Neurological Surgery, Cleveland, OH, US

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:12–10:18 a.m.
Korean Spinal Neurosurgery Society

Long-Term (Minimum 10 Years) Clinical and Radiologic Results in Single-Level Degenerative Lumbar Stenosis with Posterior Dynamic Stabilization

Sang-Gu Lee, MD, PhD, Tae-Kyoo Lim, MD, PhD
Gacheon University Hospital, Department of Neurosurgery

10:18–10:30 a.m.
Discussion

10:30–11:00 a.m.
Break/Technical Exhibition
Fairbanks A-C

11:00 a.m.–12:30 p.m.
Symposium: Cervical Radiculopathy
Bel Aire Ballroom
Chair: Scott L. Parker, MD

Cervical radiculopathy is the clinical description of dysfunction or damage to a nerve root of the cervical spine. Evolution of surgical technique and advances in technology have provided several options for the surgical treatment of cervical radiculopathy. Understanding the pros and cons of each surgical option is important so that optimal patient-specific treatment strategies for cervical radiculopathy may be developed.

Upon completion of this session, participants should gain strategies to:
• Determine the indications and common complications of cervical arthroplasty;
• Evaluate the indications and limitations of anterior vs. posterior approaches;
• Assess the reported outcomes in the literature for each surgical approach to facilitate treatment decision making.

Agenda
• Disc Replacement: Indications, Complications, and Future
• Foraminotomy and Minimally Invasive Approach
• ACDF/Hybrid
  Alan S. Hilibrand, MD
• Case Debate
  Panel

12:30–2:30 p.m.
Lunch Symposium: Korean Spinal Neurosurgery Society

MISS Suggestion for Pure Lumbar Foraminal Stenosis Management
Bel Aire Ballroom
Chair: Yong Eun Cho, MD, PhD

Agenda
• Minimized Solution by Percutaneous Endoscopic Lumbar Foraminotomy
  Hyeun Sung Kim, MD, PhD
• New Trial of MISS: Percutaneous Biportal Endoscopic Approach For Lumbar Foraminal Stenosis
  Dong Hwa Heo, MD, PhD
• Break for lunch 1:00-1:30 p.m.
• Not Enough: A More Thorough Decompression Only by MED Paraspinal Approach
  Jin-Sung Kim, MD, PhD
• Not Stable: Proven Longevity for Efficacy by MIS-TLIF
  Jeong-Yoon Park, MD, PhD
• Questions and Answers

2:30 p.m.
General Meeting Adjourns
Lumbar stenosis is essentially ubiquitous in the elderly population and remains one of the most common conditions for which older patients undergo spinal surgery. With recent advances in operative technique, it is now possible to achieve the same goals of neural element decompression and maintenance of segmental stability using less invasive surgical procedures. Nevertheless, given the prevalence of therapeutic interventions and the increasing life expectancy of individuals in our society, it is inevitable that surgeons will need to be familiar with safe and effective revision strategies to treat conditions such as recurrent stenosis, adjacent segment degeneration, and progressive spinal deformities. There are a number of patient and procedural factors that may contribute to the development of perioperative complications which surgeons need to be cognizant of because prompt recognition and the implementation of appropriate treatments are critical for minimizing morbidity and mortality. This symposium is intended for spine surgeons and other practitioners who are interested in learning more about the “best practices” that have been developed for the surgical management of lumbar stenosis with or without instability.
9:36–9:42 a.m.
15. Cigarette Smoke-Induced Inhibition of Osteogenesis Through Involvement of the Aryl Hydrocarbon Receptor
Chawon Yun, PhD; Soyeon Jeong, MS; Gurmit Singh, BS; Andrew Schneider, MD, BA; Karina Katchko, BS; Michael S. Schallmo, BS; Jonghwa Yoon; Andrew George, BA; Joseph A. Weiner, BS; Ralph W. Cook IV, BS; Danielle S. Chun; Nehal Samra; Sohyun Lee; Seung Jun Lee; Erin L. Hsu, PhD; Wellington K. Hsu, MD
Northwestern University, Department of Orthopaedic Surgery, Chicago, IL, US; Simpson Querrey Institute for BioNanotechnology, Chicago, IL, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:42–9:48 a.m.
16. Skeletal Muscle Cell Oxidative Stress as a Possible Therapeutic Target for Sarcopenia
Hideyuki Kinoshita, MD; Sumihisa Orita, MD, PhD; Kazuhide Inage, MD, PhD; Yasuhiro Shiga, MD, PhD; Hirohito Kanamoto, MD; Koki Abe, MD; Masahiro Inoue, MD; Masaki Norimoto, MD; Tomotaka Umimura, MD; Seiji Ohtori, MD, PhD
Department of Orthopedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:48–9:54 a.m.
17. Anatomical Analysis of the Lumbar Segmental Artery in the Oblique Lateral Interbody Fusion Approach Using Magnetic Resonance Imaging
Sumihisa Orita, MD, PhD; Kazuhide Inage, MD, PhD; Yasuhiro Shiga, MD, PhD; Hirohito Kanamoto, MD; Koki Abe, MD; Masahiro Inoue, MD; Masaki Norimoto, MD; Tomotaka Umimura, MD; Seiji Ohtori, MD, PhD
Department of Orthopedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:54–10:00 a.m.
18. Mechanical Diagnosis and Therapy: Benefits of Early Access versus Delayed in Risk-Stratified Low Back Pain Populations
Sara Shupe, PT, Dip.MDT; Becky McCathie, MEd, ATC; Emily K. Karlen, MBA, MPT; M. Russell Giveans, PhD
Institute for Athletic Medicine, MN, Rosemount, MN, US; Fairview Health Services, Minneapolis, MN, US; Fairview Health Services, Saint Paul, MN, US; Fairview Health Services, Institute for Athletic Medicine, Minnetrista, MN, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:00–10:06 a.m.
19. Modic Changes on Magnetic Resonance Imaging and Endplate Remodeling on Computed Tomography after Posterolateral Fusion Surgery
Yasuhiro Shiga, MD, PhD; Sumihisa Orita, MD, PhD; Kazuhide Inage, MD, PhD; Koki Abe, MD; Hirohito Kanamoto, MD; Masahiro Inoue, MD; Hideyuki Kinoshita, MD; Masaki Norimoto, MD; Tomotaka Umimura, MD; Seiji Ohtori, MD, PhD
Department of Orthopedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:06–10:12 a.m.
20. The Impact of Immediate Post-Discharge Complications on Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) Survey Results in a Lumbar Spine Surgery Population
Jay M. Levin, BA; Thomas E. Mroz, MD; Michael P. Steinmetz, MD
University Hospital Case Medical Center, Department of Orthopaedic Surgery, Cleveland, OH, US; Cleveland Clinic Foundation Departments of Orthopaedic and Neurological Surgery, Cleveland, OH, US; Cleveland Clinic, Cleveland, OH, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:12–10:18 a.m.
Robert Winkelman; Jay M. Levin, BA; Gabriel A. Smith, MD; Thomas E. Mroz, MD; Michael P. Steinmetz, MD
Case Western Reserve University’s School of Medicine, Cleveland, OH, US; Center for Spine Health, Cleveland Clinic, Cleveland, OH, US; University Hospital Case Medical Center, Department of Orthopaedic Surgery, Cleveland, OH, US; University Hospitals Case Medical Center, Cleveland, OH, US; Cleveland Clinic Foundation Departments of Orthopaedic and Neurological Surgery, Cleveland, OH, US; Cleveland Clinic, Cleveland, OH, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:18–10:24 a.m.
Korean Spinal Neurosurgery Society
Risk Factors of Proximal Junctional Kyphosis after Multilevel Fusion Surgery: More Than Two-Years Follow-Up Data
Seung Hwan Yoon, MD, PhD, Do Keun Kim, MD, Ji Yong Kim
Discussion

10:24–10:30 a.m.
Discussion
10:30 a.m.–12:00 p.m.
**Symposium: Oncology**
Bel Aire Ballroom
Chair: Mohamad Bydon, MD

A panel of experts will provide an overview of spinal oncology, both primary and metastatic tumors in addition to extradural and intradural tumors. The session will conclude with case debates.

**Upon completion of this session, participants should gain strategies to:**
- Manage primary versus metastatic tumors;
- Manage intradural tumors, both intramedullary and extramedullary;
- Understand a variety of surgical approaches for spinal oncology.

**Agenda**
- **Metastatic Spine Disease and Stability**  
  Clinton J. Devin, MD
- **Primary Spine Tumors**  
  Peter S. Rose, MD
- **XRT Strategies**  
  Mohamad Bydon, MD
- **Case Debate**  
  Panel

12:00 p.m.
**General Meeting Adjourns**
P1. Freeze-Dried Platelet-Rich Plasma Accelerates Bone Union with Adequate Mechanical Rigidity Through the Formation of Multi-Branched Trabecular Bone in Posterolateral Lumbar Fusion Surgery Model in Rats

Yasuhiro Shiga, MD, PhD; Sumihisa Orita, MD, PhD; Kazuhide Inage, MD, PhD; Koki Abe, MD; Hirohito Kanamoto, MD; Masahiro Inoue, MD; Hideyuki Kinoshita, MD; Masaki Norimoto, MD; Tomotaka Umimura, MD; Seiji Ohtori, MD, PhD

Department of Orthopedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P2. Longitudinal Evaluation of Histological Changes in a Rat Model of Paravertebral Muscle Injury Considering the Type of Pain

Koki Abe, MD1; Kazuhide Inage, MD, PhD2; Sumihisa Orita, MD, PhD2; Yasuhiro Shiga, MD1; Hirohito Kanamoto, MD2; Masahiro Inoue, MD2; Hideyuki Kinoshita, MD2; Masaki Norimoto, MD2; Tomotaka Umimura; Seiji Ohtori, MD, PhD2

1Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan; 2Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.


Anthony T. Yeung, MD

Desert Institute for Spine Care, Phoenix, AZ, US

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P4. Impact of Intraoperative Endplate Injury Incurred During Oblique Lateral Interbody Fusion Surgery with Midterm Follow-Up

Koki Abe, MD1; Sumihisa Orita, MD, PhD2; Kazuhide Inage, MD, PhD2; Yasuhiro Shiga, MD1; Hirohito Kanamoto, MD1; Masahiro Inoue, MD1; Hideyuki Kinoshita, MD1; Masaki Norimoto, MD1; Tomotaka Umimura; Seiji Ohtori, MD, PhD1

1Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan; 2Graduate School of Medicine, Chiba University, Chiba, Chiba, Japan

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P9. Prophylactic Vertebral Cement Augmentation at the Uppermost Instrumented Vertebra and Rostral Adjacent Vertebra for the Prevention of Proximal Junctional Failure Following Long Segment Fusion for Adult Spinal Deformity
George M. Ghobrial, MD; Joseph P. Gjolaj, MD
1University of Miami, Miami, FL, US; 2Jackson Memorial Hospital, Department of Orthopaedic Surgery, Miami, FL, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P10. Posterior Column Osteotomies with and without Multilevel Anterior Lumbar Interbody Fusion in the Management of Sagittal Plane Deformity
George M. Ghobrial, MD; Joseph P. Gjolaj, MD
1University of Miami, Miami, FL, US; 2Jackson Memorial Hospital, Department of Orthopaedic Surgery, Miami, FL, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P11. Outcomes Following Posterior Cervical Fusion Among Octogenarians with Cervical Spondylotic Myelopathy: A NSQIP Database Analysis
Caroline E. Vonck, BS; Joseph E. Tanenbaum, BA; Thomas T. Bomberger, BA; Edward C. Benzel, MD; Thomas E. Mroz, MD; Michael P. Steinmetz, MD
1Cleveland Clinic Center for Spine Health, Cleveland, OH, US; 2CCF Center for Spine Health, Cleveland, OH, US; 3Cleveland Clinic Foundation, Cleveland, OH, US; 4Cleveland Clinic Foundation, Departments of Orthopaedic and Neurological Surgery, Cleveland, OH, US; 5Cleveland Clinic, Cleveland, OH, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P12. Surgeon-Level Variability in Cost and Outcomes for Elective Anterior Cervical Discectomy and Fusion
Silky Chotai, MD; Anhil Sivaganesan, MD; John A. Sielatycki, MD; Kristin Archer, PhD, DPT; Matthew J. McGirt, MD; Clinton J. Devin, MD
1Vanderbilt University Medical Center, Nashville, TN, US; 2Carolina Neurosurgery & Spine Associates, Charlotte, NC, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P13. Improvement in Disability and Quality of Life and Pain 12-Month after Elective Spine Surgery for Degenerative Cervical Radiculopathy: Analysis from Quality Outcome Database
Anthony L. Asher, MD; Silky Chotai, MD; Clinton J. Devin, MD; Mohamad Bydon, MD; Matthew J. McGirt, MD; Kristin Archer, PhD, DPT; Steven D. Glassman, MD; Christopher I. Shaffrey, MD; Anthony L. Asher, MD
1Mayo Clinic, Rochester, MN, US; 2Vanderbilt University Medical Center, Nashville, TN, US; 3University of Virginia, Charlottesville, VA, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P14. Improvement in Disability and Quality of Life and Pain 12-Month after Elective Spine Surgery for Degenerative Cervical Myelopathy: Analysis from Quality Outcome Database
Mohamad Bydon, MD; Silky Chotai, MD; Clinton J. Devin, MD; Matthew J. McGirt, MD; Kristin Archer, PhD, DPT; Steven D. Glassman, MD; Christopher I. Shaffrey, MD; Anthony L. Asher, MD
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P15. Comorbid Conditions as Predictors of Postoperative Outcome Following Cervical Spine Surgery: A Survey of United States Orthopaedic and Neurological Surgeons
Heath Gould, BS; Jeffrey A. O’Donnell, BS; Vincent J. Alentado, BS; Colin M. Haines, MD; Jason W. Savage, MD; Thomas E. Mroz, MD
1Cleveland, OH, US; 2University Hospitals Case Medical Center, Department of Orthopaedic Surgery, Cleveland, OH, US; 3Cleveland Heights, OH, US; 4Virginia Spine Institute, Reston, VA, US; 5Cleveland Clinic Center for Spine Health, Cleveland, OH, US; 6Cleveland Clinic Foundation, Departments of Orthopaedic and Neurological Surgery, Cleveland, OH, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P16. Ossification of the Ligamentum Flavum: 17 Years Personal Experience, Lessons Learned
Natarajan Muthukumar, MD
Anna Nagar, Tamil Nadu, India
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
**P17. Clinical and Radiographic Outcomes of Thoracolumbar Fractures Treated by Corpectomy and Fusion Through a Mini-Open Lateral Approach**

William D. Smith, MD; Nick Ghazarian, DO; Xueshi Li, MD, PhD

1Western Regional Center for Brain & Spine Surgery, Las Vegas, NV, US; 2Valley Hospital Medical Center, Las Vegas, NV, US; 3The 1st Affiliated Hospital of Sun-Yatsen University, Guangzhou, China

**FDA Device/Drug Status:** This abstract does not discuss or include any applicable devices or drugs.

**P18. Spinal Decompression Using a Curved High-Speed Drill-Like Device: Comparison to Traditional Methods in Cadaver Study and Clinical Experience**

Michal Tepper, PhD; Nahshon Rand, MD; William Beutler, MD, FACS; Walter Peppelman, DO; Ely Ashkenazi, MD; Richard D. Guyer, MD

1Carevantage Medical, Rehovot, Israel; 2Israel Spine Center Assuta Hospital, Tel-Aviv, Israel; 3Pennsylvania Spine Institute, Harrisburg, PA, US; 4Texas Back Institute, Plano, TX, US

**FDA Device/Drug Status:** The Dreal Tissue Removal Device (Approved for this indication)

**P19. Incidence of Non-Fracture Pathology in Osteoporotic Vertebral Compression Fractures During Kyphoplasty**

Jun Kim, DO; Douglas Blaty, DO; Stefan Yakel, DO, MS; Todd Lewis, MD

1Good Samaritan Regional Medical Center, Corvallis, OR, US; 2Samaritan Health Services, Corvallis, OR, US; 3RAN, Corvallis, OR, US

**FDA Device/Drug Status:** This abstract does not discuss or include any applicable devices or drugs.

**P20. Operative versus Nonoperative Management of Civilian Gunshot Wounds to the Spine**

Peter McCunniff, MD; Meredith Scott; James Ramey, BS; Timothy A. Moore, MD; Heather A. Vallier, MD

1University Hospitals Case Medical Center, Cleveland, OH, US; 2Case Western Reserve University School of Medicine, Cleveland, OH, US; 3MetroHealth Medical Center, Cleveland, OH, US; 4Cleveland, OH, US

**FDA Device/Drug Status:** This abstract does not discuss or include any applicable devices or drugs.

**P21. Open versus MIS Pedicle Screw Fixation of Thoracolumbar Burst Fractures: The Impact of Surgical Correction and Loss of Correction on Functional Outcome: A Systematic Review and Meta-Analysis**

Abduljabbar Alhammoud, MD; Waleed A. Asad, MD; Abdul Moeen Baco, FRCS, MSc, MbChB; Kenan Alkhalili, MD

1Doha, Qatar; 2Hamad General Hospital, Doha, Qatar; 3Lahey Clinic, Burlington, MA, US

**FDA Device/Drug Status:** This abstract does not discuss or include any applicable devices or drugs.

**P22. Intermediate Screw in Thoracolumbar Fracture Fixation: Does it Maintain the Correction?**

Abduljabbar Alhammoud, MD; Osama M. Aldahamsheh, MbChB; Ashik M. Parambathkandi, MBBS; Abdul Moeen Baco, FRCS, MSc, MbChB; Mahmood A. Arbash, MD

1Doha, Qatar; 2Hamad Medical Corporation, Doha, Qatar; 3Hamad General Hospital, Doha, Qatar

**FDA Device/Drug Status:** This abstract does not discuss or include any applicable devices or drugs.

**P23. The Impact of Type of Screw on Kyphotic Deformity Correction after Spine Fracture Fixation-Cannulated versus Solid Pedicle Screw**

Abduljabbar Alhammoud, MD; Ashik M. Parambathkandi, MBBS; Abdul Moeen Baco, FRCS, MSc, MbChB; Mahmood A. Arbash, MD

1Doha, Qatar; 2Hamad General Hospital, Doha, Qatar; 3Hamad Medical Corporation, Doha, Qatar

**FDA Device/Drug Status:** This abstract does not discuss or include any applicable devices or drugs.
As well as severity of dysphagia diminishes up until 3 months and course of dysphagia recovery in a large patient sample. Incidence have reported to be associated with dysphagia, and describe the results affirm the risk factors several studies included. CONCLUSIONS: These results confirm the risk factors identified were revision surgery, diabetes, and longer operation duration. Additionally, a distinct delayed-onset dysphagia pathology was imputed via comparative chi-square analysis of relevant probability-webs.

RESULTS: Incidence of dysphagia at 3, 6, and 12 months was 63.5%, 47.0%, 30.6%, and 31.7%, respectively. The incidence of moderate to severe dysphagia symptoms at 3, 6, and 12 months were 25.7%, 14.1%, 9.1%, and 9.3%, respectively. Short-term risk factors identified were revision surgery, diabetes, and longer operation duration. Long-term risk factors identified were GERD, older age, revision, and longer operation duration. Additionally, a distinct delayed-onset dysphagia pathology was imputed via comparative chi-square analysis of relevant probability-webs.

