WELCOME TO SPINE ACROSS THE SEA IN KAUAI

Thank you for attending Spine Across the Sea, a joint meeting of the North American Spine Society (NASS) and Japanese Society for Spine Surgery and Related Research (JSSR).

The meeting brings together spine specialists to hear research and discuss topics related to the treatment of elderly patients with spinal disorders. Examine topics important to your practice, evaluate the latest research and enjoy all Kauai has to offer.

Come to the opening reception on the white sands of Kalapaki Beach fronting Nawiliwili Bay where you’ll enjoy beautiful views, good conversation, cool beverages and delicious appetizers. Watch the sunset on Kauai.

Days begin early with a hot breakfast and the opportunity to view instruments and devices in the Technical Exhibition. Podium presentations and symposia follow addressing adult spinal deformity, MIS fusion, biologics, motion preservation, lumbar and cervical spine disorders, and osteoporosis.

The education ends by 1:30 p.m. so you have time to explore Kauai and take advantage of the numerous resort activities and picturesque island adventures such as the Garden Isle’s Na Pali Coast and Kalalau Trail, and hike through Waimea Canyon.

Interact with faculty and colleagues in a casual setting conducive to open discussion. It’s a great opportunity to invigorate your mind and body.

Jason W. Savage, MD, NASS Chair
Hirotaka Haro, MD, JSSR Chair
Gregory D. Schroeder, MD, NASS Co-chair

TABLE OF CONTENTS
Meeting Information . . . . . . 4
Meeting-at-a-Glance . . . . . . 6
Program Schedule . . . . . . 8
Sun., July 29/Mon., July 30 . 8
Tuesday, July 31 . . . . . . . . . 13
Wednesday, August 1 . . . . 17
Thursday, August 2 . . . . . . 21
Electronic Posters . . . . . . . 25
Author Index . . . . . . . . . . 35
Disclosure Index . . . . . . . 38
Technical Exhibition . . . . . 45
Proceedings . . . . . . . . . . 47

NASS Overall Chair
Jeffrey C. Wang, MD

JSSR President and Overall Chair
Toshihiko Taguchi, MD

JSSR Organizing Committee
Yasuaki Tokuhashi, Vice-President, JSSR
Atushi Okawa, Secretary, JSSR
Masashi Yamazaki, MD
Mamoru Kawakami, MD
Yoichi Shimada, MD

2018 Spine Across the Sea Scientific Abstract Reviewers
NASS thanks these volunteers who spent numerous hours reviewing abstracts:
Barrett Boody, MD
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Gen Inoue, MD, PhD
Manabu Ito, MD, PhD
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Miho Sekiguchi, MD
Patrick A. Sugrue, MD
Jun Takahashi, MD, PhD
Katsushi Takeshita, MD, PhD
Hiroshi Taneichi, MD
Daisuke Togawa, MD, PhD
Robert R. Turner, DPT, MS, OCS
Scott Wagner, MD
Kevin M. Walsh, MD
Jeffrey C. Wang, MD
Gregory Whitcomb, DC
Barrett Woods, MD
Jack E. Zigler, MD
Learning Objectives
Upon completion of this meeting, participants will 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.

About NASS
The North American Spine Society (NASS) is a multidisciplinary organization with approximately 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 delivery of quality spine care.

About JSSR
The Japanese Society for Spine Surgery and Related Research (JSSR) is the largest Japanese organization representing members in the field of spine and spinal cord disorders. JSSR has more than 3,600 members, mainly orthopedic surgeons. They hold an annual meeting and publish its official journal to promote basic research and clinical innovation.

Continuing Medical Education 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 18.75 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. to participate in this CME activity are eligible for AMA PRA Category 1 Credits™.

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.

Each state has different requirements for nurses, physical therapists and other nonphysician providers; please contact the credit granting organization for their requirements.

For credit that may be acceptable to state medical associations, specialty societies or state boards for medical licensure, please contact those organizations for their requirements.

CME Certificates
Attendees can submit evaluations electronically after the meeting and print CME certificates directly from the NASS website at www.spine.org/CME. Contact education@spine.org with questions. Forgotten passwords can be requested from the login page by using the email address used to register for the conference.
**Session Recordings OnDemand**

NASS and JSSR members will receive free access to the recordings with a general registration. The recording includes abstract presentations, symposia and ePosters. These web-based, fully synchronized audio, video and slide presentations are available anywhere you can access the Internet. CME credit is available for all content. www.spineacrosstthesea.org.

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.

**Speaker Information Center**

**Kauai Court**

Symposia presenters can upload or amend their presentations by visiting the Speaker Information Center in the Kauai Court at least 3 hours prior to the scheduled session start time. Speakers are not permitted to use their own laptops for their presentations.

Podium and ePoster presentations cannot be uploaded or amended on site. No exceptions will be made.

Speaker Information Center hours:

- **Sunday, July 29**  2:00 - 6:00 p.m.
- **Monday, July 30**  6:30 a.m. – 1:00 p.m.
- **Tuesday, July 31**  6:30 a.m. – 1:00 p.m.
- **Wednesday, August 1**  6:30 a.m. – 1:00 p.m.
- **Thursday, August 2**  6:30 a.m. – 1:00 p.m.

**Technical Exhibition**

**Halele’a**

Experience first-hand technology, products and services from vendors who can help you manage your professional goals and strategic objectives.

Technical Exhibition hours:

- **Monday, July 30**  6:30–11:30 a.m.
- **Tuesday, July 31**  6:30 a.m.–12:30 p.m.
- **Wednesday, August 1**  6:30–9:30 a.m.

**Opening Reception**

The Opening Reception marks the official start of Spine Across the Sea on Sunday, July 29, from 6:00-7:30 p.m. at Luau Grounds. Enjoy beer, wine and appetizers while mingling with friends and colleagues. Please join us.

**SpinePAC at Spine Across the Sea 2nd Annual Golf Outing**

**Tuesday, July 31, 2018**

2:30 p.m.

**The Ocean Course, Hokuala Resort**

Hosts Drs. Jason W. Savage, Jeff C. Wang and David A. Wong cordially invite you to the second annual SpinePAC President’s Golf Outing taking place during the meeting. Guests will enjoy a relaxing afternoon at one of the world’s “twelve most beautiful courses” – MSN Travel. The Ocean Course at the Hokuala Resort, a Jack Nicklaus Signature track, features the longest continuous strip of oceanfront golf in all of Hawaii. This is an event you won’t want to miss. All donations benefit the NASS political action committee, SpinePAC, our voice in Washington, DC.

**Disclaimer**

The material presented at Spine Across the Sea is made available by the North American Spine Society and Japanese Society for Spine Surgery and Related Research 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.

On occasion, changes in program content or faculty may occur. This Final Program contains the current program, faculty and presenters information available. Any further changes will be announced at the beginning of the session.
### SUNDAY, JULY 29

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>2:00-6:00 p.m.</td>
<td>Registration</td>
<td>Speaker Information Center, Kauai Court</td>
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<tr>
<td>6:00-7:30 p.m.</td>
<td>Opening Reception</td>
<td>Luau Grounds</td>
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### MONDAY, JULY 30

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>6:30-8:00 a.m.</td>
<td>Hot Breakfast</td>
<td>Halele’a</td>
</tr>
<tr>
<td>6:30-11:30 a.m.</td>
<td>Technical Exhibition</td>
<td>Halele’a</td>
</tr>
<tr>
<td>6:30 a.m.-1:00 p.m.</td>
<td>Registration</td>
<td>Speaker Information Center, Kauai Court</td>
</tr>
<tr>
<td>7:10-7:15 a.m.</td>
<td>Opening Remarks</td>
<td>Kona I</td>
</tr>
<tr>
<td>7:15-7:30 a.m.</td>
<td>Advocacy Update</td>
<td>Kona I</td>
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<tr>
<td>7:30-9:00 a.m.</td>
<td>Abstract Session: Adult Spinal Deformity</td>
<td>Kona I</td>
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<tr>
<td>9:00-9:30 a.m.</td>
<td>Food and Beverage Break</td>
<td>Technical Exhibition Halele’a</td>
</tr>
<tr>
<td>9:30-11:00 a.m.</td>
<td>Symposium: Minimally Invasive Fusion</td>
<td>Kona I</td>
</tr>
<tr>
<td>11:00-11:30 a.m.</td>
<td>Food and Beverage Break</td>
<td>Technical Exhibition Halele’a</td>
</tr>
<tr>
<td>11:30 a.m.-1:00 p.m.</td>
<td>Abstract Session:</td>
<td>Cervical Spine Kona I</td>
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<tr>
<td>1:00 p.m.</td>
<td>General Meeting Adjourns</td>
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### TUESDAY, JULY 31

<table>
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<th>Time</th>
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<tr>
<td>6:30-8:00 a.m.</td>
<td>Hot Breakfast</td>
<td>Halele’a</td>
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<tr>
<td>6:30 a.m.-12:30 p.m.</td>
<td>Technical Exhibition</td>
<td>Halele’a</td>
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<tr>
<td>6:30 a.m.-1:00 p.m.</td>
<td>Registration</td>
<td>Speaker Information Center, Kauai Court</td>
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<tr>
<td>7:25-7:30 a.m.</td>
<td>Opening Remarks</td>
<td>Kona I</td>
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<tr>
<td>7:30-9:00 a.m.</td>
<td>Symposium: Minimally Invasive Fusion: LIF, MIS TLIF, PPS, OLIF</td>
<td>Kona I</td>
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<tr>
<td>9:00-9:30 a.m.</td>
<td>Food and Beverage Break</td>
<td>Technical Exhibition Halele’a</td>
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<tr>
<td>9:30-10:30 a.m.</td>
<td>Abstract Session: Motion Preservation</td>
<td>Kona I</td>
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<tr>
<td>10:30 a.m.-12:00 p.m.</td>
<td>Symposium: Biologics, Navigation and New Technology</td>
<td>Kona I</td>
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<tr>
<td>12:00-12:30 p.m.</td>
<td>Food and Beverage Break</td>
<td>Technical Exhibition Halele’a</td>
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<tr>
<td>12:30-1:30 p.m.</td>
<td>Abstract Session: Lumbar Part I</td>
<td>Kona I</td>
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<tr>
<td>1:30 p.m.</td>
<td>General Meeting Adjourns</td>
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### WEDNESDAY, AUGUST 1

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<td>6:30-8:00 a.m.</td>
<td>Hot Breakfast</td>
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<td>6:30-9:30 a.m.</td>
<td>Technical Exhibition</td>
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<tr>
<td>6:30 a.m.-1:00 p.m.</td>
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<td>Halele'a</td>
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<tr>
<td>7:25-7:30 a.m.</td>
<td>Opening Remarks</td>
<td>Kona I</td>
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<tr>
<td>7:30-9:00 a.m.</td>
<td>Symposium: Treatment of Cervical Spine Disorders</td>
<td>Kona I</td>
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<tr>
<td>9:00-9:30 a.m.</td>
<td>Food and Beverage Break Technical Exhibition</td>
<td>Halele'a</td>
</tr>
<tr>
<td>9:30-10:30 a.m.</td>
<td>Abstract Session: Trauma and Tumor</td>
<td>Kona I</td>
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<tr>
<td>10:30 a.m.-12:00 p.m.</td>
<td>Symposium: Osteoporosis and Sarcopenia</td>
<td>Kona I</td>
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<tr>
<td>12:00-12:15 p.m.</td>
<td>Food and Beverage Break</td>
<td>Kauai Court</td>
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<tr>
<td>12:15-1:15 p.m.</td>
<td>Abstract Session: Diagnostics/Imaging</td>
<td>Kona I</td>
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<tr>
<td>1:15 p.m.</td>
<td>General Meeting Adjourns</td>
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### THURSDAY, AUGUST 2

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<th>Time</th>
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<tr>
<td>6:30-8:00 a.m.</td>
<td>Hot Breakfast</td>
<td>Kauai Court</td>
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<tr>
<td>6:30 a.m.-1:00 p.m.</td>
<td>Registration</td>
<td>Speaker Information Center</td>
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<td>Kauai Court</td>
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<tr>
<td>7:25-7:30 a.m.</td>
<td>Opening Remarks</td>
<td>Kona I</td>
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<tr>
<td>7:30-9:00 a.m.</td>
<td>Abstract Session: Complications</td>
<td>Kona I</td>
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<tr>
<td>9:00-9:15 a.m.</td>
<td>Food and Beverage Break</td>
<td>Kauai Court</td>
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<tr>
<td>9:15-10:15 a.m.</td>
<td>Abstract Session: Lumbar Part II</td>
<td>Kona I</td>
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<tr>
<td>10:15-11:45 a.m.</td>
<td>Symposium: Help the Professor! Case Presentations</td>
<td>Kona I</td>
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<tr>
<td>11:45 a.m.</td>
<td>General Meeting Concludes</td>
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**Not a NASS Member? It’s FREE in 2018 for First-time Applicants!**

If you're not already a member of NASS, visit www.spine.org/jointoday to complete an application for a complimentary membership for the remainder of 2018!*

This exclusive offer for nonmember attendees of the meeting includes access 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!

*Offer available to first-time applicants only who registered for the meeting at the non-member rate. Offer expires August 31, 2018; application (form and CV) must be complete by this date to qualify.
SUNDAY, JULY 29

2:00-6:00 p.m.
Registration
Speaker Information Center
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Registration
Speaker Information Center
Kauai Court

7:10–7:15 a.m.
Opening Remarks
Kona I
Jason W. Savage, MD, NASS; Hirotaka Haro, MD, JSSR

7:15–7:30 a.m.
Advocacy Update
Kona I
Moderator: John G. Finkenberg, MD, NASS

7:30–9:00 a.m.
Abstract Session:
Adult Spinal Deformity
Kona I
Moderators:
Daniel M. Sciuubba, MD, NASS
Daisuke Togawa, MD, PhD, JSSR

7:30-7:36 a.m.
1. Correction of Intervertebral Rotation by Insertion of Oblique Lumbar Interbody Fusion Cage
Yoshiharu Nakaya, MD; Atsushi Nakano, MD, PhD; Ichiro Baba, MD; Kenta Fujiwara, MD, PhD; Takashi Fujishiro, MD; Sachio Hayama, MD; Toma Yano, MD; Yoshitada Usami, MD; Keiichiro Kino, MD; Mutsumi Ohue, MD; Masashi Neo, MD

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

7:36-7:42 a.m.
2. What is the Expected Corrective Outcome in Adolescent Idiopathic Scoliosis Curve Larger Than 70 Degrees based on Lenke Curve Subtypes?
Kazuya Nishizawa, MD; Gabriel K. Liu, MD; Kanji Mori, MD, PhD; Wong H. Kit, MD

1Kusatsu General Hospital, Kusatsu, Japan; 2National University of Singapore, Singapore; 3Shiga University of Medical Science, Department of Orthopedic Surgery, Otsu, Japan

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

7:42-7:48 a.m.
Masatoshi Teraguchi, MD, PhD; Mamoru Kawakami, MD, PhD; Yuyu Ishimoto, MD, PhD; Keiji Nagata, MD, PhD; Ryoho Kagotani, MD, PhD; Masafumi Nakagawa, PT; Masakazu Mineta, PT; Hiroshi Yamada, MD, PhD

1Spine Care Center, Wakayama Medical University Kihoku Hospital, Ito-gun, Wakayama, Japan; 2Department of Orthopaedic Surgery, Wakayama Medical University, Ito-gun, Wakayama, Japan

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

7:48-7:54 a.m.
4. The Relationship Between Sagittal Spino-Pelvic Alignment and the Acetabular Anteversion Angle on Computed Tomography in Patients with Hip Osteoarthritis
Takaomi Kobayashi, MD; Tadatsugu Morimoto, PhD

1Dept. of Orthopedic Surgery, Saga University, Saga, Japan; 2Saga University Hospital, Saga City, Saga Pref, Japan

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

7:54-8:00 a.m.
5. Impact of Postoperative Symptom Improvement and Disability on Health Related Quality of Life and Treatment Satisfaction in Adult Spinal Deformity Patients Treated by Corrective Long Fusion
Daisuke Togawa, MD, PhD; Tomohiko Hasegawa, MD, PhD; Yu Yamato, MD, PhD; Go Yoshida, MD, PhD; Shin Oe, MD; Tomohiro Banno, MD; Hideyuki Arima, MD, PhD; Yuki Mihara, MD; Hiroki Ushirozako, MD; Yukihiro Matsuyama, MD, PhD

1Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 2Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 3Hamamatsu University School of Medicine, Hamamatsu City, Japan

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
8:00-8:06 a.m.

6. Is It Beneficial to Adapt Minimally Invasive Lateral Lumbar Interbody Fusion for Adult Spinal Deformity?

Hiroshi Moridaira, MD, PhD1; Satoshi Inami, MD, PhD1; Daisaku Takeuchi, MD2; Haruki Ueda, MD3; Yo Shiba, PhD4; Futoshi Asano, PhD5; Hiromichi Aoki, MD1; Takuya Iimura, MD6; Hiroshi Taneichi, MD6

1Dokkyo Medical University, Tochigi, Japan; 2Mibu-Machi, Japan; 3Dokkyo Medical University, Shimotsuga-gun, Tochigi, Japan; 4Shimotugagunn, Tochigikenn, Japan; 5Tochigi, Japan; 6Mibu, Japan

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

8:06-8:12 a.m.

7. Transcranial Motor Evoked Potentials for Preventing Nerve Root Injury during Adult Spinal Deformity Surgery

Hiroki Ushirozako, MD1; Go Yoshida, MD, PhD1; Sho Kobayashi, MD, PhD1; Tomohiko Hasegawa, MD, PhD1; Yu Yamato, MD, PhD1; Tatsuya Yasuda, MD, PhD1; Tomohiro Banno, MD, PhD1; Hideyuki Arima, MD, PhD1; Shin Oe, MD, PhD1; Yuki Mihara, MD, PhD1; Daisuke Togawa, MD, PhD1; Yukihiro Matsuyama, MD, PhD1

1Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan 2University of California, San Francisco, San Francisco, CA, US; 3Hamamatsu Medical Center, Hamamatsu, Japan; 4Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan

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

8:12-8:18 a.m.

8. Sagittal Alignment after Surgical Treatment of Adolescent Idiopathic Scoliosis: Application of the Roussouly Classification

Søren Ohrt-Nissen, MD, PhD1; Tanvir J. Bari, MD2; Benny Dahl, MD, PhD3; Martin Gehrchen, MD, PhD4

1Copenhagen, Denmark; 2Rigshospitalet, University of Copenhagen, Copenhagen, Denmark; 3Texas Children’s Hospital, Houston, Texas, US; 4Rigshospitalet, University of Copenhagen, Copenhagen, Denmark

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

8:18-8:24 a.m.

Short Limited Fusion versus Long Fusion with Deformity Correction for Spinal Stenosis with Balanced De Novo Degenerative Lumbar Scoliosis

Chang-Hyung Lee, MD, MSc1; Chun Kee Chung, MD, PhD2; Chi Heon Kim, MD, PhD3

1 Ilsan Paik Hospital, Inje University, Goyang, Gyeonggi, Republic of Korea; 2Seoul National University, Seoul, Republic of Korea; 3Seoul National University Hospital, Department of Neurosurgery, Seoul, Republic of Korea

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

8:24-8:30 a.m.

10. Spinal Correction Surgery Enables Long-Term Relief of Gastroesophageal Reflux Disease Symptoms in Adult Spinal Deformity

Tomohiko Hasegawa, MD, PhD1; Yu Yamato, MD, PhD1; Daisuke Togawa, MD, PhD1; Go Yoshida, MD, PhD1; Tomohiro Banno, MD1; Hideyuki Arima, MD, PhD1; Shin Oe, MD1; Yuki Mihara, MD1; Hiroki Ushirozako, MD1; Sho Kobayashi, MD1; Tatsuya Yasuda, MD1; Yukihiro Matsuyama, MD, PhD1

1Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 2Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 3Hamamatsu University School of Medicine, Hamamatsu City, Japan; 4University of California, San Francisco, San Francisco, CA, US; 5Hamamatsu Medical Center, Hamamatsu, Japan

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

8:30-8:36 a.m.

11. Minimum Clinically Important Difference in Oswestry Disability Index Domains and Their Impact on Adult Spinal Deformity Surgery

Go Yoshida, MD, PhD1; Tomohiko Hasegawa, MD, PhD1; Yu Yamato, MD, PhD1; Tomohiro Banno, MD1; Sho Kobayashi, MD, PhD1; Hideyuki Arima, MD, PhD1; Shin Oe, MD1; Tatsuya Yasuda, MD1; Yuki Mihara, MD1; Hiroki Ushirozako, MD1; Daisuke Togawa, MD, PhD1; Yukihiro Matsuyama, MD, PhD1

1Hamamatsu University School of Medicine, Hamamatsu City, Japan; 2Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 3University of California, San Francisco, San Francisco, CA, US; 4Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 5Hamamatsu Medical Center, Hamamatsu, Japan

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
10. Sagittal Spinopelvic Alignment in Patients with Osteoarthritis of the Hip
Tadatsugu Morimoto, PhD
Saga University Hospital, Saga City, Saga Pref, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

8:42-9:00 a.m.
Discussion

9:00-9:30 a.m.
Food and Beverage Break
Technical Exhibition
Halele’a

9:30-11:00 a.m.
Symposium: Adult Spinal Deformity
Kona I
Moderators:
Jason W. Savage, MD, NASS
Hiroshi Taneichi, MD, JSSR

Faculty will review the evaluation and treatment of patients with adult spinal deformity (ASD) and focus on understanding radiographic parameters and alignment objectives in ASD. Additionally, faculty will debate/discuss the role of minimally invasive surgery in ASD, as well as discuss proximal junctional kyphosis/failure.

Upon completion of this session, participants should gain strategies to:
• Determine radiographic parameters and alignment objectives in adult spinal deformity;
• Review the perioperative evaluation and optimization of patients undergoing deformity correction;
• Strategically plan the “right” operation for patients with adult spinal deformity (MIS versus Open);
• Discover tips and tricks in the management and avoidance of proximal junctional kyphosis;
• Develop a better understanding of “when to go big or go home.”

Agenda
• Understanding Radiographic Parameters and Alignment Objectives in Adult Spinal Deformity
  Yu Yamato, MD, JSSR
• Perioperative Optimization of Patients Undergoing Deformity Surgery
  Satoshi Inami, MD, JSSR
• MIS vs. Open Deformity Surgery: When, Why and How
  John H. Shin, MD, NASS
• Proximal Junctional Kyphosis: Avoidance and Management
  Patrick A. Sugrue, MD, NASS
• Case Debate with Panel: Deformity Correction vs. Selective Decompression/Fusion
  Jason W. Savage, MD, NASS; Daniel M. Sciubba, MD, NASS

11:00-11:30 a.m.
Food and Beverage Break
Technical Exhibition
Halele’a

11:30 a.m.-1:00 p.m.
Abstract Session: Cervical Spine
Kona I
Moderators:
Thomas E. Mroz, MD, NASS
Masahiko Watanabe, MD, PhD, JSSR

13. Moved to ePosters

11:30-11:36 a.m.
14. Relationship of T1 Slope with Loss of Lordosis and Surgical Outcomes after Laminoplasty for Cervical OPLL
Masashi Miyazaki, MD; Toshinobu Ishihara, MD
Oita University, Yufu-shi, Oita, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

11:36-11:42 a.m.
15. Negative C7 SVA is a Risk Factor for Developing Postoperative Cervical Kyphosis after Expansive Open-Door Laminoplasty
Yuji Matsuoaka, MD1; Kenji Endo, MD, PhD1; Hidekazu Suzuki, MD, PhD2; Yasunobu Sawaji, PhD3; Hirosuke Nishimura, PhD, MD4; Taichihiro Takamatsu, MD, PhD5; Kazuma Murata, MD, PhD5; Takeshi Seki, MD1; Takamitsu Konishi, MD1; Takato Aihara, MD, PhD5; Kengo Yamamoto, MD, PhD1
1Tokyo Medical University, Tokyo, Japan; 2Tokyo, Japan; 3Department of Orthopedic Surgery, Tokyo Medical University, Shinjuku-ku, Tokyo, Japan; 4Tokyo Medical University Hachioji Medical Center, Hachioji, Tokyo, Japan; 5Tokyo Medical University Hospital, Shinjuku-ku, Tokyo, Japan; 6Funabashi Orthopedic Hospital, Funabashi-City, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
11:42-11:48 a.m.
16. The Impact of the Cervical Flexion and Extension on the Global Sagittal Spinal Alignment
Takamitsu Konishi, MD1; Kenji Endo, MD, PhD2; Hidekazu Suzuki, MD, PhD2; Yuji Matsuoka, MD1; Taichiro Takamatsu, MD, PhD1; Takeshi Seki, MD1; Takuya Kusakabe, MD1; Hirose Nishimura, PhD, MD4; Kazuma Murata, MD, PhD2; Yasunobu Sawaji, PhD1; Takato Alhara, MD, PhD2; Kengo Yamamoto, MD, PhD1
1Tokyo Medical University, Shinjuku-ku, Tokyo, Japan; 2Tokyo, Japan; 3Department of Orthopedic Surgery Tokyo Medical University, Nishishinjuku, Shinjuku-ku, Tokyo-to, Japan; 4Tokyo Medical University Hachioji Medical Center, Hachioji, Tokyo, Japan; 5Tokyo Medical University Hospital, Shinjuku-Ku, Tokyo, Japan; 6Funabashi Orthopedic Hospital, Funabashi-City, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

11:48-11:54 a.m.
17. Characteristics and Predictors of Patients Who Fail to Achieve a Minimum Clinically Important Difference Following Laminoplasty for Cervical Spondylotic Myelopathy
Akiy Yabu1; Koji Tamai, MD; Hidetomi Terai, MD, PhD; Masatoshii Hoshino, MD; Hiromitsu Toyoda, MD, PhD; Shinji Takahashi, MD; Kazunori Hayashi, MD; Shiochiro Ohyama, MD; Yusu Hori, MD; Akinobu Suzuki, MD, PhD2; Hiroaki Nakamura, MD, PhD2
1Department of Orthopedic Surgery, Ishikiriseiki Hospital, Osaka, Japan; 2Department of Orthopaedic Surgery, Osaka City University, Graduate School of Medicine, Osaka, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

11:54 a.m.-12:00 p.m.
18. Preoperative Severity of Facet Joint Degeneration Does Not Impact on Two-Year Clinical Outcomes Following Laminoplasty
Koji Tamai, MD1; Akinobu Suzuki, MD, PhD1; Aki Yabu; Hidetomi Terai, MD, PhD2; Masatoshii Hoshino, MD; Hiromitsu Toyoda, MD, PhD; Shinji Takahashi, MD; Kazunori Hayashi, MD; Shiochiro Ohyama, MD; Yusu Hori, MD; Hiroaki Nakamura, MD, PhD1
1Osaka City University, Osaka, Japan; 2Department of Orthopaedic Surgery, Osaka City University, Graduate School of Medicine, Osaka, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:00-12:06 p.m.
20. Surgical Treatment Improves Survival of Elderly with Axis Fracture: A National Population-Based Multi-Registry Cohort Study
Anna-Lena Robinson, PhD1; Claes Olerud, MD, PhD2; Yohan Robinson, MD, PhD2
1Stockholm Spine Center, Upplands-Väsby, Sweden; 2Department of Orthopaedics, Uppsala, Uppsala, Sweden; 3Uppsala University Hospital, Uppsala, Sweden
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:06-12:12 p.m.
21. Prediction of Anterior versus Posterior Surgical Approach for Degenerative Cervical Myelopathy Based on MRI Pathology: Analysis of a Global Cohort
Aria Nouri, MD, MSc1; Allan R. Martin, MD2; So Kato, MD3; Christopher Witiw, MD4; Anick Nater, MD1; Lindsay Tetreault, PhD3; Hamed Reihani Kermani, MD2; Carlo Santaguida, MD2; Rani Nasser, MD4; Joseph S. Cheng, MD, MS5; Michael G. Fehlings, MD, PhD, FRCSC6
1Cincinnati, OH, US; 2University of Toronto, Toronto, ON, Canada; 3The University of Tokyo Hospital, Bunkyo-Ku, Tokyo, Japan; 4Toronto Western Hospital, University of Toronto, Ontario, Canada; 5University of Toronto, Oakville, ON, Canada; 6Kerman, Islamic Republic of Iran; 7Montreal Neurological Institute, Montreal, QC, Canada; 8Montefiore Medical Center, Department of Neurosurgery, Spine Research Group, Bronx, NY, US; 9University of Cincinnati College of Medicine, Cincinnati, OH, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:12-12:18 p.m.
22. Neuromuscular Activity during Gait in Patients with Cervical Spondylotic Myelopathy Post Cervical Surgery
Ram Haddas, PhD, MSc, MEng1; Kevin L. Ju, MD2; Theodore A. Belanger, MD2; Akwasi Boah, MD2
1Texas Back Institute, Plano, TX, US; 2Texas Back Institute, Rockwall, TX, US; 3Texas Back Institute - Denton, Denton, TX, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

19. Moved to ePosters

So Kato, MD; Aria Nouri, MD, MSc; Satoshi Nori, MD, PhD; Dongjin Wu, PhD; Lindsay Tetreault, PhD; Michael G. Fehlings, MD, PhD, FRCSC

1The University of Tokyo Hospital, Bunkyo-Ku, Tokyo, Japan; 2Cincinnati, OH, US; 3University Health Network, Toronto, ON, Canada; 4Ji-Nan City, Shandong Province, China, Ji-Nan, China; 5University of Toronto, Oakville, ON, Canada; 6Toronto Western Hospital, Toronto, ON, Canada

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

24. The Incidence of Postoperative Stroke after Anterior Cervical Discectomy and Fusion in Patients who have Carotid Stenosis

Jared M. Newman, MD; Morad Chughtai, MD; Neil V. Shah, MD, MS; George A. Beyer, MS; Lee Bloom, MD; Douglas A. Holland, MD; Louis M. Day, MD; Bassel G. Diebo, MD; Rohan Desai, MD; Hiroyuki Yoshihara, MD, PhD; Carl B. Paulino, MD

1SUNY Downstate Medical Center, Brooklyn, NY, US; 2Cleveland Clinic, Cleveland, OH, US; 3Downstate Medical Center: Orthopaedic Surgery, Brooklyn, New York, US; 4Department of Orthopaedic Surgery, SUNY Downstate Medical Center, Brooklyn, NY, US

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
TUESDAY, JULY 31

6:30-8:00 a.m.
Hot Breakfast
Halele’a

6:30 a.m.-12:30 p.m.
Technical Exhibition
Halele’a

6:30 a.m.-1:00 p.m.
Registration
Speaker Information Center
Kauai Court

7:25-7:30 a.m.
Opening Remarks
Kona I

7:30-9:00 a.m.
Symposium:
Minimally Invasive Fusion: LIF, MIS TLIF, PPS, OLIF
Kona I
Moderators:
Michael P. Steinmetz, MD, NASS
Hiroaki Nakamura, MD, JSSR

Faculty will present minimally invasive approaches to common degenerative pathologies and the latest technologies. Presentations will address indications and describe technical procedures as well as tricks, pearls and complications.

Upon completion of this session, participants should gain strategies to:
• List the indications for common minimally invasive procedures in the treatment of degenerative spine disease;
• Outline the general technical approaches to minimally invasive approaches to the degenerative spine;
• Determine the differences between different minimally invasive lateral approaches to the lumbar spine.

Agenda
Case Debate: L4-L5 Degenerative Spondylolisthesis
• Decompression Alone with MED
  Hiroaki Nakamura, MD, JSSR
• Decompression and PSF
  Dominic W. Pelle, MD, NASS
• MIS TLIF
  Wellington K. Hsu, MD, NASS
• Cortical Screws +/- TLIF
  Takashi Kaito, MD, JSSR
• Endoscopic TLIF
  Michael P. Steinmetz, MD, NASS

9:00-9:30 a.m.
Food and Beverage Break
Technical Exhibition
Halele’a

9:30-10:30 a.m.
Abstract Session:
Motion Preservation
Kona I
Moderators:
Gregory D. Schroeder, MD, NASS
Shinichi Konno, MD, JSSR

Gregory J. Kirchner, MPH; Alexander M. Lieber, BA; Yehuda E. Kerbel, MD; Amrit Khalsa, MD
1Drexel University College of Medicine, Philadelphia, PA, US; 2Drexel University College of Medicine, Department of Orthopaedics, Philadelphia, PA, US; 3Hahnemann/Drexel Department of Orthopaedic Surgery, Philadelphia, PA, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

26. Long-Term Outcomes of Lumbar Total Disc Replacement versus Spinal Fusion for the Treatment of DDD: A Novel Meta-Analysis of Randomized Controlled Trials
Jack E. Zigler, MD; Richard D. Guyer, MD; Matthew F. Gornet, MD; Nicole Ferno, MSc; Chris Cameron, PhD; Leena Patel, PhD; Donna D. Ohnmeiss, PhD
1Texas Back Institute, Plano, TX, US; 2The Orthopedic Center of St. Louis, St. Louis, MO, US; 3Cornerstone Research Group, Burlington, ON, Canada
FDA Device/Drug Status: Lumbar TDR (Approved for this indication)
27. Seven Year Outcomes of Lumbar Total Disc Replacement Systems on Patient Lifestyle and Quality of Life
Scott L. Blumenthal, MD
Center for Disc Replacement at Texas Back Institute, Plano, TX, US
FDA Device/Drug Status: ProDisc-L, Charite, activL (investigational during the study, currently approved) (Approved for this indication)

28. Should Decision Making for Lower Instrumented Vertebra Selection Go Beyond Traditional Classification of Adolescent Idiopathic Scoliosis? A Dynamic Three-Dimensional Gait Assessment
Bassel G. Diebo, MD; Ashish Patel, MD; Jeffrey Varghese; Neil V. Shah, MD, MS; Virginie Lafage, PhD; Frank J. Schwab, MD; Carl B. Paulino, MD
1Department of Orthopaedic Surgery, SUNY Downstate Medical Center, Brooklyn, NY, US; 2Methodist Hospital, Merrillville, IN, US; 3Hospital for Special Surgery, New York, NY, US; 4SUNY Downstate Medical Center, Brooklyn, NY, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

29. Analysis of Lumbar Total Disc Replacement Removals and Revisions: A 17-Year Experience
Richard D. Guyer, MD; Donna D. Ohnmeiss, PhD; Scott L. Blumenthal, MD; Jack E. Zigler, MD
1Center for Disc Replacement at Texas Back Institute, Plano, TX, US; 2Texas Back Institute Research Foundation, Plano, TX, US
FDA Device/Drug Status: Lumbar TDR, 1-level (Approved for this indication), Lumbar TDR 2-level (Not approved for this indication)

30. Do the Degenerative Changes on Lumbar Plain MRI Explain the Cause of Low Back Pain? The Wakayama Spine Study
Hiroshi Hashizume, MD, PhD; Hiroshi Yamada, MD, PhD; Hiroyuki Oka, MD; Yasutsugu Yukawa, MD, PhD; Akihito Minamide, MD, PhD; Yukihiro Nakagawa, MD, PhD; Hiroshi Iwasaki, MD, PhD; Shunji Tsutsui, MD, PhD; Masanari Takami, MD, PhD; Hiroki Iwashashi, MD; Munehito Yoshida, MD, PhD
1Wakayama, Japan; 2Department of Orthopaedic Surgery, Wakayama Medical University, Wakayama, Japan; 3Tokyo, Japan; 4Wakayama Medical University-Orthopaedics, Wakayama City, Japan; 5Wakayama Medical University, Wakayama, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

31. Can Triggered Electromyography Thresholds Assure Accurate Pedicle Screw Placements? A Systematic Review and Meta-Analysis of Diagnostic Test Accuracy
Chang-Hyun Lee, MD, MSc
Ilsan Paik Hospital, Inje University, Goyang, Gyeonggi, Republic of Korea
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

Symposium: Biologics, Navigation and New Technology
Kona I
Moderators:
Zorica Buser, PhD, NASS
Masaya Nakamura, MD, JSSR
New technology in spine surgery can be exciting yet confusing at the same time. With the development of novel products, techniques and software, surgeons should have a solid understanding of the science and evidence behind these technologies. During this session faculty will review the most recent literature and provide commentary on a variety of apropos spine surgery products which have been and are being developed.

Upon completion of this session, participants should gain strategies to:
• Assess the current evidence regarding commercially available biologics and its efficacy in spine fusion;
• Evaluate the literature pertaining to biologic solutions for spinal cord injury and regeneration of the intervertebral disc;
• Discuss the aptitude of current navigation and robotics systems and predict the future capabilities of further developed technologies.

Agenda
• An Evidence-based Approach to Biologics
  Wellington K. Hsu, MD, NASS
• Regenerative Medicine for Spinal Cord Injury: Where Are We Now and Where Are We Going?
  Narihito Nagoshi, MD, JSSR
• Stem Cell Injections for Acute Spinal Cord Injuries
  Richard G. Fessler, MD, PhD, NASS
• Regenerative Medicine for Intervertebral Disc: Where Are We Now and Where Are We Going?
  Daisuke Sakai, MD, JSSR
• The Utility of Navigation in Spine Surgery
  Raymond J. Hah, MD, NASS
12:00-12:30 p.m.  
Food and Beverage Break  
Technical Exhibition  
Halele‘a

12:30-12:36 p.m.  
Abstract Session:  
Lumbar Part I  
Kona I  
Moderators:  
Dominic Pelle, MD, NASS  
Katsushi Takeshita, MD, PhD, JSSR

12:30-12:36 p.m.  
32. Categorizing the Hip-Spine Syndrome: A Step Toward a Collaborative Multidisciplinary Classification  
Bassel G. Diebo, MD1; Louis M. Day, MD1; Renaud Lafage, MSc2; Peter G. Passias, MD1; Carl B. Paulino, MD1; Thomas J. Errico, MD1; Frank J. Schwab, MD1; Virginie Lafage, PhD2; Neil V. Shah, MD, MS4  
1Department of Orthopaedic Surgery, SUNY Downstate Medical Center, Brooklyn, NY, US; 2NY Spine Institute, NYU Langone Health, New York, NY, US; 3SUNY Downstate Medical Center, Brooklyn, NY, US; 4Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, NY, US  
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:36-12:42 p.m.  
33. The Influence of Diffuse Idiopathic Skeletal Hyperostosis on Physical Function in Elderly Populations  
Tomohiro Banno, MD1; Daisuke Togawa, MD, PhD2; Tomohiko Hasegawa, MD, PhD1; Yu Yamato, MD, PhD1; Go Yoshida, MD, PhD1; Sho Kobayashi, MD, PhD1; Tatsuya Yasuda, MD1; Hideyuki Arima, MD, PhD1; Shin Oe, MD1; Yuki Mihara, MD1; Hiroki Ushirozako, MD1; Yukihiro Matsuyama, MD, PhD1  
1Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 2Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 3Hamamatsu University School of Medicine, Hamamatsu City, Japan; 4University of California, San Francisco, San Francisco, CA, US; 5Hamamatsu Medical Center, Hamamatsu, Japan  
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:42-12:48 p.m.  
34. Factors Related to Spinal Sagittal Imbalance among an Elderly Population in a Japanese Suburban Community: The Shiraniwa Study  
Shoichiro Ohyama, MD1; Masatoshi Hoshino, MD1; Shinji Takahashi, MD1; Yusuke Horii, MD1; Tadao Tsujio, MD, PhD1; Hidetomi Terai, MD, PhD1; Hiromitsu Toyoda, MD, PhD1; Akinozuki, MD, PhD1; Koji Tamai, MD1; Kazunori Hayashi, MD1; Akiyo Yabu; Hiroaki Nakamura, MD, PhD1  
1Department of Orthopaedic Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan; 2Osaka City University, Osaka, Japan; 3Osaka City General Hospital, Osaka, Japan; 4Shiraniwa Hospital, Ikoma, Japan  
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:48-12:54 p.m.  
35. Minimally Invasive Spinal Decompression Surgery for Degenerative Lumbar Spondylolisthesis and Stenosis Maintains Segmental Stability and May Avoid the Need for Fusion in Many Patients  
Akihito Minamide, MD, PhD1; Munehito Yoshida, MD, PhD1; Andrew Simpson, MD1; Yukihiro Nakagawa, MD, PhD1; Hiroshi Iwasaki, MD, PhD1; Shunji Tsutsui, MD, PhD1; Keiji Nagata, MD, PhD1; Yasutugu Mayaka, MD, PhD1; Hiroshi Hashizume, MD, PhD1; Hiroshi Yamada, MD, PhD1  
1Wakayama Medical University-Orthopaedics, Wakayama City, Japan; 2Wakayama Medical University, Wakayama City, Japan; 3Texas Back Institute, Dallas, TX, US; 4Wakayama City, Japan; 5Department of Orthopaedic Surgery, Wakayama Medical University, Ito-gun, Wakayama, Japan  
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:54-1:00 p.m.  
36. The Role of Lumber Retrolisthesis in Whole Spinopelvic Alignment and Health-Related Quality of Life among Elderly Volunteers: Lumbar Retrolisthesis Compensates for Spinal Kyphosis  
Yuki Mihara, MD1; Daisuke Togawa, MD, PhD2; Tomohiko Hasegawa, MD, PhD1; Yu Yamato, MD, PhD1; Go Yoshida, MD, PhD1; Tatsuya Yasuda, MD1; Tomohiro Banno, MD1; Hideyuki Arima, MD, PhD1; Shin Oe, MD1; Hiroki Ushirozako, MD1; Yukihiro Matsuyama, MD, PhD1  
1Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 2Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 3Hamamatsu University School of Medicine, Hamamatsu City, Japan; 4Hamamatsu Medical Center, Hamamatsu, Japan  
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
1:00-1:06 p.m.
37. Supervised Exercise versus Unsupervised Exercise for Patients with Lumbar Spinal Stenosis: A Randomized Controlled Trial
Masakazu Minetama, PT¹; Mamoru Kawakami, MD, PhD¹; Masatoshi Teraguchi, MD, PhD¹; Ryohei Kagotani, MD, PhD¹; Masafumi Nakagawa, PT¹; Tomoko Kitano, CPT²
¹Spine Care Center, Wakayama Medical University Kihoku Hospital, Ito-gun, Wakayama, Japan; ²Wakayama Medical University Kihoku Hospital, Katuragicho, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

1:06-1:12 p.m.
38. The Degeneration of Adjacent Intervertebral Discs Negatively Influences Union Rate of Osteoporotic Vertebral Fracture: A Multicenter Cohort Study
Shinji Takahashi, MD¹; Masatoshi Hoshino, MD²; Kazushi Takayama, MD, PhD³; Hiromitsu Toyoda, MD, PhD¹; Hiroyuki Yasuda, PhD²; Hiroaki Nakamura, MD, PhD¹
¹Osaka City University, Osaka, Japan; ²Department of Orthopedic Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan; ³Seikeikai Hospital, Osaka, Japan; ⁴Osaka City University, Graduate School of Medicine, Osaka, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

1:12-1:30 p.m.
Discussion

1:30 p.m.
General Meeting Adjourns
WEDNESDAY, AUGUST 1

6:30-8:00 a.m.
Hot Breakfast
Halele'a

6:30-9:30 a.m.
Technical Exhibition
Halele'a

6:30 a.m.-1:00 p.m.
Registration
Speaker Information Center
Kauai Court

7:25-7:30 a.m.
Opening Remarks
Kona I

7:30-9:00 a.m.
Symposium:
Treatment of Cervical Spine Disorders
Kona I
Moderators:
Thomas E. Mroz, MD, NASS
Morio Matsumoto, MD, JSSR

A robust review and discussion of pertinent topics addressing cervical spine surgery. Experts in their respective subject areas will debate appropriate treatment for cervical radiculopathy as well as discuss treatment options for multilevel cervical myelopathy, central cord syndrome, deformity correction, and the use of neural monitoring.

Upon completion of this session, participants should gain strategies to:
• Identify treatment options and supporting evidence for 1- and 2-level cervical radiculopathy;
• Determine the state of the art literature for management of central cord syndrome;
• Identify the various treatment approaches for multilevel cervical myelopathy;
• Appreciate novel techniques for cervical deformity correction;
• Determine the utility of neural monitoring during cervical spine surgery.

Agenda
• Case Debate: 1- or 2-Level Radiculopathy
  Anterior Cervical Discectomy and Fusion (ACDF)
  Gregory D. Schroeder, MD, NASS

  Total Disc Replacement (TDR)
  Wellington K. Hsu, MD, NASS

  Foraminotomy
  Thomas E. Mroz, MD, NASS

  Central Cord Syndrome: Timing of Surgery
  Ajit A. Krishnaney, MD, NASS

  Treatment of Multi-level Cervical Spondylotic Myelopathy (CSM) or Ossification of the Posterior Longitudinal Ligament (OPLL)

  Multi-level Anterior Cervical Discectomy and Fusion (ACDF)
  Alpesh A. Patel, MD, FACS, NASS

  Posterior Decompression and Posterior Spinal Fusion
  Jeffrey C. Wang, MD, NASS

  Laminoplasty
  Morio Matsumoto, MD, JSSR

  Anterior or Posterior Approach
  Toshitaka Yoshii, MD, JSSR

• New Techniques for Cervical Spine Instrumentation for Spinal Deformity
  Hirotaka Chikuda, MD, JSSR

• Efficacy of Evoked Potential Monitoring During Cervical Spine Surgeries
  Tsukasa Kanchiku, MD, JSSR

• Discussion
  Faculty Panel

9:00-9:30 a.m.
Food and Beverage Break
Technical Exhibition
Halele'a

9:30-10:30 a.m.
Abstract Session:
Trauma and Tumor
Kona I
Moderators
Ajit A. Krishnaney, MD, NASS
Takeshi Maeda, MD, PhD, JSSR

9:30-9:36 a.m.
39. Intrathecal Administration of Recombinant Human Hepatocyte Growth Factor for Acute Spinal Cord Injury: The Road from Bench to Clinical Trial and Future Perspective
Kazuya Kitamura, MD, PhD; Narihito Nagoshi, MD, PhD; Oshikho Tsuji, MD, PhD; Hideyuki Okano, MD, PhD; Morio Matsumoto, MD; Masaya Nakamura, MD, PhD

1 Saiseikai Yokohamashi Tobu Hospital, Kanagawa, Japan; 2Toronto Western Hospital, Toronto, ON, Canada; 3Saitama, Japan; 4Department of Physiology, Keio University School of Medicine, Tokyo, Japan; 5Keio University School of Medicine, Tokyo, Japan; 6Department of Orthopedic Surgery, Keio University School of Medicine, Shinjuku, Tokyo, Japan

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
9:36-9:42 a.m.
40. Time Course of Respiratory Dysfunction and Motor Paralysis for 12 Weeks in Cervical Spinal Cord Injury without Bone Injury
Chikara Ushiku, MD; Kota Suda, MD, PhD; Satoko M. Harmon, MD, PhD; Miki Komatsu, MD, PhD; Masahiko Takahata, MD, PhD; Akio Minami, MD
1Hokkaido Spinal Cord Injury Center, Tokyo, Japan; 2Hokkaido Spinal Cord Injury Center, Bibai, Japan; 3Hokkaido University, Sapporo, Japan; 4Sapporo, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:42-9:48 a.m.
41. 12-Month Safety and Efficacy Results from the SCIStar Study: A Phase 1/2a Trial of Human Embryonic Stem Cell-Derived Oligodendrocyte Progenitor Cells (AST-OPC1) in Patients with Subacute Cervical Spinal Cord Injury
Richard G. Fessler, MD, PhD; Ed Wirth; Gary K. Steinberg, MD; Shekar N. Kurpad, MD, PhD
1Department of Neurosurgery, Rush Medical Center, Chicago, IL, US; 2Geron Corporation, Menlo Park, California, US; 3Stanford University SOM, Stanford, CA, US; 4Medical College of Wisconsin, Milwaukee, WI, US
FDA Device/Drug Status: FDA trial (Investigational/Not approved)

9:48-9:54 a.m.
42. Balloon Kyphoplasty for Fresh Osteoporotic Vertebral Fractures with Poor Prognostic Factors: Multicenter Prospective Intervention Study
Masatoshi Hoshino, MD; Masatoshi Hoshino, MD; Shinji Takahashi, MD; Hiroyuki Yasuda, PhD; Hidetomi Terai, MD, PhD; Kazunori Hayashi, MD; Tadao Tsujio, MD, PhD; Hiroshi Kono, MD, PhD; Akinobu Suzuki, MD, PhD; Koji Tamai, MD, PhD; Shoichiro Ohyama, MD; Hiromitsu Toyoda, MD, PhD; Sho Dohzono, MD, PhD; Yusuke Hori, MD; Hiroaki Nakamura, MD, PhD
1Department of Orthopedic Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan; 2Osaka City University, Osaka, Japan; 3Shiraniwa Hospital, Ikoma, Japan; 4Higashiosaka, Japan; 5Osaka, Japan; 6Osaka City General Hospital, Osaka, Japan; 7Osaka City University, Graduate School of Medicine, Osaka, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

9:54-10:00 a.m.
43. Comparative Study of Spinal Reconstruction after Total En Bloc Spondylectomy
Katsuhito Yoshioka, MD; Hideki Murakami; Satoru Demura, MD; Satoshi Kato, MD, PhD; Noriaki Yokogawa, MD, PhD; Takaki Shimizu, MD; Hiroyuki Tsuchiya, MD, PhD
1National Hospital Organization Kanazawa Medical Center, Kanazawa, Japan; 2Kanazawa, Japan; 3Kanazawa University Department of Orthopaedic Surgery, Kanazawa, Japan; 4Kanazawa University, Kanazawa, Japan; 5Kanazawa University School of Medicine, Kanazawa, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:00-10:06 a.m.
44. Surgery for Metastatic Epidural Spinal Cord Compression in Thoracic Spine: Anterior or Posterior Approach?
Jen-Chung Liao, MD
Chang Gung Memorial Hospital, Tao Yuan, Taiwan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:06-10:12 a.m.
45. Patients with Unknown Primary Tumor have Longer Expected Survival after Surgery for Spinal Metastatic Disease
Christian Carrwik, MD; Claes Olerud, MD, PhD; Yohan Robinson, MD, PhD
1Uppsala University Hospital, Uppsala, Sweden; 2Department Orthopaedics, Uppsala, Uppsala, Sweden
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

10:12-10:30 a.m.
Discussion
**10:30 a.m.-12:00 p.m.**

**Symposium:**
**Osteoporosis and Sarcopenia**

Kona I

**Moderators:**
Gregory D. Schroeder, MD, NASS
Hirotaka Haro, MD, JSSR

Faculty will evaluate the status of osteoporosis in patients undergoing spinal fusion surgery or suffering vertebral fracture, as well as address a decrease in the complication rate.