CONCLUSIONS: These results affirm the risk factors several studies have reported to be associated with dysphagia, and describe the course of dysphagia recovery in a large patient sample. Incidence as well as severity of dysphagia diminishes up until 3 months and then begins to plateau, with the presence of dysphagia at the 6 month follow-up being highly predictive of dysphagia at 12 months. Additionally, these findings suggest delayed-onset dysphagia to be a complication distinct from typical postoperative dysphagia. Future research will attempt to elucidate the risk factors associated with this type of dysphagia and the etiologies of dysphagia types.

FDA DEVICE/DUeG STATUS: This abstract does not discuss or include any applicable devices or drugs.

2. Comparative-Effectiveness of Single-Level Anterior Cervical Discectomy and Fusion versus Posterior Cervical Foraminotomy for Patients with Cervical Radiculopathy: Analysis from Quality Outcome Database

Silky Chotai, MD1; Anthony L. Asher, MD2; Clinton J. Devin, MD1; Ahilan Sivaganesan, MD1; Mohammad Bydon, MD1; Matthew J. McGirt, MD2; Kristin Archer, PhD, DPT1; Steven D. Glassman, MD1; Christopher I. Shaffrey, MD1


BACKGROUND CONTEXT: Cervical spine surgeries are one of the most common surgical procedures performed in the United States. Cervical radiculopathy that fails to respond to non-operative management is treated by either anterior cervical discectomy and fusion (ACDF) or posterior cervical foraminotomy (PCF).

PURPOSE: In this study, we set out to determine the comparative-effectiveness of ACDF versus PCF for patients undergoing elective spine surgery for single-level cervical radiculopathy.

STUDY DESIGN/SETTING: Analysis of prospective multicenter longitudinal registry based data.

PATIENT SAMPLE: A total of 881 patients undergoing ACDF and 42 undergoing PCF for single-level cervical radiculopathy were queried from a prospective multi-center registry (QOD).

OUTCOME MEASURES: Baseline and 12-months PROs: NDI, EQ-5D and NRS -neck pain (NP) and arm pain (AP) and were recorded.

METHODS: Multivariable regression model was fitted for length of hospital stay (LOS), 90-day readmission, 90-day return to work (RTW) and 12-month PROs and satisfaction (NASS satisfaction questionnaire). An array of preoperative variables, and surgery variables (including ACDF and PCF) were included in the model.

RESULTS: In risk-adjusted multivariable analysis the patients undergoing PCF has lower LOS (OR-0.18, CI-0.071-0.42, p=0.00003), had higher 12-month NDI scores (OR-2.62, CI-1.5-4.7, p=0.00137), and NRS-AP scores (OR-2.1, CI-1.1-3.8, p=0.03) and lower quality of life (OR-0.37, CI-0.20-0.67, p=0.001). The effect of surgical approach (ACDF vs. PCF) was not significant for 90-day readmission, 90-day RTW and 12-month NRS-NP scores and patient satisfaction.

CONCLUSIONS: Patients undergoing single-level PCF for cervical radiculopathy had lower hospital length of stay, however these patients had worse postoperative 12-month neck-related disability, quality of life and arm pain outcomes compared to those who underwent single-level ACDF. In regards to PROs, ACDF offers a comparative benefit over PCF for single-level cervical radiculopathy. Further studies are needed to evaluate the long-term reoperation rates and cost-effectiveness of these procedures.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
3. The Outcomes of Posterior Arthrodesis for Atlantoaxial Subluxation in Down Syndrome Patients: A Meta-Analysis

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BACKGROUND CONTEXT: Down Syndrome (DS) is due to a trisomy of chromosome 21, leading to varied pathological presentations, including atlantoaxial subluxation due to increased ligamentous laxity of the cervical spine. Posterior arthrodesis is an established surgical intervention designed to correct the laxity. Previous studies have reported complication rates of 100%, with reoperation rates as high as 50%. Global complication rates remained unknown.

PURPOSE: To establish the published rates of (1) neurologic complications, (2) bony related complications, (3) delayed wound healing, (4) reoperation, and (5) death. We also sought to determine whether presenting symptoms had any relationship to postoperative complications.

STUDY DESIGN/SETTING: Systematic review and meta-analysis

PATIENT SAMPLE: 12 studies were included with total of 128 primary posterior arthrodeses of cervical vertebrae, in DS patients

OUTCOME MEASURES: The rate of: (1) Neurologic complications, (2) bony related complications, (3) delayed wound healing, (4) reoperation, and (5) death.

METHODS: Following the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) guidelines, 408 studies were evaluated. After cross-referencing and applying explicit inclusion and exclusion criteria, 12 studies were included in the final cohort. Data from the studies were sorted into five categories; 1) neurologic complications, 2) delayed recovery complications, 3) bone related complications, 4) reoperations, and 5) fatalities. Neurologic complications included continued myelopathy; loss/no gain of ambulation, hyperreflexia, Horner syndrome, and quadraparesis. Delayed recovery included infections, hematomas, and wound dehiscence. Bony related complications included bone deformities such as graft resorption, vertebral instability, fractures, and nonunions. Reoperations included any subsequent surgical intervention due to a specific complication in one of the three previous categories, and fatalities included all deaths Random effect models reported the global complication rates, and odds ratios determined the association of presenting symptoms to complications.

RESULTS: A total of 128 Down syndrome patients were included. Mean follow-up was 31.7 months (14.9 - 77 months). Mean age was 13.8 years (6.7 - 32.7 years) and 47.8% of patients were males. Patients had average preoperative atlanto-dental interval (ADI) was 76 mm. 13.3% of patients had quadraparesis, 7.8% had torticolis, 14.1% had gait disturbance, 10.2% had neck pain and 7.8% had hyperreflexia. All patients underwent primary posterior arthrodesis of the cervical spine with average number of vertebrae fused of 2.5 levels. The most common complication was bony related 39.6% (95% CI, [31.4 - 48.5%]). The rate of neurological deficits was 23.3% (95% CI, [16.6 - 31.6%]) and delayed wound healing occurred at a rate of 26.4% (95% CI, [19.4 - 34.9%]). The pooled reoperation rate was 34.9% (95% CI, [25.5 - 45.6%]). The rate of death was 3.9% (95% CI, [1.5 - 9.7%]). Meta-analysis revealed that neurological complications is 4 times higher.

CONCLUSIONS: This is the first meta-analysis identifying the rates of complication, reoperation, and death after posterior cervical arthrodesis of DS patients. It also is the first to associate outcomes with presenting symptoms. This study has shown that bony related complications are the most common, followed by delayed wound healing, neurological deficits, and death in that order. Reoperations occur after 34.9% of all procedures, and death occurs during or after 3.9% of surgeries. Patient presenting with neurological symptoms have > 5.5-fold greater odds to require reoperations and > 4-fold greater odds to sustain postoperative neurological complications.}

4. One- or Two-Level Treatment by Arthroplasty of Cervical Degenerative Disease: Preliminary Results after Five-Years Postoperative Controls

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BACKGROUND CONTEXT: Cervical total disc replacement with disc prostheses has been widely used over the last decade and has shown promising short term results. However, long terms results are missing, particularly for the latest designed implants such as semi constrained prostheses.

PURPOSE: Observational study aiming to evaluate long term safety and potential late complications related to the use of the cervical prosthesis Baguera® C.

STUDY DESIGN/SETTING: Observational, multicenter.

PATIENT SAMPLE: 78 patients were enrolled in 4 different surgical centers and five years postoperative controls were performed. All patients had been treated by total disc replacement (TDR) using Baguera® C at one or two cervical level(s) during the period June 2009 – June 2011, were available for the extended follow-up, according to the protocol, and had signed the informed consent for use of their data. Age at the surgery time: 47.0 ± 7.1 yearsGender: 38 Females (48.7%) 40 Males (51.3%)

OUTCOME MEASURES: At the 5 years FU visit, the patients were assessed by clinical examination, neurological evaluation, self-assessment by questionnaires (NDI, SF12) and radiological examination was performed by plain standard X ray images. Lateral X rays were done in neutral, flexion and extension positions. This study was conducted according to the ISO 14155:2011 standard, to national regulations applicable in the participating countries and in agreement to the Good Clinical Practices guidelines.

METHODS: The Case Report File was completed at each patient control visit, safety data were collected continuously, during the overall study period, using adverse events forms. Complications were reported in specific forms.

RESULTS: There were no cases of surgical revision at the arthroplasty level, no fracture of system components, no loss of fixation, migration nor subsidence and no vascular injury or vertebral fracture. Four patients needed surgical intervention at another spine level (non cervical) and 13 patients had signs of adjacent level(s) degeneration. 60 patients (76.9%) took no pain medication at all. 16 patients (20.5%) took Level 1, 1 (1.3%) Level 2, and 1 Level 3 (1.3%) painkillers.
All 78 subjects (100%) had normal clinical examinations. Neurological examination was normal in all but one patient who presented with new C6 paresthesia, probably related to degeneration of the adjacent level. The self-reported questionnaires showed an average functional disability of 18.9% for 14.1%. 5 subjects (6.4%) noted at least 50% functional disability. Motion at the treated level was evaluated by the Range of Motion (ROM) on flexion/extension X-Rays. The average ROM was 8.8°±4.9°. Motion was considered preserved (ROM >2°) in 75 levels (87.2%). Lack of motion (ROM < 2°) was observed in 11 levels (12.8%).

**CONCLUSIONS:** Cervical disc replacement with the BagueraC prosthesis shows an excellent record in terms of safety, clinical results and long term motion preservation. There was no index or adjacent level degeneration after 5 years. Radiological progression of adjacent level degeneration was seen in a significant minority of cases, but without clinical expression.

**FDA DEVICE/DRUG STATUS:** This abstract does not discuss or include any applicable devices or drugs.

### 5. Prospective Clinical and Radiographic Assessment of the Cervical Spine in Professional Rodeo Riders after Exposure to Greater than 10G Linear Acceleration

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**BACKGROUND CONTEXT:** Whiplash injury remains a controversial clinical diagnosis. Few models exist to comprehensively assess the clinical effects of whiplash on the cervical spine. As professional rodeo riders are subjected to repeated whiplash events during each of their rides, they represent an ideal population in which to assess the clinical effects of whiplash.

**PURPOSE:** The purpose of the present study was to evaluate the clinical effect of repeated acceleration / deceleration events on the cervical spine in professional rodeo riders using objective clinical data and validated HRQL (health related quality of life) scores.

**STUDY DESIGN/SETTING:** Prospective observational cohort study

**PATIENT SAMPLE:** Adult (>18 years) professional rodeo riders

**OUTCOME MEASURES:** Pre- and Post-Ride Physical Examination, VAS (Visual Analogue Scale) Neck, Back and Arm scores, NDI (Neck Disability Index), SF-36 (Short Form (36)), EQ-5D (EuroQol).

**METHODS:** After informed consent, subjects underwent focused physical examination by a licensed physician and completed validated HRQL questionnaires before and after each ride. Pre- and post-ride data was recorded and analyzed. Mean and peak continuous linear accelerometer data was recorded. Descriptive statistics were performed, pre- and post-ride data were compared with a student’s t-test.

**RESULTS:** 21 professional bareback (8), saddle bronc (7) and bull (6) riders were enrolled. All riders were male, mean age was 24.3±15.6. They completed an average of 556.2±15.6 rodeos per year. 5/21 patients reported prior neck injury, 0/21 had prior neck surgery, 17/21 reported previous concussions, 4/21 had missed rodeos previously due to neck injuries. Baseline NDI (4.9±16.5), EQ-5D (0.89±0.15), and SF-36 (PCS 51.9±16.2, MCS 55.1±14.2) were recorded. Mean linear acceleration was 16.5±6.4g. Peak linear acceleration was 34.1g. Post ride neck, arm and back VAS were not significantly different from pre-ride (P<0.05). There was no difference between bareback, saddle bronc and bull riding groups (P<0.05).

**CONCLUSIONS:** Repeated high acceleration / deceleration moments do not appear to significantly impact the clinical incidence of neck or back pain in professional rodeo riders. Apparent g-forces experienced by riders are greater than or comparable to those experienced in motor vehicle accidents. These data provide clinically useful context for evaluating patients with whiplash type injuries.

**FDA DEVICE/DRUG STATUS:** This abstract does not discuss or include any applicable devices or drugs.

### 6. Effect of Neck-Related Disability Scores on Satisfaction with Outcomes 12-Months after Elective Surgery for Cervical Spine Degenerative Disease

Silky Chotai, MD; Athil Sivaganesan, MD; Anthony L. Asher, MD; Mohamad Bydon, MD; Clinton J. Devin, MD


**BACKGROUND CONTEXT:** Comprehensive assessment of quality of care includes patient-reported outcomes, safety of care delivered, and patient satisfaction. The impact of the patient-reported NDI (baseline and 12-month) scores on satisfaction with outcomes following spine surgery is not well documented.

**PURPOSE:** To determine the impact of patient disability [Neck Disability Index (NDI) scores] at baseline and 12-months on satisfaction with outcomes following surgery.

**STUDY DESIGN/SETTING:** Analysis of prospective multicenter registry based data

**PATIENT SAMPLE:** Patients undergoing elective surgery for degenerative cervical spine disease were queried from prospective multicenter quality outcomes database registry (QOD).

**OUTCOME MEASURES:** Baseline and 12-month NDI scores were recorded. Satisfaction at 12-month after surgery was measured using North American Spine Society satisfaction (NASS) questionnaire.

**METHODS:** Multivariable proportional odds logistic regression analysis was conducted to determine the impact of baseline and 12-month NDI on satisfaction with outcomes.

**RESULTS:** Of total 2805 patients, 66% (n=1848) were satisfied at a level where surgery met their expectations (NASS level 1) at postoperative 12-month. After adjusting for all baseline and surgery-specific variables, the 12-month NDI score had the highest impact (Wald χ²=664.7, 83% of the total χ²) on achieving satisfaction with outcomes followed by baseline NDI scores (Wald χ²=44, 5.4% of the total χ²). The level of satisfaction decreases with increasing 12-month NDI score and a higher change in NDI score is required to achieve a better satisfaction level in a patient with a higher baseline NDI score.

**CONCLUSIONS:** Absolute 12-month NDI following surgery had significant association with satisfaction with outcomes 12-month after surgery. Patients with higher baseline NDI required a larger change in NDI score to achieve satisfaction. Satisfaction may be utilized in conjunction with baseline and 12m NDI scores to provide an assessment of the quality of spine surgery provided in a patient centric fashion.

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7. Key Drivers of Patient Satisfaction in Lumbar Spine Surgery Setting

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BACKGROUND CONTEXT: The Centers for Medicare and Medicaid Services withholds a percentage of reimbursement from all hospitals, rising to 2% by 2017, which are then redistributed from low-performing to high-performing hospitals. Patient experience accounts for 25% of this adjustment, and is composed of eleven domains derived from the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey. The percentage of patients who provide “top box”, or the highest possible HCAHPS response, for each domain is used to calculate each institution’s total performance score. As the patient experience of care begins to play a larger role in determining the quality of care given, it is important to identify areas within unique patient populations that contribute the most to a highly satisfying hospital experience. Currently, there are minimal data on key drivers of top-box scores and how scores on the constituent HCAHPS items impact the global domain of satisfaction, Overall Hospital Rating (OHR).

PURPOSE: The purpose of this study is to determine they key drivers of overall patient satisfaction in the in-patient lumbar spine surgery setting.

STUDY DESIGN/SETTING: This is a retrospective study at a single institution.

PATIENT SAMPLE: 461 patients undergoing lumbar spine surgery between 2013-2015 who also completed an HCAHPS survey.

OUTCOME MEASURES: Our primary outcome was the OHR component of the HCAHPS survey. The OHR is on a scale of 0-10, where 0 is the worst hospital possible and 10 is the best hospital possible. A score of 9 or 10 is considered a top-box hospital rating.

METHODS: First, demographic and preoperative characteristics were obtained. Then the study population was split into a satisfied group and an unsatisfied group according to their OHR. Those patients selecting a top-box score for OHR (a 9 or 10) were included in the satisfied group and the remaining patients comprised the unsatisfied group. A baseline multivariate logistic regression model was then determined at the midpoint of the pedicle in the sagittal plane was used to determine hospital and physician reimbursement. The present study analyzed the key drivers of patient experience among patients undergoing lumbar spine surgery and found several important associations. Nurses always being respectful, pain staff always doing everything they could to help with pain, and always taking personal and family preferences into account were the strongest predictors of overall satisfaction in this population. These findings highlight opportunities for quality improvement efforts in the spine care setting.

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8. 3D Printed Pedicle Targeting Guide Provide a Safe, Reliable and Accurate Method for Placement of Pedicle Screws

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BACKGROUND CONTEXT: Transpedicular screw placement is a commonly used technique to achieve spinal stabilization in a wide range of pathologies such as degenerative disease, congenital malformations, trauma or oncologic process that induce spinal instability. Despite advancements in pedicle screw technologies, surgical techniques, neuromonitoring, and image guidance, breaches in the pedicle cortex might occur. In published literature the rate of pedicle screw misplacement in the two most commonly used techniques for placement of pedicle screws range from 6-31% in free handed method and 8-19% in fluoroscopy based navigation method. Newer technologies such as CT guided navigation and robotic placement of pedicle screws reduce the rate of misplacement however come at high costs and are available only at large centers. In this abstract we look to study the accuracy of a low cost patient customized 3D printed tubular guides for accurate placement of pedicle screws.

METHODS: A prospective in vivo clinical study was performed in twelve patients with placement of a total of seventy screws in the thoracolumbar region. Patients were randomly selected from a single surgeon’s practice scheduled to undergo spinal stabilization. After informed consent was obtained, preoperative CT was acquired to allow the surgeon to pre plan the trajectory of the screw and subsequently create 3D models for intraoperative guidance. Primary measure of the study involved assessing accuracy of the pedicle screw placement on post operative CT to identify any violation of the pedicle. This was assessed as follows: A, completely within the confines of the pedicle; B, pedicle wall breach <2 mm; C, pedicle wall breach 2 to 4 mm; D pedicle wall breach >4 mm. Secondary measures involved deviation from planned trajectory in the sagittal and coronal plane at the midpoint of pedicle.

RESULTS: Postoperative CT was studied for an in depth review of seventy transpedicular screws. Sixty eight of the pedicle screws were within the confines of the pedicle (grade A). Two screws penetrated the cortex within <2mm (grade B). There was no grade C or D pedicle wall breach. The overall accuracy of the system was determined to be 97.1% with a misplacement rate of 2.9%. None of the grade B screws resulted in neurological symptoms post operatively. The mean deviation between the planned and actual screw placement as determined at the midpoint of the pedicle in the sagittal plane was 0.37 mm and 0.28 mm in the coronal plane.
CONCLUSIONS: 3D printed patient customized tubular guides is a viable low cost technology that exhibits higher accuracy and increased safety compared to free hand technique and use of fluoroscopy navigation in placement of pedicle screws.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

9. Multilevel Posterior Column Osteotomies for Sagittal Plane Correction in the Management of Adult Degenerative Scoliosis

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BACKGROUND CONTEXT: Prior reports have compared pedicle column osteotomies(PCOs) such as Smith-Petersen Osteotomies and Ponte Osteotomies to three-column osteotomies such as pedicle subtraction osteotomies for fixed coronal and sagittal plane deformity in adolescent scoliosis and adult spinal deformity (ASD). No prior reports have described the systematic use of three or more PCOs for ASD in an adult spinal deformity population at a single institution.

PURPOSE: To determine the utility of polysegmental posterior column osteotomies in the management of sagittal and coronal plane imbalance in adult spinal deformity patients.