**Upon completion of this session, participants should gain strategies to:**
- Identify the status of osteoporosis before surgery;
- Apply appropriate pharmacological treatment pre- and postoperative surgery and surgical technique;
- Choose the appropriate treatment of vertebral fractures.

**Agenda**
- **The Relationship Between Osteoporosis and Sarcopenia**
  Naohisa Miyakoshi, MD, JSSR
- **Diagnostic Workup of Osteoporosis in Patients Undergoing Spinal Fusion Surgery**
  Gregory D. Schroeder, MD, NASS
- **Pharmacological Treatment of Osteoporosis Before and After Spinal Fusion Surgery**
  Hirotaka Haro, MD, JSSR
- **Strategies to Reduce the Incidence of Pedicle Screw Loosening, Case Subsidence, and Pseudoarthrosis After Fusion Surgery in Patients With Osteoporosis**
  Gen Inoue, MD, JSSR
- **Treatment of Osteoporotic Vertebral Fractures: Nonoperative Care and Indications to Perform Surgery**
  Clinton J. Devin, MD, NASS
- **Discussion**
  Faculty Panel

**12:00-12:15 p.m.**

**Food and Beverage Break**
Kauai Court

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**12:15-1:15 p.m.**

**Abstract Session:**
**Diagnostics/Imaging**

Kona I

**Moderators:**
Clinton J. Devin, MD, NASS
Toshihiko Yamashita, MD, JSSR

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**12:15-12:21 p.m.**

**46. The Poor Neck Disability Index Score is Associated with Cervical Spinal Malalignment: The Cutoff Values of Japanese NDI**

Shin Oe, MD\(^1\); Daisuke Togawa, MD, PhD\(^1\); Tomohiko Hasegawa, MD, PhD\(^1\); Yu Yamato, MD, PhD\(^2\); Go Yoshida, MD, PhD\(^3\); Sho Kobayashi, MD, PhD\(^4\); Tatsuya Yasuda, MD\(^5\); Tomohiro Banno, MD\(^6\); Hideyuki Arima, MD, PhD\(^2\); Yuki Mihara, MD, PhD\(^2\); Hiroki Ushirozako, MD\(^2\); Yuukihiro Matsuyama, MD, PhD\(^2\)

\(^1\)Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; \(^2\)Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; \(^3\)Hamamatsu University School of Medicine, Hamamatsu City, Japan; \(^4\)University of California, San Francisco, San Francisco, CA, US; \(^5\)Hamamatsu Medical Center, Hamamatsu, Japan

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

**12:21-12:27 p.m.**

**47. Spinal Cord Swelling after Surgery in Cervical Spondylotic Myelopathy: Relationship with Intramedullary Gd-DTPA Enhancement on MRI**

Hiroshi Ozawa, MD, PhD\(^1\); Tetsuro Sato, MD, PhD\(^2\)

\(^1\)Department of Orthopaedic Surgery Tohoku Medical and Pharmaceutical University, Sendai, Miyagi, Japan; \(^2\)Sendai Orthopaedic Hospital, Sendai, Japan

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

**12:27-12:33 p.m.**

**48. Foraminal Stenotic Ratio to Identify Lumbar Foraminal Stenosis Requiring Surgery or Not: MRI Study Using 3D T1 SPACE Sequence**

Kentaro Yamada, MD\(^1\); Yuichiro Abe, MD, PhD\(^2\); Shigenobu Satoh, MD\(^3\); Hiroaki Nakamura, MD, PhD\(^4\)

\(^1\)Osaka City University Graduate School of Medicine, Osaka City, Japan; \(^2\)Eniwa Hospital, Eniwa, Japan; \(^3\)Eniwa Hospital, Hokkaido, Japan

**FDA Device/Drug Status:** This abstract does not discuss or include any applicable devices or drugs.
12:33-12:39 p.m.
49. Prevalence of Cervical Myelopathy and Symptomatic Lumbar Spinal Stenosis among Participants with Radiographic Tandem Spinal Stenosis
Keiji Nagata, PhD1; Hiroshi Hashizume, MD, PhD2; Hiroshi Yamada, MD, PhD2; Yuu Ichimoto, MD, PhD2; Akihito Minamide, MD, PhD2; Yukihiro Nakagawa, MD, PhD2; Yasutsugu Yukawa, MD, PhD2; Munehito Yoshida, MD, PhD1
1Wakayama Medical University, Wakayama, Japan; 2Wakayama, Japan; 3Department of Orthopaedic Surgery, Wakayama Medical University, Ito-Gun, Wakayama, Japan; 4Wakayama Medical University-Orthopaedics, Wakayama City, Japan; 5Wakayama City, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:39-12:45 p.m.
50. Relationship Between Cauda Equina Conduction Time and Type of Neurogenic Intermittent Claudication Due to Lumbar Spinal Stenosis
Yuji Nagao, MD1; Tsukasa Kanchiku, MD, PhD2; Yasuaki Imajo, MD2; Hidenori Suzuki, MD, PhD3; Masahiro Funaba, MD, PhD3; Norihiro Nishida, MD1; Toshihiko Taguchi, MD1
1Department of Orthopaedic Surgery Yamaguchi University Graduate School of Medicine, Ube, Yamaguchi, Japan; 2Ube, Japan; 3Yamaguchi University Graduate School of Medicine, Ube, Yamaguchi, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

12:45-12:51 p.m.
51. Thoracic Spine Translation and Angular Motion: An Analysis Using Thoracic Spine Kinematic MRI (kMRI)
Permsak Paholpak, MD1; Ishan D. Shah, BA2; Koji Tamai, MD1; Zorica Buser, PhD4; Jeffrey C. Wang, MD5
1Department of Orthopaedics, Faculty of Medicine, Meung Khon Kaen, Khon Kaen, Thailand; 2Los Angeles, CA, US; 3Osaka City University, Osaka, Japan; 4Norris Research Tower, Keck School of Medicine, USC, Los Angeles, CA, US; 5USC Spine Center, Los Angeles, CA, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
7:42-7:48 a.m.
55. The Incidence of Proximal Junctional Kyphosis Increases in Patients with Large Change of Thoracic Kyphosis after Surgery
Shin Oe, MD1; Daisuke Togawa, MD, PhD1; Tomohiko Hasegawa, MD, PhD2; Yu Yamato, MD, PhD2; Go Yoshida, MD, PhD2; Sho Kobayashi, MD, PhD2; Tatsuya Yasuda, MD2; Tomohiro Banno, MD2; Hideyuki Arima, MD, PhD2; Yuki Mihara, MD2; Hiroki Ushirozako, MD2; Yuukihiro Matsuyama, MD, PhD2
1Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 2Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 3Hamamatsu University School of Medicine, Hamamatsu City, Japan; 4University of California, San Francisco, San Francisco, CA, US; 5Hamamatsu Medical Center, Hamamatsu, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

7:48-7:54 a.m.
56. Psychiatric Disorders Increase the Rate of Postoperative Infection and Wound Complications after Lumbar Spine Surgery
Permsak Paholpak, MD1; Christopher Wang, BS2; Koji Tamai, MD2; Zorica Buser, PhD4; Jeffrey C. Wang, MD5
1Department of Orthopaedics, Faculty of Medicine, Meung Khon Kaen, Khon Kaen, Thailand; 2Los Angeles, CA, US; 3Osaka City University, Osaka, Japan; 4Norris Research Tower, Keck School of Medicine, USC, Los Angeles, CA, US; 5USC Spine Center, Los Angeles, CA, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

7:54-8:00 a.m.
57. Robotic-Assisted Lumbar Fusion Fails to Reduce Perioperative Complications
Alexander M. Lieber, BA1; Gregory J. Kirchner, MPH12; Yehuda E. Kerbel, MD2; Amrit Khalsa, MD2
1Drexel University College of Medicine, Philadelphia , PA, US; 2Drexel University College of Medicine, Department of Orthopaedics, Philadelphia, PA, US; 3Hahnemann/Drexel Department of Orthopaedic Surgery, Philadelphia, PA, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
58. Sarcopenia Predicts Overall Survival in Patients with Lung, Breast, Prostate, or Myeloma Spine Metastases, Regardless of Histology

Hesham M. Zakaria, MD1; Lara W. Massie, MD1; Lonni R. Schultz, PhD1; Brent Griffith, MD2; Farzan Siddiqui, MD, PhD2; Victor Chang, MD2

1Henry Ford Hospital, Detroit, MI, US; 2Henry Ford Health System, Detroit, MI, US; 3Detroit, MI, US; 4Henry Ford West Bloomfield Hospital, West Bloomfield, MI, US

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

59. Is Chronic Kidney Disease Associated with Postoperative Complications after Spinal Fusion Surgery?

Stanley Weng, MS1; George A. Beyer, MS1; Neil V. Shah, MD, MS1; Jared M. Newman, MD1; Omar K. Hariri, MD1; Scott C. Pascal, MD2; Lee Bloom, MD3; Bassel G. Diebo, MD2; Hiroyuki Yoshihara, MD, PhD1; Carl B. Paulino, MD1

1SUNY Downstate Medical Center, Brooklyn, NY, US; 2Department of Orthopaedic Surgery, SUNY Downstate Medical Center, Brooklyn, NY, US

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

60. The Risk of Recurrent Laryngeal Nerve Injury with Laterality of Approach in Anterior Cervical Discectomy and Fusion Procedures: A Randomized, Prospective Study Over 10 Years

Shalin Shah, DO1; Manminder S. Bhatia, DO1; William Beutler, MD, FACS2

1Pinnacle Health, Harrisburg, PA, US; 2Pennsylvania Spine Institute, Harrisburg, PA, US

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

61. Intraoperative Navigation Decreases the Risk of Reoperation for Implant-Related Complication Following Spinal Fusion Surgery

Junichi Ohya, MD1; Takeshi Ochi, MD1; Naohiro Kawamura, MD2; Yasushi Oshima, MD, PhD3; Hirotaka Chikuda, MD, PhD3; Jun-ichi Kunogi, MD3

1Tokyo, Japan; 2Sanraku Hospital, Tokyo, Japan; 3The University of Tokyo, Tokyo, Japan; 4Department of Orthopaedic Surgery, Gunma University, Maebashi, Gunma, Japan

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

62. Readmissions, Length of Stay and Mortality after Primary Surgery for Adult Spinal Deformity: A 10-Year Follow-Up Study

Frederik Taylor Pitter, MD1; Martin Lindberg-Larsen, PhD, MD1; Alma B. Pedersen, PhD, MD1; Benny Dahl, MD, PhD1; Martin Gehrchen, MD, PhD1

1Rigshospitalet, Copenhagen, Denmark; 2Odense University Hospital, Aarhus, Denmark; 3Department of Clinical Epidemiology Aarhus University Hospital, Aarhus N, Denmark, Denmark; 4Texas Children’s Hospital, Houston, Texas, US; 5Rigshospitalet, University of Copenhagen, Copenhagen, Denmark

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

64. The Fate Thoracolumbar Surgeries in Patients with Parkinson Disease, and Analysis of Risk Factors for Revision Surgeries

Jen-Chung Liao, MD; Huan Sheu, MD

Chang Gung Memorial Hospital, Linkou, Guishan District, Taoyuan City, Taoyuan City, Taiwan

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
65. Weekly Teriparatide Administration and Preoperative Anterior Spondylolisthesis of Upper Adjacent Vertebra: Independent Predictors of Osseous Union Enhancement
Hiroki Ushirozako, MD; Tomohiko Hasegawa, MD, PhD; Yu Yamato, MD, PhD; Go Yoshida, MD, PhD; Sho Kobayashi, MD, PhD; Tatsuya Yasuda, MD, PhD; Tomohiro Banno, MD; Hideyuki Arima, MD, PhD; Shin Oe, MD; Yuki Mihara, MD; Daisuke Togawa, MD, PhD; Yuhiro Matsuyama, MD, PhD

1Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan; 2Hamamatsu University School of Medicine, Hamamatsu City, Japan; 3University of California, San Francisco, San Francisco, CA, US; 4Hamamatsu Medical Center, Hamamatsu, Japan; 5Division of Geriatric Musculoskeletal Health and Department of Orthopaedic Surgery, Hamamatsu University School of Medicine, Shizuoka, Japan

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

66. Radiological Features and Clinical Outcomes of Concomitant Decompression Surgery to Adjacent Segment and Posterior Lumbar Interbody Fusion at Five Years
Tomiya Matsumoto, MD, PhD; Shinya Okuda, MD, PhD; Yukitaka Nagamoto, MD, PhD; Tsuyoshi Sugiura, MD, PhD; Yoshifumi Takahashi, MD; Motoki Iwasaki, MD, PhD

1Sakai, Osaka Japan; 2Osaka Rosai Hospital, Sakai, Japan

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

67. Propensity Matched Comparison of Outcomes and Cost after Macroscopic and Microscopic Lumbar Discectomy Using a National Longitudinal Database
Allen L. Ho, MD

Stanford Hospital and Clinics, Stanford, CA, US

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

9:39-9:45 a.m.
68. Over 10 Years Follow Up Results of MIS-TLIF for Patients with Degenerative Spondylolisthesis of the Lumbar Spine: Preservation of Posterior Structures Might Reduce Adjacent Segment Degeneration
Akihito Wada, MD, PhD; Katsunori FukutakeMD, PhD; Hasegawa Keiji, MD; Shintaro Tsuge, MD; Yasuaki Iida, MD; Hiroshi Takahashi, MD

1Toho University School of Medicine, Tokyo, Japan; 2Toho University Omori Medical Center, Tokyo, Japan; 3Toho University, Oomorishin, Ootaku, Tokyo, Japan; 4Omorinis, Ootaku, Tokyo, Japan; 5Tokyo, Japan

FDA Device/Drug Status: METRx system (Approved for this indication), Sextant system (Approved for this indication)

69. Comparison of Decompression, Decompression Plus Fusion, and Decompression Plus Stabilization for Degenerative Spondylolisthesis: A Prospective, Randomized Study
Hiroyuki Inose, MD, PhD; Tsuyoshi Kato, MD, PhD; Toshitaka Yoshii, MD

Tokyo Medical and Dental University, Tokyo, Japan

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

70. Retrospective Multicenter Study of Perioperative Complications in 1,015 Patients Who Underwent Oblique Lateral Interbody Fusion Surgery
Sumihisa Orita, MD, PhD; Yoshihisa Kotani, MD; Hideki Murakami, MD, PhD; Tomohisa Harada, MD; Keisuke Nakano, MD, PhD; Yoshiyasu Arai, MD, PhD; Masahiro Yoshida, MD; Takahiro Iida, MD; Takanori Saito, MD; Koki Abe, MD; Richard A. Hynes, MD; Shunsuke Fujibayashi, MD; Seiji Ohtori, MD, PhD

1Graduate School of Medicine, Chiba University, Chiba, Japan; 2Steel Memorial Muroran Hospital, Muroran, Japan; 3Morioka, Iwate, Japan; 4Rakukai Marumachi Hospital, Kyoto, Japan; 5Maki Hospital, Osaka, Osaka, Japan; 6Saiseikai Kawaguchi General Hospital, Kawaguchi, Saitama, Japan; 7Seirei Mikatabara General Hospital, Hamamatsu City, Japan; 8Dokkyo Medical University, Koshigaya Hospital, Koshigaya, Japan; 9Kansai Medical University, Hirakata, Osaka, Japan; 10Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Japan; 11The B.A.C.K. Center, Melbourne, FL, US; 12Kyoto University, Japan; 13Chiba, Japan

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

9:57-10:15 a.m.
Discussion
10:15-11:45 a.m.

Symposium:
Help the Professor! Case Presentations

Kona I
Moderators:
Jason W. Savage, MD, NASS
Yukihiro Matsuyama, MD, JSSR

Faculty will focus on complex case presentations including adult spinal deformity, spinal oncology and spinal infections, as well as review the appropriate diagnostic work-up of these complex cases, explore surgical treatment options, and review “tips and tricks” of performing these complex operations.

Upon completion of this session, participants should gain strategies to:
• Determine the clinical and diagnostic work-up involved in treating complex spinal deformity, spinal infections and tumors;
• Review the “tips and tricks” of performing complex spinal reconstructions.

Agenda
Case Presentations

Faculty Panel
R. Douglas Orr, MD, NASS
Seiji Ohtori, MD, JSSR
Daniel M. Sciubba, MD, NASS
Yukihiro Matsuyama, MD, JSSR

11:45 a.m.
General Meeting Concludes
P1. Significance of Serum Homocysteine Level for the Prevention of Osteoporotic Vertebral Fracture
Kosuke Sugiura, MD; Akihiro Nagamachi, MD, PhD; Koichi Sairyo, MD
1Mitoyo General Hospital, Kagawa, Japan; 2Takamatsu Municipal Hospital, Takamatsu, Kagawa, Japan; 3University of Tokushima, Tokushima, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P2. Thrombin Induces PAR1-Dependent MCP-1 Expression and Macrophage Migration in Mouse Intervertebral Disc
Yoshihiro Takayama, MD; Takashi Ando, MD, PhD; Hirotaka Haro, MD, PhD
1University of Yamanashi, Chuou-City, Yamanashi, Japan; 2Department of Orthopaedic Surgery, Faculty of Medicine, University of Yamanashi, Chuo, Yamanashi, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P3. Age-Related Changes of the Spinal Cord: A Biomechanical Study
Tomoya Okazaki, MD; Norihiro Nishida, MD; Tsukasa Kanchiku, MD, PhD; Yasuaki Imajo, MD; Hidenori Suzuki, MD, PhD; Masahiro Funaba, MD, PhD; Toshihiko Taguchi, MD
1Yamaguchi University Graduate School of Medicine, Department of Orthopedic Surgery, Ube City, Yamaguchi Prefecture, Japan; 2Ube, Japan; 3Yamaguchi University Graduate School of Medicine, Ube, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

James L. West, MD
Wake Forest Baptist Health, Winston Salem, NC, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P5. Risk Factors for Delirium after Spine Surgery: An Age-Matched Analysis
Masayuki Hino, MD, PhD; Tadao Morino, MD, PhD; Hiroshi Misaki, MD; Hiromasa Miura, MD, PhD
1Spine Center, Ehime University Hospital, Tohon, Ehime, Japan; 2Ehime University Hospital Spine Center, Tohon, Japan; 3Ehime University Orthopedic Surgery, Tohon, Japan

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

P6. Age is Not a Significant Predictor of Adverse Events after Cervical Spine Surgery: Analysis from the Michigan Spine Surgery Improvement Collaborative (MSSIC)
Hesham M. Zakaria, MD; Michael S. Bazydlo, MS; Lonni R. Schultz, PhD; Jason M. Schwab, MD; Victor Chang, MD
1Henry Ford Hospital, Detroit, MI, US; 2Henry Ford Health System, Detroit, MI, US; 3Department of Neurological Surgery, University of Rochester, Rochester, NY, US; 4Henry Ford West Bloomfield Hospital, West Bloomfield, MI, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P7. Error Propagation in Spinal Intraoperative Navigation from Non-Segmental Registration: A Prospective Cadaveric and Clinical Study
Daipayan Guha, MD
University of Toronto Division of Neurosurgery, Toronto, ON, Canada
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

Hiroaki Manabe, MD; Toshinori Sakai, MD, PhD; Masatoshi Morimoto, MD; Fumitake Tezuka, MD; Kazuta Yamashita, MD; Yoichiro Takata, MD, PhD; Takashi Chikawa, MD, PhD; Koichi Sairyo, MD
1Tokushima University, Tokushima, Tokushima, Japan; 2Kuramoto, Japan; 3Tokushima, Japan; 4Tokushima University Graduate School, Department of Orthopedics, Tokushima, Japan; 5University of Tokushima, Tokushima, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P9. Supine versus Weight-Bearing MRI in the Evaluation of Patients with Lumbar Spondylolisthesis
Richard D. Guyer, MD; Donna D. Ohnmeiss, PhD
1Texas Back Institute, Plano, TX, US; 2Texas Back Institute Research Foundation, Plano, TX, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P10. Anatomical Study of the Lumbar Segmental Artery and Vein to Prevent Vascular Complications during Lateral Lumbar Interbody Fusion
Nobuyuki Suzuki, MD, PhD; Jun Mizutani, MD, PhD; Akira Kondo, MD, PhD; Seiji Otsuka, MD, PhD; Takanobu Otsuka, MD, PhD
Department of Orthopedic Surgery, Nagoya City University, Graduate School of Medical Sciences Nagoya, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P11. Electrophysiological Assessment and Classification of Motor Pathway Function in Patients with Spinal Dural Arteriovenous Fistula
Kazuyoshi Nakanishi, MD, PhD; Nobuhiro Tanaka, MD, PhD; Yoshinori Fujimoto, MD, PhD; Koichiro Nishikawa, MD; Naouke Kamei, MD, PhD; Nobuo Adachi, MD, PhD
1Hiroshima University, Hiroshima, Japan; 2Hiroshima University, Department of Orthopedic Surgery, Hiroshima, Japan; 3Hiroshima General Hospital, Hatsukaichi, Japan; 4Hiroshima City Hospital, Hiroshima, Japan; 5Hiroshima, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P12. Dropped Head Syndrome Caused by the Thoracolumbar Kyphosis
Kenji Endo, MD, PhD; Yuji Matsuoka, MD; Hidekazu Suzuki, MD, PhD; Hirosuke Nishimura, MD, PhD; Taichiro Takamatsu, MD, PhD; Yasunobu Sawaji, PhD; Kazuma Murata, MD, PhD; Takeshi Seki, MD; Takamitsu Konishi, MD; Takato Alhara, MD, PhD; Kengo Yamamoto, MD, PhD
1Tokyo Medical University, Tokyo, ID, Japan; 2Tokyo, Japan; 3Tokyo Medical University Hachioji Medical Center, Hachioji, Tokyo, Japan; 4Department of Orthopedic Surgery Tokyo Medical University, Nishinjuku, Shinjuku-Ku, Tokyo-to, Japan; 5Tokyo Medical University Hospital, Shinjuku-Ku, Tokyo, Japan; 6Funabashi Orthopedic Hospital, Funabashi-City, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P13. Utility of the Serum Cystatin C-Level for Diagnosis of Osteoporosis
Satoshi Tanaka, MD; Shiro Imagama, MD; Kei Ando; Kenyu Ito, MD; Masayoshi Morozumi, MD; Sadayuki Ito, MD
1Nagoya, Japan; 2Nagoya University Graduate School of Medicine, Nagoya, Japan; 3Showa-Ku, Nagoya City, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P14. Application of Neurite Orientation Dispersion and Density Imaging and Diffusion Tensor Imaging to Quantify the Severity of Cervical Spondylotic Myelopathy and to Assess Postoperative Neurologic Recovery
Genki Okita, MD, PhD; Tetsuro Oba, MD, PhD; Hirotaka Haro, MD, PhD
1Kyonan Medical Center Fujikawa Hospital, Minamikoma-Gun Fujikawa-Cho, Yamanashi-ken, Japan; 2Chou, Japan; 3University of Yamanashi, Yamanashi, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P15. Diffuse Idiopathic Skeletal Hyperostosis is Associated with Lumbar Spinal Stenosis Required Surgery
Kentaro Yamada, MD; Shigenobu Satoh, MD; Hirosi Hashizume, MD, PhD; Ryoei Kagotani, MD, PhD; Yuyu Ishimoto, MD, PhD; Yuichiro Abe, MD, PhD; Hiromitsu Toyoda, MD, PhD; Hidetomi Terai, MD, PhD; Shigeyuki Muruki, MD, PhD; Hiroaki Nakamura, MD, PhD
1Osaka City University Graduate School of Medicine, Osaka City, Japan; 2Eniwa Hospital, Hokkaido, Japan; 3Wakayama, Japan; 4Spine Care Center, Wakayama Medical University, Kihoku Hospital, Ito-Gun, Wakayama, Japan; 5Department of Orthopaedic Surgery, Wakayama Medical University, Ito-Gun, Wakayama, Japan; 6Eniwa Hospital, Eniwa, Japan; 7Osaka City University, Osaka, Japan; 8Department of Orthopaedic Surgery, Osaka City University, Graduate School of Medicine, Osaka, Japan; 922nd Century Medical and Research Center, The University of Tokyo, Tokyo, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P16. Accuracy of Three Scoring System for Prediction of Metastatic Spine Tumor Prognosis: Analysis of Revised Tokuhashi, Katagiri, and Tomita Scores
Masahiro Inuma, MD; Tsutomu Akazawa, MD, PhD; Yoshiaki Torii, MD; Shingo Kuroya, MD; Hisateru Niki, MD, PhD
1St. Marianna University, Kawasaki-City, Kanagawa, Japan; 2Department of Orthopaedic Surgery, St. Marianna University School of Medicine, Kawasaki, Japan; 3St Marianna University, School of Medicine, Kawasaki, Kanagawa, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P17. Clinical Features and Treatments of Pyogenic Spondylodiscitis with Severe Paralysis
Teppei Hayashi, MD; Masanori Kato
1Department of Orthopaedic Surgery, National Tokyo Medical Center, Meguroku, Tokyo, Japan; 2Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P18. The Sex and Age Distribution of Indices for Muscle Evaluation and Their Association with Spinal Sagittal Alignment: The Wakayama Spine Study
Hiroshi Hashizume, MD, PhD1; Hiroshi Yamada, MD, PhD2; Hiroyuki Oka, MD, PhD3; Shunji Tsutsui, MD, PhD4; Yasutsgu Yokawa, MD, PhD5; Hiroshi Iwasaki, MD, PhD5; Masanari Takami, MD, PhD5; Hiroki Iwashashi, MD, Munehito Yoshida, MD, PhD6
1Wakayama, Japan; 2Department of Orthopaedic Surgery, Wakayama Medical University, Wakayama, Japan; 3Tokyo, Japan; 4Wakayama Medical University, Wakayama, Japan; 5Wakayama, Japan