STUDY DESIGN/SETTING: A Retrospective Cohort-Matched Radiographic Observational Study of Adult Spinal Deformity Patients at a single academic institution over a 16 year period.

PATIENT SAMPLE: The records and radiographs of 85 adult spinal deformity patients were retrospectively evaluated that had underwent long-segment (>5 spinal levels) fusion and polysegmental PCOs (≥3 levels) to correct sagittal and coronal imbalance.

OUTCOME MEASURES: Preoperative and postoperative regional measurements of sagittal alignment included the lumbar lordosis (LL) and thoracic kyphosis (TK) while coronal angulation was quantified via the Cobb angle method. Main structural and compensatory curves were identified using AP and lateral standing scoliosis films, as well as side-bending radiographs. Spinopelvic parameters assessed including the PT, pelvic incidence(PI), and sacral slope(SS), using commonly reported methods. Measures of global alignment assessed included the SVA, TPA, and central sacral vertical line(CSVL). All measurements were facilitated with a validated radiographic measurement software package (Surgimap®, Nemaris Inc.™, New York, NY). The number of posterior column osteotomies were recorded for each patient, as well as the mean PCOs per patient, and degrees of correction per PCO.

METHODS: A retrospective chart review was conducted from July 20, 2000 to November 1, 2016 to identify spinal surgery patients 18 years or greater with adult spinal deformity, that underwent multiple PCOs for sagittal or coronal deformity correction. All PCOs herein are Grade II osteotomies according to the previously published and validated osteotomy classification by Schwab.14 Grade II osteotomies entail the complete removal of the spinous processes, superior and inferior facets, and all intervening ligaments. Institutional review board approval for this study was obtained. Preoperative enrollment for surgery and intraoperative decision-making remained unchanged throughout the 16-year study period. Further database criteria included a long segment fusion(defined as greater than five spinal levels) and at least one of the following: lumbar scoliosis greater than 20°, pelvic tilt(PT) greater than 20°, T1 pelvic angle greater than 20°(TPA; The angle formed by two lines intersecting at the femoral head drawn from the T1 centrum and midpoint of the sacral endplate), sagittal vertical axis(SVA) greater than 5 cm, central sacral vertical line(CS VL) greater than 2 cm, and thoracic kyphosis greater than 60 degrees. Patients were excluded that did not have preoperative, postoperative, and long term follow-up 36° full-length antero-posterior(AP) and lateral standing radiographs. Patients that were commonly included in this population consisted of idiopathic scoliosis in the adult, adult degenerative scoliosis, and iatrogenic flatback deformity, but also included Scheuermann’s and post-traumatic kyphosis etiologies. Patients with relatively less common deformities attributed to underlying neuromuscular, syndromic, infectious, inflammatory, and neoplastic conditions were excluded. Preoperative and postoperative regional measurements of sagittal alignment included the lumbar lordosis (LL) and thoracic kyphosis (TK) while coronal angulation was quantified via the Cobb angle method. Main structural and compensatory curves were identified using AP and lateral standing scoliosis films, as well as side-bending radiographs. Spinopelvic parameters assessed including the PT, pelvic incidence(PI), and sacral slope(SS), using commonly reported methods. Measures of global alignment assessed included the SVA, TPA, and central sacral vertical line(CS VL). All measurements were facilitated with a validated radiographic measurement software package (Surgimap®, Nemaris Inc.™, New York, NY). The number of posterior column osteotomies were recorded for each patient, as well as the mean PCOs per patient, and degrees of correction per PCO. The influence of a prior instrumented fusion on the effectiveness of PCOs at the restoration of coronal and sagittal alignment was assessed, as well as the feasibility of PCOs at restoring sagittal balance at magnitudes greater than 10 cm.

RESULTS: 85 patients (mean age 67.5±11 years) were identified who had underwent 372 PCOs (mean 4.38 per patient) for the treatment of coronal and sagittal imbalance (Table 1). The most common indication for surgery was scoliosis, followed by iatrogenic sagittal or coronal deformity, and sagittal imbalance secondary to hyperkyphosis. Global measurements of sagittal imbalance were measured for all patients, finding the mean preoperative SVA and TPA to be 8.16 cm and 25°. Coronal and sagittal balance restoration, measured by the mean CSVL and SVA, as 0.67 and 1.29, respectively. The mean improvement in SVA was 6.29 cm achieved with a correction of approximately 5.05° per PCO. A comparison of the effectiveness of PCOs at restoring lumbar lordosis, lumbar-Spinal pelvic harmony, sagittal and coronal balance in previously fused patients was performed. Prior instrumented fusion was present in 18 patients (21%) preoperatively, with a mean of 4.38 levels fused and a greater preoperative SVA (10.73 vs. 6.71 cm, p=0.121). After PCO, on long-term follow-up, there was no significant difference in final LL, TK, SVA, PI-LL, or TPA. Also, there was no measured difference in correction per PCO (4.87 versus 5.72° per level in revision patients, p=0.192). There was a significantly higher postoperative CSVL in revision patients, (0.61 vs. 0.91, p=0.048). The utility of PCOs at the restoration of sagittal imbalance greater than 10 cm was evaluated. Two cohorts were studied, 63 patients with a mean SVA < 10cm and 22 patients with an SVA ≥ 10cm. The mean PCOs per patient in the 3.98 and 3.68 in the groups with an SVA less than 10 cm and SVA ≥ 10 cm, respectively. There was no significant difference in the final LL, TK, PI-LL, SVA, CSVL, and TPA, between groups. There was a significantly greater correction per PCO maintained at long term follow-up in the SVA ≥10cm (7.17 cm vs. 4.31cm, p=0.0006). There were twenty-two complications reported (25.9%). Of those, 4 were major complications, all of which were pulmonary embolisms encountered.
in the postoperative inpatient period requiring antiocoagulation in 3 and inferior vena cava filter in one patient followed by anticoagulation. There were 6 durotomies, which were repaired primarily at the time of surgery, and did not require future surgical management. 6 patients developed proximal junctional failure requiring proximal extension of fusion. There were no neurologic deficits attributed to deformity correction. There were 6 late complications, all of which were pseudoarthrosis (7.1%) equally divided between the osteotomy site (n=3) and at the L5-S1 level (n=3). There were no mortalities.

CONCLUSIONS: Polysegmental posterior column osteotomies are a safe and effective alternative to pedicle subtraction osteotomies for the restoration of lumbar lordosis as well as sagittal and coronal alignment in the adult spinal deformity population with or without prior instrumented fusion.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

10. Is there a Preoperative Morphine Equianalgesic Dose that Predicts Ability to Achieve a Clinically Meaningful Improvement Following Spine Surgery?

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BACKGROUND CONTEXT: Preoperative opioid use is widespread and associated with worse patient reported outcomes following spine surgery.

PURPOSE: The purpose of this study was to calculate a threshold preoperative morphine equianalgesic (MEA) dose above which patients have difficulty achieving minimum clinically important difference (MCID) following elective cervical and lumbar spine surgery as measured by Neck Disability Index (NDI) and Oswestry Disability Index (ODI), respectively.

STUDY DESIGN/SETTING: Analysis of prospective longitudinal registry based data.

PATIENT SAMPLE: The study included 543 cervical and 1293 patients undergoing elective surgery for lumbar degenerative diseases.

OUTCOME MEASURES: NDI and ODI were prospectively collected at the preoperative and 12-month postoperative time points.

METHODS: Opioid use data were collected retrospectively and converted to MEA doses. Combined analysis of cervical and lumbar patients was performed using multivariable logistic regression models, and model parameters were assessed using Markov Chain Monte Carlo methods.

RESULTS: Overall, 1020 (55.5%) patients used preoperative opioids. A total 61.9% of lumbar and 50.3% of cervical patients achieved MCID. With all patients included in the analysis, achievement of MCID decreased significantly between MEA doses of 25.7-85.8 mg/day. Repeating the analysis after excluding patients with MEA doses ≥ 90 mg/day demonstrated significantly decreased achievement of MCID for doses ≥ 47.8 mg/day, with a 95% confidence interval of 29.0-60.0 mg/day.

CONCLUSIONS: Minimum and maximum MEA doses exist, between which increasing opioid dose predicts decreased ability to achieve clinically meaningful improvement following spine surgery. Patients with preoperative MEA dose exceeding 29 mg/day, the lower limit of the 95% confidence interval above which patients exhibit significantly decreased achievement of MCID, are less likely to benefit from surgery and should be considered for preoperative opioid weaning.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.


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BACKGROUND CONTEXT: Minimally Invasive (MSI) fusions of the lumbar spine are associated with lower complication rates and improved outcomes relative to their open equivalents, but have not gained widespread acceptance in part because they are technically challenging procedures. Oblique Lateral Lumbar Interbody Fusion (OLLIF) is a new MIS fusion of the lumbar spine that is technically straightforward, because it does not require direct visualization. In OLLIF the disk space is approached through Kambin’s triangle guided by electrophysiological monitoring and biplanar fluoroscopic imaging. Unlike other MIS fusions, OLLIF does not require facetectomy or laminectomy.

PURPOSE: OLLIF is a novel MIS technique for fusion of the lumbar spine that overcomes the technical limitations of similar techniques like MIS TLIF. This study presents the first large cohort of patients undergoing OLLIF. The purpose of this study is to determine both perioperative and clinical outcomes of OLLIF.

STUDY DESIGN/SETTING: This is a retrospective study of perioperative outcomes, patient reported disability and fusion data. All surgeries were performed by the same surgeon.

PATIENT SAMPLE: The patient sample includes 292 OLLIF surgeries on 538 levels with a control group of 58 open Transforaminal Lumbar Interbody Fusions (TLIFs) on 153 levels, all performed by the same surgeon. OLLIF is indicated for severe degenerative disk disease, Listhesis, Stenosis and Disk Herniation. All patients have gone through a full course of conservative theory before being considered candidates for surgery.

OUTCOME MEASURES: Perioperative outcome measures include surgery times, blood loss, fluoroscopy times and hospital stay. We also collected complications, fusion rates and patient reported pain scores (0-10) and outcomes on the Oswestry disability index (ODI) one year post surgery.

METHODS: The disk is approached through Kambin’s triangle, which can easily be located as a silent window with an electrophysiological probe. Discectomy is performed through a single access portal with a 10 mm diameter. After a discectomy, the disc space is packed with beta-tricalcium phosphate soaked in autologous bone marrow, aspirated, and the cage is inserted. Finally, a minimally invasive posterior fixation is performed.

RESULTS: OLLIF cuts surgery times and hospital stay in half relative to TLIF (59/132 min, 4.7/2.3 days respectively) and reduces blood loss by over 87% (355/44ml). OLLIF patients report significant...
12. Assessment of Damage to the Iliopsoas Muscle from the Oblique Lateral Interbody Fusion Approach

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BACKGROUND CONTEXT: Lumbar lateral interbody fusion (LLIF) has been widely performed to achieve minimally invasive, rigid lumbar interbody fusion. LLIF via splitting psoas muscle tends to result in postoperative muscle weakness of the iliopsoas muscle and thigh numbness due to the damage to the psoas major muscle and lumbar plexus. Similar postoperative complications have been made on the LLIF via oblique lateral corridor (OLIF; oblique LLIF) approach, but the detailed perioperative changes in the psoas major muscles in the medium to long term are not clarified.

PURPOSE: To investigate the relationship between clinical symptoms and changes in the psoas major muscle before and after OLIF surgery.

METHODS: The subjects were 27 patients who underwent OLIF surgery under the diagnosis of degenerative lumbar disease between November 2013 and April 2015 in our hospital. The cross-sectional areas (CSAs) of the psoas major muscle on the approaching and contralateral sides were measured using an axial computed tomography of the surgical intervertebral space before, after, and 1 year after surgery. Change in the muscle property was also evaluated retrospectively by using axial magnetic resonance imaging of the same level. To evaluate the psoas major muscle in each period, the change in the CSA from before to after the surgery was compared, with the ratio of those in the approach side to the contralateral side, and the progression of fat degeneration, measured by fat cross-sectional area, were also measured. In addition, the relationship between these parameters and postoperative lower limb neuropathy was investigated.

RESULTS: The ratio of the CSA of psoas major muscle in each period was 1.09±0.21 before surgery, 1.25±0.29 immediately after surgery, and 1.02±0.29 one year after surgery. Significant swelling of the psoas major muscle on the approach side was observed immediately after surgery. No significant difference was observed in mean total CSA before (1550±746 cm²) and 1 year after surgery (1583±690 cm²). No postoperative fat degeneration was observed in mean total CSA before (1550±746 cm²) and 1 year after surgery, and 1.02±0.29 one year after surgery. Significant long-term prolongation is considered to be due to a temporary swelling after surgery caused by intraoperative muscle, which implies that OLIF approach has minimal effect on the psoas major muscle.

CONCLUSIONS: The swelling of the psoas major muscle on the approach side was observed only immediately after surgery with no significant long-term prolongation. This is considered to be due to a temporary swelling after surgery caused by intraoperative muscle, which implies that OLIF approach has minimal effect on the psoas major muscle.

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13. Comparative Effectiveness Between Primary and Revision Foraminotomy for the Treatment of Lumbar Foraminal Stenosis

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BACKGROUND CONTEXT: Foraminotomy has demonstrated clinical benefit in small retrospective investigations for the management of lumbar foraminal stenosis. Although a substantial number of patients undergo more than one foraminotomy procedure, there is little data comparing primary foraminotomy (PF) and revision foraminotomy (RF) in terms of both cost and quality of life (QOL) outcomes.

PURPOSE: To compare the impact of PF and RF on QOL outcomes, and to compare the perioperative costs of these procedures in order to evaluate their relative cost effectiveness.

STUDY DESIGN/SETTING: A retrospective cohort study was conducted at the Cleveland Clinic in Cleveland, OH.

PATIENT SAMPLE: Patients undergoing foraminotomy for the treatment of lumbar foraminal stenosis between 2008 and 2016 at a single tertiary hospital were identified. Patients were excluded if they were under 18 years of age, or if they had spinal malignancy, infection, or history of acute trauma.

OUTCOME MEASURES: The primary outcome measure was improvement in postoperative QOL. Secondary outcome measures included perioperative cost and QOL minimum clinically important difference (MCID).

METHODS: A retrospective chart review was conducted to identify individuals who underwent PF or RF for lumbar foraminal stenosis and to collect clinical, operative, and demographic data. QOL instruments (EQ-5D, PDQ, and PHQ-9) were prospectively collected between 2008 and 2016. Scores were collected preoperatively and at the last available postoperative follow-up visit. Perioperative financial data were extracted via the institution’s cost utilization engine. Paired t-tests were used to assess changes within treatment groups and chi-squared tests were used for inter-cohort comparisons.

RESULTS: 703 procedures were eligible for study inclusion – 580 (83%) PF and 123 (17%) RF. There were no significant differences in demographics between the PF and RF groups. The number of levels operated on was significantly greater in the PF cohort (2.53 vs. 2.32, p<0.02). Preoperatively, mean EQ-5D index (0.542 vs. 0.503, p=0.15), total PDQ (78.9 vs. 84.1, p=0.20), and total PHQ-9 (7.95 vs. 9.05, p=0.22) demonstrated marginally greater QOL in the PF cohort compared to the RF cohort. Postoperatively, EQ-5D index showed significant improvement in both the PF (0.542 -> 0.636, p<0.0001) and the RF (0.503 -> 0.645, p<0.0001) cohorts. Similarly, total PHQ-9
Peptide Amphiphile Nano-Slurry as an Improved BMP-2 Carrier for Spinal Arthrodesis

PURPOSE: The purpose of this study was to improve the handling and osteoconductive properties of our PA technology by creating a novel collagen slurry with the intent of reducing the amount of rhBMP-2 necessary to achieve bone regeneration and successful spine fusion.

METHODS: Female Sprague-Dawley rats and New Zealand white rabbits underwent bilateral L4-L5 and L5-L6 fusion, respectively, with low dose rhBMP-2. For the rat studies, animals received either a peptide amphiphile nanogel—collagen slurry (NanoSlurry), control collagen slurry (no PA nanofibers), or ACS alone pre-loaded with 100 ng rhBMP-2 per animal (50 ng per scaffold), which is a dose that does not promote fusion when applied on ACS. For the more stringent rabbit PLF model, animals received either the NanoSlurry or ACS pre-loaded, which were preloaded with 30 or 60 ug rhBMP-2 per animal (15 or 30 µg per implant). Bone regeneration and spine fusion were assessed in both animal models using radiographs, fusion scoring, and microCT imaging. Fusion scores were determined by blinded manual palpation using an established scoring system: 0 = no bridging bone, 1 = unilateral bridging, and 2 = bilateral bridging. Spines with an average score of 1 or higher were considered fused.

RESULTS: NanoSlurry treated rats showed significantly higher mean fusion score relative to equivalently pre-loaded ACS (p<0.001) or control slurry (p<0.001) in the rat PLF model. Successful fusion was seen in 100% of rats treated with NanoSlurry + 100ng rhBMP-2 (per animal). This was significantly higher than fusion rates of equivalently preloaded ACS (0%) and control collagen slurry (8%) groups. Similarly, fusion rates in rabbits treated with the NanoSlurry were significantly higher than equivalently pre-loaded ACS (100% vs 0% for the 30 µg groups (p<0.05).

CONCLUSIONS: Previous work has established that 10µg rhBMP-2 (per animal) applied on ACS results in successful fusion at a rate of 100% in the ratPLF model. In this study a slurry composed of peptide amphiphile nanofibers and collagen particles was formed into a malleable paste that could be used to fill bone defects and potentially reduce the exogenous growth-factor necessary to achieve spine arthrodesis. Our data suggest, the NanoSlurry can effectively reduce the requirement for rhBMP-2 by a factor of 100 relative to ACS, which is the current FDA-approved carrier for the growth factor. This success also translated to the more stringent rabbit PLF model, suggesting that this technology maybe robust enough for success in the clinical setting. Future studies will identify the lowest rhBMP-2 loading dose at which the NanoSlurry can promote fusion rates approaching 100%.

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dioxin, a minor constituent of cigarette smoke and high-affinity prototype ligand of the Ahr, has shown that dioxin-induced Ahr activation inhibits bone regeneration and spine fusion in vivo.

**PURPOSE:** The purpose of this study was to elucidate the downstream mechanisms underlying the adverse effects of cigarette smoke extract (CSE), the Ahr ligand-containing fraction of cigarette smoke, on bone regeneration.

**METHODS:** Bone marrow stromal cells (BMSC) were harvested from Long-Evans rats and cultured under standard or osteogenic conditions. CSE was prepared by drawing smoke from reference cigarettes through a 0.1 μm PTFE membrane filter and washing the filter in dimethyl sulfoxide (DMSO) overnight to yield a final concentration of 40 mg/mL. Factors critical to osteogenesis were then evaluated after BMSC were exposed to DMSO vehicle, 10 nM dioxin, 10 or 20 ug/mL CSE, or co-treated with Ahr antagonists (4 μM Resveratrol, Res; 2 μM △Naphthoflavone, ANF; 10 μM 3’3-Diindolylmethane, DIM). Endpoints included cell viability (MTS assay), ALP activity, mineralization, and gene and protein expression of targets relevant to osteogenic differentiation.

**RESULTS:** CYP1A1 mRNA was induced in CSE-treated BMSC, as was ethoxyresorufin-o-deethylase (EROD) activity, both of which are markers for Ahr activation. CSE reduced cell number and ALP activity, and also inhibited mineral deposition relative to vehicle control. CSE also led to reduced expression of ALP, OCN, RUNX2, CXCL12, PHEX, and OPN transcripts. Co-treatment with each of the Ahr antagonists generally mitigated these effects.

**CONCLUSIONS:** Our results suggest that Ahr activation may play a critical role in the adverse effects of cigarette smoke on bone healing, and that these effects may be reduced with Ahr antagonist co-treatment. Administration of natural and synthetic Ahr antagonists should be investigated as a therapeutic option to block these inhibitory effects. The phytochemical-based Ahr antagonists used in this study are available over-the-counter as dietary supplements, and are currently under investigation in clinical trials for chemoprotective effects. The identification of safe Ahr antagonists that provide a protective effect against the negative impact of the dioxin-like compounds found in cigarette smoke on bone could answer the call for a therapeutic that may protect against the deleterious effects of smoking on bone healing.

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**16. Skeletal Muscle Cell Oxidative Stress as a Possible Therapeutic Target for Sarcopenia**

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**BACKGROUND CONTEXT:** Sarcopenia is an age-related disease characterized by the gradual decline of skeletal muscle mass, strength, and function. In recent times, sarcopenia research in relation to the spine has attracted great interest. It is well recognized that leg muscle atrophy can interrupt rehabilitation treatment in the perioperative period of spine surgery, with sarcopenia in the paraspinal muscle contributing to low back pain. Although oxidative stress has been reported to be involved in a number of human diseases, including musculoskeletal disorders such as sarcopenia, the relationship between sarcopenia and oxidative stress is not yet fully understood. Consequently, the purpose of this study was to elucidate the contribution of oxidative stress to muscle degeneration and the efficacy of antioxidant treatment for sarcopenia.

**METHODS:** Myoblast cell lines (C2C12) were treated with an antioxidant N-acetyl-L-cysteine (NAC). Apoptotic effects induced by oxidative stress were assessed by western blotting and MTCell viability assays. Animal sarcopenia models were made by axotomy of sciatic nerves-induced muscle atrophy. These rats were provided water containing NAC (1 g/L) for one week. The gastrocnemius muscle was isolated and stained with hematoxylin and eosin (H&E) one week after the axotomy, from which muscle cells were harvested and protein extracted for evaluation.

**RESULTS:** Results indicated that mitogen-activated protein kinase (MAPK) and cleaved caspase-3 were significantly activated by H2O2 treatment in C2C12 cells. Additionally, NAC was proven to inhibit the activation of MAPK and cleave caspase-3 in these cells, implying that NAC can prevent apoptosis in myoblasts. This indicates that oxidative stress is associated with apoptosis and NAC inhibits apoptosis in C2C12 cells. Furthermore, we showed that oral administration of NAC prevented amyotrophy and fatty degeneration in sarcopenic rats. Lastly, we observed only low levels of reactive oxygen species (ROS) in the muscle of rats administered NAC. These results indicated that oxidative stress produced ROS, resulting in apoptosis in C2C12 cells and rat muscle cells; particularly, NAC inhibited the apoptosis of muscle cells with antioxidant effects.

**CONCLUSIONS:** Considering the fact that oxidative stress contributes to the progression of sarcopenia, the current study revealed the potential of NAC as a future therapeutic drug for preventing amyotrophy and fatty degeneration add value to emerging research in this area.

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**17. Anatomical Analysis of the Lumbar Segmental Artery in the Oblique Lateral Interbody Fusion Approach Using Magnetic Resonance Imaging**

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**BACKGROUND CONTEXT:** Lateral interbody fusion (LIF) restores disc height and enables indirect decompression of narrowed spinal canals in patients with lumbar disease such as spondylolisthesis causing decreased disc height and foraminal narrowing. Some mini-open retroperitoneal LIF approaches, such as oblique lateral interbody fusion (OLIF), are safer and less invasive for achieving LIF and show sufficient efficacy. OLIF uses its own retractor system set in the anterolateral portion of an intervertebral disc (IVD). The mini-open OLIF approach can provide a small surgical field around the anterolateral portion of an IVD, which can include segmental arteries branched from the aorta. Insulting these arteries can cause massive hemorrhage, rendering the procedure unachievable.
**18. Mechanical Diagnosis and Therapy: Benefits of Early Access versus Delayed in Risk-Stratified Low Back Pain Populations**

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**BACKGROUND CONTEXT:** The importance of referral to MDT in the early onset of LBP is contested. It has been recently suggested that risk-stratifying patients experiencing an episode of LBP and/or leg referral pain improves efficiencies. Combining risk-stratification with early MDT intervention to determine the effect on patient-reported medical utilization and functional improvement is needed.

**PURPOSE:** To analyze functional improvement and patient-reported medical utilization of risk-stratified patients with low back pain (LBP) initiating Mechanical Diagnosis and Therapy (MDT) both within and greater than 15 days of symptom onset.

**STUDY DESIGN/SETTING:** The study design is a Cohort Case Series with post treatment and 12 month follow up. All physical therapists achieved Certification or Diplomate training in MDT, levels at which demonstrate acceptable inter-clinician reliability. IRB#1606M89061.

**PATIENT SAMPLE:** 173 consecutive patients completed an episode of care and submitted within-episode and 12 month data. Regardless of SBT risk level, 79% of early access patients compared to 55% of delayed access patients achieved a functional improvement by end of episode (p<.002), and maintained a statistically significant difference of 90% and 61% respectively at 12 month follow up (p<.036). 93% of high risk, early access patients achieved functional improvement at end of episode and at 12 months, compared to high risk, delayed access patients of which 41% achieved functional improvement at end of episode and 53% at 12 months. The overall mean ODI improvement for high risk patients was 77% for early access and 34% for delayed access patients at 12 month follow up (p<.001). 7% of patients accessing early MDT reported to seek additional medical utilization compared to 35% of delayed access patients.

**CONCLUSIONS:** Patients that access MDT within 15 days from LBP pain onset, specifically patients at high risk of long term disability, experience statistically significant functional improvement within the episode and maintain these results at 12 month follow up compared to patients delaying MDT. Early access to MDT significantly reduces patient self-reported seeking of additional medical utilization in the 12 months after LBP onset, likely due to more early access patients experiencing a functional improvement within the episode and maintaining for 12 months than patients delaying MDT.

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METHODS: We conducted a retrospective study on 112 individuals who underwent PLF surgery between January 2007 and October 2010. We used MRI to examine Modic changes and CT for endplate damage, by calculating a ratio of damaged endplates including adjacent bone marrow to the vertebral width, also to examine changes in the visual analogue scale (VAS) scores for lower back pain (LBP). Three experienced spine surgeons were involved in the judgment. RESULTS: Preoperative distribution of Modic changes was: 28 Type-1, 14 Type-2, and 48 Type-3 cases, and 32 cases showed no Modic change. After the surgery, 11 cases (9.0%) cases showed subtype change as following: Type 1 to normal: 3 cases, Type 1to 2: 3 cases, Type 2 to 3: 3 cases, and Type 3 to 2: 2 cases. However, significant improvement was found in the endplate damage ratio from an average of 48.5% to 32.8% which indicates bone remodeling. The remodeling was observed in 69 of 112 (61.6%) cases after spinal fusion. The LBP VAS score (cm) improved from 7.8 to 3.2 a month after the surgery, and was 3.5 at the final examination. No correlation was observed between Modic changes and endplate damage ratios. CONCLUSIONS: In the current study, Modic Type 1 signals changed to Type 2 or normal; however, Type 2 did not change to Type 1, suggesting that Type 2 signals indicate a stabilized stage. Type 2and 3signalsshowed reciprocal change, suggesting that these two were changeable each other. In contrast, endplate remodeling occurred more frequently than the Modic change alteration. The finding indicates the Modic changes are lacking in prompt reaction, and should be assessed in the evaluation of postoperative morphological change in combination with end plate degeneration by using CT imaging. However, postoperative Modic change on MRI bone remodeling on CT had no significant correlation with the LBP VAS scores. This indicates that LBP does not emanate from degenerations of the intervertebral disks and vertebral endplates in postoperative LSS patients. FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

20. The Impact of Immediate Post-Discharge Complications on Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) Survey Results in a Lumbar Spine Surgery Population

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BACKGROUND CONTEXT: Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) surveys are used to assess the quality of the patient experience, and directly influences reimbursement for hospital systems and spine surgeons nationwide. Since a portion of patients undergoing surgery will inevitably experience a postoperative complication, this is an element of surgical care that may influence patient satisfaction with their experience of care. Currently, there is conflicting evidence to suggest whether surgical complications affect patient responses on the HCAHPS survey. Also, HCAHPS are meant to capture the in-hospital experience, and therefore it is important to recognize whether immediate post-discharge complications may affect the survey responses.

PURPOSE: The purpose of this study is to investigate whether immediate post-discharge complications influence how lumbar spine surgery patients rate their experience of hospital care.

STUDY DESIGN/SETTING: This is a retrospective cohort study at a single tertiary care center.

PATIENT SAMPLE: This study includes 456 lumbar spine surgery patients who completed the HCAHPS survey between 2013 – 2015.

OUTCOME MEASURES: The HCAHPS survey - the Centers for Medicare and Medicaid Services’ official measure of patient experience - results for each patient were analyzed as the primary outcome of this study. Specifically, 22 individual survey items from the HCAHPS survey were included in our study.

METHODS: All patients undergoing lumbar spine surgery between 2013-2015 who completed an HCAHPS survey were studied. Patients were excluded from the study if they had been diagnosed with spinal malignancy or scoliosis. Patients who had an emergency department visit within 30 days of discharge were considered to have a post-discharge complication, and were therefore included in the complication group. The remaining patients were placed in the control group. The primary outcomes of this study include 22 measures of patient experience on the HCAHPS survey. Fisher’s exact test was used to determine whether there were any differences between the two study groups’ HCAHPS scores. Furthermore, multivariate logistic regression analysis helped identify whether these associations held after correcting for a number of covariates.

RESULTS: Patients who experienced a post-discharge complication were associated with lower HCAHPS scores for several items. Only 69.6% of patients with a complication always felt their doctor treated them with respect, compared to 89.8% of the control group (p=0.009). Also, 65.2% of patients with a post-discharge complication felt doctors always listened to them, compared to 84.0% of patients without a complication (p=0.039). As for global measures of satisfaction, patients with a complication were less likely to definitely recommend the hospital to family or friends (p=0.007) and were less likely to rate the hospital as a 9 or 10 out of 10, the top-box score (p=0.039). Multivariate logistic regression analysis found that having a post-discharge complication was independently associated with lower HCAHPS scores, even after correcting for a number of important covariates.

CONCLUSIONS: Our results show a strong association between post-discharge complications and low HCAHPS scores for doctor communication and global measures of satisfaction in a lumbar spine surgery population. These findings show that HCAHPS scores may be influenced by events immediately following discharge, even though HCAHPS are designed to reflect a patients perspective of in-hospital care.

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**RESULTS:** The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey has made patient experience a key driver of quality and reimbursement for hospital systems and spine surgeons nationwide. Patients with a history of prior spine surgery have been linked to worse outcomes, such as longer hospital stays and higher complication rates, following additional surgery compared to patients with no prior history of spine surgery.

**PURPOSE:** The aim of this study was to explore the effect that prior spine surgery may have on the HCAHPS scores of lumbar surgery patients. This research will help the field of spine surgery to understand factors that may influence patient experience. By identifying these factors, hospital systems and providers can better address the needs of patients affected by these factors.

**STUDY DESIGN/SETTING:** A retrospective cohort analysis was performed using HCAHPS survey data from patients who underwent lumbar decompression and/or fusion surgery at Cleveland Clinic Foundation’s Main Campus location from 1/1/2013-12/31/2015. HCAHPS survey data was supplemented by data collected via chart review and our institution’s Patient Experience database.

**PATIENT SAMPLE:** From 1/1/2013-12/31/2015, 405 patients underwent lumbar decompression and/or fusion surgery at Cleveland Clinic Foundation’s Main Campus location and also completed the HCAHPS survey. All of these subjects were included in the present study.

**OUTCOME MEASURES:** HCAHPS survey scores for each question associated with one of eight Patient Experience of Care domains (Communication with Doctors, Communication with Nurses, Responsiveness of Hospital Staff, Pain Management, Communication about Medicines, Hospital Cleanliness and Quietness, Discharge Information, Overall Hospital Rating) were the primary outcomes of this study.

**METHODS:** Prior surgery information was obtained via chart review and patients were stratified into three groups: no prior (n=258), one prior (n=96), and > 2 prior surgeries (n=56). Preoperative data for Patient Health Questionnaire (PHQ-9), EuroQol 5 Dimensions (EQ-5D), Pain Disability Questionnaire (PDQ), and Visual Analog Score for back pain (VAS-BP) were also analyzed.

**RESULTS:** A chi-squared analysis of preoperative quality of life and disability scores demonstrated a significant difference across the three groups (p=0.02 and p=0.002, respectively). Analysis of HCAHPS responses revealed significantly lower scores in patients with a history of prior surgery for questions pertaining to pain control (p=0.03) and overall rating of the hospital (p=0.04). Additionally, patients with two or more surgeries were found to have lower HCAHPS scores in doctor listening (p=0.01), doctor explanations (p=0.02), and staff response to pain control (p=0.01).

**CONCLUSIONS:** In our lumbar spine surgery cohort, history of prior lumbar spine surgery had a significant impact on several of the Patient Experience of Care domains as measured by the HCAHPS survey.

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P2. Longitudinal Evaluation of Histological Changes in a Rat Model of Paravertebral Muscle Injury Considering the Type of Pain

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BACKGROUND CONTEXT: Paravertebral muscle injury that occurs because of extended posterior approach during vertebral surgery has been suggested to prolong back muscle pain after the surgery. Previously, we had reported a time-series of histological changes in the injured paravertebral muscle and in the dominant nerve during the first 3 weeks post-injury in rats. So far, very few reports have described the time-series histological variation in injured tissues for durations greater than 3 weeks while considering the type of pain.

PURPOSE: To evaluate histological changes in injured paravertebral muscle and dominant nerve considering the type of pain over a longer period of 6 weeks.

STUDY DESIGN/SETTING: Animal model experiment

PATIENT SAMPLE: Sprague Dawley rats

OUTCOME MEASURES: histological evaluation of injured muscle by hematoxylin and eosin staining and L2 dorsal root ganglion byimmunohistochemistry technique

METHODS: We used 50 male-8-week old Sprague Dawley rats. The right and left sides of the paravertebral muscle were considered injured and uninjured sides, respectively. A 115-g weight was dropped from a height of 1 m on the right paravertebral muscle. FluoroGold, a sensory nerve tracer, was injected into the paravertebral muscle. Hematoxylin and eosin staining of the muscle was performed for histological evaluation. The L2 dorsal root ganglia on both sides were resected, and immunohistochemical staining for the calcitonin gene-related peptide(a pain-related neuropeptide) and activating transcription factor 3 (ATF3, a neuron injury marker) was performed. Each examination was performed at 3 days, 1 week, 2 weeks, 3 weeks, and 6 weeks after the injury.

RESULTS: Hematoxylin and eosin staining of the paravertebral muscle indicated infiltration of inflammatory cells and the presence of granulation tissue in the injured part on the ipsilateral side at 3 days and 1 week after the injury. Muscle atrophy occurred after 3 weeks. At 6 weeks, injured tissue was almost completely repaired. The percentage of cells double-labeled with FluoroGold and calcitonin gene-related peptide in FluoroGold-positive cells of the primary muscle was significantly higher in the injured side at all time points studied (3 days, injured side: 47.1 ± 6.1%, mean ± SD%, uninjured side: 29.2 ± 4.1%, P < 0.05; 1 week, injured side: 51.9 ± 9.4%, uninjured side: 25.6 ± 4.4%, P < 0.05; 2 weeks, injured side: 41.1 ± 7.9%, uninjured side: 21.3 ± 6.2%, P < 0.05; 3 weeks, injured side: 40.5 ± 5.4%, uninjured side: 20.4 ± 6.1%, P < 0.05). However, after 6 weeks, no significant difference was observed (injured side: 24.5 ± 6.9%, uninjured side: 26.4 ± 8.7%). No significant expression of ATF3 was observed.

CONCLUSIONS: Although the inflammatory phase in the injured muscles terminated after 1 week, the proportion of calcitonin gene-related peptide in dorsal root ganglions remained elevated for over 3 weeks. In contrast, ATF3 was not expressed at all, owing to insufficient neuron injury in the model. These results suggested that sensitization of the dominant nerve in dorsal root ganglia, which may be caused by cicatrix formation, can protract pain in the injured muscle. These data may be helpful in elucidating the mechanism of persistent pain after back injury.

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BACKGROUND CONTEXT: Minimally Invasive surgery has the same complication risks as traditional surgery, but with less morbidity. It is in the 3.5% range for all previously reported complicationsin the literature, in spite of pitfalls by operating near the DRG. Endoscopic documentation and visualization of patho-anatomy has also identified additional, but lesser known causes of sciatica and dysesthesia rare in the literature because there are few transforaminal surgeons compared to traditional translaminar surgery.

PURPOSE: To identify the risks of endoscopic transforaminal decompression, especially when the approach exposes other anatomic risks not readily known from the literature or from surgeons utilizing the translaminar approach, the risks can be compared with the known risks of translaminar decompression that has abundant literature compared to the lesser know transforaminendoscopic approach.


OUTCOME MEASURES: VAS, Oswestry, patient satisfaction

METHODS: Patients under going endoscopic foraminal surgery are prospectively studied and retrospectively reviewed. Painful and Inflammatory conditions and pathoanatomy identified with the endoscope recorded in vivo of over 10,000 cases since 1991 serves as the data base this study. Postoperative dysesthesia and complications in a continued and periodic review spanning over 10,000 consecutive endoscopic procedures for painful degenerative conditions of the lumbar spine for discogenic pain, herniated discs, spinal and foraminal stenosis was tabulated from surgical cases from 1991-2016 following an IRB approved study by Saint Lukes Medical Center, Phoenix, Arizona.

RESULTS: Postop and delayed dysesthesia, usually temporary and self-limited, occurred an average of 8-15% of the time. This was not considered a complication unless the dysesthesia resulted in a permanent residual of numbness or weakness. Findings of “anomalous” nerves, synovial cysts, inflammatory membranes and increased vasculature in the foraminal zone are routinely seen, even when not cited in the literature as a complication risk. Foraminal branches of the dorsal rami, neuromas, and branches of spinal nerves (furcal nerves) contribute significantly to the pre-and post-operative symptom complex. Furcal nerves in the foramen may be difficult to differentiate from a conjoined nerve and can look like foraminal ligaments. Autonomic nerves (confirmed by endoscopic excisional biopsy), have also been identified. The most common pathologic endoscopic finding is inflammatory and granulation tissue.
in the foramen, disc, and annulus. The presence of inflammation is correlated with pain. This finding correlated well with severe back pain and sciatica produced by evocative discography. It's severity postoperatively may be correlated with the extent of thermal annulopasty of the annulus or the presence of anomalous nerves in the foramen. Discussion of Results: Traditional complications of nerve root injury, incidental durotomy, infection, hematoma are much lower than in translaminar surgery, but new anatomic risks are part of the transforaminal approach that needs to be identified. Dysesthesia is a “complication” that is an unavoidable consequence just from surgical access through the foramen. Even when no adverse event occurs, during surgery, and when the surgery goes well. Surgeons working in the foramen through a paramedian posterior approach should encounters the same surgical risk. Working near the DRG, however, is a little a known risk by itself. Judicious ablation or removal of nerves in the inflammatory membrane, results in a satisfactory surgical outcome of overall pain relief, but may also produce a temporary side effect of dysesthesia of varied severity, by agressive ablation. Furcal nerves, when identified, are correlated with temporary dysesthesia. Dysesthesia is usually mild, self limited, and temporary, but a major concern to patients who get it severely postoperatively. Permanent residuals are rare, and usually self-limited, but may result in residual numbness and extremity weakness. Postoperative dysesthesia responds well to gabapentin or pre gabapentin, foraminal nerve blocks, and lumbar sympathetic blocks. Co-morbidities such as peripheral neuropathy of known or unknown etiology, and seizure disorders are additional risk factors encountered in the author’s personal extensive database.