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

Hiroshi Hashizume, MD, PhD1; Hiroshi Yamada, MD, PhD2; Hiroyuki Oka, MD3; Shunji Tsutsui, MD, PhD4; Yasutsgu Yokawa, MD, PhD5; Akihito Minamide, MD, PhD6; Yukihiro Nakagawa, MD, PhD7; Hiroshi Iwasaki, MD, PhD1; Masanari Takami, MD, PhD5; Hiroki Iwashashi, MD; Munehito Yoshida, MD, PhD4
1Wakayama, Japan; 2Department of Orthopaedic Surgery, Wakayama Medical University, Wakayama, Japan; 3Tokyo, Japan; 4Wakayama Medical University, Wakayama, Japan; 5Wakayama, Japan; 6Wakayama Medical University-Orthopaedics, Wakayama City, Japan; 7Wakayama City, Japan

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

P20. Lower Lumbar Retrolisthesis Indicates Worse Spinopelvic Alignment and Health-Related Quality of Life
Yuki Mihara, MD1; Daisuke Togawa, MD, PhD2; Tomohiko Hasegawa, MD, PhD3; Yu Yamato, MD, PhD3; Go Yoshida, MD, PhD3; Tatsuya Yasuda, MD4; Tomohiro Banno, MD4; Hideyuki Arima, MD, PhD5; Shin Oe, MD5; Hiroki Ushirozako, MD5; Yukihiro Matsuyama, MD, PhD6
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P21. Percutaneous Endoscopic Radiofrequency Treatment for Chronic Low Back Pain: Technique Description and Clinical Outcomes
Jin-Sung L. Kim, MD, PhD1; Javier Quillo-Olvera, MD2
1Seoul St. Mary’s Hospital, Seocho Gu, Seoul, 2The Brain and Spine Care Center, Hospital Star Medica, Queretaro, Mexico

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

P22. Cervical Artificial Disc Replacement with Prodisc-C: 10 Year Clinical and Radiographic Results of Prospective Observational Study in a Single Institute
Jung-Woo Hur, MD
Seoul St. Mary’s Hospital, The Catholic University of Korea, Seoul, Republic of Korea

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

P23. Utility of Mobile Apps for Video Conferencing to Follow Patients at Home after Outpatient Surgery
Fabio J. Pencle, MBBS1; Jason A. Seale, MBBS2; Kingsley R. Chin, MD3
1Less Exposure Society, Malden, MA, US; 2Fort Lauderdale, FL, US; 3LESS Institute, Hollywood, FL, US

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

Ryo Ugawa, MD1; Tomoyuki Takigawa, MD, PhD2; Yasuyuki Shiozaki, MD, PhD2; Haruo Misawa, MD, PhD2; Toshifumi Ozaki, MD, PhD3
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P25. Treatment of the Fractional Curve Only in Adult Scoliosis: Comparison to Lower Thoracic and Upper Thoracic Fusions
Dominic Amara, BA1; Sigurd H. Berven, MD2; Christopher P. Ames, MD3; Bobby Tay, MD3; Vedat Deviren, MD3; Shane Burch, MD3; Dean Chou, MD3

FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P26. Pulmonary Function in Adolescent Idiopathic Scoliosis after Harrington Instrumentation
Tsutomu Akazawa, MD, PhD1; Masahiro Inumira, MD2; Shingo Kuroya, MD2; Yoshiaki Torii, MD2; Toshiaki Kotani, MD, PhD2; Shohei Minami, MD, PhD2; Hisateru Niki, MD, PhD1
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P27. Minimally Invasive Decompression Surgery for Lumbar Spinal Stenosis with Degenerative Scoliosis: Predictive Factors of Radiographic and Clinical Outcomes
Akihito Minamide, MD, PhD1; Munehito Yoshida, MD, PhD2; Andrew Simpson, MD3; Hiroki Iwashashi, MD; Ryoeji Kagotani, MD, PhD4; Shunji Tsutsui, MD, PhD5; Yukihiro Nakagawa, MD, PhD6; Hiroshi Iwasaki, MD, PhD7; Yasutaka Yuki, MD8; Hiroshi Hashizume, MD, PhD9; Hiroshi Yamada, MD, PhD1
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P28. Reciprocal Relationship Between Thoracic Kyphosis and Lumbo-Sacro-Pelvic Sagittal Alignment in Adolescent Idiopathic Scoliosis
Takuya Iimura, MD1; Haruki Ueda, MD, PhD2; Satoshi Inami, MD, PhD2; Hiroshi Moridaira, MD, PhD2; Daisaku Takeuchi, MD2; Yo Shiba, PhD3; Futoshi Asano, PhD3; Hiroshi Aoki, MD, PhD2; Hiroshi Taneichi, MD1
1Mibu, Japan; 2Dokkyo Medical University, Shimosuga-Gun, Tochigi, Tochigi, Japan; 3Shimotugagunn, Tochigikenn, Japan; 4Tochigi, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P29. Gait Assessment is Important for Postoperative Evaluation of Corrective Fixation Surgery for Adult Spinal Deformity: Two Years Postoperative Evaluation
Hideyuki Arima, MD, PhD1; Yu Yamato, MD, PhD2; Tomohiko Hasegawa, MD, PhD2; Daisuke Togawa, MD, PhD2; Go Yoshida, MD2; Shinkobayashi, MD, PhD2; Tatsuya Yasuda, MD2; Tomohiro Banno, MD2; Shin Oe, MD2; Yuki Mihara, MD2; Hiroki Ushirozako, MD2; Yukihiro Matsuyama, MD, PhD1
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P30. Inter- and Intra-Rater Reliability and Agreement of the Roussouly Classification System in Patients with Adult Spinal Deformity
Tanvir J. Bari, MD1; Dennis W. Hallager, MD2; Niklas Tondervold, MD2; Ture Karbo, MD2; Lars Valentin Hansen, MD2; Benny Dahl, MD, PhD2; Martin Gehrchen, MD, PhD1
1Rigshospitalet, University of Copenhagen, Copenhagen, Copenhagen N, Denmark; 2Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; 3Rigshospitalet, AFD U, Spine Unit, Copenhagen, Denmark; 4Rigshospitalet, Copenhagen, Denmark; 5Texas Children's Hospital, Houston, Texas, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P31. Effect of Fixation to Pelvis on Rigid Kyphosis Patient Due to Osteoporotic Vertebral Fracture with Poor Sagittal Alignment
Tomohiko Hasegawa, MD, PhD1; Yu Yamato, MD, PhD2; Daisuke Togawa, MD, PhD2; Go Yoshida, MD1; Tomohiro Banno, MD1; Hideyuki Arima, MD, PhD1; Shinkobayashi, MD, PhD2; Yuki Mihara, MD2; Hiroki Ushirozako, MD2; Sho Kobayashi, MD, PhD2; Tatsuya Yasuda, MD2; Yukihiro Matsuyama, MD, PhD1
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P32. Utility of Oblique Sagittal Reformatted and Three-Dimensional Surface Reconstruction Computed Tomography in Foraminal Stenosis Decompression
Masahito Oshina, MD, Yasushi Oshima, MD, PhD; Sakae Tanaka, MD, PhD; K. Daniel Riew, MD
1Department of Orthopaedic Surgery, The University of Tokyo Hospital 7-3-1, Hongo, Bunkyo-Ku, Tokyo, Japan; 2Department of Orthopedic Surgery, Columbia University, New York, New York, US; 3Department of Orthopaedic Surgery, Inanami Spine and Joint Hospital, 3-17-5, Higashishinagawa, Shinagawa-Ku, Tokyo, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P33. Radiological Fusion Criteria of Postoperative Anterior Cervical Discectomy and Fusion: Systematic Review
Masahito Oshina, MD; Yasushi Oshima, MD, PhD; Sakae Tanaka, MD, PhD; K. Daniel Riew, MD
1Department of Orthopaedic Surgery, The University of Tokyo Hospital 7-3-1, Hongo, Bunkyo-Ku, Tokyo, Japan; 2Department of Orthopedic Surgery, Columbia University, New York, NY, US; 3Department of Orthopaedic Surgery, Inanami Spine and Joint Hospital, 3-17-5, Higashishinagawa, Shinagawa-Ku, Tokyo, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P34. Does It Need to be Inserted in all the Lamina in the Plate Type Open-Door Laminoplasty? Evaluation Focusing on Bone Healing of Hinge Part and Recluse of Spinal Canal
Shinji Horie, MD, PhD; Kenji Endo, MD, PhD; Kengo Yamamoto, MD, PhD
1Tokyo Medical University Hospital, Shinjuku-ku, Tokyo-to, Japan; 2Tokyo Medical University, Tokyo, ID, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P35. Clinical Outcomes of 15 Cases of Cervical Pyogenic Spondylodiscitis
Yoshifumi Kudo, MD, PhD; Tomoaki Toyone, MD, PhD; Akira Matsuoka, MD; Hiroshi Maruyama, PhD, MD; Ryo Yamamura, PhD; Yushi Hoshino, MD, PhD; Hiroki Omata, MD, PhD; Yusuke Oshita, MD, PhD
1Showa University Hospital, Shinagawa-Ku, Japan; 2Showa University, Tokyo, Japan; 3Showa University Hospital, Hatanodai Shinagawa-Ku, Tokyo, Japan; 4Showa University, Tokyo, Japan; 5Showa University Koto Toyosu Hospital, Tokyo, Japan; 6Showa University, Japan; 7Showa University Northern Yokohama Hospital, Yokohama, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P36. The Postoperative Cervical Kyphosis after Cervical Laminoplasty in Patients with Ossification of Posterior Longitudinal Ligament
Kenji Endo, MD, PhD; Takeshi Seki, MD; Hidekazu Suzuki, MD, PhD; Yuji Matsuoka, MD; Yasunobu Sawaji, PhD; Hirosuhe Nishimura, PhD, MD; Taichiro Takamatsu, MD, PhD; Kazuma Murata, MD, PhD; Takamitsu Konishi, MD; Takato Aihara, MD, PhD; Kenyo Yamamoto, MD, PhD
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P37. Anterior Decompression and Fusion versus Laminoplasty for Cervical Myelopathy Caused by Soft Disc Herniation: A Long-Term Prospective Multicenter Study
Tomoaki Koakutsu, MD; Morichika Sasaki, MD; Akira Sekiguchi, MD; Naoki Morozumi, MD; Shoichi Kokubun, MD; Ko Hashimoto, MD, PhD; Toshimi Aizawa, MD, PhD; Fumio Kasama, MD; Yasuhisa Tanaka, MD; Tetsuro Sato, MD, PhD; Eiji Itoi, MD, PhD; Shin Yamazaki, MD, PhD
1Tohoku University Hospital, Sendai, Miyagi, Japan; 2Ishinomaki Red Cross Hospital, Ishinomaki, Miyagi, Japan; 3Osaki Citizen Hospital, Osaki, Miyagi, Japan; 4Sendai, Miyagi, Japan; 5Tohoku University School of Medicine, Sendai, Japan; 6Department of Orthopaedic Surgery, Tohoku University Hospital, Sendai, Miyagi, Japan; 7Matsuda Hospital, Sendai, Miyagi, Japan; 8Sendai, Yamagata, Japan; 9Sendai Orthopaedic Hospital, Sendai, Japan; 10Tohoku University School of Medicine, Sendai, Miyagi, Japan; 11Miyagino Orthopedic Clinic, Sendai City, Miyagino Ku, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P38. The Effect of Posterior Shift of the Spinal Cord after Laminoplasty with Prophylactic Foraminotomy for Postoperative C5 Paralysis
Tomohiro Izumi, MD
Spine Center, Orthopedic Department of Niigata Central Hospital, Niigata, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P39. The Influence of Multi-Factor on Spinal Cord of Patients with C-OPLL Using Extension-Flexion CT

Kenyu Ito, MD; Shiro Imagama, MD; Kei Ando; Masayoshi Morozumi, MD; Satoshi Tanaka, MD; Sadayuki Ito, MD

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

P40. Preoperative Factors for Fair Surgical Outcome after Surgical Treatment for Patients with Proximal CSA Using Electrophysiological Exam and Neurological Findings.

Yasuaki Imajo, MD; Tsukasa Kanchiku, MD, PhD; Hidenori Suzuki, MD, PhD; Masahiro Funaba, MD, PhD; Norihiro Nishida, MD; Toshihiko Taguchi, MD

1Ube, Japan; 2Yamaguchi University Graduate School of Medicine, Ube, Yamaguchi, Japan; 3Department of Orthopedic Surgery, Yamaguchi University Graduate School of Medicine, Yamaguchi, Japan

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

P41. A Comparison of Anterior Cervical Discectomy and Corpectomy in Patients with Multilevel Cervical Spondylosis

Makoto Takeuchi, MD; Takashi Chikawa, MD, PhD; Akihiro Nagamachi, MD, PhD; Koichi Sairyo, MD

1Tokushima Municipal Hospital, Tokushima, Japan; 2Tokushima University Graduate School of Medicine, Tokushima, Japan; 3Department of Orthopedics, Tokushima, Japan; 4Takamatsu Municipal Hospital, Takamatsu, Kagawa, Japan; 5University of Tokushima, Tokushima, Japan

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

P42. An Evaluation of Finger Posture and a Disorder Level for Finger Drop Due to Cervical Radiculopathy

Soya Kawabata, MD; Mitsuru Furukawa; Ishimine Yohei, MD; Takeshi Fujii, MD; Soraya Nishimura, MD, PhD; Masayuki Ishikawa, MD; Michihiro Kamata, MD, PhD

1Yokohama, Japan; 2Tokyo, Japan; 3Keiyu Hospital, Yokohama, Kanagawa, Japan; 4Mita Hospital, Tokyo, Japan; 5Kawasaki Municipal Hospital, Kawasaki, Japan; 6Yokohama Kanagawa, Japan

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

P43. Anterior Cervical Discectomy and Fusion in Professional Athletes: Allograft versus Autograft

William R. Hotchkiss, MD; Andrew L. Clavenna, MD; Andrew Dossett, MD

1The Carrell Clinic, Dallas, TX, US; 2W.B. Carrell Memorial Clinic, Dallas, TX, US

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

P44. Improvement versus Deterioration of the Neck Disability Index after Surgery for Degenerative Cervical Myelopathy: An Analysis of a Global Cohort of Patients

Jonathan P. Nakhla, MD; Rafael De la Garza Ramos, MD; Aria Nouri, MD, MSc; Andrew J. Kobets, MD, MHS; Murray Echt, MD; So Kato, MD; Joseph S. Cheng, MD, MS; Reza Yassari, MD, MSc; Michael G. Feihlings, MD, PhD, FRSCS

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

P45. Best versus Worst Neurological Outcome after Surgery for Degenerative Cervical Myelopathy: An Analysis of A Global AOSpine Cohort of Patients

Rafael De la Garza Ramos, MD; Aria Nouri, MD, MSc; Jonathan P. Nakhla, MD; Murray Echt, MD; Merritt Kinon, MD; Joseph S. Cheng, MD, MS; Reza Yassari, MD, MSc; Michael G. Feihlings, MD, PhD, FRSCS

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

P46. Spinopelvic Sagittal Alignment after Minimally Invasive Decompression Surgery without Fusion in Patients with Lumbar Degenerative Spondylolisthesis

Sho Dohzono, MD, PhD; Hiromitsu Toyoda, MD, PhD; Shinji Takahashi, MD; Akinobu Suzuki, MD, PhD; Masatoshi Hoshino, MD; Hidetomi Terai, MD, PhD; Hiroaki Nakamura, MD, PhD

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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P47. Low Back Pain after Single Level Posterior Lumbar Interbody Fusion for Lumbar Spinal Stenosis with Adult Spinal Deformity
Ryoji Yamasaki; Kenta Ariga, MD; Eiji Wada, MD
Osaka Police Hospital, Osaka, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P48. Surgical Outcomes for Degenerative Lumbar Spondylolisthesis: AOSpine Asia Pacific Prospective, Comparative, Multicenter Trial
Mamoru Kawakami, MD, PhD1; Shigenobu Satoh, MD2; Yoshiharu Kawaguchi, MD, PhD3; Seiji Ohtori, MD, PhD3; Hiroshi Miyamoto, MD3; Hideki Nagashima, MD4; Ryoji Yamasaki; Motoki Iwasaki, MD, PhD; Takeshi Fuji, MD, PhD3; Hiroaki Konishi, MD3; Hideki Shigematsu, MD, PhD3; Hiroshi Yamada, MD, PhD1; Norio Kawahara, MD, PhD3
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P49. Total En Boc Spondylectomy for Primary Tumors of the Lumbar Spine
Takaki Shimizu, MD1; Hideki Murakami2; Satoru Demura, MD2; Satoshi Kato, MD, PhD3; Katsuhito Yoshioka, MD4; Noriaki Yokogawa, MD, PhD5; Hideki Suzuki, MD3; Yasunobu Sawaji, PhD4; Makoto Urushihara, MD, PhD5; Yuji Matsuoka, MD; Taichiro Takamatsu, MD, PhD5; Takeshi Seki, MD; Takamitsu Konishi, MD; Seiji Ohtori, MD, PhD5
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P50. Over 10 Year Outcomes Following Lumbar Microendoscopic Decompression
Takato Aiha, MD, PhD1; Kenji Endo, MD, PhD2; Hidekazu Suzuki, MD, PhD3; Yasunobu Sawaji, PhD4; Makoto Urushihara, MD, PhD5; Yuji Matsuoka, MD; Taichiro Takamatsu, MD, PhD5; Takeshi Seki, MD; Takamitsu Konishi, MD; Seiji Ohtori, MD, PhD5
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P51. Total Spondylectomy for Enneking Stage III Giant Cell Tumor of the Mobile Spine
Noriaki Yokogawa, MD, PhD1; Hideki Murakami2; Satoru Demura, MD2; Satoshi Kato, MD, PhD3; Katsuhito Yoshioka, MD4; Takaki Shimizu, MD2; Hiroyuki Tsuchiya, MD, PhD5
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P52. Complications and Outcomes of Posterior Thoracic Corpectomies for Metastatic Disease: Analysis of 90 Patients
RongPing Zhou, MD1; Can Zhang, MD2; Kai-Yuan Chen, MD3; Dean Chou, MD4
1NanChang, JiangXi, China; 2Xuanwu Hospital Capital Medical University, Beijing, China; 3San Francisco, CA, US; 4University of California San Francisco, San Francisco, CA, US
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P53. The Influence of Ossification Occupancy and the Analysis of Postoperative Outcomes for the Patients with Thoracic Ossification of Posterior Longitudinal Ligament
Kensuke Shinohara, MD1; Tomohiko Hirose, MD1; Kazuhiro Takeuchi, MD2; Shinnosuke Nakahara, MD3
1Okayama Medical Center, Okayama, Okayama, Japan; 2National Okayama Medical Center, Okayama, Japan; 3Okayama, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P54. Surgical Results of Microsurgical Bilateral Decompression via a Unilateral Approach for L4/5 Lumbar Spinal Canal Stenosis with Wedging More than Five Degree
Kensuke Iimori, MD1; Takafumi Maeno, MD2; Hiroshi Kono, MD, PhD2; Hiroaki Nakamura, MD, PhD2
1Isikiriseiki Hospital, Higashiosaka, Japan; 2Osaka Rosai Hospital, Sakai, Japan; 3Higashiosaka, Japan; 4Osaka City University, Graduate School of Medicine, Osaka, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P55. Evaluation of Neck Circumference as a Predictor of Postoperative Retropharyngeal Hematoma after Anterior Cervical Fusion
Yohei Yuzawa, PhD
Inanami Spine and Joint Hospital, Tokyo, Tokyo, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P56. Evaluation of the Surgical Stress in the Lumbar Interbody Fusion Using E-PASS Scoring System
Norio Numata, MD, PhD1; Hideki Murakami, MD, PhD2; Hirooki Endo, MD, PhD2; Daisuke Yamabe, MD, PhD2; Satoshi Yoshihisa, MD, PhD2; Takayuki Kikuchi, MD2; Minoru Doita, MD2
1Tochinai Hospital, Morioka, Iwate, Japan; 2Morioka, Iwate, Japan; 3Iwate Medical University, Morioka, Japan; 4Iwate Medical University School of Medicine, Morioka, Iwate, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P57. Retrospective Review of Short to Mid Term Outcome in Oblique Lateral Lumbosacral Fusion (OLIF51) Surgery
Sumihisa Orita, MD, PhD2; Kazuhide Inage, MD, PhD3; Masahiro Inoue, MD3; Hideyuki Kinoshita, MD3; Masaki Norimoto, MD3; Tomotaka Umimura, MD3; Hideki Murakami, MD3; Richard A. Hynes, MD, PhD4; Seiji Ohtori, MD, PhD5; Yawara Eguchi, MD1; Sumihisa Orita, MD, PhD2; Kazuhide Inage, MD, PhD3; Masaki Norimoto, MD3; Takao Furuya, MD, PhD2; Seiji Ohtori, MD, PhD5
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P58. Early Onset Adjacent Vertebral Fracture Following Kyphoplasty for the Osteoporotic Vertebral Fracture in Thoracolumbar Lesion
Masayoshi Morozumi, MD1; Kei Ando; Kenyu Ito, MD2; Satoshi Tanaka, MD2; Sadayuki Ito, MD2; Shiro Imagama, MD2
1Showa-Ku Nagoya City, Japan; 2Nagoya, Japan; 3Aichi, Japan; 4Nagoya University Graduate School of Medicine, Nagoya, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P59. Influence of Skeletal Muscle Mass and Spinal Alignment on Surgical Outcomes for Lumbar Spinal Stenosis
Tomotaka Umimura, MD1; Yawara Eguchi, MD2; Sumihisa Orita, MD, PhD2; Kazuhide Inage, MD, PhD3; Masaki Norimoto, MD4; Takeo Furuya, MD, PhD2; Seiji Ohtori, MD, PhD5
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P60. Clinical Assessment and Prevalence of Patients with Ossification of Posterior Longitudinal Ligament (OPLL) in Lumbar Spine
Takuya Mishiro, MD, PhD
Takamatsu Redcross Hospital, Kagawa, Japan
FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.

P61. Two Years Outcome and Risk Factors for the Poor Results of the Microendoscopic Foraminotomy for the Extraforaminal Stenosis at the Lumbosacral Junction
Ryo Taiji, MD1; Hiroshi Hashizume, MD, PhD2; Hiroshi Iwasaki, MD, PhD2; Yasutugu Yukawa, MD, PhD2; Akihito Minamide, MD, PhD2; Yoshihiro Nakagawa, MD, PhD2; Shunji Tsutsui, MD, PhD2; Masanari Takami, MD, PhD2; Keiji Nagata, PhD2; Misaki Umemoto, MD2; Shizumasa Murata, MD2; Hiroshi Yamada, MD, PhD2
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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
P62. Cost Effectiveness of Vancomycin Powder in Lumbar Laminectomy

Gregory J. Kirchner, MPH1; Alexander M. Lieber, BA1; Yehuda E. Kerbel, MD4; Anisha R. Sunkerneni, BS2; Vincent M. Moretti, MD2; Amrit Khalsa, MD3

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

P63. Balloon Kyphoplasty for Osteoporotic Vertebral Fractures with Posterior Wall Injury

Makoto Takeuchi, MD1; Takashi Chikawa, MD, PhD2; Akihiro Nagamachi, MD, PhD1; Koichi Sairyo, MD1

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

P64. Hemoglobin A1c as a Predictor of Surgical Site Infection Following Single Level Lumbar/Lumbosacral Posterior Fusion in Patients with Diabetes

Dong Wuk Son1; Geun S. Song, MD, PhD; Sang Weon Lee, MD, PhD1; Soon Ki Sung, MD, PhD1; Su Hun Lee, MD1; Jun Seok Lee, MD1; Youngha Kim, MD1; Dookyung Son, MD; Kyounghak Kang, MD1; Chihyung Lee, MD1; Oik Kwon, MD2

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

P65. Spinal Metastasis Surgery in the Elderly: A Survival Analysis of 83 Cases

Christian Carwik, MD1; Claes Olerud, MD, PhD2; Yohan Robinson, MD, PhD1

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


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

P67. Minimally Invasive Lumbar Foraminotomy: Clinical Experience with a Novel Decompressive Tool and Meta-Analysis of the Literature

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

P68. Is Lateral Access Interbody Fusion Procedure Safe Even in the Cases with Prior Abdominal Surgery?

Tsuyoshi Okudaira, MD

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


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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
13. The Predictable Factors of the Postoperative Kyphotic Change of Sagittal Alignment of the Cervical Spine after the Laminoplasty

Dong Wuk Son¹; Sang Weon Lee, MD, PhD¹; Soon Ki Sung, MD, PhD¹; Jun Seok Lee, MD²; Youngha Kim, MD²; Oik Kwon, MD²; Chihyung Lee, MD¹; Su Hun Lee, MD²; Dookyung Son, MD²; Kyoung Tak Kang, MD²

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

19. A Lower T1 Slope as a Predictor of Subsidence in Anterior Cervical Discectomy and Fusion with Stand-Alone Cages

Dong Wuk Son¹; Sang Weon Lee, MD, PhD¹; Soon Ki Sung, MD, PhD¹; Youngha Kim, MD²; Su Hun Lee, MD²; Oik Kwon, MD²; Dookyung Son, MD²; Kyoung Tak Kang, MD²; Chihyung Lee, MD¹; Jun Seok Lee, MD¹

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FDA Device/Drug Status: This abstract does not discuss or include any applicable devices or drugs.
Abe, Koki: 70, P57
Abe, Yuichiro: 48, P15
Adachi, Nobuo: P11
Aihara, Takato: 15, 16, P12, P36, P50
Aizawa, Toshimi: P37
Akazawa, Tsutomu: P16, P26
Amara, Dominick: P25
Ames, Christopher P.: P25
Ando, Kei: P13, P39, P58
Ando, Takashi: P2
Aoki, Hiromichi: 6, P28
Arai, Yoshiyasu: 70, P66
Ariga, Kent: P47
Arima, Hideyuki: 5, 7, 10, 11, 33, 36, 46, 53, 55, 65, P20, P29, P31
Asano, Futoshi: 6, P28
Baba, Ichiro: 1
Banno, Tomohiro: 5, 7, 10, 11, 33, 36, 46, 53, 55, 65, P20, P29, P31
Bari, Tanvir J.: 8, P30
Bazylko, Michael S.: P6
Belanger, Theodore A.: 22
Berven, Sigurd H.: P25
Beutler, William: 60
Beyer, George A.: 24, 59
Bhatia, Manminder S.: 60
Bloom, Lee: 24, 59
Blumenthal, Scott L.: 27, 29
Bloom, Lee: 24, 59
Blumenthal, Scott L.: 27, 29
Boah, Akwasi: 22
Burch, Shane: P25
Buser, Zorica: 51, 56
Cameron, Chris: 26
Carrwik, Christian: 45, P65
Chang, Victor: 58, P6
Chen, Kai-Yuan: P52
Cheng, Joseph S.: 21, P44, P45
Chiba, Yusuke: 54
Chikawa, Takashi: P8, P41, P63, Chikuda, Hirotaka: 61
Chin, Kingsley R.: P23
Chou, Dean: P25, P52
Chughtai, Morad: 24
Chung, Chun Kee: 9
Clavenna, Andrew L.: P43
Dahl, Benny: 8, 62, P30
Day, Louis M.: 24, 32
De la Garza, Rafael: P44, P45
Demura, Satoru: 43, P49, P51
Desai, Rohan: 24
Devire, Vedat: P25
Diebo, Bassey G.: 24, 28, 32, 59
Dohzono, Sho: 42, P46
Doita, Minoru: 54, P56
Dossett, Andrew: P43
Echt, Murray: P44, P45
Eguchi, Yawara: P59
Endo, Hiroki: 54, P56
Endo, Kenji: 15, 16, P12, P34, P36, P50
Errico, Thomas J.: 32
Fehlings, Michael G.: 21, 23, P44, P45
Ferro, Nicole: 26
Fessler, Richard G.: 41
Fuji, Takashi: P48
Fujibayashi, Shunsoke: 70
Fujii, Takashi: P42
Fujimoto, Yoshinori: P11
Fujishiro, Takashi: 1
Fujiwara, Kent: 1
Fukutake, Katsunori: 68
Furuya, Masahiro: 50, P3, P40
Furukawa, Masahiro: 50, P3, P40
Gehrchen, Martin: 8, 62, P30
Gornet, Matthew F.: 26
Guha, Daipayan: P7
Guyer, Richard D.: 29, P9
Haddas, Ram: 22
Hallager, Dennis W.: P30
Harada, Tomohisa: 70
Hariri, Omar K.: 59
Harmon, Satoko M.: 40
Haro, Hirotaka: 63, P14, P2
Hasegawa, Tomohiko: 5, 7, 10, 11, 33, 36, 46, 53, 55, 65, P20, P29, P31
Hashimoto, Ko: P37
Hashizume, Hiroshi: 30, 35, 49, P15, P18, P19, P27, P61
Hayama, Sachio: 1
Hayashi, Kazunori: 17, 18, 34, 42
Hayashi, Teppei: P17
Hino, Masayuki: P5
Hirose, Tomohiko: P53
Ho, Allen L.: 67
Hollem, Douglas A.: 24
Hori, Yusuke: 17, 18, 34, 42
Horie, Shinji: P34
Hoshino, Masatoshi: 17, 18, 34, 38, 42, P46
Hoshino, Yushi: P35
Hotchkiss, William R.: P43
Hur, Jung-Woo: P22
Hynes, Richard A.: 70, P57
Iida, Takahiro: 70
Iida, Yusaku: 68
Iimori, Kansuke: P54
Iimura, Takuya: 6, P28
Inuma, Masahiro: P16, P26
Imagama, Shiro: P13, P39, P58
Imajo, Yasuuki: 50, P3, P40
Inage, Kazuhide: P57, P59
Inami, Satoshi: 6, P28
Inose, Hiro: 69
Inoue, Masahiro: P57
Ishihara, Toshinobu: 14
Ishikawa, Masayuki: P42
Ishimoto, Yuya: 3, 49, P15
Ito, Kenyu: P13, P39, P58
Ito, Sadayuki: P13, P39, P58
Itoi, Eiji: P37
Iwahashi, Hiroki: 30, P18, P19, P27
Iwasaki, Hiroshi: 30, 35, P18, P19, P27, P61
Iwasaki, Motoki: 66, P48
Izumi, Tomohiro: P38
Ju, Kevin L.: 22
Kagotani, Ryoh: 3, 37, P15, P27
Kamata, Michihiro: P42
Kameda, Takuya: 52
Kamei, Naouke: P11
Kanchiku, Tsukasa: 50, P3, P40
Kang, Kyoung Tak: 13, 19, P64
Karlo, Ture: P30
Kasama, Fumio: P37
Kato, Masanori: P17
Kato, Satoshi: 43, P49, P51
Kato, So: 21, 23, P44
Kato, Tsuyo: 69
Katsu, Marina: 63
Kawabata, Soya: P42
Kawaguchi, Yoshinari: P48
Kawahara, Norio: P48
Kawakami, Mamoru: 3, 37, P48
Kawamura, Naohiro: 61
Keiji, Hasegawa: 68
Kerbel, Yehuda E.: 25, 57, P62, P69
Khalsa, Amrit: 25, 57, P62, P69
Khoo, Larry T.: P67
Kikuchi, Takayuki: P56
Kim, Chi Hee: 9
Kim, Jin-Sung L.: P21
Kim, Young: 13, 19, P64
Kino, Keiichiro: 1
Kion, Merrit: P45
Kinosita, Hideyuki: P57
Kirchner, Gregory J.: 25, 57, P62, P69
Kit, Woon H.: 2
Kitamura, Kazuyuki: 39
Kitano, Taisuke: 37
Koakutsu, Tomohisa: P37
Kobayashi, Sho: 7, 10, 11, 33, 46, 53, 55, 65, P29, P31
Kobayashi, Takaomi: 4
Kobets, Andrew J.: P44
Kokubun, Shoichi: P37
AUTHOR INDEX

Song, Geun S.: 13, 19, P64
Steinberg, Gary K.: 41
Suda, Kota: 40
Sugiura, Kosuke: P1
Sugiura, Tsuyoshi: 66
Sung, Soon Ki: 13, 19, P64
Sunkerneni, Anisha R.: P62
Suzuki, Akinobu: 17, 18, 34, 42, P46
Suzuki, Hidekazu: 15, 16, P12, P36, P50
Suzuki, Hidenori: 50, P3, P40
Suzuki, Nobuyuki: P10
Taguchi, Toshihiko: 50, P3, P40
Taiji, Ryo: P61
Takahashi, Hiroshi: 68
Takahashi, Shinji: 17, 18, 34, 38, 42, P46
Takahashi, Yoshifumi: 66
Takahata, Masahiko: 40
Takamatsu, Taichiro: 15, 16, P12, P36, P50
Takami, Masanari: 30, P18, P19, P61
Takata, Yoichiro: P8
Takayama, Kazushi: 38
Takayama, Yoshihiro: P2
Takeuchi, Daisaku: 6, P28
Takeuchi, Kazuhiro: P53
Takeuchi, Makoto: P41, P63
Takigawa, Tomoyuki: P24
Tamai, Koji: 17, 18, 34, 42, 51, 56
Tamaru, Michiko
Tanaka, Nobuhiro: P11
Tanaka, Sakae: P32, P33
Tanaka, Satoshi: P13, P39, P58
Tanaka, Yasuhiro: P37
Taneichi, Hiroshi: 6, P28
Tay, Bobby: P25
Taylor Pitter, Frederik: 62
Teraguchi, Masatoshi: 3, 37
Terai, Hidetomi: 17, 18, 34, 42, P15, P46
Tetreault, Lindsay: 21, 23
Tezuka, Fumitake: P8
Togawa, Daisuke: 5, 7, 10, 11, 33, 36, 46, 53, 55, 65, P20, P29, P31
Tominaga, Ryoo: 52
Tondevold, Niklas: P30
Torigoe, Ichiro: P66
Torii, Yoshiaki: P16, P26
Toyoda, Hiromitsu: 17, 18, 34, 38, 42, P15, P46
Toyone, Tomoaki: P35
Tsuchiya, Hiroyuki: 43, P49, P51
Tsuge, Shintaro: 68
Tsujii, Osahiko: 39
Tsujio, Tadao: 34, 42
Tsutsui, Shunji: 30, 35, P18, P19, P27, P61
Ueda, Haruki: 6, P28
Ugawa, Ryo: P24
Umamoto, Misaki: P61
Uminuma, Tomotaka: P57, P59
Urushibara, Makoto: P50
Usami, Yoshitada: 1
Ushiku, Chikara: 40
Ushirozako, Hiroki: 5, 7, 10, 11, 33, 36, 46, 53, 55, 65, P20, P29, P31
Valentin Hansen, Lars: P30
Varghese, Jeffrey: 28
Wada, Akihito: 68
Wada, Eiji: P47
Wang, Christopher: 56
Wang, Jeffrey C.: 51, 56
Weng, Stanley: 59
West, James L.: P4
Wirth, Ed: 41
Witiw, Christopher: 21
Wu, Dongjin: 23
Yabu, Akito: 17, 18, 34
Yamabe, Daisuke: 54, P56
Yamada, Hiroshi: 3, 30, 35, 49, P18, P19, P27, P48, P61
Yamada, Kentaro: 48, P15
Yamamoto, Kengo: 15, 16, P12, P34, P36
Yamamura, Ryo: P35
Yamasaki, Tatsuya: 48, 55
Yamashita, Kazuta: P8
Yamato, Yu: 5, 7, 10, 11, 33, 36, 46, 53, 55, 65, P20, P29, P31
Yamazaki, Shin: P37
Yano, Toma: 1
Yassari, Reza: P44, P45
Yasuda, Hiroyuki: 38, 42
Yasuda, Tatsuya: 7, 10, 11, 33, 36, 46, 53, 55, 65, P20, P29, P31
Yohei, Ishimine: P42
Yokogawa, Noriaki: 43, P49, P51
Yoshida, Go: 7, 10, 11, 33, 36, 46, 53, 55, 65, P20
Yoshida, Go: P29, P31
Yoshida, Masahiro: 70
Yoshida, Munehito: 30, 35, 49, P18, P19, P27
Yoshida, Satoshi: P56
Yoshiihara, Hiroyuki: 24, 59
Yoshii, Toshitaka: 69
Yoshioka, Katsuhito: 43, P49, P51
Yukawa, Yasutsugu: 30, 35, 49, P18, P19, P61
Yukawa, Yasutsugu: P27
Yuzawa, Yohei: P55
Zakaria, Hesham M.: 58, P6
Zhang, Can: P52
Zhou, RongPing: P52
Zigler, Jack E.: 26, 29
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**DISCLOSURE INDEX**

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Consulting: Clariance (B, Paid directly to institution/employer).

**Hsu, Wellington K.**:
Royalties: Stryker (F); Consulting: Stryker (F), Allosource (A), Agnovos (A), Mirus (B), JBJS (C), Grafixys (A), Wright Medical (B), Micromedicin (B), Medtronic (C), Bioventus (A); Speaking and/or Teaching Arrangements: AONA (A); Trips/Travel: Stryker (B), Medtronic (B), Micromedicine (A); 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).

**Hynes, Richard A.**:
Royalties: Medtronic (D); Consulting: Medtronic (A); Speaking and/or teaching arrangements: Medtronic (Amount not disclosed); Trips/travel: Medtronic (A); Research Support (Staff and/or Materials): Medtronic (D).

**Ito, Manabu**:
Trips/Travel: AO Spine (B); Board of Directors: AO Foundation (B).

**Iwasaki, Motoki**:
Consulting: Japanese Orthopaedic Association (None); Trips/travel: JSSR (A); Scientific Advisory Board: JSSR (A).

**Kepler, Christopher K.**:
Research Support - Staff and/or Materials: CSRS (D, Paid directly to institution/employer); Grants: NIH (A, Paid directly to institution/employer).

**Khoo, Larry T.**:
Royalties: Zimmer Biomet (E); Stock Ownership: Paradigm Spine (10000 shares); Consulting: Globus (Amount not disclosed); Speaking and/or teaching arrangements: ChoiceSpine (Amount not disclosed); Trips/travel: Aesculap Spine (Amount not disclosed); Scientific Advisory Board: Medacta Spine (B); Research Support (Staff and/or Materials): Carevate (B).

**Kim, Chi Heon**:
Consulting: Richard Wolf GmbH (Travel expenses).

**Kim, Jin-Sung L.**:
Stock Ownership: Innovative (<1%); Consulting: Richard Wolf (Amount not disclosed); Scientific Advisory Board: Innovative (Amount not disclosed); Grants: AO Spine (None).

**Kinon, Merritt**:
Speaking and/or teaching arrangements: Globus (B).

**Kit, Wong H.**:
Royalties: SpineGuard (B); Stock Ownership: SpineGuard (1000 shares); Consulting: SpineGuard (B); Speaking and/or teaching arrangements: SpineGuard (None); Trips/travel: SpineGuard (B); Board of Directors: ISASS (None); Scientific Advisory Board: SpineGuard (None).

**Knight, Reginald Q.**:
Stock Ownership: VT1 (<1%); Consulting: Stryker (C); Speaking and/or Teaching Arrangements: Stryker Spine (None); Scientific Advisory Board: Spine Universe (None), Vertera (Amount not disclosed), Gerstner Medical (Amount not disclosed).

**Kotani, Yoshihisa**:
Device or Biologic Distributorship (Physician-Owned Distributorship): L&K Biomed (B, Paid directly to institution/employer); Consulting: L&K Biomed (A, Paid directly to institution/employer).

**Kreiner, Scott**:
Board of Directors: NASS (Clinical Research Development Chair); Speaking and/or Teaching Arrangements: Spine Intervention Society (Travel expenses); Trips/Travel: MPW AUC on Vertebral Augmentation (B).

**Krishnaney, Ajit A.**:
Speaking and/or Teaching Arrangements: Stryker (C).

**Lafage, Virginie**:
Stock Ownership: Nemaris (20%); Speaking and/or teaching arrangements: DePuy Synthes (B), AO Spine (B); Board of Directors: Nemaris (None); Other Office: International Spine Study Group (Executive Committee).

**Lahey, Donna M.**:
Speaking and/or Teaching Arrangements: NASS (A, Paid directly to institution/employer); Trips/Travel: NASS (B, 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 (C); Scientific Advisory Board: Stryker (B); Grants: Department of Defense (DoD) (I, Paid directly to institution/employer).

**Liu, Gabriel K.**:
Speaking and/or teaching arrangements: DePuy Spine (Travel expenses); Board of Directors: Cervical spine Research Society - Asian specific (None); Other Office: Singapore spine Society (None).

**Matsumoto, Morio**:
Consulting: Nuvasive (A); Scientific Advisory Board: Kyocera (A); Research Support (Staff and/or Materials): Medtronic Japan (D, Paid directly to institution/employer).

**Mayer, E. Kano**:
Stock Ownership: Infinite Orthopedics (<1%); Private Investments: Trabecular (16%); Speaking and/or Teaching Arrangements: North America Spine Society (B); Trips/Travel: American College of Surgeons (Trips/travel), North American Spine Society (B).

**Mroz, Thomas E.**:
Royalties: Stryker (F); Stock Ownership: Pearl Diver (<1%); Consulting: Stryker Spine (D); Fellowship Support: AO Spine (B).

**Muehlbauer, Eric J.**:
Board of Directors: NASS (Executive Director).

**Nagashima, Hideki**:
Speaking and/or teaching arrangements: AOSpine (B), Astellas Pharma (B), Chugai Pharmaceutical (B), Daichi Sankyo (B), Teijin Pharma (A), Asahi Kasei Pharma (B), Eli Lilly Japan K. K. (A); Other Office: AOSpine (B); Research Support: Simizu Hospital (B, Paid directly to institution/employer), Motomachi Hospital (C, Paid directly to institution/employer), Misasa Onsen Hospital (B, Paid directly to institution/employer), Chugai Pharma (B, Paid directly to institution/employer), Asahi Kasei Pharma (B, Paid directly to institution/employer), Kaken Pharmaceutical (B, Paid directly to institution/employer), Taisho Toyama Pharmaceutical (B, Paid directly to institution/employer), Pfizer Japan (B, Paid directly to institution/employer), MSD, K. K. (B, Paid directly to institution/employer), Shionogi (B, Paid directly to institution/employer), Eisai (B, Paid directly to institution/employer), Nippon Zoki Pharmaceutical (B, Paid directly to institution/employer), Astellas Pharma (B, Paid directly to institution/employer), Teijin Pharma (B, Paid directly to institution/employer), Takeda Pharmaceutical (B, Paid directly to institution/employer), Daiichi Sankyo. (B, Paid directly to institution/employer), Grants: Grants-in-Aid for Scientific Research (B, Paid directly to institution/employer).

**Neo, Masashi**:
Consulting: DePuy Synthes (C).

**Nouri, Aria**:
Other: NASS - Research Project Management Committee Member (None).

**Nunley, Pierce D.**:
Royalties: Zimmer Biomet (E), K2M (E); Stock Ownership: Amedica (<1%), Paradigm Spine (<1%), Spineology (<1%); Consulting: Vertiflex (B), K2M (C), ZimmerBiomet (B); Speaking and/or Teaching Arrangements: K2M (C), ZimmerBiomet (B).
O’Brien, David R.: Stock Ownership: OrthoCarolina (<1%), Transformant Health (<1%), Arrowlytics (<1%); Board of Directors: NASS (Health Policy Council Director); Speaking and/or Teaching Arrangements: SIS (Travel expenses); Trips/Travel: SIS (Travel expenses).

Oe, Shin: Consulting: Medtronic Sofamor Danek (D, Paid directly to institution/employer); Other Office: Japan Medical Dynamic Marketing Hospital (E, Paid directly to institution/employer).

Ohnmeiss, Donna D.: Board of Directors: NASS (Travel expenses); Other: Texas Back Institute Research Foundation (Amount not disclosed Salary).

Ohrn-Nissen, Søren: Grants: K2M (C, Paid directly to institution/employer).


Olsson, Erik: Trips/Travel: Nuvasive (B).

Olerud, Claes: Speaking and/or teaching arrangements: Anatomica AB (B), Medtronic (Amount not disclosed); Relationships Outside the One Year Requirement: DePuy Synthes (Research Support Staff and/or Materials, F, Dissolved 2010).

Orr, R. Douglas: Stock Ownership: Tyber Medical (<1%); Consulting: Medtronic/Midas Rex (None); Speaking and/or Teaching Arrangements: Stryker Spine (B); Fellowship Support: AOSpine (D, 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: Global Medical (C); Research Support - Investigator Salary: Pfizer (B, Paid directly to institution/employer); Grants: Pfizer (C, Paid directly to institution/employer).

Passias, Peter G.: Consulting: Medicea (None), Spine Wave (None); Speaking and/or teaching arrangements: Zimmer-Biomet (None); Scientific Advisory Board: AlloSource (None); Grants: CSRS (D, Paid directly to institution/employer).

Patel, Alpesh A.: Royalties: Amedica (B); Stock Ownership: Amedica (<1%), Cytonics (<1%), Nocimed (<1%), Vital5 (<1%), Endoluxe (<1%), Tissue Differentiation Intelligence (<1%); Consulting: Amedica (None), Zimmer Biomet (B), DePuy Synthes (None), NuVasive (None); Board of Directors: Cervical Spine Research Society (None), Lumbar Spine Research Society (None); Grants: Cervical Spine Research Society (B, Paid directly to institution/employer); Fellowship Support: AO Spine North America (E, Paid directly to institution/employer), Nuvasive (D, Paid directly to institution/employer), Globus (D, Paid directly to institution/employer).

Patel, Leena: Consulting: Aesculap (Amount not disclosed, Paid directly to institution/employer).

Paulino, Carl B.: Consulting: Ethicon (B); Speaking and/or teaching arrangements: DePuy/Johnson & Johnson (B); Trips/travel: Ethicon (B).

Peoloza, John H.: Royalties: DePuy Synthes (B, Aegis Scout); Stock Ownership: Paradigm Spine (<1%), 4 Web (<1%); Consulting: Spineology (A, Paid directly to institution/employer), Medtronic (B), 4web (None), RTI (B, Paid directly to institution/employer); Speaking and/or teaching arrangements: RTI (None), 4Web (Amount not disclosed); Trips/travel: Nuvasive (B); Scientific Advisory Board: K2M (Board of Scientific Advisors).

Qureshi, Sheeraz A.: Royalties: Zimmer-Biomet Spine (A); Private Investments: Avaz Surgical (2%); Consulting: Stryker Spine (B), Medtronic Spine (None), Globus (B); Speaking and/or Teaching Arrangements: Globus (B), Stryker (B), Medtronic (None); Board of Directors: MTF (None, Paid directly to institution/employer); Scientific Advisory Board: Orthofix (None), Zimmer (None); Other Office: CSRS (Program Committee), NASS (Value Committee, MIS Committee), CSRS (Survey Committee), AAOS (Evaluations Committee); Grants: CSRS (C, Paid directly to institution/employer); Fellowship Support: Globus Medical (E, Paid directly to institution/employer).

Radcliff, Kris E.: Royalties: Globus Medical (B), Orthopedic Sciences, (A); Stock Ownership: 4 Web Medical (<1%), Scientific advisory board. Paid directly to institution/employer, Rothman Institute (2%); Consulting: Advance Medical (C), Medtronic Advanced Energy (A), Zimmer Biomet LDR Spine (None); Trips/Travel: Zimmer Biomet LDR (B); Board of Directors: Association for Collaborative Spinal Research (None); Scientific Advisory Board: 4 Web Medical (None); Research Support - Staff and/or Materials: Simplify Medical (A, Paid directly to institution/employer).


Reitman, Charles A.: Trips/Travel: NASS (Travel expenses); Board of Directors: NASS (Administration & Development Council Director); Scientific Advisory Board: Clinical Orthopedics and Related Research (Deputy Editor, B, Paid directly to institution/employer).