CONCLUSIONS: Postoperative neuropathic pain staying the same or worsening, a risk of the endoscopic procedure, may not be able to be completely eliminated. Preoperative Consent should include neuropathic pain, usually transient, but with a possibility, but rare incidence of permanent numbness or weakness. A thorough discussion of the risks associated with foraminal surgery must be explained to any patient undergoing open or endoscopic foraminal surgery. Knowledge of the effect of foraminal epidural injections intraoperatively, postoperatively, and in the management of postoperative dysesthesia will decrease this adverse side effect of foraminal surgery. The overall risks and surgical morbidity are still less than posterior trans-canal surgery.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P4. Impact of Intraoperative Endplate Injury Incurred During Oblique Lateral Interbody Fusion Surgery with Midterm Follow-Up
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BACKGROUND CONTEXT: Endplate injuries incurred during interbody fusion surgery using the posterior approach are widely known to induce cage subsidence at high rates. However only few reports described cage subsidence in Oblique Lateral Interbody Fusion (OLIF), in which cages have larger bearing areas than those in posterior surgeries.

PURPOSE: The aim of this study was to validate the correlation between cage subsidence and bone union.

STUDY DESIGN/SETTING: A retrospective clinical study

PATIENT SAMPLE: Patients who underwent OLIF in our institution between January 2013 and May 2015 and examined using computed tomography (CT) before the surgery, at 1 week, and 1 year after surgery were included in this study.

OUTCOME MEASURES: Cage subsidence, bone union

METHODS: The new discontinuity of the bony end plate detected at 1 week after surgery was defined as early cage subsidence (ECS). Furthermore, progressing cage subsidence of >1 mm that is detected on sagittal sectional CT at 1 year after surgery compared to at 1 week was defined as delayed cage subsidence (DCS). Among four groups categorized according to the presence or absence of DCS and ECS, we made a comparative review of the following items: bone union, bone density, posterior screw (PS) loosening, the ratio of cage height to preoperative intervertebral disk height (cage-to-disk ratio), and visual analog scale (VAS) score. During the operation, we inserted a polyetheretherketone cage containing grafted bone between end plates and added a posterior instrumentation with pedicle screws for each patient.

RESULTS: Fifty-six patients (82 levels composed of 164 end plates) were included. Their mean age was 63.3 years. Of the patients, 34 were male. We detected 29 ECS (17.9%) which accompanied 12 DCS and 17 non-DCS. The remaining 135 non-ECS end plates bifurcated to 23 DCS and 112 non-DCS. The bone union rate in the ECS(+)DCS(+) group was 50.0%, which was significantly lower than that in the other groups (73.6%). The PS loosening ratio in the DCS(+) and DCS(−) groups were 25.7% and 7.0%, respectively, indicating a significant difference (p<0.01). Moreover, the cage-to-disk ratio in the ECS(+) groups were higher than those in the ECS(−) groups. To predict the occurrence of ECS, we set up the cutoff value of the ratio as 1.8 based on the receiver-operating characteristic curve. In the patients with values higher and lower than the cutoff, ECS was observed in 26.1% and 14.4%, respectively. Bone density and VAS score did not show significant differences.

CONCLUSIONS: Unless it induces DCS, bone union in the ECS(+) groups was not delayed when compared with the ECS(−) cases. Furthermore, the cage-to-disk ratio can be responsible for ECS, and PS loosening was significantly related to DCS. Therefore, this implied that avoiding one of such causative conditions could block the delayed bone union.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P5. Complications of Oblique Lateral Interbody Fusion in Chiba Prefecture, Japan
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BACKGROUND CONTEXT: Mini-open anterior retroperitoneal
lumbar interbody fusion surgeries have been performed widely and got a certain amount of approval these days. The complications associated with extreme lateral interbody fusion (XLIF) have been reported well. Meanwhile oblique lateral interbody fusion (OLIF) have not researched enough about their complications.

**PURPOSE:** To report the complications in OLIF surgery.

**STUDY DESIGN/SETTING:** multicenter study

**PATIENT SAMPLE:** All patients underwent OLIF surgery between April 2013 to May 2015 were included in Chiba prefecture, Japan.

**OUTCOME MEASURES:** Pre-surgical and postsurgical complications

**METHODS:** Questionary investigation was done among related hospitals in Chiba prefecture. Japan. All patients underwent OLIF surgery between April 2013 to May 2015 were included. PERSurgical and postsurgical complications were noted. Relations between incidence rate and experiments or occurrence period were evaluated.

**RESULTS:** 155 patients (male 44.7% and female 55.3%) underwent OLIF surgery in 11 institutions. Average age was 63.5 yrs (range 14-87). Diagnosis included lumbar spinal canal stenosis (65.2%), kyphoscoliosis (20.0%), lumbar discopathy (9.4%) and the others (5.4%). Overall 75 complications were reported and incidence rate was 48.3%. The highest complication was endplate fracture (18.7%), followed by transient psoas weakness and thigh dysesthesias (13.5%), segmental artery injury (2.6%), surface layer infection (1.9%) and so on. Almost all of them were transient or mild case. However only three cases suffered from permanent damage; ureteral injury (1 case), nerve root injury (1 case) and cauda equine damage (1 case). Although one patient died postoperative 1 week, it is certain that there was no relation between surgery and death. There was no difference in incidence rate of complications between supervisory doctor’s cases and other cases. The incidence rate of early period was 50% and improved to 38% in latter period.

**CONCLUSIONS:** Minor complications which present no clinical problem occurred in high rate, but major complications led to harmful result were rare in OLIF surgery. It is implied that even doctor-in-training can operate OLIF surgery safely as long as the supervisory doctor instruct appropriate procedure.

**FDA DEVICE/DRUG STATUS:** This abstract does not discuss or include any applicable devices or drugs.

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**P6. Prospective Evaluation of Sleep Quality in Patients Who Undergo Spine Surgery**

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**BACKGROUND CONTEXT:** Sleep disturbance is a frequent complaint among patients who present to our Orthopaedic Spine clinic. Long standing interruptions in normal sleep patterns can negatively affect multiple physiologic systems; cardiovascular, endocrine and psychiatric manifestations have been well established. Sleep hygiene is influenced by many variables. Patients with spine pathology often present with multiple medical co-morbidities which may affect sleep habits as well.

**PURPOSE:** This study was performed to establish an association between spine pathology (specifically radiculopathy and myelopathy) and sleep disturbance, as well as determine if sleep quality improves after surgical intervention.

**STUDY DESIGN/SETTING:** This is an ongoing IRB-approved, prospective cohort study performed at a single institution - a community hospital in a large metropolitan area.

**PATIENT SAMPLE:** 155 patients, consisting of 81 (52.3%) males and 74 (47.7%) females at an average age of 50.5 +/- 10.1 were included. The ethnic groups were comprised of 42.9% African Americans, 32.2% Caucasians, 20% Hispanic and 3.9% other. Average BMI was 31.9 +/- 6.7. The diagnoses were distributed as follows: 35 (22.6%) cervical radiculopathy/myelopathy, 102 (65.8%) lumbar radiculopathy and 18 (11.6%) combined cervical and lumbar pathology.

**OUTCOME MEASURES:** Patient Reported Outcomes Measurement Information System (PROMIS) 8a Sleep Disturbance Short Form, Visual Analog Scale (VAS), Oswestry Disability Index (ODI) and Neck Disability Index (NDI) scores.

**METHODS:** After written consent is obtained, patients are given PROMIS 8a Sleep Disturbance Short Form, VAS, ODI and NDI questionnaires. Demographic, physical exam and radiographic findings are then recorded. Demographic variables include age, gender, Body Mass Index (BMI), ethnicity and clinical depression or anxiety. Only patients with physical exam and radiographic findings consistent with lumbar or cervical radiculopathy/myelopathy are included in the study. Patients who undergo surgery are then given the same questionnaires at the six-week, three-month, six-month, and one-year postoperative visits.

**RESULTS:** The average preoperative PROMIS 8a score was 30.6 +/- 8.1 (T-score = 62.6); mean VAS was 76 +/- 2.0; mean ODI was 56 +/- 18% and mean NDI was 46 +/- 25%. In the sample of 155 patients, worse baseline PROMIS scores were predicted by combined cervical and lumbar disease (p=0.019), ODI (p<0.001) and VAS scores (p=0.003) of this cohort, 59 (38.1%) went on to have surgery. Three month follow-up data was available in 39 (66.1%) surgical patients. There was statistically significant improvement in the PROMIS score at six-weeks from 31.9 to 28.9 (T score = 59.4) (p<0.05). The PROMIS score remained 28.9 at the three month-post op visit. There was significant improvement in ODI (61% to 55%, p<0.05) over this interval. There was also significant improvement in VAS scores from 7.68 to 6.88 (p<0.05) at six-weeks and these further improved to 6.56 at three months postop. The only factor associated with improved PROMIS scores at three months was baseline PROMIS score (p=0.024). Age (p=0.34), gender (p=0.31), Ethnicity (p=0.43), BMI (p=0.33), location (p=0.53) and anxiety/depression (p=0.13) did not influence PROMIS score outcome.

**CONCLUSIONS:** Patients with lumbar and/or cervical radiculopathy or myelopathy have poor sleep quality as evidenced by a mean PROMIS 8a Sleep Disturbance score of 30.6, which is over a standard deviation above the mean (T-score = 62.6). Those with combined cervical and lumbar disease, worse ODI and VAS scores are more likely to have impaired sleep. Patients who undergo surgery are likely to have improved sleep hygiene by six weeks postop, and this remains improved at three months post op. The “minimally important difference” to suggest clinically meaningful change on many PROMIS scoring systems ranges from 2.5-6.0 points on the T-score. The change in T-score from 62.6 to 59.4 (3.2) falls within this range and suggests clinically relevant improvement. This effect is independent from variables that are associated with poor sleep quality such as age, BMI and clinical depression or anxiety.

**FDA DEVICE/DRUG STATUS:** This abstract does not discuss or include any applicable devices or drugs.
**P7. Evaluation of Sleep Disorders Associated with Acute Low Back Pain Using a Wearable Tracking Device**

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**BACKGROUND CONTEXT:** Patient-based outcome scores are mainly used for the evaluation of pathological conditions and therapeutic effects in patients with low back pain. Some reports indicate that patients with chronic low back pain have a sleep disorder, and that the amount of daytime activity and the results of sleep analysis should be considered as a part of a new quality of life (QOL) evaluation method. A wearable accelerometer (actigraph; Ambulatory Monitoring, Inc.) is a device that enables to capture daily physical activity. The purposes of this study were to investigate physical activity measured with an actigraph in patients with acute low back pain (aLBP), and to objectively evaluate the effect of sleep disorders on QOL.

**METHODS:** The subjects were 10 aLBP patients (P group) and 10 healthy individuals (C group). All participants wore a wrist actigraph for two weeks. For analysis of accumulated data, Cole and Kripke’s sleep/wake prediction algorithm was used. We assessed average body movement frequency during sleep, sleep efficiency, and total awake frequency in the two groups, and compared the results at the first visit with the results two weeks later in the P group. We also investigated correlations with the Japanese Orthopedic Association Back Pain Evaluation Questionnaire (JOABPEQ) and visual analog scale (VAS).

**RESULTS:** In a comparison between the two groups, the C group showed a significantly lower (p <0.01) body movement frequency and total awake frequency, and significantly higher sleep efficiency (95.0 ffl 2.2%) than the P group (89.0 ffl 4.4%; p <0.01). In comparison among subjects in the P group, there were no significant differences in the number of body movements, sleep efficiency, and total awake frequency, and also no correlation with the VAS. With regard to correlations with JOABPEQ, spinal and gait function scores improved from 36.8 and 54.6 at initial diagnosis to 51.4 and 67.3 at two weeks, respectively, but in cases with unimproved psychological and social function, there was a tendency toward an increase in the number of body movements and total awake frequency.

**CONCLUSIONS:** The current study objectively quantified sleep disorders in aLBP cases. Patients with aLBP were found to have sleep disorders similar to those with chronic low back pain, and even had decreased physical QOL at rest. In addition, although activities of daily living increased with improvement in low back pain, the absence of improvement in psychological factors tended to prolong the sleep disorder; this suggests that sleep disorders in aLBP may be derived not only from pain but also psychological factors. The use of an actigraph in aLBP patients can be useful for QOL evaluation.

**FDA DEVICE/DRUG STATUS:** This abstract does not discuss or include any applicable devices or drugs.

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**P8. Economic Performance of Oblique Lateral Lumbar Interbody Fusion (OLLIF) with a Focus on Hospital Throughput Efficiency**

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**BACKGROUND CONTEXT:** In recent years, the rate of disability due to low back pain has increased dramatically, and consequently, costs have skyrocketed. Advancements in the surgical treatment of lower back pain could benefit numerous patients annually and contribute to lower health care costs. Oblique posterior lateral lumbar fusion (OLLIF) is a surgical procedure designed for a minimally invasive spinal fusion. The OLLIF procedure allows for fusion of the lumbar spine through a single 10–15 mm incision, with faster surgery times and easier approach than any previous technique. This procedure is normally performed for patients that require a spinal fusion but do not want the recovery time required in a traditional spinal fusion surgery.

**PURPOSE:** The reduction in the use of key hospital resources suggests that hospitals that are constrained by OR or hospital bed availability may be able to achieve greater throughput efficiency by increasing the overall percentage of patients receiving the OLLIF surgery.

**STUDY DESIGN/SETTING:** This was a retrospective case series including 69 OLLIF patients and 55 open TLIF controls. The exempt status of this study, in accordance with FDA 21 CFR 56.104 and DHHS 45 CFR 46.101 regulations, was approved by the Pearl Institutional Review Board (15-TRIS-101; Indianapolis, IN 46225) in February 2015. To eliminate selection bias, the TLIF control group was selected from patients who underwent surgery before the surgeon started performing OLLIF. All 124 procedures were performed in two Minnesota hospitals: Douglas County Hospital, 111 17th Ave E, Alexandria, MN and Riverview Health, 323 Minnesota St, Crookston, MN. Surgeries were performed between March 2012 and December 2013. The study size derives from the number of surgeries accomplished in this time frame.

**PATIENT SAMPLE:** This was a retrospective case series including 69 consecutive OLLIF surgeries and 55 consecutive open TLIF controls.

**OUTCOME MEASURES:** Anesthesia/surgery times and blood loss were recorded for all patients by clinic staff and entered into the EMR database immediately after surgery. Because no suction is used in OLLIF procedures, blood loss for the OLLIF group was measured by weighing sponges and subtracting dry weight. To monetize the cost per minute for an operating room (OR) per case and for an average hospital day, a published reference for this amount was identified in the medical literature and adjusted by using consumer price index for medical costs. These values were reported both in aggregate and stratified based on the number of levels they had addressed at the time of their surgery (one, two, three or four).

**METHODS:** All procedures were completed by the same surgeon as single surgeon procedures. To eliminate selection bias, the TLIF control group was selected from patients who underwent surgery before the surgeon started performing OLLIF. All 124 procedures were performed in two Minnesota hospitals. Surgeries were performed between March 2012 and December 2013. The study size derives from the number of surgeries accomplished in this time frame. We present 69 OLLIF procedures, vs 55 open TLIFs on 125 levels, and monetize quantifiable differences in the resource utilization.

**RESULTS:** Overall, across all surgeries studied, LOS for OLLIF surgeries was 58.5% of that seen with TLIF surgeries (3.1 vs. 5.3
P9. Prophylactic Vertebral Cement Augmentation at the Uppermost Instrumented Vertebra and Rostral Adjacent Vertebra for the Prevention of Proximal Junctional Failure Following Long Segment Fusion for Adult Spinal Deformity

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BACKGROUND CONTEXT: Proximal junctional kyphosis (PJK) is a recognized postsurgical phenomenon after spinal fusion in both the treatment of adolescents idiopathic scoliosis (AIS) and adults after long segment instrumented fusion in adult spinal deformity (ASD). PJK occurs at the rostral junction between the fixed instrumented spinal segment and the mobile vertebral levels above. One surgical technique that may mitigate the development of PJK and proximal junctional failure (PJF) is the use of prophylactic vertebraloplasty (PV) with polymethyl methacrylate (PMMA). The placement of PMMA in the UIV has two potential benefits: increasing pedicle screw pull-out strength at the UIV and increasing the overall construct stiffness. Fusion alone in a long segment construct has been thought to increase stress at the UIV-1. Increasing construct stiffness at the UIV level alone with cement augmentation has been thought to load the UIV+1 and vertebral body, augmenting the forces that contribute to PJK.

PURPOSE: To assess the incidence in PJK and PJF in patients treated with prophylactic vertebral cement augmentation at the uppermost instrumented vertebra (UIV) and rostral adjacent vertebra.

STUDY DESIGN/SETTING: Retrospective cohort-matched surgical case series of adult adult spinal deformity patients that had undergone long-segment lumbar or thoracolumbar fusion (>5 levels).

PATIENT SAMPLE: 85 consecutive adult patients were identified with long segment (>5 levels) posterior thoracolumbar instrumented fusions for adult spinal deformity.

OUTCOME MEASURES: Preoperative and postoperative global and regional measurements of sagittal and coronal alignment were digitally measured for all patients which included the sagittal vertical axis (SVA), lumbar lordosis (LL), thoracic kyphosis (TK) and coronal angulation quantified with the Cobb angle method. Main structural and compensatory curves were identified using AP and lateral standing scoliosis films, as well as as side-bending radiographs. The location and frequency of the UIV, lower instrumented vertebra (LIV), sublaminar hooks at the UIV, anterior column interbody fusion, and the presence of a previous lumbar fusion were recorded. Spinopelvic parameters were assessed pre- and postoperatively, including the pelvic tilt, pelvic incidence, and sacral slope, using commonly reported methods. Two measurements were made in order to identify PJK. The first angle made was from the rostral endplate of the UIV and one rostral endplate above (defined as ‘UIV angle’). The angle of the rostral endplate of the UIV and two rostral endplates was then measured (defined as ‘UIV+1’ angle). Two rostral endplates above the UIV was selected as a correlate to measure the junction above the UIV+1 due to high intrasurgeon and intersurgeon concordance. Revision surgeries were identified in each group. The mean measurement of PJK was calculated in each group.

METHODS: Adult spinal surgery patients aged 18-80 were retrospectively identified who had undergone a long segment posterior fusion (>5 levels) for the indication of refractory back pain with significant loss of functional independence attributable to a loss of sagittal and/or coronal balance with radiographic and clinical progression. Common procedural terminology (CPT) code 22848 was chosen to identify adult spinal deformity patient due to the uniform use of pelvic instrumentation. Patients who had undergone vertebraloplasty of the thoracic spine were identified with CPT codes 22523 and 22520. Patients from the CPT code search were identified who had long segment posterior instrumented fusions in the thoracolumbar or lumbosacral spine. Two cohorts were studied, a control group where vertebraloplasty was not utilized at the time of surgery (Group A) and another group with PV at the UIV and UIV+1 at the time of instrumented fusion and deformity correction (Group B).