Resnick, Daniel K.: Royalties: Elsevier (B); Stock Ownership: Nidus (<1%); Board of Directors: American Board of Neurological Surgeons (None), NASS (President).

Riew, K. Daniel: Royalties: Biomet (F), Zeiss (B), Medtronic (G); Stock Ownership: Osprey (<1%), PSD (<1%), Paradigm Spine (<1%), Benveture (<1%), Vertiflex (<1%), Amedica (<1%), Nexiong Spine (<1%), Spinal Kinetics (<1%), Spineology (<1%), Expanding Orthopedics (<1%); Consulting: BIOMET (Amount not disclosed); Speaking and/or Teaching Arrangements: BIOMET (C), Medtronic (Amount not disclosed); Trips/Travel: DePuy Synthes (Travel expenses); Board of Directors: AOSSpine (E), Spine Journal (None); Research Support - Staff and/or Materials: AO Spine (B, Paid directly to institution/employer).

Robinson, Anna-Lena: Speaking and/or teaching arrangements: Medtronic (A), DePuy (A).

Robinson, Yohan: Speaking and/or teaching arrangements: Medtronic (B), DePuy Synthes (A).

Santaguida, Carlo: Consulting: CSL Behring (B, Paid directly to institution/employer); Speaking and/or teaching arrangements: Medtronic (B); Trips/travel: Stryker Canada (A); Grants: CSL Behring (B, Paid directly to institution/employer).

Savage, Jason W.: Consulting: Stryker Spine (D); Fellowship Support: AO Spine (E, Paid directly to institution/employer).

Schoenfeld, Andrew J.: Royalties: Wolters Kluwer (A); Springer (A); Consulting: ArborMetrix (B); Other Office: Journal of Bone and Joint Surgery (C); Research Support - Staff and/or Materials: Robert Wood Johnson Foundation (C, Paid directly to institution/employer); Grants: Department of Defense (D, Paid directly to institution/employer).

Schroeder, Gregory D.: Trips/Travel: Medtronic (Amount not disclosed, Paid directly to institution/employer); Grants: Medtronic (C, Paid directly to institution/employer).

Schwab, Frank J.: Royalties: MSD (D); Stock Ownership: Nemaris (30%); Consulting: MSD (B), Zimmer - Biomet (E), NuVasive (C); Speaking and/or teaching arrangements: Zimmer-Biomet (B); Board of Directors: Nemaris (shares); Grants: DePuy Spine (H, Paid directly to institution/employer), Stryker (D, Paid directly to institution/employer), NuVasive (E, Paid directly to institution/employer), K2M (E, Paid directly to institution/employer).
Schwalb, Jason M.: Research Support (Staff and/or Materials): Medtronic (D, Paid directly to institution/employer), Boston Scientific (C, Paid directly to institution/employer); Other: Blue Cross Blue Shield of Michigan (5% Paid directly to institution/employer).

Sciuitta, Daniel M.: Consulting: Medtronic (D, Paid directly to institution/employer), Stryker (C), Nuvasive (B), Depuy-Synthes (B).

Sengupta, Dilip K.: Royalties: Globus Medical (D); Stock Ownership: Globus Medical (<1%); Private Investments: International Spine and Orthopaedic Institute (1%); Consulting: Globus Medical (None); Scientific Advisory Board: Globus Medical (None); Research Support - Staff and/or Materials: Globus Medical (A, Paid directly to institution/employer); Fellowship Support: Globus Medical (A, Paid directly to institution/employer).

Sullivan, William J.: Trips/Travel: NASS (Travel expenses); Board of Directors: NASS (Second Vice President).

Takahata, Masahiko: Research Support (Investigator Salary): Daiichi-Sankyo, (B, Paid directly to institution/employer).

Takeda, Katsuhi: Speaking and/or Teaching Arrangements: Pfizer (B, Paid directly to institution/employer), Johnson & Johnson (B, Paid directly to institution/employer), Medtronic Sofamor Danek (B), Stryker (A, Paid directly to institution/employer).

Taneichi, Hiroshi: Consulting: Century Medical (D); Speaking and/or teaching arrangements: Stryker (D), NuVasive (D).

Tay, Bobby: Royalties: Stryker (C); Fellowship Support: NuVasive (D, Paid directly to institution/employer), Globus Medical (E, Paid directly to institution/employer), AO Spine (E, Paid directly to institution/employer).

Togawa, Daisuke: Consulting: Medtronic Sofamor Danek (Amount not disclosed, Paid directly to institution/employer), Meitoku Medical Institute Jyuen Memorial Hospital (Amount not disclosed, Paid directly to institution/employer), Japan Medical Dynamic Marketing (Amount not disclosed, Paid directly to institution/employer), Journal of Bone and Joint Surgery American (Amount not disclosed, Paid directly to institution/employer), Endowments: Medtronic Sofamor Danek (D, Paid directly to institution/employer), Japan Medical Dynamic Marketing (E, Paid directly to institution/employer), Meitoku Medical Institute Jyuen Memorial Hospital (E, Paid directly to institution/employer).

Trommees, Eric: Trips/Travel: AAOS (Travel expenses); Board of Directors: Seton Family of Doctors (None), NASS (Treasurer); Other Office: AAOS Communications Cabinet (AAOS Now Editor-in-Chief of AAOS Now); Research Support - Staff and/or Materials: Relievant (B, Paid directly to institution/employer), Pfizer (B, Paid directly to institution/employer), Stryker Spin (B, Paid directly to institution/employer).

Vaccaro, Alexander R.: Royalties: Elsevier Books (B), Alphatec (C), Japree Books (B), Taylor Francis (A), Globus (F), Medtronic (F), Stryker Spine (G); Stock Ownership: Gamma Spine (<1%), Avaz Surgical (<1%), Innovative Surgical Design (<1%), Electrocore (<1%), Rothman Institute and related holdings (3%), Cytokines (<1%), Location Based Intelligence (<1%), Progressive Spinal Technology (<1%), Computational Biodynamics (<1%), Stotud Medical (<1%), Bonovo Orthopaedics (<1%), Flagship Surgical (<1%), In Vivo (1%), Small Bone Innovations (<1%), Paradigm Spine (<1%), Spineology (<1%), Replication Medica (<1%), Globus (111,098 shares), Flow Pharma (None), Advanced Spinal Intellectual Properties (30%), Spine Medica (<1%), Nuvasive (Number of shares unknown); Consulting: Gerson Lehrman Group (<1%), ICON Clinical Research (B), Medtronic (B), Innovative Surgical Design (None), Stout Medical (None), Guidepoint Global (B), MediaCorp (B), Stryker Spine (C), Globus (C), Ellipse (B), Orthobullets (None), Nuvasive (None); Speaking and/or Teaching Arrangements: listed under consultation (None); Trips/Travel: Company Sponsored Travel (Amount not disclosed); Board of Directors: AO Spine (Knowledge Forum Director), Association of Collaborative Spine Research (President Emeritus), Innovative Surgical Design (None), Flagship Surgical (None); Scientific Advisory Board: listed under Board of Directors (Board of directors); Other: Employment: Rothman Institute (None), Honorarium for Lectures (None), Clinical Spine Surgery (Editor in Chief).
Wada, Akihito: Device or Biologic Distributorship (Amount not disclosed, Physician-Owned Distributorship); Medronic Sofamor Danes (D, Paid directly to institution/employer).

Walsh, Kevin M.: Stock Ownership: Roche Pharmaceuticals (<1%); Private Investments: SpinalCyte (None).

Wang, Christopher: Royalties: Aesculap (B), Biomet (G), Amedica (C), Seaspine (D), Synthes (C); Stock Ownership: Fziomed (<1%); Private Investments: Promethean (<1%), Paradigm Spine (<1%), Surgitech (<1%), Benevenue (<1%), Nexgen (<1%), Vertiflex (<1%), Electrocore (<1%), Expanding Orthopedics (<1%), Osprey (<1%), Bone Biologics (<1%), Pearlliver (<1%); Board of Directors: North American Spine Society (None), North American Spine Foundation (Amount not disclosed), Cervical Spine Research Society (Amount not disclosed), AOSpine (E); Fellowship Support: AOFoundation (E, Paid directly to institution/employer).

Wang, Jeffrey C.: Royalties: DePuy Synthes (C), Amedica (B), Seaspine (C), Biomet (F); Stock Ownership: Fziomed (<1%); Private Investments: Promethean (<1%), Paradigm Spine (<1%), Benevenue (<1%), Nexgen (<1%), Vertiflex (<1%), Electrocore (<1%), Surgitech (<1%), Expanding Orthopedics (<1%), Osprey (<1%), Bone Biologics (<1%), Pearlliver (<1%); Board of Directors: NASS (First Vice President), North American Spine Foundation (None), Cervical Spine Research Society (Travel Expenses), AOFoundation (C); Fellowship Support: AOFoundation (E, Paid directly to institution/employer).

Weng, Stanley: Stock Ownership: Medronic (Amount not disclosed), Illumina (Amount not disclosed), Bristol-Meyers Squibb (Amount not disclosed).

Wetzel, F. Todd: Stock Ownership: Relievant Medical (<1%); Board of Directors: McKenzie Institute International (None), NASS (Past President).

Whitcomb, Gregory L.: Speaking and/or Teaching Arrangements: North American Spine Society (B); Trips/Travel: North American Spine Society (B).

Wirth, Ed: Stock Ownership: Asterias Biotherapeutics (<1%); Other Office: Asterias Biotherapeutics (Amount not disclosed).

Yassari, Reza: Private Investments: Sigma Surgical (15%); Consulting: Globus (Amount not disclosed); Speaking and/or teaching arrangements: AOSpine (Amount not disclosed).

Zigler, Jack E.: Royalties: Zimmer Spine (B); Stock Ownership: Expanding Orthopedics (<1%), Safe Orthopaedics (<1%), Spinal Kinetics (<1%); Consulting: DePuy Synthes (C), Aesculap (C), Medronic Spine (B), Orthofix (B), Simplify Medical (B), FloSpine (B), Centinel Spine (B); Speaking and/or teaching arrangements: Synthes Spine (C); Scientific Advisory Board: Safe Orthopedics (None); Research Support (Staff and/or Materials): Various (D, Paid directly to institution/employer); Fellowship Support: several (D).

The following participants have Nothing to Disclose:

Otsuka, Seiji
Abe, Koki
Abe, Yuichiro
Adachi, Nobuo
Aihara, Takato
Aizawa, Toshimi
Akazawa, Tsutomu
Amara, Dominic
Ando, Kei
Ando, Takashi
Aoki, Hiromichi
Arai, Yoshiyasu
Arima, Kenta
Arima, Hideyuki
Asano, Futoshi
Baba, Ichiro
Banno, Tomohiro
Bari, Tanvir J.
Bazyldo, Michael S.
Beyer, George A.
Bhatia, Manninder S.
Bloom, Lee
Boah, Akwasi
Boody, Barrett
Bouchard, Jacques A
Bronson, Joseph S
Carrwik, Christian
Chen, Kai-Yuan
Cheng, David S
Chiba, Yusuke
Chikawa, Takashi
Chikuda, Hirotaka
Chung, Chun Kee
Day, Louis M.
De la Garza Ramos, Rafael
Demura, Satoru
DePasse, John M
Desai, Rohan
Devin, Clinton J
Diebo, Bassel G.
Dohzono, Sho
Doita, Minoru
Echt, Murray
Eguchi, Yawara
Endo, Hirooki
Endo, Kenji
Fujibayashi, Shunsuke
Fujii, Takeshi
Fujimoto, Yoshinori
Fujishiro, Takashi
Fujikawa, Kenta
Funaba, Masahiro
Furukawa, Mitsuru
Furuya, Takeo
Griffith, Brent
Guha, Daipayan
Haines, Colin M
Haller, Dennis W
Harada, Tomohisa
Hariri, Omar K
Harmon, Satoko M
Hasegawa, Kazuhiro
Hasegawa, Tomohiko
Hashimoto, Ko
Hashizume, Hiroshi
Hayama, Sachio
Hayashi, Kazunori
Hayashi, Teppie
Hino, Masayuki
Hirose, Tomohiko
Ho, Allen L.
Hollern, Douglas A.
Hori, Yusuke
Horie, Shinji
Hoshino, Masatoshi
Hoshino, Yushi
Hur, Jung-Woo
Iida, Takahiro
Iida, Yasuaki
Iimori, Kenseuke
Imura, Takuya
Linuma, Masahiro
Imagama, Shiro
Imajo, Yasuaki
Inage, Kazuhide
Inami, Satoshi
Inose, Hiroyuki
Inoue, Gen
Inoue, Masahiro
Ishihara, Tosinobu
Ishikawa, Masayuki
Ishimoto, Yuyu
Ito, Kenyu
Ito, Sadayuki
Itô, Eiji
Iwahashi, Hiroki
Iwasaki, Hiroshi
Izumi, Tomohiro
Ju, Kevin L.
Kagotani, Ryohei
Kaito, Takashi
Kamata, Michihiro
Kameda, Takuya
Kamei, Naouke
Kanchiku, Tsukasa
Kang, Kyoung Tak
Karbo, Ture
Kasama, Fumio
Kato, Masanori
Kato, Satoshi
Kato, So
Kato, Tsuyoshi
Katsu, Marina
Kawabata, Soya
Kawaguchi, Yoshiharu
Kawahara, Norio
Kawakami, Mamoru
Kawamura, Naohiro
Kaye, Ian D
Keiji, Hasegawa
Kerbel, Yehuda E.
Khalas, Amrit
Kikuchi, Takayuki
Kim, Youngha
Kino, Kita, Hideyuki
Kirchner, Gregory J.
<table>
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<th>Name</th>
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<tbody>
<tr>
<td>Kitamura, Kazuya</td>
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<td>Kitano, Tomoko</td>
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1. Correction of Intervertebral Rotation by Insertion of Oblique Lumbar Interbody Fusion Cage

Yoshitaka Nakano, MD1; Atushi Nakano, MD, PhD1; Chihiro Baba, PhD1; Kenta Fujiwara, MD, PhD1; Takashi Fukushima, MD, PhD1; Sachio Hayama, MD1; Toma Yano, MD1; Yoshitada Usami, MD1; Keiichiro Kino, MD1; Mutsumi Ohue, MD1; Masashi Neo, MD1

1Osaka Medical College, Takatsuki, Osaka, Japan; 2Spinal Unit 1, Bordeaux University Hospital, Bordeaux, France; 3Katsuragi Hospital, Kishiwada-shi, Japan

BACKGROUND CONTEXT: Lateral lumbar interbody fusion (LLIF) has been reported for correction of deformities in both sagittal and coronal planes with a large interbody cage using ligamentotaxis, preserving both anterior and posterior longitudinal ligaments. However, few reports of correction of intervertebral rotation using LLIF surgery are found.

PURPOSE: The purpose of this study was to evaluate the efficacy of oblique lumbar interbody fusion (OLIF) cage insertion alone in reducing intervertebral rotation.

METHODS: Each intervertebral rotational angle was measured in the preoperative and intraoperative CT, and the efficacy of OLIF cage insertion alone in reducing rotation was evaluated. In addition, correlation of the correction rate with cage height, levels of lumbar spine, disc height, and grade of facet arthropathy was investigated. On the basis of cage height, patients were divided into the high cage group (12 mm, 14 mm) or low cage group (8 mm, 10 mm) for evaluation. Intraoperative CT was performed for the registration of posterior navigation surgery. Vertebral rotation was measured using Aaro & Dahlborn’s method. Facet arthropathy was assessed using 4 grades (grade 0–3) by Pathria’s method.

RESULTS: The mean preoperative intervertebral rotational angle was 6.7 degrees. The mean intervertebral rotational angle in the intraoperative CT was 2.8 degrees. The intervertebral rotational angle was significantly decreased because of the insertion of the OLIF cage. (p < 0.0001) The mean correction angle was 3.9 degrees. Further, the mean correction rate in intervertebral rotation was 59.4%. In the high cage group (n = 23), the correction rate was 71.0%, and in the low cage group (n = 34), the correction rate was 51.6%, there was a significant difference between the groups (p = 0.0005). There was no significant correlation between correction rate and levels of lumbar spine, disc height, and grade of facet arthropathy.

CONCLUSIONS: Approximately 60% correction in intervertebral rotation was obtained because of the insertion of the OLIF cage. A greater rotational correction rate was achieved by inserting a high cage.

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

2. What is the Expected Corrective Outcome in Adolescent Idiopathic Scoliosis Curve Larger Than 70 Degrees based on Lenke Curve Subtypes?

Kazuya Nishizawa, MD1; Gabriel K. Liu, MD2; Kanji Mori, MD, PhD3; Wong H. Kit, MD4

1Kusatsu General Hospital, Kusatsu, Japan; 2National University of Singapore, Singapore; 3Shiga University of Medical Science, Department of Orthopedic Surgery, Otsu, Japan

BACKGROUND CONTEXT: The surgery for the AIS is common; however, it has still some difficulty to achieve the better correction for the large and rigid curve compared with small curve AIS. It is important to consider the various factors of demographic data and surgical procedure to obtain the better curve correction for sever AIS.

PURPOSE: The purpose of the present study is to investigate what the expected corrective outcome in AIS curve larger than 70 degrees is, using multivariate analysis.

METHODS: Each intervertebral rotational angle was measured in the preoperative and intraoperative CT, and the efficacy of OLIF cage insertion alone in reducing rotation was evaluated. In addition, correlation of the correction rate with cage height, levels of lumbar spine, disc height, and grade of facet arthropathy was investigated. On the basis of cage height, patients were divided into the high cage group (12 mm, 14 mm) or low cage group (8 mm, 10 mm) for evaluation. Intraoperative CT was performed for the registration of posterior navigation surgery. Vertebral rotation was measured using Aaro & Dahlborn’s method. Facet arthropathy was assessed using 4 grades (grade 0–3) by Pathria’s method.

RESULTS: The mean preoperative intervertebral rotational angle was 6.7 degrees. The mean intervertebral rotational angle in the intraoperative CT was 2.8 degrees. The intervertebral rotational angle was significantly decreased because of the insertion of the OLIF cage. (p < 0.0001) The mean correction angle was 3.9 degrees. Further, the mean correction rate in intervertebral rotation was 59.4%. In the high cage group (n = 23), the correction rate was 71.0%, and in the low cage group (n = 34), the correction rate was 51.6%, there was a significant difference between the groups (p = 0.0005). There was no significant correlation between correction rate and levels of lumbar spine, disc height, and grade of facet arthropathy.

CONCLUSIONS: Approximately 60% correction in intervertebral rotation was obtained because of the insertion of the OLIF cage. A greater rotational correction rate was achieved by inserting a high cage.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
are independently important predictors of Cobb angle correction for large AIS curve. However, there were no significant relationships to Cobb angle correction with anterior release, Ponte osteotomy, and implant density. We might be able to reduce Ponte osteotomy, anterior release, and number of implants for the lumbar major curve and/or flexible curve of more than 40 degrees, even though the Cobb angle is more than 70 degrees.

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

### 3. Sagittal Imbalance of the Spine-Pelvis-Lower Extremity Axis is Associated with Back-Related Disability in Inhabitant Volunteers

Masatoshi Teraguchi, MD, PhD1; Mamoru Kawakami, MD, PhD1; Yuyu Ishimoto, MD, PhD2; Keiji Nagata, MD, PhD2; Ryoei Kagotani, MD, PhD1; Masafumi Nakagawa, PT1; Masakazu Minetama, PT1; Hiroshi Yamada, MD, PhD1

1Spine Care Center, Wakayama Medical University Kihoku Hospital, Ito-gun, Wakayama, Japan; 2Department of Orthopaedic Surgery, Kihoku Hospital, Ito-gun, Wakayama, Japan; 3Institute of Orthopaedic Research, Kagawa University School of Medicine, Kagawa, Japan

**BACKGROUND CONTEXT:** Loss of lumbar lordosis owing to degenerative changes of the lumbar spine results in not only an increase in pelvic tilt (PT) and thoracic kyphosis, but also compensation of the lower extremity axis. The impact of sagittal imbalance on low back pain (LBP) and LBP-related disability in patients has been recently reported. However, there have been no reports regarding the evaluation of the spine-pelvis-lower extremity axis with lateral images of the spine-pelvis axis and the pelvis-lower extremity separately, and the relationships of LBP, LBP-related disability, and knee pain with sagittal alignment of the spine-pelvis-lower extremity axis in inhabitant volunteers.

**PURPOSE:** The purposes of this study were to introduce a novel parameter of the spine-pelvis-lower extremity axis using two separate lateral images and to evaluate if this parameter was related to LBP, LBP-related disability, and knee pain.

**STUDY DESIGN/SETTING:** Cross-sectional, inhabitant volunteer study.

**PATIENT SAMPLE:** Three-hundred forty four subjects (124 men; mean age, 64.4±7.9 years and 220 women; mean age, 61.6±8.8 years) from Katsuragi town, Japan was included.

**OUTCOME MEASURES:** The prevalences of LBP and knee pain were examined. LBP-related disability was evaluated using the Oswestry Disability Index (ODI) score. Standing spine-pelvis and standing pelvis-lower extremity radiographs were obtained to assess the sagittal vertical axis (SVA), PT, pelvic incidence, sacral slope, lumbar lordosis (LL), and TK. Additionally, the S1-knee distance (S1-KD), which is the distance from the anterior femoral condyle to the vertical axis at the upper posterior edge of the S1 body, was measured. Furthermore, the SVA/S1-KD ratio was calculated.

**METHODS:** The volunteers were divided into leg compensated (LC; SVA/S1-KD ratio <0.8) and decompensated (LD; SVA/S1-KD ratio >0.8) groups. The SVA was divided into balanced spine (BS; SVA ≤40 mm) and imbalanced spine (IS; SVA >40 mm) groups. All participants were classified into LC+BS, LC+IS, LD+BS, and LD+IS groups. The relationships among the four groups and LBP, ODI, and knee pain were examined.

**RESULTS:** The prevalences of LBP and knee pain were 31.7% and 24.4% in men, and 34.4% and 20.0% in women, respectively. The ODI score was 10.0±10.4% in men and 9.4±12.2% in women. The SVA, PT, PI, SS, LL, TK, and S1-KD were 19.9±3.4 cm, 23.0±11.1°, 54.5±12.5°, 31.1±8.6°, 35.8±12.9°, 36.6±11.4°, and 4.7±2.8 cm, respectively. There were 228, 29, 29, and 57 individuals in the LC+BS, LC+IS, LD+BS, and LD+IS groups, respectively. There were no significant correlations between groups and radiological parameters in the ANOVA analysis. However, in multinomial logistic analysis, ODI was significantly higher in the LC+IS group than the LD+BS group and the prevalence of knee pain was significantly higher in the LC+IS and LC+BS groups than the LD+IS group.

**CONCLUSIONS:** LBP-related disability was associated with global spinal sagittal imbalance as well as reciprocal change through compensation of the lower extremity. Knee pain was influenced by compensation of the lower extremity, but not spinal sagittal imbalance. Our results suggest that global balance is important in the case of LBP, LBP-related disability, or knee pain, and that the SVA/S1-KD ratio is useful for evaluating the spine-pelvis-lower extremity axis and elucidating the possible mechanism of “knee-spine syndrome.”

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

### 4. The Relationship Between Sagittal Spino-Pelvic Alignment and the Acetabular Anteversion Angle on Computed Tomography in Patients with Hip Osteoarthritis

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**BACKGROUND CONTEXT:** The importance of evaluating the sagittal spino-pelvic alignment (SSPA) has been recognized in treatment planning. Lazennec et al. advocated the concept of spine users and hip users: spine users have a high pelvic incidence (PI) and lumbar lordosis (LL) in order to mainly move their spine, which results in a low rate of anatomic acetabular anteversion (AAA); hip users have low PI and LL values in order to mainly move their hips, which results in a high rate of AAA. In the present study, we investigated the relationship between the SSPA and AAA in patients with hip osteoarthritis.

**METHODS:** We performed a retrospective comparative cohort study of 427 women who underwent primary total hip arthroplasty (THA). The patients were classified into the following age groups (in years): <60 (n=92), 60–69 (n=148), 70–79 (n=114), ≥80 (n=73). The PI, pelvic tilt (PT), sacral slope (SS), LL, and AAA were measured. AAA was defined based on the angle between the antero-posterior line of the acetabular edge and the transverse line of the lateral pelvis on the axial plane of computed tomography. Malalignment (PI-LL>20° and PT>30°), which was defined by Schwab et al., was investigated according to age. The patients were classified into categories defined by Lazennec et al. according to the PI as follows: PI<40 (n=105), 40–60 (n=256), and >60 (n=66). We also investigated the relationship between the PI and AAA. A one-way analysis of variance was performed, and P values of <0.05 were considered to indicate statistical significance.