RESULTS: 85 total surgical patients were identified (mean age 64 years, SD = 11.1). Of that, 46 patients (54.1%) had adult degenerative idiopathic scoliosis and 39 patients (45.9%) had primarily a global sagittal imbalance (Table 1). 19 patients (22.4%) were identified with a prior lumbar spinal fusion (Table 2). 47 patients (56%) were identified (Group A) without cement augmentation and 38 patients (44%) (Group B) were identified with cement augmentation at the UIV and UIV+1. The respective mean age of groups A and B were 58.3 and 71.0 years, which differed significantly (p<0.0001). There were more females in patients without cement augmentation (33 vs. 15, p = 0.004) and significantly more patients with osteoporosis in patients with cement augmentation (10 vs. 24, p = 0.0001). There was no significant difference in patients with a prior lumbar fusion (10 vs 9 in groups A and B, respectively). However, there were significantly more patients with lumbar interbody fusion in group A (n=25(53.2%)) than in group B (4(10.5%)). There was no significant difference between groups in the frequency of the UIV, and the LIV where 81 of 85 (95.3%) patients were fused to the pelvis using iliac instrumentation. There was no significant difference in mean blood loss or operative duration. The mean follow-up duration was 28 and 11 months in Groups A and B, respectively. There was a significant difference in preoperative pelvic tilt (26.6 vs. 31.4, p = 0.032) and structural curve magnitude (21.1 vs. 11.1, p = 0.030). Postoperatively, there was a significantly greater SVA (4.0 vs. 2.5, p = 0.018) as well as lumbopevic mismatch (79 vs. 14.6, p=0.037) in the cement augmentation group. The mean UIV+1 angle was greater
postoperatively in patients treated without cement (10.0 degrees) as compared to the cement augmentation group (6.8 degrees, p =0.023). All of the six revisions encountered were in control patients (Group A), and there were no instances of compression fracture or PJF in the group treated with cement augmentation (Group B) (p=0.031).

In the patients requiring revision surgery for PJF, the UIV angle was larger (10.33 vs. 4.00, p=0.0006) and the UIV+1 angle was twice that of non-revision patients (16 vs. 8, p=0.001). Lumbopelvic mismatch was significantly lower in the revision surgery group (2.5 vs. 16 degrees, p =0.004).

CONCLUSIONS: The use of prophylactic vertebral cement augmentation at the uppermost instrumented vertebra and rostral adjacent vertebral segment at the time of deformity correction appears to be preventative in the development of proximal junctional kyphosis and failure.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

**P10.** Posterior Column Osteotomies with and without Multilevel Anterior Lumbar Interbody Fusion in the Management of Sagittal Plane Deformity

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BACKGROUND CONTEXT: The management of adult spinal deformity (ASD) is becoming increasingly prevalent. The restoration of lumbopelvic harmony and sagittal balance while minimizing blood loss and operative duration is a technical challenge with the use of pedicle subtraction osteotomies (PSO). Limited research has evaluated the use of posterior column osteotomies alone (PCOs), or PCOs combined with anterior lumbar interbody fusions (ALIFs) as an alternative surgical strategy for ASD.

PURPOSE: To assess the relative efficacy of posterior column osteotomies (PCOs) alone or PCOs combined with ALIFs for the correction of sagittal balance in the deformity patient.

STUDY DESIGN/SETTING: Retrospective cohort-matched surgical case series of adult spinal deformity patients that had undergone long-segment lumbar/thoracolumbar fusion (>5 levels), at a single academic institution.

PATIENT SAMPLE: 85 consecutive adult patients over a sixteen-year enrollment period were identified with long segment (>5 levels) posterior lumbar/thoracolumbar instrumented fusion for adults spinal deformity.

OUTCOME MEASURES: Preoperative and postoperative global and regional measurements of sagittal and coronal alignment were measured including the sagittal vertical axis (SVA), T1 pelvic angle (T1PA), central sacral vertical line (CSVL), lumbar lordosis (LL), thoracic kyphosis (TK) and Cobb angle method. Main structural and compensatory curves were identified using anteroposterior and lateral standing scoliosis films, as well as side-bending radiographs. The location and frequency of the UIV, lower instrumented vertebra (LIV), anterior lumbar interbody fusion (ALIF), and the presence of a previous lumbar fusion were recorded. Spondylolisthesis parameters were assessed pre- and postoperatively and on long-term follow-up. These included pelvic tilt, pelvic incidence, and sacral slope, using commonly reported methods. Revision surgeries were identified in each group. The mean measurement of proximal junctional kyphosis was calculated in each group.

METHODS: Adult spinal surgery patients aged 18-80 were retrospectively identified who had undergone a long segment posterior fusion (>5 levels) for the indication of refractory back pain with significant loss of functional independence attributable to a loss of sagittal balance with radiographic and clinical progression. These cases were consecutively registered in an administrative database throughout the study period. Two cohorts were studied, patients who had undergone polysegmental posterior column osteotomies (PCOs) (Group A), and patients that had underwent PCOs and one or more anterior lumbar interbody fusions (ALIFs) (Group B). Characteristics of the patient population were recorded including age, gender, BMI, and surgical indication. Serial radiographic imaging including standing upright 36-inch anteroposterior and lateral scoliosis x-ray studies were obtained preoperatively, postoperatively by hospital discharge, and on last-known follow-up. Measures of radiographic outcomes (see above, outcomes measures) were recorded, with attention to long-term follow-up.

RESULTS: Eighty-five patients with ASD were identified (mean age 64 years, SD = 11.1). Forty-six patients (54.1%) had adult degenerative idiopathic scoliosis and 39 patients (45.9%) had primarily a global sagittal imbalance. 19 patients (22.4%) were identified with aprior lumbar spinal fusion. There were 52 patients (61%) that had underwent a PCO alone and 33 patients (39%) that had underwent ALIF and PCO. The mean number of ALIFs was 1.968 ± 0.782 (range 1-4). The mean follow-up in the ALIF group was 29 ± 23.8 months, which was significantly greater than the control group (PCOs, 16.9 ± 15.8 months, p=0.02). Preoperatively, there was no statistically significant difference in the LL, TK, SVA, PI-LL mismatch, CSVL, and TIPA. There was no statistically significant difference in the number of PCOs in either group (4.08 vs 4.38, in groups A and B, respectively, p=0.11). Postoperatively, the lumbar lordosis was significantly greater in patients with ALIFs in addition to PCOs (61° vs 46°, p=0.05). Lumbopelvic harmony was more closely restored in patients with both ALIF and PCO (11.7 vs 16.3°, p=0.02). While there was no significant differences in the CSVL and SVA postoperatively, the TIPA, a positional-independent marker of global deformity was markedly improved in patients with the addition of ALIF (10.2° vs. 19.9°, p<0.00005). At long-term follow-up, the TIPA was 12.1° and 20° in the ALIF and PCO-only groups, respectively (p=0.0025). The reduction in SVA at long term was 3.11 cm in the ALIF group and 4.81 cm in controls, but this did not reach statistical significance.

CONCLUSIONS: The use of anterior lumbar interbody fusion in tandem with multiple posterior column osteotomies is an effective treatment strategy for the restoration of sagittal alignment in adults. Larger, homogeneous patient populations with prospective enrollment are needed to determine if the superior corrections of global deformity demonstrated on postoperative and long-term radiographs by the T1 pelvic angle are attributable to the addition of anterior column support.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
P11. Outcomes Following Posterior Cervical Fusion Among Octogenarians with Cervical Spondylotic Myelopathy: A NSQIP Database Analysis

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BACKGROUND CONTEXT: Degenerative changes in the cervical spine occur in an age-dependent manner. As the U.S. population continues to age, the incidence of age-dependent, multi-level, degenerative cervical pathologies is expected to increase. Similarly, the average age of patients with cervical spondylotic myelopathy (CSM) should trend upward. Posterior cervical fusion (PCF) is often the treatment modality of choice in the management of multi-level cervical spine disease. Although outcomes following anterior cervical fusion for degenerative disease have been studied among older patients (aged 80 years and older), it is unknown if these results extend to octogenarian patients undergoing PCF for the surgical management of CSM.

PURPOSE: The present study aimed to quantify national trends in surgical outcomes following PCF for the treatment of CSM among the octogenarian patient population, as compared to patients younger than 80 years old.

STUDY DESIGN/SETTING: This was a retrospective study that used the National Surgical Quality Improvement Project (NSQIP).


OUTCOME MEASURES: The outcome measures were 30-day morbidity, discharge disposition (to home or skilled nursing/rehabilitation facility), 30-day all-cause readmission, and 30-day reoperation.

METHODS: The NSQIP was queried for CSM patients aged 60-89 who underwent PCF from 2012-2014. Cohorts were defined by age group (60-69, 70-79, 80-89). Data was collected on gender, race, elective or emergent status, inpatient or outpatient status, ASA class, comorbidities, and single- or multi-level fusion. After controlling for these variables, logistic regression analysis was used to compare outcome measures in the different age groups.

RESULTS: 2,067 patients with CSM who underwent PCF (1,087 aged 60-69, 745 aged 70-79, 235 aged 80-89) were identified from 2012-2014. 74.8% of PCF procedures were multi-level. There were no significant differences in the odds of major morbidity, readmission, or reoperation when comparing octogenarian patients to patients aged 70-79 or when compared to patients aged 60-69. Patients over 80 were significantly more likely than 60-69 year olds to be discharged to a rehabilitation or skilled nursing facility (OR 1.80, 95% CI 1.55-2.10, p<0.0001); however there was no significant difference between 80-89 and 70-79 year olds.

CONCLUSIONS: Compared to patients aged 60-69, octogenarian patients with CSM were significantly more likely to be discharged to a place other than home following PCF. After controlling for patient comorbidities and demographics, 80-89 year old CSM patients undergoing PCF did not differ in outcomes when compared to patients aged 70-79. These results can improve preoperative risk counseling and surgical decision-making.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P12. Surgeon-Level Variability in Cost and Outcomes for Elective Anterior Cervical Discectomy and Fusion

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BACKGROUND CONTEXT: The costs and outcomes following degenerative spine surgery may vary from surgeon to surgeon. These variations are not well studied in the literature.

PURPOSE: We set out to understand the variation in patient profiles, costs, and outcomes for each surgeon performing anterior cervical discectomy and fusion (ACDF) for degenerative cervical spine disease at a single center.

STUDY DESIGN/SETTING: Analysis of prospective longitudinal registry based data.

PATIENT SAMPLE: Patients undergoing elective ACDF surgery for cervical spine degenerative pathologies, performed by five surgeons, were analyzed.

OUTCOME MEASURES: Total 3-month patient-reported outcomes (PROs) and 90-day cost included the hospital cost, surgeons’ professional cost and post-discharge resource utilization.

METHODS: Multivariate regression model was built for high-cost surgery (above third quartile) and a separate linear regression model was built to derive comorbidity adjusted 90-day costs.

RESULTS: There were no significant differences in 90-day PROs among the surgeons (Table 1). In multivariable model, compared to surgeon #1, surgeons #3 (OR=0.31, 95% CI=0.15 – 0.63, P=0.001) had lower odds and surgeon #4 (OR=2.5, 95% CI=1.1 – 5.7, P=0.034), had higher odds of performing high-cost ACDF surgery. Interestingly, the comorbidity-adjusted costs were significantly higher than the actual 90-day costs for surgeons #3 (p<0.001), and #5 (p<0.005), whereas they were significantly lower than the actual costs for surgeons #1 (p<0.0001), and #4 (p<0.0001).

CONCLUSIONS: Our study provides valuable insight into variations in outcomes, and 90-day costs among the surgeons performing elective ACDF at a single institution. Specific surgeons were found to have greater odds of performing high cost surgeries. Adjusting for preoperative comorbidities, however, led to costs that were higher than the actual costs for certain surgeons and lower than the actual costs for others. Patient’s preoperative comorbidities must therefore be accounted for when crafting value-based bundled payment models.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
P13. Improvement in Disability and Quality of Life and Pain 12-Month after Elective Spine Surgery for Degenerative Cervical Radiculopathy: Analysis from Quality Outcome Database

Anthony L. Asher, MD1; Silky Chotai, MD2; Clinton J. Devin, MD2; Mohamad Bydon, MD3; Matthew J. McGirt, MD3; Kristin Archer, PhD, DPT4; Steven D. Glassman, MD4; Christopher I. Shaffrey, MD5


BACKGROUND CONTEXT: In the current era of value-based health care reform engaging patients in shared-decision making in their treatment planning is imperative. Predictive model capable of providing individualized predictions of patient-reported outcomes (PROs) following cervical spine surgery is not yet developed.

PURPOSE: In this analysis, we set out to introduce predictive models for 12-month postoperative disability, quality of life, and pain outcomes in patients undergoing elective spine surgery for degenerative cervical radiculopathy.

STUDY DESIGN/SETTING: Analysis of prospective multicenter longitudinal registry based data.

PATIENT SAMPLE: A total of 2154 patients undergoing degenerative cervical spine surgery were entered into a prospective multi-center registry (QOD).

OUTCOME MEASURES: Baseline and 12-months neck related disability (NDI), quality of life (EQ-5D) and pain [NRS- neck pain (NP) and arm pain (AP)] were recorded.

METHODS: Multivariable proportional odds ordinal logistic regression model was fitted for 12-month PROs. Calibration and discrimination were internally validated using bootstrap resampling to estimate likely performance of the model on a new sample of patients.

RESULTS: There was a significant improvement in all PROs (p<0.0001) at 12 months after surgery (P<0.0001). The most important predictors of overall disability, QOL, and pain outcomes, in descending order, were baseline PROs scores, symptom duration, psychological distress, age, Worker’s compensation status, ASA grades, patients’ level of education, employment status, and race. The prediction discrimination for models were: NDI-0.70, EQ-5D-0.71, NRS-BP-0.68, and NRS-LP-0.65.

CONCLUSIONS: We present prediction models that can provide individualized risk-adjusted estimates of 12-month disability, quality of life, and pain outcomes for patients undergoing spine surgery for cervical radiculopathy. Novel predictive models constructed with these data hold the potential to have individualized patient discussions on outcomes and expectations.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P14. Improvement in Disability and Quality of Life and Pain 12-Month after Elective Spine Surgery for Degenerative Cervical Myelopathy: Analysis from Quality Outcome Database

Mohamad Bydon, MD1; Silky Chotai, MD2; Clinton J. Devin, MD2; Matthew J. McGirt, MD3; Kristin Archer, PhD, DPT4; Steven D. Glassman, MD4; Christopher I. Shaffrey, MD5; Anthony L. Asher, MD3


BACKGROUND CONTEXT: In the current era of value-based health care reform, engaging patients in shared-decision making in their treatment planning is imperative. Predictive model capable of providing individualized predictions of patient-reported outcomes (PROs) following cervical spine surgery is not yet developed.

PURPOSE: We set out to introduce predictive models for 12-month postoperative disability, quality of life, pain and myelopathy outcomes in patients undergoing elective spine surgery for degenerative cervical myelopathy.

STUDY DESIGN/SETTING: Analysis of prospective multi-center registry based data.

PATIENT SAMPLE: Patients undergoing elective spine surgery for cervical myelopathy that were entered into a prospective multi-center registry (QOD) were analyzed.

OUTCOME MEASURES: Baseline and 12-months neck related disability (NDI), quality of life (EQ-5D), pain [NRS- neck pain (NP) and arm pain (AP)] and modified Japanese Orthopedic Association score for myelopathy (mJOA) were recorded.

METHODS: Multivariable proportional odds ordinal logistic regression model was fitted for 12-month PROs. Calibration and discrimination were internally validated using bootstrap resampling to estimate likely performance of the model on a new sample of patients.

RESULTS: A total of 912 patients were analyzed. There was a significant improvement in all PROs (p<0.0001) at 12 months after surgery (P<0.0001). The most important predictors of overall outcomes, in descending order, were baseline PROs scores, pre-operative ambulatory status, psychological distress, patients’ employment status, patients’ education status, symptom duration, age, and history of diabetes. The prediction discrimination for models were: NDI-0.69, EQ-5D-0.69, NRS-BP-0.68, NRS-LP-0.68 and mJOA-0.73.

CONCLUSIONS: We present prediction models that can provide individualized risk-adjusted estimates of 12-month disability, quality of life, pain, and myelopathy outcomes for patients undergoing spine surgery for cervical myelopathy. Novel predictive models constructed with these data hold the potential to have individualized patient discussions on outcomes and expectations.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
P15. Comorbid Conditions as Predictors of Postoperative Outcome Following Cervical Spine Surgery: A Survey of United States Orthopaedic and Neurological Surgeons

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BACKGROUND CONTEXT: The direct relationship between comorbid conditions and postoperative outcome following cervical spine surgery has not been well described. Although some data have been presented, there remains a lack of consensus among surgeons regarding the value of common comorbidities as predictors of poor postoperative outcome.

PURPOSE: To elicit surgeons’ beliefs regarding the value of common comorbidities as predictors of poor postoperative outcome following cervical spine surgery.

STUDY DESIGN/SETTING: Nationally-distributed electronic survey

OUTCOME MEASURES: 5-point Likert scale

METHODS: An electronic survey was distributed to orthopaedic and neurological surgeons throughout the United States. In addition to providing demographic information, respondents were asked to rate the value of five comorbidities as predictors of poor postoperative outcome following cervical spine surgery. The following comorbidities were surveyed: history of smoking, chronic narcotic use, diabetes, obesity, and psychosocial complication (e.g., depression, anxiety). Study participants recorded their responses using a 5-point Likert scale that ranged from 1 – “very weak predictor” to 5 – “very strong predictor”.

RESULTS: 164 surgeons completed the survey, including 126 orthopaedic surgeons (76.8%) and 38 neurological surgeons (23.2%). All major U.S. geographical regions were represented. Psychosocial complication and narcotic use were deemed the strongest predictors of poor postoperative outcome, with mean Likert values of 4.0 and 3.9, respectively. Smoking was assigned a “moderate” predictive value of 3.0 on the 5-point scale. Diabetes and obesity were designated as “weak” predictors with values of 2.7 and 2.8, respectively. Interestingly, the comorbidities with the highest overall Likert ratings – psychosocial complication and narcotic use – were also the greatest sources of discrepancy among responding surgeons. Orthopaedic surgeons assigned a higher predictive value to narcotic use (3.9 vs. 3.6, p=0.032) and psychosocial complication (4.1 vs. 3.8, p=0.055) compared to neurological surgeons. Similarly, surgeons who perform fewer than 150 spine surgeries per year deemed narcotic use (4.1 vs. 3.7, p=0.028) and psychosocial complication (4.3 vs. 3.9, p=0.017) significantly more predictive of poor postoperative outcome than their colleagues who perform at least 250 spine cases annually. Fellowship-trained surgeons also rated narcotic use (3.9 vs. 3.6, p=0.074) and psychosocial complication (4.1 vs. 3.8, p=0.085) higher on the Likert scale compared to surgeons who were not fellowship-trained, although this difference did not reach significance. In addition to narcotic use and psychosocial complication, history of smoking also generated significant disagreement among surgeons stratified by practice setting. Surgeons practicing in an academic center rated smoking more predictive of poor postoperative outcome than their colleagues in a hybrid practice (3.3 vs. 2.8, p=0.008) or private practice (3.3 vs. 3.1, p=0.133). Fellowship-trained surgeons also rated smoking higher on the Likert scale than surgeons who were not fellowship-trained (3.1 vs. 2.8, p=0.083); again, however, this difference fell short of reaching significance.