**RESULTS:** SSPA and AAA according to age: Elderly patients tended to have a high PT (r=0.66), a low SS (r=0.94), low LL (r=0.94), and high AAA (r=0.79) values compared with young patients. The values did not differ significantly according to age or PI (P=0.17). The frequency of malalignment (in Schwab classification) according to age: The frequency of PI-LL<20° and PT<30° was 15.7% and 8.0%, respectively, in all patients, 9.8% and 2.2% in those <60 years of age, 10.1% and 6.1% in those
60–69 years of age, 17.5% and 7.9% in those 70–79 years of age, and 31.5% and 19.2% in those ≥80 years of age. Aging increased the degree of malalignment (P<0.05). The Lazennec classification and AAA: The AAA was 13.5° for PI<40, 14.1° for PI 40–60, and 18.2° for PI>60. The PT was -1.1° for PI<40, 13.9° for PI 40–60, and 26.7° for PI>60. There were positive correlations between the PI and AAA (r=0.92) as well as between the PI and PT (r=0.94).

CONCLUSIONS: The present study had two main findings. First, there was a positive correlation between the PI and AAA; this result was the opposite of the assumptions and hypotheses of Lazennec et al. In the present study, the majority of the targets were elderly, and patients with a high PI tend to exhibit an increased posterior pelvic tilt with aging. Pelvic retroversion causes an increase in AAA because of the differing morphology of the acetabular horns on the caudal side, where the ventral horn runs less caudally than the dorsal horn. Second, since pelvic retroversion is related to an increased AAA and PI with aging, as mentioned, a high AAA as well as a high PI with aging may be risk factors for both posterior- and lateral-direction dislocation after THA. Pelvic retroversion causes a concomitant increase in the rate of acetabular anteversion and inclination, which results in posterior and lateral THA dislocation.

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

5. Impact of Postoperative Symptom Improvement and Disability on Health Related Quality of Life and Treatment Satisfaction in Adult Spinal Deformity Patients Treated by Corrective Long Fusion

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BACKGROUND CONTEXT: Long spinal fusion is often performed to correct coronal and sagittal deformities in the adult spinal deformity patients. However, the long spinal fusion sometimes cause disability in daily activities, especially in case with pelvic fusion.

PURPOSE: The purpose of this study was to investigate the impact of postoperative symptom improvements and disability on HRQOLs and treatment satisfaction in the adult spinal deformity patients treated by corrective long fusion from the thoracic spine to the pelvis.

STUDY DESIGN/SETTING: Prospective Case Series in a Single Center

PATIENT SAMPLE: A consecutive 139 adult deformity patients who underwent corrective long fusion from the thoracic spine to the pelvis were included in this study. There were 22 males and 117 females with mean age of 68 years. All patients were followed-up over 2 years. The patients with incomplete information in the HRQOL and disability questionnaires were excluded.

OUTCOME MEASURES: Numerical Rating Scale (NRS), Oswestry Disability Index (ODI), and Treatment Satisfaction Score (0-100).

METHODS: Four main symptoms including a) socio-mental, b) visceral (respiratory, digestive), c) leg symptoms, and d) back pain were evaluated by Numerical Rating Scale (NRS, 0-10), preoperatively and 2 years after the surgery. Difficulty of daily activities including e) gait, f) trim toe nails, g) lie supine, h) perform personal hygiene, i) put on pants, j) pick up an item from the floor, and k) get down on all fours, were also evaluated by NRS at the same time periods. HRQOL was investigated by ODI, and treatment satisfaction score (0-100) was evaluated by patients themselves at 2 years after the surgery. Relationship between change of each symptom (improvement: +, deterioration: -) and ODI/treatment satisfaction score were investigated.

RESULTS: Average scores of NRS in main symptoms were changed from pre-operatively to Postoperative 2 years: a) 7.1 to 4.8, b) 3.5 to 2.8, c) 4.8 to 4.7, and d) 7.0 to 4.3, respectively. Average improvement of NRS (main symptoms) were a) 2.3, b) 0.7, c) 0.03, and d) 2.6, suggesting that greater improvements were observed in socio-mental and back pain. Average scores of difficulty in daily activities were changed from pre-operatively to Postoperative 2 years: e) 7.4 to 5.2, f) 4.9 to 8.0, g) 5.2 to 4.2, h) 3.9 to 4.9, i) 4.6 to 6.0, j) 4.9 to 7.0, and k) 6.1 to 8.0, respectively. Average improvement/deterioration in daily activities were e) +2.1, f) -3.2, g) +0.9, h) -1.1, i) -1.6, j) -2.3, and k) -2.0, respectively, suggesting that most of these activities were worse at 2 years after the surgery. Average ODI was improved 46.1% in pre-operatively to 31.1% at Postoperative 2 years. Significant correlations (p<0.01) were observed between the ΔODI and d) r=0.43, e) r=0.55, g) r=0.31, h) r=0.26, i) r=0.30, and j) r=0.34. Average treatment satisfaction scores at 2 years after surgery was 76.1. Significant correlations (p<0.01) was observed between the satisfaction score and a) r=0.35, c) r=0.36, d) r=0.31, and e) r=0.30. These results suggested that improvements of main symptoms were directly associated with treatment satisfaction.

CONCLUSIONS: Although postoperative disability has affected HRQOLs 2 years after the corrective long fusion for adult spinal deformity patients, these daily disability did not have greater impacts on the satisfaction for their surgical treatment compared to the improvements of the main symptoms.

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6. Is it Beneficial to Adapt Minimally Invasive Lateral Lumbar Interbody Fusion for Adult Spinal Deformity?

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BACKGROUND CONTEXT: Less invasive surgery with lateral lumbar interbody fusion (LLIF) for the treatment of adult spinal deformity (ASD) has been gaining popularity in recent years. A propensity matched study between LLIF combined with open posterior spinal fusion (PSF) and conventional PSF for ASD has yet to be performed.

PURPOSE: To evaluate early radiographic outcomes and safety of LLIF combined with PSF, and compare them with conventional PSF for ASD.

STUDY DESIGN/SETTING: Retrospective analysis of clinical and imaging data
METHODS: Hybrid correction and fusion surgery with LLIF was employed for intervertebral release instead of more aggressive release procedures such as 3-column osteotomy has been conducted. We investigated 40 patients (Group L; n=40) who underwent corrective hybrid procedures with a minimum of 12 months follow up, and compared them with 40 patients (Group C; n=40) who underwent conventional procedures for sagittal imbalance of ASD. Group L and Group C were matched according to the age at surgery, gender, preoperative sagittal vertebral axis (SVA), lumbar coronal Cobb angle (CCA) and SRS-Schwab classification (Curve type L: 17; D: 4; N: 19) in an attempt to neutralize these patient variables. Surgical data, perioperative complications and following pre- and postoperative radiographic parameters were compared: CCA, central sacral vertebral line (CSVL), lumbar lordosis (LL), pelvic incidence minus lumbar lordosis (PI-LL), and SVA. Statistical comparisons were determined using a Wilcoxon signed-rank test.

RESULTS: The mean age was 67.3 years in Group L and 65.4 years in Group C. A mean of 6.7 levels were fused and 2.2 levels were treated with LLIF per patient in Group L. A mean of 7.6 levels were fused per patient in Group C patients. Patients underwent traditional 3-column osteotomies in Group C. Statistically, blood loss was significantly less in Group L than in Group C (1154 vs. 2051 ml, p < 0.001). Whereas our research showed that operative time in Group C was significantly less than Group L (405 vs. 464 minutes, p = 0.001). Mean preoperative CCA, CSVL, LL, PI-LL, and SVA in Groups L and C were 49.0/49.6°, 3.0/4.2cm, 4.8/1.9°, 47.1/49.2° and 12.9/11.9cm, respectively. Mean postoperative CCA, CSVL, LL, PI-LL, and SVA in both groups were 17.3/17.0°, 1.7/1.9cm, 39.8/40.4°, 12.1/9.0° and 3.6/3.1cm, respectively. There were no significant differences between groups in terms of radiographic parameters. Perioperative complications occurred in 17.5% of patients in Group L, 27.5% in Group C including 8 patients with massive bleeding (>3000mL). In Group L, 12 patients had isolated, mild transient hip flexion weakness on the approach side, but there were no persistent motor deficits.

CONCLUSIONS: In severe sagittal imbalance cases, with or without coronal deformity, sagittal realignment is the priority of surgical strategy. Three-column osteotomy has been indicated for patients with sagittal imbalance but it is traditionally associated with high morbidity and complication rates. Hybrid procedures of LLIF combined with Ponte osteotomy and pedicle screw instrumentation achieved powerful correction of degenerative deformity with less blood loss than conventional open procedures.

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7. Transcranial Motor Evoked Potentials for Preventing Nerve Root Injury during Adult Spinal Deformity Surgery

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BACKGROUND CONTEXT: Nerve root injury often occurs as a complication of adult spinal deformity (ASD) surgery. Intraoperative neuromonitoring is important for avoiding neurological injury or postoperative paralysis. Especially, transcranial motor evoked potentials (TcMEPs) monitoring is now used with high sensitivity and specificity to detect postoperative paralysis. In points of detecting nerve root injury using TcMEPs monitoring, there is conflicting evidence concerning segmental innervation’s effect in individual muscles.

PURPOSE: To evaluate the utility of TcMEPs monitoring for preventing nerve root injury during ASD surgery and to clarify the risk factors from characteristic, surgical, and radiographic data.

STUDY DESIGN/SETTING: A retrospective study.

PATIENT SAMPLE: We analyzed 295 patients who underwent ASD surgery using multi-channel TcMEPs monitoring between 2010 and 2016 (58 men, 237 women; median age: 68 years; follow up period: ≥1 year).

OUTCOME MEASURES: We assessed relationship between results of TcMEPs and neurological events related to nerve root injury.

METHODS: The baseline control TcMEPs amplitude was defined as that observed at the time of incision or prior to decompression, depending on each case’s circumstances. We defined our alarm point as TcMEPs amplitudes less than 30% of baseline, and neurological events related to nerve root injury as meeting the alarm point in the selected muscles soon after proper interventions. We defined nerve root injury as the patient’s muscle strength decreasing by at least 2 grades on the manual muscle test. Patients were classified into 2 groups: cases with the neurological events and true-negative cases. A multivariate logistic regression analysis was used to assess the risk factors of the neurological events after ASD surgery.

RESULTS: There were 16 cases (5.4%) with the neurological events, comprising 9 rescue cases, 6 true-positive cases, and a false-negative case. TcMEPs monitoring from multiple myotomes was effective to detect nerve root injury. The 9 rescue cases with intraoperative recovery of TcMEPs amplitudes did not develop motor weakness. Compared to 279 true-negative cases, 16 cases with neurological events had a significantly higher American Society of Anesthesiologists (ASA) classification score (2.2 versus 1.8, p<0.006), higher estimated blood loss (2020 mL versus 1380 mL, p=0.025), but did not significantly differ in length of surgery, number of levels fused, or presence of 3-column osteotomies. Compared to the true-negative cases, the cases with the neurological events had significantly lower preoperative lumbar lordosis values, lower preoperative pelvic tilt values, but did not significantly differ in preoperative Cobb angle, or any postoperative parameter. In multivariate logistic analysis, ASA classification (odds ratio [OR], 6.074; 95% confidence interval [CI], 1.822–20.251; P = 0.003) and preoperative sacral slope (OR, 0.952; 95% CI, 0.912–0.995; P = 0.027) were independently associated with the neurological events.

CONCLUSIONS: Multi-channel TcMEPs monitoring is useful for detecting and preventing nerve root injury. Nerve root injury can be rescued by proper interventions soon after TcMEPs alert. Preoperative physical status and pelvic retroversion may be significant risk factors for neurological events related to nerve root injury.

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8. Sagittal Alignment after Surgical Treatment of Adolescent Idiopathic Scoliosis: Application of the Roussouly Classification

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BACKGROUND CONTEXT: How spinopelvic alignment is affected in AIS patients is not well established. Roussouly et al proposed a classification based on the sagittal spinal profile and spinopelvic alignment that may have clinical utility in this patient group.

PURPOSE: To investigate spinopelvic alignment and spinal shape in patients surgically treated for adolescent idiopathic scoliosis (AIS) and to assess the distribution and clinical applicability of the Roussouly classification.

METHODS: A consecutive cohort of AIS patients surgically treated over a four-year period were included. Whole-spine standing lateral radiographs were analyzed preoperatively, one-week postoperatively and at two-year follow-up. Patients were categorized using the modified Roussouly classification and sagittal alignment were analyzed.

RESULTS: Postoperatively, global thoracic kyphosis decreased by 2.6° and LL decreased by 6.2° (p<0.012) while Pelvic tilt (PT) increased 1.4° (p=0.024). PI and sacral slope remained stable. At two-year follow-up, thoracic kyphosis and LL had returned to preoperative values (p=0.346) while PT had decreased from preoperative 9.7±7.6° to 7.0±7.5° (p<0.001). Proximal junctional angle increased from 8.4±5.0° preoperatively to 12.8±8.9° (p<0.001). Preoperatively, Roussouly curve types were distributed equally apart from a lower rate of type 1 (12%). At final follow-up, 30% were categorized as type 3 with pelvic anteversion which is considerably higher than the normal adolescent population. Only three patients were type 1 at the final follow-up. Overall, we found a high rate of PI-JK (16%), PI-LL mismatch (60%) and Pelvic anteversion (38%). In preoperative type 1 patients, the rate was 50%, 82% and 64%, respectively.

CONCLUSIONS: We found that immediate postoperative changes in lordosis and kyphosis were reversed at final follow-up. Patients were categorized using the modified Roussouly classification and sagittal alignment were analyzed.

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9. Short Limited Fusion versus Long Fusion with Deformity Correction for Spinal Stenosis with Balanced De Novo Degenerative Lumbar Scoliosis

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BACKGROUND CONTEXT: Degenerative scoliosis can be categorized into de novo degenerative lumbar scoliosis (dDLS) and secondary degenerative scoliosis. A subtype of dDLS, balanced dDLS, comprises of cases whose scoliosis angle is mild to moderate at baseline. Spinal stenosis with balanced dDLS can be treated by decompression alone, decompression with short segment (limited) fusion, and decompression with long segment fusion with full curve correction. Some investigators have insisted that short fusion may cause rapid progression of scoliosis. However, other researchers have reported that the overall magnitude of progression of the Cobb angle after short fusion surgery for patients with dDLS is similar to that of the natural curve progression, and therefore clinicians may not need to monitor progression of the Cobb angle when treating patients with balanced dDLS. Patients with Spinal stenosis with Balanced de novo degenerative lumbar Scoliosis without substantial Sagittal imbalance (SBSS) usually undergo short limited fusion or long fusion with curve correction. There is debate regarding whether short fusion is insufficient for SBSS for prevention scoliosis progression.

PURPOSE: The aim of this study was to identify advantages and disadvantages of long versus short fusion for patients with SBSS, and to determine whether short fusions and long fusions have different curve progression after surgeries and differences in operative characteristics.

STUDY DESIGN/SETTING: A meta-analysis of randomized controlled trials was carried out.

PATIENT SAMPLE: Adult patients undergoing short (limited) fusion or long (curve correction) fusion for balanced de novo degenerative scoliosis without substantial sagittal imbalance (SBSS) comprised the patient sample.

OUTCOME MEASURES: Cobb angle, C7 plumb line, osteoarthritis index (ODI), perioperative outcomes (bloss loss, operation time, and hospital stay) were measured and stratified by response of diagnostic block procedures.

METHODS: A systematic search of PubMed, Embase, Web of Science, and the Cochrane Library was performed to find studies assessing the comparison of surgical techniques for SBSS. We included all direct comparative studies comparing short and long fusion and extracted data about scoliosis progression, changes in the Oswestry Disability Index (ODI), perioperative outcomes, and complication rates. A meta-analysis was performed to calculate weighted mean differences (WMDs) and 95% confidence intervals (CIs).

RESULTS: We included data from six studies involving 362 patients (short fusion, 202 patients; long fusion, 160 patients). Both the short fusion and the long fusion groups showed decreased Cobb angle (short, 22.388–11.698; long, 30.748–12.778) and C7 plumb at the final follow-up. The long fusion group showed a substantial decrease in Cobb angle (WMD, 8.94; 95% CI, 2.55–15.33) and in C7 plumb (WMD, 5.90; 95% CI, -0.39–12.18), compared to the short fusion group. At final follow-up, ODI had decreased similarly in both groups (WMD, 1.70; 95% CI, -13.04–9.65). The short fusion group showed advantages including decreased blood loss (mean difference, 739.9 mL) and shorter operative time (mean difference, 68.0 minutes) compared to the long fusion group.

CONCLUSIONS: Short fusion may not be inferior to long fusion for treating patients with SBSS and it has the advantage of being less invasive. Surgical decision-making should consider any risk factors for deformity progression as well as overall sagittal and coronal balance. Short fusion may be a reasonable option for patients with SBSS and at low risk for curve progression.

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10. Spinal Correction Surgery Enables Long-Term Relief of Gastroesophageal Reflux Disease Symptoms in Adult Spinal Deformity

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BACKGROUND CONTEXT: Gastroesophageal reflux disease (GERD) is reported to be one of the complications for adult spinal deformity especially in patients with thoracolumbar kyphosis due to vertebral fracture. We previously reported the impact of spinal correction on GERD symptom relief (Sugimoto, Dig Endosc 2016). However the long-term effect of the spinal correction on GERD symptom is not yet to be revealed.

PURPOSE: The purpose of this study was to investigate the immediate and long-term impact of spinal correction on GERD symptom relief.

STUDY DESIGN/SETTING: Case Series in a Single Center

PATIENT SAMPLE: 132 adult spinal deformity patients consisting of 10 males and 122 females with an average age of 63.7 years old, who had GERD symptoms with the F-scale questionnaire score of 8 points and more. All the patients were over the age of 18, and had undergone at least 5 vertebral levels of spinal correction and fusion during 2010-2015 in our hospital.

OUTCOME MEASURES: F-scale questionnaire (FS) was the one of the evaluation methods for GERD with 62% sensitivity and 59% specificity for the diagnosis at the cut-off value 8 points (Kusano, J Gastroenterol 2004). X-ray parameters: sagittal vertical axis (SVA), thoracic kyphosis (TK), lumbar kyphosis (LL), pelvic tilt (PT) and coronal Cobb angle

METHODS: Preoperatively 132 patients had over 8 points examined by FS. Patients with the preoperative value of 8 points or more showing any recovery within 6 months from surgery were defined as correction effective group. Among the correction effective group, 85 patients were followed for at least 2 years (average 4.1 years) and was examined for their FS scores on their first, second postoperative year. 29 patients were examined on their fifth postoperative year. These patients were further divided in to subgroups. Patients with the FS score improvement of more than 5 points were categorized as maintained group and patients with the FS score of less than 5 was categorized as worsened group. Using standing whole spine X-ray, the relationship between the FS scores and the changes in sagittal vertical axis (SVA), thoracic kyphosis (TK), lumbar kyphosis (LL), pelvic tilt (PT) and coronal Cobb angle were investigated. ANOVA, Bonferroni test and t-test was used for statistical analysis.

RESULTS: Among the 132 patients with the FS value of over 8 preoperatively, 111(84%) showed improvement of the score at 6 months postoperatively. X-ray parameters significantly improved postoperatively, TK (Pre OP vs Post OP: 28°±23 vs 34°±12°, p=0.02), LL (18°±27° vs 43°±15°, p<0.001), PT (35°±13° vs 23°±11°, p<0.001), SVA (118±85mm vs 40±59mm, p<0.001) and Cobb angle (26°±24° vs 9°±8°, p<0.001). As for the 85 patients who were followed for at least 2 years, FS values significantly improved from 16.0 to 4.8 immediately after operation and the scores were maintained at the first (FS 8.6±7.1) and second (8.6±7.5) postoperative year (p<0.0001). For 29 patients with the follow up of over five years, The FS values were still significantly lower in comparison with the preoperative values (6.9±5.6 vs 16.0±8.0) (p<0.001). The X-ray analysis showed that there were no significant differences in the local X-ray parameters changes between the FS maintained group and the worsened group.

CONCLUSIONS: In adult spinal deformity patients, GERD symptoms are immediately improved directly after operation and the improvement is still maintained throughout the second and fifth postoperative years. Thus patients with GERD symptoms due to adult spinal deformity have good operative indication for deformity correction.

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

11. Minimum Clinically Important Difference in Oswestry Disability Index Domains and Their Impact on Adult Spinal Deformity Surgery

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BACKGROUND CONTEXT: Despite the common use of Oswestry Disability Index (ODI) in assessing adult spinal deformity (ASD), there is no robust study defining minimum clinically important difference (MCID) values for ODI, which domain of ODI has better or worse outcome in ASD surgery, and whether good correction encourages good clinical results.

PURPOSE: To calculate minimum clinically important difference (MCID) for total and individual domains of the Oswestry Disability Index (ODI) and assess score distribution and change over time, with a minimum of 2 years follow-up, in surgically treated adult spinal deformity (ASD) patients.

STUDY DESIGN/SETTING: Retrospective analysis

PATIENT SAMPLE: The study protocol was approved by the institutional review board of our university. We retrospectively reviewed consecutive patients who underwent posterior corrective spinal fusion surgery for ASD at our institution in March 2010–April 2015. Patients who were not followed up for least 2 years were excluded. ASD was defined as the presence of at least one of the following indicators: coronal spinal curvature, ≥20°; sagittal vertical axis (SVA), >5 cm; pelvic tilt, >25°; or thoracic kyphosis, >60°. Inclusion criteria were (1) age ≥18 years, (2) number of fused vertebra, ≥4 segments, (3) HRQOL questionnaire of SRS-22R and ODI, available; (4) standing whole-spine and pelvic radiographs, available; and (5) informed consent, available.

OUTCOME MEASURES: ODI was determined for each patient at baseline; 6 months; and at 1-, 2-, and 5-year follow-up. It has emerged as the most commonly recommended condition-
specific outcome measure for spinal disorder patients; it contains 10 sections: pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, sex life, and traveling. For each subclass, scores range from 0 (best measured health) to 5 (worst measured health). SRS-22R is a sclerosis-specific HRQOL questionnaire with 22 items and 5 domains: pain, appearance, activity, mental, and satisfaction. Each domain score ranges from 1 to 5, with higher scores indicating better outcomes.

METHODS: We used total or part of the SRS-22R as anchors for MCID values of ODI domains. MCID values for ODI domains were determined using receiver-operating characteristic curve (ROC) analysis with the anchor scores. Cutoff values for an ROC correspond to the points of optimal trade-off between sensitivity and specificity to distinguish “unchanged” and “changed.” Accuracy of ROC is evaluated using calculated area under the curve (AUC). Using MCID for ODI domain, the distribution and change over time for each subclass were analyzed. Different pathology (idiopathic, degenerative, Parkinson, or vertebral fracture), different age (<64, 64–74, or ≤75 years), lower instrumented vertebrae (LIV) location (above L5 or S1 to the ilium), and upper instrumented vertebra (UIV) location (above T8 or below T9) were analyzed.

RESULTS: Overall, 240 consecutive patients were enrolled, with a mean age of 63.4 years (SD, 16.3; range: 18–84 years; 42 men, 198 women). Mean follow-up period was 55 months (24–86 months). Overall, 71 patients were followed for >5 years. MCID of the total ODI score was 11% with area under the curve of 0.737, and each domain ranged 0–2 and was mostly 1 in ASD surgery. In the pain and standing domain, >60% of patients obtained MCID, although the acquisition rates of personal care, lifting, sleep, and sex activity domains were relatively low (20%–35%). Patients with MCID had more radiographic improvement in lumbar lordosis, sagittal vertical axis, and T1 pelvic angle than those without (p < 0.05).

CONCLUSIONS: To our knowledge, this is the first study to describe MCID of ODI (11%) after ASD surgery. In the pain and standing domain, most patients obtained MCID, although the acquisition rates of MCID in personal care, lifting, sleep, and sex activity domains were low. Therefore, spinal surgeons must counsel patients regarding improvements and setbacks of ASD surgery.

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

12. Sagittal Spino-pelvic Alignment in Patients with Osteoarthritis of the Hip

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BACKGROUND CONTEXT: Since the introduction of the sagittal spino-pelvic alignment (SSPA) assessment, studies on the relationship between spinal alignment and pelvic orientation have been increasing, especially with regard to spinal deformities that occur in elderly individuals.

PURPOSE: The present investigation examined the sagittal alignment of the spine and pelvis in patients with osteoarthritis of the hip (HOA) using the SRS-Schwab classification.

STUDY DESIGN/SETTING: retrospective case series

PATIENT SAMPLE: The subjects were 56 males and 268 females with an average age of 65 treated by total hip arthroplasty due to unilateral HOA. The subjects were divided by age in decades as <60s (n=90), 60s (n=122), and ≥70s (n=122).

OUTCOME MEASURES: Lateral whole spine radiography was prospectively performed in all patients before surgery. The parameters of SSPA examined were the sagittal vertical axis (SVA), pelvic tilt (PT), lumbar lordosis (LL) and pelvic incidence (PI). The pelvic inclination angle (PIA) in the supine position and the change in the PIA from the supine to the standing position (∆PIA) were measured using the anteroposterior pelvic radiographs.