CONCLUSIONS: Surgeons across all demographic backgrounds showed consensus with regard to the role of obesity and diabetes as weak predictors of poor postoperative outcome. With respect to narcotic use and psychosocial complication, however, surgeons’ opinions varied by specialty, annual case volume, and fellowship training. Further studies are needed to investigate the educational and institutional factors underlying this discordance, as well as to determine whether the comorbidities with the highest Likert ratings are indeed the strongest predictors of poor postoperative outcome.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P16. Ossification of the Ligamentum Flavum: 17 Years Personal Experience, Lessons Learned

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BACKGROUND CONTEXT: Ossification of the ligamentum flavum (OLF) is an important cause of thoracic myelopathy in the Asian population. The severity of the disease may vary from single level involvement to multiple level involvement which may be contiguous or non-contiguous. The diverse etiology, the importance of proper pre-operative evaluation which includes preoperative identification of dural ossification, intra-operative difficulties, immediate postoperative complications and outcome are not adequately highlighted in the literature.

PURPOSE: To report this author’s personal experience with 35 cases of Ossification of the Ligamentum Flavum (OLF) treated during a period of 17 years with a specific emphasis to highlight certain under-reported facets of this disease.

STUDY DESIGN/SETTING: Retrospective review of prospectively collected data.

PATIENT SAMPLE: Total number of patients: 35. Age range: 19 – 70 years; Male: Female- 25:10

OUTCOME MEASURES: Nurick’s grading and JOA score for Thoracic myelopathy were used for preoperative and postoperative assessment of neurological function.

METHODS: All patients with myelopathy due to OLF treated by this author were included. Neurological status was graded using Nurick’s scale and JOA Score for Thoracic myelopathy. Plain radiographs, whole spine MRI & CT of the spine at the affected levels to look for dural ossification were performed. Preoperative CT was specifically done to identify the signs of dural ossification – “tram track sign” and the “comma sign”, described by us earlier. The excised specimen was submitted for identification of calcium pyrophosphate dihydrate deposition disease (CPPD). Patients were also evaluated for the presence of fluorosis, DISH or other known causes of OLF. Complications were recorded and the postoperative status was assessed. Mean follow up was 14 months

RESULTS: Period of study: 1998 -2015. Lower thoracic region was the most commonly involved site, especially, T9- T12 followed by mid and upper thoracic levels. Three patients had cervical OLF.
PURPOSE: The purpose of this work is to present clinical and radiographic outcomes of MIS lateral corpectomy in the treatment of thoracolumbar junction spine fracture.

METHODS: Twenty-eight consecutive patients [16 men, 12 women, mean age 47.3, mean BMI 25.4] with thoracolumbar junction fractures (T11-L3) treated with a mini-open lateral corpectomy and anterolateral/posterior instrumentation. All 28 patients were successfully treated with mini-open lateral corpectomy and anterolateral/posterior instrumentation. Mean total estimated blood loss was 430 cc, operative time was 128 minutes, and length of postoperative hospital stay was 7.1 days, though excluding outliers with extended hospitalizations (19 and 22 days) due to polytrauma injuries at admit, average LOS was 5.8 days. No complications were observed through last follow-up and three reoperations were performed. Preoperatively, lumbar lordosis, segmental angle, and fractured segment height were -47.4 degrees, -9.5 degrees, and 28.8mm, respectively. Postoperatively, the same measurements were -50.4 degrees (+6%), 4.2 degrees (+13.7%), and 43.3 mm (+50%), respectively. At last follow-up, the measurements were -49.3 degrees (from preop = +4%; from postop = -2%), 1.2 degrees (+10.7 degrees; -2.5 degrees), and 44.7 mm (+55%; +3%), respectively. Average radiographic follow-up was 15.8 months (range 1-46).

CONCLUSIONS: The results show the technical feasibility of two-column MIS corpectomy and fixation for a variety of pathology, with low morbidity and substantially improved and maintained radiographic outcomes through mid-term time points.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P17. Clinical and Radiographic Outcomes of Thoracolumbar Fractures Treated by Corpectomy and Fusion Through a Mini-Open Lateral Approach

William D. Smith, MD; Nick Ghazarian, DO; Xueshi Li, MD, PhD

BACKGROUND CONTEXT: Controversies exist in the optimal management of thoracolumbar fractures. MIS approaches, including the 90 degree mini-open lateral extracavitary approach, are increasingly being used for corpectomies, though radiographic data available to guide fracture treatment decision making for these newer approaches is scarce.

PURPOSE: The purpose of this work is to present clinical and radiographic outcomes of MIS lateral corpectomy in the treatment of thoracolumbar junction spine fracture.

OUTCOME MEASURES: The cadaver decompression efficiency was quantified as the relative changes of the lateral recess diameter, taken preoperatively, typically on midsagittal CT as patients were not ambulatory, immediately postoperatively, and at last follow-up. Measurements were made using SurgiMap image analysis software.

RESULTS: All 28 patients were successfully treated with mini-open lateral corpectomy and anterolateral/posterior instrumentation. Mean total estimated blood loss was 430 cc, operative time was 128 minutes, and length of postoperative hospital stay was 7.1 days, though excluding outliers with extended hospitalizations (19 and 22 days) due to polytrauma injuries at admit, average LOS was 5.8 days. No complications were observed through last follow-up and three reoperations were performed. Preoperatively, lumbar lordosis, segmental angle, and fractured segment height were -47.4 degrees, -9.5 degrees, and 28.8mm, respectively. Postoperatively, the same measurements were -50.4 degrees (+6%), 4.2 degrees (+13.7%), and 43.3 mm (+50%), respectively. At last follow-up, the measurements were -49.3 degrees (from preop = +4%; from postop = -2%), 1.2 degrees (+10.7 degrees; -2.5 degrees), and 44.7 mm (+55%; +3%), respectively. Average radiographic follow-up was 15.8 months (range 1-46).

CONCLUSIONS: The results show the technical feasibility of two-column MIS corpectomy and fixation for a variety of pathology, with low morbidity and substantially improved and maintained radiographic outcomes through mid-term time points.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P18. Spinal Decompression Using a Curved High-Speed Drill-Like Device: Comparison to Traditional Methods in Cadaver Study and Clinical Experience

Michal Tepper, PhD; Nahshon Rand, MD; William Beutler, MD, FACS; Walter Peppelman, DO; Ely Ashkenazi, MD; Richard D. Guyer, MD

BACKGROUND CONTEXT: Foraminotomy is a decompression procedure performed to increase the size of the foraminal volume in order to prevent nerve root compression and the consequent pain and neurological symptoms. This operation is gaining popularity due to its advantages, particularly over spinal fusion: Shorter procedure time, hospitalization and recovery and significantly lower cost. Unfortunately, in some cases, sufficient decompression cannot be achieved without compromising structural stability. Therefore, improving surgeon ability to perform this procedure effectively, especially on difficult-access areas, improves treatment quality and allows more patients to benefit from its advantages. A recently developed device with a shielded curved high-speed drill, can offer potential improvement, since it enables access to difficult areas while protecting neural elements, allowing the surgeon to reduce healthy bone destruction while significantly increasing the foraminal volume.

PURPOSE: This study aims to estimate decompression efficiency using the new device, compared with traditional techniques, in a cadaver study and the accumulated clinical experience.

STUDY DESIGN/SETTING: A cadaver study and a retrospective cohort patient study.

PATIENT SAMPLE: All relevant patients were included.

OUTCOME MEASURES: The cadaver decompression efficiency was quantified as the relative changes of the lateral recess diameter,
foraminal area, minimal-foraminal-volume (the product of the foraminal area and the lateral recess diameter, a conservative estimate of foraminal volume), and the pars interarticularis (pars) diameter (marker for potential spinal instability). For the clinical case-series, intraoperative parameters and postoperative parameters were compared with a matched control series.

METHODS: The cadaver procedures were performed using both methods on the lumbar vertebrae of three cadavers. CT scans were performed before and after the procedures in order to quantify decompression efficiency and the extent of bone removal and the measurements were compared in order to assess their relative performance. The case series included five patients, with six treated levels, previously candidates for fusion surgery due to suspected insufficient decompression ability, who underwent decompression using the device.

RESULTS: The improvements of the foraminal area, the lateral recess diameter and the minimal-foraminal-volume were higher by 129%, 92% and 115%, respectively, for the cadaver foramina treated by the new device compared to the foramina treated by traditional methods (p=0.11, 0.11 and 0.03, respectively). Pars decrease was reduced by 24% on average and was found to be statistically not inferior to traditional methods (p=0.01), suggesting that this device enables a more effective procedure while requiring less unrelated bone removal. All clinical procedures were uneventful. Operation length was 22-43 and 48 minutes for single-level and two-level procedures, respectively. 14 minutes less (31%) than traditional decompression. An average of 1.7 device passes was required for each foramen. The average length-of-stay was shorter by 0.6 and 3.4 days compared with traditional decompression and fusion, respectively. Patient pain and disability significantly improved at follow-up.

CONCLUSIONS: The new device enables an over-twofold increase in foraminal volume compared to traditional methods without compromising spinal stability, allowing more patients to avoid fusion in favor of a decompression procedure.

FDA DEVICE/DRUG STATUS: The Dreal Tissue Removal Device (Approved for this indication)

P19. Incidence of Non-Fracture Pathology in Osteoporotic Vertebral Compression Fractures During Kyphoplasty

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BACKGROUND CONTEXT: Osteoporosis is a common disease that often manifests itself as fragility fractures at multiple skeletal sites including the spine, hip, or wrist. The prevalence of osteoporosis is anticipated to rise to over 14 million people in 2020. Patients with osteoporotic fractures were found to have significantly lower physical and mental domains and increased mortality when diagnosed with osteoporotic spinal fractures. Recent literature suggests strong evidence for the treatment of symptomatic vertebral compression fractures using cement augmentation through vertebroplasty or kyphoplasty. Balloon kyphoplasty has shown to reduce pain and improve function, disability, and quality of life when compared to nonsurgical treatment. Furthermore, biopsies obtained at the time of percutaneous vertebroplasties have had inconsistent outcomes in unexpected malignancy percentages.

PURPOSE: The purpose of this retrospective study was primarily to evaluate the incidence of non-fracture related pathology when performing biopsies during balloon kyphoplasty for presumed benign osteoporotic vertebral compression fractures. Secondary purpose was to evaluate subjective pain improvement at the fracture site after being treated with kyphoplasty.

STUDY DESIGN/SETTING: A retrospective histologic evaluation of biopsies obtained during balloon kyphoplasty as treatment for presumed osteoporotic vertebral compression fractures.

PATIENT SAMPLE: Between 2006 and 2012, 264 consecutive patients diagnosed with presumed osteoporotic vertebral compression fractures at Good Samaritan Regional Medical Center in Corvallis, OR were retrospectively reviewed for inclusion into the study. Patients who had undergone balloon kyphoplasty and biopsy by a single surgeon with final pathology results were included in this study.

OUTCOME MEASURES: The incidence of non-fracture pathology was evaluated based on biopsy results following balloon kyphoplasty. Subjective pain improvement at the fracture site after being treated with balloon kyphoplasty was also analyzed.

METHODS: Electronic medical records of 264 consecutive patients who were diagnosed with presumed osteoporotic vertebral compression fractures were reviewed. 243 patients with biopsy results following single or multi-level balloon kyphoplasty were analyzed to obtain the incidence of non-fracture pathology. 251 patients had available follow-up information to evaluate subjective pain improvement at the fracture site.

RESULTS: Of the 243 patients, 11 patients (4.5%) had non-fracture pathology and 232 patients (95.5%) had fracture pathologies. 299 total levels were available for analysis and 14 levels (4.7%) had non-fracture pathologies while 285 levels (95.3%) had fracture pathologies. 225 patients (89.6%) reported improvement in pain symptoms. 26 patients (10.4%) did not report improvement in pain symptoms. There was no significant difference in non-fracture pathology between men and women.

CONCLUSIONS: Obtaing bone biopsies during balloon kyphoplasty can help verify the process underlying vertebral compression fractures. This study demonstrated an incidence of non-fracture pathology in 4.5% of patients and routine obtainment of bone biopsies at the time of treatment for vertebral compression fractures can help avoid missing underlying malignancies.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P20. Operative versus Non-Operative Management of Civilian Gunshot Wounds to the Spine

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BACKGROUND CONTEXT: As gun-violence has continued to rise in recent years, the ballistic spinal cord injury has made its way from the militant battlefields to the more urban environments. Surgery for patients with spinal cord injury from gunshot wounds (GSCI) remains controversial. Some studies suggest improvement in functional outcomes with surgery for GSCI, particularly for those patients with
including any applicable devices or drugs.

PURPOSE: To analyze the difference in functional outcome measures of patients with GSCI who underwent surgical treatment for their injuries compared to those who were managed non-surgically.

METHODS: GSCI patients were divided into surgical (SX) and non-surgical (NSX) groups. Neurological function was measured according to the ASIA impairment scale (AIS) and defined as either complete or incomplete injuries. Outcomes were then analyzed separately for complete and incomplete GSCI groups during hospitalization and acute rehabilitation.

RESULTS: A total of 104 GSCI patients were identified from the trauma registry; 67 with complete GSCI and 37 with incomplete GSCI. For complete GSCI, 16 (24%) patients underwent surgery. Mean outpatient rehab follow-up was 26.9 months. Baseline admissions characteristics were similar between SX and NSX groups except for a higher median injury severity score (ISS) in the NSX group (34 vs. 27; p=0.02). For complete GSCI, total length of stay (LOS) was significantly longer in the SX group (52 vs. 42 days; p=0.04) and no difference was observed in overall FIM scores at discharge from rehabilitation (58 vs. 54; p=0.7). For incomplete GSCI, 7 (19%) patients underwent surgery. All baseline admission characteristics were similar between SX and NSX groups. For incomplete GSCI, rehabilitation LOS was longer (35 vs. 21; p=0.02) and a trend towards longer total LOS was observed in the SX group (40 vs. 32; p=0.07). No difference was observed in overall FIM scores at discharge from rehabilitation (61 vs. 62; p=0.9).

CONCLUSIONS: Surgery for patients with GSCI is associated with increased LOS and is not associated with improved FIM scores for patients with either complete or incomplete spinal cord injuries. To our knowledge, we are the first to incorporate FIM scores in the evaluation for patients with GSCI. These results likely reflect an increase in the already staggering health care costs associated for those patients with GSCI who undergo operative treatment of their injuries.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
P22. Intermediate Screw in Thoracolumbar Fracture Fixation: Does it Maintain the Correction?

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BACKGROUND CONTEXT: Thoracolumbar spine fractures are one of the most common types of traumatic injury, with approximately 90% of spinal fractures occurring at the thoracolumbar segment. Those fractures can be managed conservatively or surgically. The pedicle screw–rod construct is popular methods in posterior instrumentation and fusion. Which can be done using either open or percutaneously using the minimally invasive technique (MIS). The screw usually inserted in the above and below pedicle of fracture vertebra and sometimes in the fractured one also.

PURPOSE: We aim to figure out if the using intermediate screw will maintain the correction of fractured vertebra

STUDY DESIGN/SETTING: Retrospective case series

PATIENT SAMPLE: 100 cohort of one level fracture with short-segment posterior instrumentation with or without intermediate screw (IS) (screws at the level of the fractured vertebra).

OUTCOME MEASURES: Local kyphotic angle LKA loss = Post op LKA – Follow up LKAVertebral body height loss = Follow up VBH – Post op VBH

METHODS: We retrospectively reviewed the radiographs of all adult patients who underwent surgery for TL fracture fixation between 2011 and 2015. Radiological parameters (local kyphotic angle and vertebral body height) in pre op, post op, and final follow up.

RESULTS: 100 patient with thoracolumbar spine fractures, 84% males, average age 35.2years, involve in the study with at least follow up 6 months. There were 34 patient with IS and 66 without IS. No significant difference detected between two groups in regard of local kyphotic angle and vertebral body height p-value 0.59 and 0.69 respectively

CONCLUSIONS: Adding IS does not affect radiological parameters in thoracolumbar fracture in short-term follow-up

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

P23. The Impact of Type of Screw on Kyphotic Deformity Correction after Spine Fracture Fixation-Cannulated versus Solid Pedicle Screw

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BACKGROUND CONTEXT: Spine fractures resulting from many causes particularly falls from height and road traffic accidents. It’s a major cause of disability if not treated properly. Many advocates are in the favor that pedicle fixation method is comparatively a safer procedure when compared to the risk factor at a non-pedicle counterpart. Open spine surgery is known with several limitations sometimes in the fractured one also.

PURPOSE: Our aim is to explore and find out if the screw design differences will affect the correction of the deformity after fixation of unstable spine fractures

STUDY DESIGN/SETTING: Retrospective case series

PATIENT SAMPLE: 172 patient vertebral height and kyphotic angle of the fractured vertebra

OUTCOME MEASURES: vertebral height and kyphotic angle of the fractured vertebra

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

RESULTS: 172 cases with traumatic thoracolumbar fracture underwent to pedicle screw fixation (Open vs MIS) either with CS or SCS. 142 male and 28 female, average age 36.1 ± 12.4 years, 100 open and 72 MIS, 76 solid and 96 cannulated screws. The average preoperative, intraoperative and postoperative kyphotic angle of the fractured vertebra is respectively 18.9 ± 9.9 (range from 1 to 90), 7.4 ± 6.7 (range from 0 to 40) and 8.1 ± 6.5 (range from 0 to 40) degrees and an average 13.08 degree angle reduction is quantified with solid screws and 8.96 degrees with cannulated screws. Average height reduction in the preoperative and postoperative stages shows a wide difference which indicates a successful height gain after surgery, and it is supported statistically while performing ANOVA (p < 0.05) in solid group comparing to cannulated one procedure performed.

CONCLUSIONS: Solid screws are found to be more superior in the increased correction of kyphotic angle and the height of the fractured vertebra

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
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Thursday, July 27  6:30 a.m.–12:00 p.m.  
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As a sponsor accredited by the ACCME, the North American Spine Society must ensure balance, independence, objectivity and scientific rigor in all its sponsored activities. All individuals participating in a NASS-sponsored CME activity are expected to disclose to the audience all financial interests or other relationships with any commercial interest that occurred within the past 12 months. Financial interests or other relationships may include: grants or research support, employee, consultant, major stockholder, member of the speaker’s bureau, etc. Disclosure information will be made available visually on a PowerPoint® slide before each presentation, in this Final Program and Proceedings. It should also be noted that audience members who volunteer questions or statements during symposia, focused discussions, or other educational events should disclose their own conflicts to the assembled group before proceeding with their comments.

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The intent of this disclosure is to ensure that all conflicts of interest, if any, have been identified and have been resolved prior to the speaker’s presentation. By doing so, the North American Spine Society has determined that the speaker’s or author’s interests or relationships have not influenced the presentation with regard to exposition or conclusion; nor does the Society view the existence of these interests or commitments as necessarily implying bias or decreasing the value of the presentation.

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<td>Carroll, Linda</td>
<td>Speaking and/or Teaching Arrangements: Work Disability Prevention CIHR Strategic Training Program (A); Trips/Travel: University of Ontario Institute of Technology, Ontario Protocol for Traffic Injury Management (OPTIM) (B); Research Support - Investigator Salary: Alberta Innovates - Health Solutions (C, Paid directly to institution/employer); Grants: MS Society (D, Paid directly to institution/employer).</td>
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<tr>
<td>Chaput, Christopher D.</td>
<td>Royalties: Globus (A), Facet-Link (A); Consulting: Globus (B), Facet-Link (B); Research Support - Investigator Salary: Pfizer (D, Paid directly to institution/employer); Research Support - Staff and/or Materials: Globus (C, Paid directly to institution/employer).</td>
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<tr>
<td>Cheng, Ivan</td>
<td>Royalties: NuVasive (F); Private Investments: Cytonics (&lt;1%), Spine Innovations (&lt;1%); Consulting: Spine Wave (None), Globus Medical (C); Speaking and/or Teaching Arrangements: Stryker Spine (B); Scientific Advisory Board: Spine Craft (B).</td>
</tr>
<tr>
<td>Cheng, Joseph S.</td>
<td>Other Office: AANS/CNS (Recording Secretary: AANS/CNS Council of State Neurosurgical Societies, NASS (Section Development Chair).</td>
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<tr>
<td>Cho, Charles H.</td>
<td>Board of Directors: North American Spine Society (Evidence Compilation and Analysis Chair); Other Office: American Society of Neuroradiology (Finance Management Committee Chair).</td>
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<td>Cho, Samuel K.</td>
<td>Consulting: Zimmer Biomet (B), Globus (B), Medtronic (B); Research Support - Staff and/or Materials: Zimmer Biomet (B, Paid directly to institution/employer); Grants: OREF (D, Paid directly to institution/employer).</td>
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<td>Chutkan, Norman B.</td>
<td>Royalties: Globus Medical (D); Speaking and/or Teaching Arrangements: AO North America (Travel expenses); Board of Directors: North American Spine Society (Travel expenses, At Large Member).</td>
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<td>Daffner, Scott D.</td>
<td>Stock Ownership: Pfizer (&lt;1%), Amgen (&lt;1%); Consulting: Bioventus (A); Other Office: CSRS (Research Committee), LSRD (Program Committee), NASS (Section on Biologics &amp; Basic Research, Membership Committee); Research Support - Staff and/or Materials: Pfizer (A, Paid directly to institution/employer), Bioventus (A, Paid directly to institution/employer); Grants: CSRS (F, Paid directly to institution/employer).</td>
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**Range Key**  
- **Level A:** $100 to $1000  
- **Level B:** $1001 to $10,000  
- **Level C:** $10,001 to $25,000  
- **Level D:** $25,001 to $50,000  
- **Level E:** $50,001 to $100,000  
- **Level F:** $100,001 to $500,000  
- **Level G:** $500,001 to $1M  
- **Level H:** $1,000,001 to $2.5M  
- **Level I:** Greater than $2.5M
Glassman, Steven D.: Royalties: Medtronic (G); Board of Directors: Scoliosis Research Society (Past President); Scientific Advisory Board: N2QOD (Scientific Advisory Board); Research Support (Staff and/or Materials): Norton Healthcare (None, Paid directly to institution/employer); Other: NuVasive (Amount not disclosed).

Goldstein, Christina L.: Speaking and/or Teaching Arrangements: AOSpine North America (A); Trips/Travel: AOSpine North America (B, Paid directly to institution/employer); Other Office: AOSpine North America (Fellowship Committee), North American Spine Society (Section on Biologics and Basic Science); Grants: University of Missouri Coulter Translational Partnership (C, Paid directly to institution/employer).

Golish, S. Raymond: Stock Ownership: Cytometrics (300000 Shares); Consulting: Medacta (D), Intrinsic Therapeutics (D), Icotec AG (C), Simplify Medical (B), Jupiter Medical Center (C), FDA Center for Devices and Radiological Health (B); Speaking and/or Teaching Arrangements: Ziehm Imaging (B); Trips/Travel: Cyronics (B), Medacta (C), NuVasive (B), Jupiter Medical Center (B), FDA Center for Devices and Radiological Health (A), American Academy of Orthopaedic Surgeons (B); Board of Directors: The Spine Foundation (None).

Grauer, Jonathan N.: Consulting: Stryker (D), Medtronic (None), Bioventus (B); Other Office: NASS (Annual Meeting Program Committee Co-chair, 2017), LSRS (Program Committee Co-chair, 2016, 2017); Other: Legal consulting (Amount not disclosed).

Gregory, Carl A.: Stock Ownership: Theodent Holdings (25000 Shares, Paid directly to institution/employer); Scientific Advisory Board: Theodent Holdings (Stock ownership disclosed).

Guyer, Richard D.: Royalties: Alphatec (B); Stock Ownership: Spinal Motion (None); Private Investments: Spinal Ventures I and II (5%); Consulting: DePuy Synthes (B); Speaking and/or Teaching Arrangements: Synthes (None); Scientific Advisory Board: K2M (B), Flexuspine (Stock options), Spinal Kinetics (Stock options), Nano (A, Stock options), Crocker Technologies (A), MiMedx (B, Stock options); Fellowship Support: OREF (A, Paid directly to institution/employer), AOSpine (B, Paid directly to institution/employer), Medtronic Neurological Division (C, Paid directly to institution/employer).

Hillbrand, Alan S.: Royalties: Biomet Spine (G), Amedica (D), Aesculap (A); Stock Ownership: Amedica (<1%), LifeSpine (<1%), Spinal Ventures (<3%); Private Investments: Benvenue (B), Nexgen (B), Paradigm Spine (B), Pioneer (<1%), PSD (B), VertiFlex (B); Board of Directors: AAOS (Chair of Communications Cabinet), CSRS (President), NASS (CME Committee Chair).

Hsu, Erin L.: Royalties: Stryker (E); Other Office: Orthopaedic Research Society (Media Relations and Communications Committee); Relationships Outside the One Year Requirement: Medtronic Sofamor Danek (Grant, Dissolved 05/2011, F).

Hsu, Wellington K.: Royalties: Stryker (E); Consulting: Stryker (E), Allosource (B), Xtant (C), Mirus (B), CeramTec (B), Grafit (A), Globus (A), AONA (B), Medtronic (B), Bioventus (B); Speaking and/or teaching arrangements: AONA (B), Trips/travel: Stryker (B), Pioneer Surgical (B), Medtronic (B), Bioventus (A), AONA (B); Board of Directors: Lumbar Spine Research Society (None), American Academy of Orthopaedic Surgeons (None), North American Spine Society (None), Cervical Spine Research Society (None); Scientific Advisory Board: Bioventus (None); Grants: Medtronic (E, Paid directly to institution/employer).
Justice, Brian: Stock Ownership: Spine Care Partners (20%); Other Office: Vice President (None); Other: Primary Spine Provider Network (20%).
Karlen, Emily K.: Trips/travel: NASS (B).
Kennedy, D.J.: Speaking and/or Teaching Arrangements: Spine Intervention Society (Travel expenses); Trips/Travel: AAPM&R (Travel expenses), Spine Intervention Society (Travel expenses); Board of Directors: AAPM&R (Member at Large), Spine Intervention Society (Member at Large).
Khaleel, Mohammed A.: Consulting: DePuy Synthes Synp (A); Other: Spine Craft (A).
Khanna, A. Jay: Royalties: Thieme Medical Publishers (B), Ortho Development (B); Private Investments: New Era Orthopaedics (15%), Cortical Concepts (16%), Avitus Orthopaedics (9%); Consulting: Orthofix Spine (C); Speaking and/or Teaching Arrangements: AOSpine North America (B); Trips/Travel: AOSpine North America (A); Other Office: Johns Hopkins Center for Bioengineering, Innovation and Design (Advisory Board); Grants: Siemens Healthcare (B, Paid directly to institution/employer).
Knight, Reginald Q.: Stock Ownership: VTI (<1%); Consulting: Stryker (C); Speaking and/or Teaching Arrangements: Stryker Spine (Consulting disclosed); Scientific Advisory Board: Spine Universe (None), Vertera (None), Gerstner Medical (None).
Kreiner, Scott: Board of Directors: North American Spine Society (Clinical Research Development Chair); Speaking and/or Teaching Arrangements: North American Spine Society (Travel expenses); Trips/Travel: ISIS (Travel expenses).
Lahey, Donna M.: Speaking and/or Teaching Arrangements: North American Spine Society (Travel expenses), Paid directly to institution/employer); Trips/Travel: North American Spine Society (Speaking and/or Teaching Arrangements disclosed).
Lawrence, Brandon D.: Speaking and/or Teaching Arrangements: AOSpine North America (A); Fellowship Support: AOSpine North America (E, Paid directly to institution/employer).
Lee, Yu-Po: Consulting: DePuy (D).
Lehman, Ronald A.: Consulting: Medtronic (C); Speaking and/or Teaching Arrangements: Medtronic (D), DePuy (C), Stryker (Financial, <$20,000); Scientific Advisory Board: Stryker (Financial, <$10,000); Grants: Department of Defense (DoD) (I, "Topical Application of Tranexamic Acid to Reduce Blood Loss During Complex Combat-Related Spine Trauma Surgery."). Paid directly to institution/employer).
Lewis, Stephen J.: Consulting: Medtronic (D); Speaking and/or Teaching Arrangements: Stryker (C), DePuy Synthes (B); Trips/Travel: Stryker (B), L and K (B), IMAST (B); Scientific Advisory Board: Augmedics (None); Fellowship Support: Medtronic and Johnson and Johnson (D, Paid directly to institution/employer).
Lindley, James G.: Royalties: Globus Medical (C); Scientific Advisory Board: Globus Medical (None).
Lipson, Adam C.: Stock Ownership: Acadia Pharmaceuticals (2000000 Shares); Private Investments: Bionik Laboratories (2.5%), Sapience Therapeutics (<1%), X4 Pharmaceuticals (1.5%); Consulting: Stryker (C); Speaking and/or Teaching Arrangements: Bioventus (None), Centinel Spine (C); Other: Gerson Lehman Group (C), FundRx (Scientific Advisor).
Mac Millan, Michael: Consulting: Spineology FDA Review (B); Medtronic (B, Paid directly to institution/employer); Scientific Advisory Board: Juvent (None).
McGirt, Matthew J.: Consulting: Stryker Spine (D); Relationships Outside the One Year Requirement: Biomet-Zimmer (Scientific Advisory Board, Dissolved 9/1/201, B).
Mehta, Hitesh P.: Other Office: Integer (Salary).
Mikhael, Mark M.: Royalties: Oxford University Press (A); Consulting: DePuy Synthes (B), Clariance Spine (C).
Moss, Isaac: Royalties: Spinet (A); Stock Ownership: Orthozon (<1%); Consulting: Stryker Spine (C); Speaking and/or Teaching Arrangements: NuVasive (B), Atlas Spine (B); Scientific Advisory Board: Orthozon (Stock Options).
Mroz, Thomas E.: Royalties: Stryker (F); Stock Ownership: Pearl Diver (<1%); Consulting: Stryker Spine (B); Fellowship Support: AOSpine (E).
Nassr, Ahmad N.: Consulting: Vikon Surgical (None); Speaking and/or Teaching Arrangements: Magnifi Group (Travel expenses); Research Support - Staff and/Or Materials: Pfizer (E, Paid directly to institution/employer); Fellowship Support: AOSpine North America (E, Paid directly to institution/employer).
Neuman, Brian J.: Grants: DePuy Synthes (C, Paid directly to institution/employer); Other: ISSGF (None).
Noriega, David C.: Consulting: SpineArt (C, Paid directly to institution/employer), Medtronic (B), Vexim (C, Paid directly to institution/employer); Speaking and/or teaching arrangements: IECSCYL (C, Paid directly to institution/employer).
O’Brien, David R.: Board of Directors: North American Spine Society (Health Policy Council Director); Stock Ownership: OrthoCarolina (<1%), Transformant Healthcare Solutions (<1%), Arrowlytics (<1%); Speaking and/or Teaching Arrangements: SIS (Travel expenses).
Ohnmeiss, Donna D.: Board of Directors: North American Spine Society (Education Publishing Chair); Other: Texas Back Institute Research Foundation (Salary).
Panchal, Ripul R.: Consulting: Precision Spine (A), Globus (B), Medtronic (C), Biomet (C), Mizuho Orthopedics Systems (B); Board of Directors: California Association of Neurological Surgeons (None); Other Office: North American Spine Society (Patient Safety Committee, CME Committee); Research Support - Investigator Salary: Baxter (B); Research Support - Staff and/or Materials: Globus Medical (E, Paid directly to institution/employer).
Park, Paul: Royalties: Globus Medical (C); Consulting: Globus Medical (B), Medtronic (B), Biomet Zimmer (B), NuVasive (B); Speaking and/or Teaching Arrangements: Globus Medical (C); Research Support - Investigator Salary: Pfizer (B, Paid directly to institution/employer); Grants: Pfizer (C, Paid directly to institution/employer).
Patel, Alpesh A.: Royalties: Amedica (C); Stock Ownership: Amedica (<1%), Cytonics (<1%), Nocimed (<1%), Vital5 (<1%); Consulting: Amedica (None), Stryker (None), Biomet (C), DePuy Synthes (B), Pacira (B), Rellevant (B); Board of Directors: Cervical Spine Research Society (None); Grants: Cervical Spine Research Society (B, Paid directly to institution/employer); Other: Amedica (<1%).
Paulino, Carl: Consulting: Ethicon (B); Speaking and/or teaching arrangements: DePuy Johnson & Johnson (B); Trips/travel: Ethicon (B).
Peppelman, Walter: Royalties: Globus (E), Aesculap (E); Consulting: Globus (A), Carevate (A).
Stout, Alison A.: Consulting: State Farm (Amount not disclosed); Speaking and/or Teaching Arrangements: SIS (B), AAPMU (B), AAPMR (Program Planning Committee); Board of Directors: McKenzie Institute USA (B).

Sullivan, William J.: Board of Directors: North American Spine Society (Secretary); Trips/Travel: North American Spine Society (Travel expenses).

Tepper, Michal: Consulting: Carevature Medical (B).

Thakur, Nikhil A.: Consulting: Stryker Spine (C); Speaking and/or Teaching Arrangements: Stryker Spine (C).


Truumees, Eric: Royalties: Stryker Spine (B); Other Office: AAOS Communications Cabinet (Travel expenses, Incoming Editor-in-Chief of AAOS Now, AAOS Communications Cabinet); Research Support - Investigator Salary: Relevant (B, Paid directly to institution/employer); Research Support - Staff and/or Materials: Globus (B, Paid directly to institution/employer); Board of Directors: North American Spine Society (Treasurer).

Vaccaro, Alexander R.: Royalties: Elsevier Books (B), Alphatec (C), Jaypee Books (B), Taylor Francis (A), Globus (F), Medtronic (F), Stryker Spine (G); Stock Ownership: Gamma Spine (<1%), Avaz Surgical (Amount not disclosed), Innovative Surgical Design (<1%), Electrocure (<1%), Rothman Institute and related holdings (3%), Cytonics (Amount not disclosed), Location Based Intelligence (Amount not disclosed), Progressive Spinal Technology (Amount not disclosed), Computational Biodynamics (Amount not disclosed), Stout Medical (1%), Bonovo Orthopaedics (Amount not disclosed), Flagship Surgical (Amount not disclosed), In Vivo (F), Small Bone Innovations (Amount not disclosed), Paradigm Spine (Amount not disclosed), SpinalSpine (Amount not disclosed), Replication Medical (Amount not disclosed), Globus (111,098 shares), Flow Pharma (Amount not disclosed), Advanced Spinal Intellectual Properties (30%), Spine Medical (Amount not disclosed); Consulting: Gerson Lehrman Group (None), ICON Clinical Research (B), Medtronic (B), Innovative Surgical Design (None), Stout Medical (None), Guidepoint Global (B), MEDAcorp (B), Stryker Spine (C), Globus (C), Eipse (B), Orthobullets (None); Board of Directors: AOSpine (Knowledge Forum Director), Association of Collaborative Spine Research (President Emeritus), Innovative Surgical Design (None), Flagship Surgical (None); Other: Employment: Rothman Institute (Amount not disclosed), Honorarium for Lectures (Amount not disclosed), Clinical Spine Surgery (Editor in Chief).

Villavicencio, Alan T.: Device or Biologic Distributorship (Physician-Owned Distributorship): Leading Edge Spinal Implants (A); Board of Directors: Justin Parker Neurological Institute (None); Other Office: Boulder Neurosurgical Associates (None); Research Support - Investigator Salary: ProFibrix (F, Paid directly to institution/employer), Medtronic (F, Paid directly to institution/employer).

Wang, Jeffrey C.: Royalties: Aesculap (B), Biomet (G), Amedica (C), SeaSpine (D), Synthes (C); Stock Ownership: PzioMed (<1%); Private Investments: Prometheus Spine (<1%), Paradigm Spine (<1%), Bioenergy (<1%), NexGen (<1%), VertiFlex (<1%), Electrocure (<1%), Surgitech (<1%), Expanding Orthopaedics (<1%), Osprey (<1%); Bone Biologics (<1%), Curative Biosciences (<1%), PearlDiver (<1%); Board of Directors: North American Spine Society (Second Vice President), North American Spine Foundation (None), Cervical Spine Research Society (Travel expenses).

Wang, Michael Y.: Royalties: DePuy Spine (F); Stock Ownership: ISD (<1%), Consulting: DePuy Spine (E), K2M (C), Aesculap (D), Vallum (B); Trips/Travel: DePuy Spine (C); Grants: Department of Defense (B, Paid directly to institution/employer).

Wang, Xu: Other Office: Aalborg University (Amount not disclosed, Paid directly to institution/employer).

Wetzel, F. Todd: Stock Ownership: Relevant Medical (<1%); Board of Directors: McKenzie Institute International (B), North American Spine Society (President).

Whang, Peter G.: Consulting: Stryker Spine (C), Trevena (B), SI-BONE (C), Pacira (B), Medtronic (E); Speaking and/or Teaching Arrangements: Stryker (D), Pacira (C), Medtronic (D); Scientific Advisory Board: DiFusion (Stock options), Summus Global (B); Other Office: Cerapedics (B), Histogenics (B), Paradigm Spine (C), Simplify Medical (C); Research Support - Staff and/or Materials: VertiFlex (A, Paid directly to institution/employer), SI-BONE (A, Paid directly to institution/employer), Spinal Kinetics (A), Bioventus (A).


Yeung, Anthony T.: Royalties: Richard Wolf, Elliquence (D), Elliquence (None); Stock Ownership: Paradigm Spine (<1%, Paid directly to institution/employer), Bonovo Orthopedics (<1%), Core Spine (<1%), Mobius (<1%), Nocimed (<1%), Ouroboros (<1%), Replication Medical (<1%), Small Bone Innovations (<1%), Stimwave (<1%), Surgitech (<1%), Vivex Biomedical (<1%); Private Investments: Ouroboros (20%), Surgitech (20%); Consulting: Richard Wolf (Amount not disclosed, Paid directly to institution/employer), Elliquence (Amount not disclosed, Paid directly to institution/employer), Aleeva Medical (Amount not disclosed), Stimwave (Amount not disclosed); Other: Arizona Recovery Care Center (Amount not disclosed), Squaw Peak Surgical Facility (Amount not disclosed).
The following participants have Nothing to Disclose:

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<tr>
<th>Participants</th>
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<td>Aldahamsheh, Osama M.</td>
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