METHODS: The findings of PI-LL > 20°, SVA > 9.5 cm and PT > 30° were considered to indicate sagittal malalignment based on the SRS-Schwab classification. The significance of differences among the three age groups was evaluated by an analysis of variance (ANOVA) with Bonferroni’s correction. A value of P<0.05 was considered to be significant.

RESULTS: The percentage of patients with PI-LL > 20°, SVA > 9.5 cm and PT > 30° was 1%, 0% and 0% in the < 60s, 13%, 6% and 4% in the 60s and 34%, 26% and 18% in the ≥ 70s, respectively. Regarding a ∆PIA of > 10°, the rate was 3% in the < 60s, 8% in the 60s and 25% the ≥ 70s (P<0.001). The frequency of sagittal malalignment and the occurrence of a ∆PIA of > 10° in the ≥70s was significantly higher than in the < 60s (P<0.05) and 60s (P<0.05).

CONCLUSIONS: Our study suggests that long-term HOA may affect the sagittal alignment of the spine. In addition, the presence of a spinal deformity may rotate the pelvis backwards and exaggerate the stress on the femoral head, ultimately causing HOA, in a process known as secondary hip-spine syndrome. Recognizing specific aspects of SSPA of HOA may help predict and prevent this disease. PI-LL mismatch, higher posterior standing PT and a reduced course of posterior pelvic tilt are also considered risk factors for post-total hip arthroplasty (THA) dislocation among elderly patients. Therefore, our results regarding the high frequency of sagittal malalignment and the occurrence of a ∆PIA of > 10°in those ≥70 years of age support the notion that older age may be a strong risk factor for dislocation after THA.

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

13. The Predictable Factors of the Postoperative Kyphotic Change of Sagittal Alignment of the Cervical Spine after the Laminoplasty

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BACKGROUND CONTEXT: Laminoplasty is an effective surgical method for treating cervical degenerative disease. However, postoperative complications such as kyphosis, restriction of neck motion, and instability are often reported. Despite sufficient preoperative lordosis, this procedure often aggravates the lordotic curve of the cervical spine and straightens cervical alignment. Hence, it is important to examine preoperative
risk factors associated with postoperative kyphotic alignment changes.

**PURPOSE:** Our study aimed to investigate preoperative radiologic parameters associated with kyphotic deformity post laminoplasty.

**STUDY DESIGN/SETTING:** Retrospective case study

**PATIENT SAMPLE:** We retrospectively reviewed the medical records of 49 patients who underwent laminoplasty of the cervical spine at Pusan National University Yangsan Hospital between January 2011 and November 2015. The inclusion criteria were as follows: 1) all patients were diagnosed preoperatively with either OPLL or CSM, 2) no previous history of cervical spinal operations, cervical trauma, infection, or neoplasm, 3) all patients underwent a minimum 1-year follow-up period post laminoplasty with proper radiological examinations performed in outpatient clinics, and 4) only cases showing C7 and T1 vertebral body in the preoperative cervical sagittal plane examination.

**OUTCOME MEASURES:** Radiologic and clinical assessment C2-C7 Cobb angle, T1 slope, C2-C7 SVA, range of motion (ROM) from C2-C7, segmental instability and T2 signal change.

**METHODS:** We retrospectively reviewed the medical records of 49 patients who underwent open door laminoplasty for cervical spondyloitic myelopathy (CSM) or ossification of the posterior longitudinal ligament (OPLL) at Pusan National University Yangsan Hospital between January 2011 and December 2015. Inclusion criteria were as follows: 1) preoperative diagnosis of OPLL or CSM, 2) no previous history of cervical spinal surgery, cervical trauma, tumor, or infection, 3) minimum of one-year follow-up post laminoplasty with proper radiologic examinations performed in outpatient clinics, and 4) cases showing C7 and T1 vertebral body in the preoperative cervical sagittal plane. The radiologic parameters examined included C2-C7 Cobb angles, T1 slope, C2-C7 sagittal vertical axis (SVA), range of motion (ROM) from C2-C7, segmental instability, and T2 signal change observed on magnetic resonance imaging (MRI). Clinical factors examined included preoperative modified Japanese Orthopedic Association scores, disease classification, duration of symptoms, and the range of operation levels.

**RESULTS:** Mean preoperative sagittal alignment was 13.01° lordotic; 6.94° lordotic postoperatively. Percentage of postoperative kyphosis was 80%. Patients were subdivided into two groups according to postoperative Cobb angle change; a control group (n=22) and kyphotic group (n=27). The kyphotic group consisted of patients with more than 5° kyphotic angle change postoperatively. There were no differences in age, sex, C2-C7 Cobb angle, T1 slope, C2-C7 SVA, ROM from C2-C7, segmental instability, or T2 signal change. Multiple regression analysis revealed T1 slope had a strong relationship with postoperative cervical kyphosis. Likewise, correlation analysis revealed there was a statistical significance between T1 slope and postoperative Cobb angle change (p=0.035), and that there was a statistically significant relationship between T1 slope and C2-C7 SVA (p=0.001). Patients with higher preoperative T1 slope demonstrated loss of lordotic curvature postoperatively.

**CONCLUSIONS:** Laminoplasty has a high probability of aggravating sagittal balance of the cervical spine. T1 slope is a good predictor of postoperative kyphotic changes of the cervical spine. Similarly, T1 slope is strongly correlated with C2-C7 SVA.

**FDA DEVICE/DUG STATUS:** This abstract does not discuss or include any applicable devices or drugs.
BACKGROUND CONTEXT: Preoperative positive cervical regional sagittal imbalance is one of the risk factors for postoperative cervical kyphosis after expansive laminoplasty (ELAP) and the importance of the global spinal sagittal alignment has also been suggested for the indication of ELAP.

PURPOSE: The purpose of this study was to investigate the relationship between the incidence of postoperative cervical kyphosis after ELAP and the preoperative global spinal sagittal alignment in patients with cervical spondylotic myelopathy (CSM) without spinal sagittal imbalance.

STUDY DESIGN/SETTING: This is a retrospective radiographic study of a consecutive case series of cervical spondylosis patients.

PATIENT SAMPLE: Among 84 consecutive patients who underwent ELAP for CSM at our hospital, 43 patients without pre-operative cervical kyphosis (C2-C7 angle was greater than 0°) and spinal sagittal imbalance (C2-C7 SVA was 80 mm or less; C7 SVA was 95 mm or less) were enrolled.

OUTCOME MEASURES: The difference in preoperative global sagittal spinal alignment between the postoperative cervical lordosis group (LG) and the cervical kyphosis group (KG) was analyzed.

METHODS: The global spinal sagittal parameters were measured on lateral whole-spine standing radiographs preoperatively and at one year after the operation.

RESULTS: The prevalence of Postoperative cervical kyphosis after ELAP was 11 out of 43 cases (25.6%). LG was in 32 cases (16 men, 16 women; average age 67.7±12.0 years) and KG in 11 cases (7 men, 4 women; average age 67.2±9.6 years). The preoperative C7 SVA and PI minus LL in the KG group were significantly smaller than those in the LG group (P<0.05). The smaller C7 SVA accompanied with small PI-LL, the “truncal negative offset”, lead to postoperative cervical kyphosis due to posterior structural weakening by ELAP.

CONCLUSIONS: In patients with CSM without pre-operative cervical and global spinal sagittal imbalance, the truncal negative offset accompanied with lumbar hyperlordosis is the characteristic alignment leading to postoperative cervical kyphosis after ELAP.

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16. The Impact of the Cervical Flexion and Extension on the Global Sagittal Spinal Alignment

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BACKGROUND CONTEXT: Cervical kyphotic deformity is one of the risk factors for the poor outcome of posterior cervical decompression surgery, therefore the cervical posterior reconstruction surgery is often required. Although the parameters including the length of fixation and the level of distal end to be fixed are critical, the consensus of these parameters have yet to be identified presumably due to the complexity of sagittal spinal alignments needed to be considered. Recent study revealed the importance of the evaluation of not only cervical alignments but also global sagittal alignments for the cervical operation, because the cervical sagittal alignment is affected by the thoracic alignment vice versa. The dynamic neck motion is also an important factor that influences on the global sagittal after the cervical posterior fixation surgery.

PURPOSE: The purpose of this study was to investigate the influence of the cervical flexion and extension on the global sagittal spinal alignment.

STUDY DESIGN/SETTING: This is a retrospective radiographic study of a consecutive case series of cervical spondylolisthesis patients.

PATIENT SAMPLE: Among a total of 107 consecutive patients who presented to our department with spinal degenerative disease were enrolled from January 2016 to September 2017. The subjects with a history of trauma, infection, tumor, inflammatory disease, ossification, or adult spinal deformity and who had undergone spinal or hip surgery were excluded. Finally, 55 patients were enrolled (42 men and 13 women; average age 49.1 years).

OUTCOME MEASURES: The following parameters were analyzed; cervical sagittal vertical axis (C2-C7SVA), Occipito-Axial angle (O-C2), C2 slope (C2S), C2-C7 angle, T1 slope (T1S), C7SVA, thoracic kyphosis (TK), T1-T4 angle (T1-4A), T5-T8 angle (T5-8A), T9-T12 angle (T9-12A), lumbar lordosis (LL), sacral slope (SS), pelvic tilt (PT), and pelvic incidence (PI) in flexion, extension and neutral neck position.

METHODS: Total spine radiography of the spinal lateral view was taken in standing neutral, flexion and extension neck position. The parameters of cervical, thoracic, lumbar spine and pelvic sagittal alignment were examined.

RESULTS: Flexion and extension changed local cervical alignments compared to the neutral neck position. However, global sagittal alignment below T1-T4 angle did not change significantly among three neck positions. The cervical lordosis was significantly correlated with T1S but not T1-T4 angle both in neutral and flexion neck position.

CONCLUSIONS: T1-T4 angle was not influenced by the cervical alignment changes. The sagittal cervical alignments did not correlate with T1-T4 angle both in neutral and flexion neck position. T1-T4 angle would be independent to the cervical alignment change, indicating that and it may not be involved in reciprocal change. The reason of the stability of T1-T4 is likely due to stabilization by shoulder girdle (scapula bone and Rhomboid muscles). Rhomboids muscle consists of scapula to C6-T4 and the role of truck extensor is important. Our study suggests that the from T1 to T4 levels would be the suitable of lower end of vertebrae as a bone anchorage for the cervical fixation on the corrective surgery.

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17. Characteristics and Predictors of Patients Who Fail to Achieve a Minimum Clinically Important Difference Following Laminoplasty for Cervical Spondylotic Myelopathy

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BACKGROUND CONTEXT: Cervical spondylotic myelopathy (CSM), for which surgery is recommended, is a degenerative spine disease that results in severe disability. However, some patients develop undesirable postoperative outcomes.

PURPOSE: To investigate the characteristics of patients who fail to achieve the minimum clinically important difference (MCID) after laminoplasty and identify the pre-operative factors that are predictive of such patients.

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

PATIENT SAMPLE: A total of 101 consecutive patients who underwent laminoplasty for CSM, with >2 years of follow-up.

OUTCOME MEASURES: The Japanese Orthopedic Association (JOA) score, including detailed component score (finger, upper extremity, lower extremity motion; upper extremity, trunk, and lower extremity sensory; bladder function); the patient-oriented JOA Cervical Myelopathy Evaluation (CMEQ) score assessing five domains (cervical spine function, upper extremity function, lower extremity function, bladder function and quality of life domain); and radiographic parameters (C7 slope, C2-C7 lordotic angle (CL), C2-C7 sagittal vertical axis (cSVA)).

METHODS: Patients were divided into poor recovery (JOA score improved ≤2.0 points, n=34) or control (JOA score improved >2.0 points) groups. A previously reported MCID of the cervical JOA score of 2.0 points was used. Patient demographics of the poor recovery group and control group were matched using propensity score calculated using a logistic regression model adjusted for age, sex, and preoperative JOA score. Preoperative clinical score and radiographic parameters were compared between the two matched groups (matched poor recovery (mPR) and matched control (mCont) groups, n=22 respectively) using the Mann-Whitney U-test. In addition, the change in each score after operation was compared using two-way analysis of variance. Finally, receiver operating characteristic (ROC) curve analysis was used to identify the cutoff value. p-value <0.05 indicated statistical significance.

RESULTS: On comparing the unmatched groups, the age and preoperative JOA score were significantly higher in the poor recovery group (age: p=0.027, preop JOA: p=0.001). On comparing the matched groups, although the preoperative JOA score of all detailed segments showed no differences between the two matched groups, postoperative improvements in lower extremity function were significantly lower in the mPR group (p<0.001). Changes in other segments and radiographic parameters showed no significant differences between the two matched groups. On comparing the preoperative JOA CMEQ score of lower extremity function, the mPR group showed a significantly lower score than did the mCont group (34.5 vs 59.0, p=0.039). ROC analysis demonstrated that the preoperative JOA CMEQ score of lower extremity function could significantly predict poor surgical outcomes (area under curve=0.771, p=0.024), with a cutoff value of 34.0 (sensitivity 82.5%, specificity 66.7%).

CONCLUSIONS: Patients who failed to achieve the MCID of JOA score after laminoplasty showed little improvement in lower extremity function. Furthermore, the preoperative lower extremity function assessed by the patient-oriented score was significantly lower in the poor recovery group, even after adjusting the lower extremity function score assessed by physician. This indicates that the JOA CMEQ score of lower extremity function can predict poor recovery after laminoplasty for CSM patients.

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18. Preoperative Severity of Facet Joint Degeneration Does Not Impact on Two-Year Clinical Outcomes Following Laminoplasty

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BACKGROUND CONTEXT: While the cervical facet joints have important roles in guiding cervical motion and distributing the axial load, they are affected by degenerative changes that are characterized by space narrowing, erosion of the subchondral bone, and hypertrophy with osteophytes. However, the impact of facet degeneration (FD) on surgical outcomes after laminoplasty is not established.

PURPOSE: To determine the impact of FD severity on patient symptoms and whether laminoplasty is appropriate for patients with severe FD.

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

PATIENT SAMPLE: A total of 135 consecutive patients who underwent laminoplasty for cervical spondylotic myelopathy, with >2 years follow-up.

OUTCOME MEASURES: Clinical scores (cervical Japanese Orthopedic Association (cJOA) score, visual analog scale (VAS) of neck pain, Short Form-36 physical component summary (PCS), and mental component summary (MCS)) and radiographic parameters (C7 lobe, C2-C7 sagittal vertical axis (cSVA) and C2-C7 lordotic angle (CL), and scoring of FD (1: none, 2: mild, 3: moderate, 4: severe)).

METHODS: Preoperative FD severity was evaluated bilaterally from C2-3 to C6-7 using computer tomography (CT) data that were obtained for surgical planning. Patients were divided into severe FD (mean score ≥2.0, n=66) or mild FD (≤2.0, n=69) groups. The preoperative clinical score and radiographic parameters were compared between the two groups using Mann-Whitney U-test. Variables that were significantly different between the two groups were included as dependent variables in the subsequent multinomial logistic regression model. The changes from pre-operative to 2-year follow-up clinical scores between the two FD groups were analyzed using repeated-measures analysis of variance (rMANOVA). Finally, the change in FD severity from before surgery to 1 year after surgery was compared by rMANOVA using patient data from CT images obtained for the evaluation of bone union at 1-year.
postoperatively (severe FD group, n=43; mild FD group, n=50).
RESULTS: The mean age (70.3 vs 62.4 years, p<0.001) and
preoperative VAS of neck pain (30.1 vs 14.8 mm, p=0.013)
were significantly higher in the severe FD group than in the
mild FD group. However, the cJOA score, MCS, PCS, and each
radiographic parameter were not significantly different. In
multinomial analysis, age and neck pain were independently
associated with FD severity (age: p=0.004, neck pain: p=0.004).
With regard to the change in clinical score, there were no
significant differences between the severe and mild FD groups
(cJOA: p=0.724, neck pain: p=0.634, PCS: p=0.868, MCS:
p=0.333). Likewise, the change in radiographic parameters was
not significantly different between the two groups. Finally, the
severity of FD 1 year Postoperatively was significantly increased
in both groups compared with their preoperative scores (severe
FD group, p=0.001; mild FD group, p=0.010). However, the
change in FD severity was not significantly different between
the severe and mild FD groups (p=0.202).
CONCLUSIONS: FD severity is independently associated with
neck pain. However, it did not impact on the two-year surgical
outcomes of laminoplasty regarding improvement in myelopathy,
patient-oriented quality of life, and neck pain. This may reflect
the observation that FD severity does not impact the progression
of FD after surgery. These findings indicate that laminoplasty
can effectively treat patients regardless of preoperative FD
severity.
FDA DEVICE/DRUG STATUS: This abstract does not discuss or
include any applicable devices or drugs.

19. A Lower T1 Slope as a Predictor of Subsidence in
Anterior Cervical Discectomy and Fusion with Stand-
alone Cages

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BACKGROUND CONTEXT: Preoperative parameters including
the T1 slope (T1S) and C2-C7 sagittal vertical axis (SVA) have
been recognized as predictors of kyphosis after laminoplasty,
which is accompanied by posterior neck muscle damage.
The importance of preoperative parameters has been under-
estimated in anterior cervical discectomy and fusion (ACDF)
because there is no posterior neck muscle damage.
PURPOSE: We aimed to determine whether postoperative
subsidence and pseudarthrosis could be predicted according to
specific parameters on preoperative plain radiographs.
STUDY DESIGN/SETTING: Retrospective case study
PATIENT SAMPLE: Between January 2011 and December
2015, data from 190 patients who underwent ACDF for cervical
spondylosis at a single institution were reviewed. The inclusion
criteria were as follows: 1) ACDF using a stand-alone polyether-
ether-ketone (PEEK) cage and 2) a minimum follow-up period of
more than 1 year. Forty-one patients (22 men) met the inclusion
and exclusion criteria
OUTCOME MEASURES: clinical evaluation: neck disability
index (NDI), visual analog scales for neck (VAS-neck) and
arm pain (VAS-arm) radiological evaluation: lateral standing
radiographs TH, disc height, C2-C7 CA, SA, C2-C7 SVA, T1
slope, T1 slope-C2-C7 CA, CA ROM, segmental ROM.

METHODS: We retrospectively analyzed 41 consecutive
patients (male: female, 22: 19; mean age, 51.15±9.25 years)
who underwent ACDF with a stand-alone polyether-ether-
ketone (PEEK) cage (>1 year follow-up). Parameters including
SVA, T1S, segmental angle and range of motion (ROM), C2-C7
cervical angle and ROM, and segmental inter-spinous distance
were measured on preoperative plain radiographs. Risk factors
of subsidence and pseudarthrosis were determined using
multivariate logistic regression.
RESULTS: Fifty-five segments (27 single-segment and 14
two-segment fusions) were included. The subsidence and
pseudarthrosis rates based on the number of segments were
36.4% and 29.1%, respectively. Demographic data and
fusion level were unrelated to subsidence. A greater T1S was
associated with a lower risk of subsidence (p=0.017, odds
ratio=0.206). A cutoff value of T1S<28° significantly predicted
subsidence (sensitivity: 70%, specificity: 68.6%). There were no
preoperative predictors of pseudarthrosis except old age.
CONCLUSIONS: A lower T1S (T1S<28°) could be a risk factor
of subsidence following ACDF. Surgeons need to be aware of this
risk factor and should consider various supportive procedures to
reduce the subsidence rates for such cases.
FDA DEVICE/DRUG STATUS: This abstract does not discuss or
include any applicable devices or drugs.

20. Surgical Treatment Improves Survival of Elderly
with Axis Fracture: A National Population-Based Multi-
Registry Cohort Study

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BACKGROUND CONTEXT: Fractures of the axis (C2) are the
most common cervical spinal injuries in the elderly population.
Several authors have reported improved survival among elderly
patients with C2 fractures when treated surgically.
PURPOSE: To analyze whether surgery improves survival of
elderly with C2 fractures.
STUDY DESIGN/SETTING: Observational population-based
longitudinal multi-registry study.
PATIENT SAMPLE: Swedish Patient Registry 1997 to 2014, and
Swedish Cause of Death Registry 1997 to 2014.
OUTCOME MEASURES: Survival after C2 fracture according to
non-surgical and surgical treatment.
METHODS: Included were all patients treated for the primary
diagnosis of C2 fracture (ICD-10: S12.1) at an age ≥70 years,
receiving treatment at a healthcare facility. Non-surgical
treatment comprises of cervical collar or halo-vest treatment.
Surgical treatment was identified in the Swedish patient registry
extract using the Swedish classification of procedural codes.
Survival was determined using the Kaplan Meier method.
Comorbidity was determined using the Charlson Comorbidity
Index.
RESULTS: Of the included 3,375 elderly patients with C2
fractures (43% male, aged 83±7 years), 22% were treated
surgically. Surgical treatment was assigned based on age,
gender and year of treatment. The one-year survival of 2,618
non-surgically treated patients was 72% (n=1,856), and 81%
(n=614) for the 757 surgically treated (p<0.001, RRR=11%).
Adjusted for age, gender, comorbidity and year of injury,
surgically treated patients had greater survival than non-
surgically treated patients (HR=0.88, 95% CI: 0.79-0.97).
Among those above 88 years of age (95% CI: 85-92), surgical treatment lost its effect on survival.

**CONCLUSIONS:** Despite the frailty of elderly patients, the morbidity of cervical external immobilization with a rigid collar seemingly weighs greater than surgical morbidity, even in octogenarians. For those above 88 years of age, non-surgical treatment should be primarily attempted.

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

### 21. Prediction of Anterior versus Posterior Surgical Approach for Degenerative Cervical Myelopathy Based on MRI Pathology: Analysis of a Global Cohort

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**BACKGROUND CONTEXT:** Degenerative Cervical Myelopathy (DCM) is the most common cause of spinal cord compression (SCC) and impairment. Surgical treatment is usually undertaken but the decision between an anterior or posterior approach as the optimal choice is often controversial.

**PURPOSE:** To better understand the influence of MRI features on surgical decision-making, we analyzed data from two multicenter prospective studies to evaluate which factors are predictive of an anterior vs. posterior surgical approach.

**STUDY DESIGN/SETTING:** Two prospective and multicenter studies comprising a global cohort of patients receiving surgical treatment for DCM.

**PATIENT SAMPLE:** Patients were derived from the AOSpine CSM-North America and CSM-International studies. A total of 458 patients with MRIs were available from the combined studies.

**OUTCOME MEASURES:** Anterior vs. posterior surgical approach.

**METHODS:** Preoperative MRIs were analyzed for various pathological features, characteristics of SCC, sagittal alignment using the modified K-line method, and signal changes on MRI Pathology: Analysis of a Global Cohort. Regression were used to assess relationships between clinical/MRI features and surgical approach.

**RESULTS:** Operative approach was A=265, P=184, and AP=9. Anterior surgery was favored with lower age, mJOA≥15, single-level disc pathology, anterior-only SCC, and kyphosis, while the posterior approach was favored in South America or with multilevel spondylosis, ligamentum flavum enlargement, spondylolisthesis, SCC at or above C4-5, SCC at or below C6-7, more levels with SCC, T2WI hyperintensity, and more levels with T2WI hyperintensity (all p<0.05). In multivariate analysis, levels with SCC (p<0.001), age (p<0.001), South American region (p<0.001), mJOA≥15 (p=0.008), kyphosis (p=0.02), and maximal SCC at or above C4-5 (p=0.05) were significant independent predictors. Models based on clinical and MRI factors predicted A vs. P approach with 78% and 80% accuracy, respectively, whereas a combined model achieved 87% accuracy.

**CONCLUSIONS:** Clinical and MRI factors are independently able to predict surgical approach in DCM, and a combined model has excellent predictive capacity. While the predictive utility of specific MRI factors on surgical approach corroborated expert opinion, this study has also provided information regarding the magnitude of their influence. These findings may be used in conjunction with machine learning techniques to develop surgical treatment algorithms for DCM.

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

### 22. Neuromuscular Activity during Gait in Patients with Cervical Spondylotic Myelopathy Post Cervical Surgery

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**BACKGROUND CONTEXT:** Cervical spondylotic myelopathy (CSM) is a degenerative condition of the cervical spine leading to a spectrum of neurological dysfunction. Gait impairment is one hallmark of CSM and has been shown to affect quality of life and ability to work, and has been reported to be improved by surgical intervention. Currently, the gait disturbance in CSM is poorly understood. Some studies describe the gait as spastic, while others suggest a paretic component. Further EMG characterization of the gait cycle may help elucidate the true neuromuscular pathology with implications on patient prognosis and rehabilitation techniques.

**PURPOSE:** To compare spine and lower extremity neuromuscular activity in patients with CSM before and after surgical intervention.

**STUDY DESIGN/SETTING:** Prospective

**PATIENT SAMPLE:** Thirty patients with symptomatic CSM who underwent surgical intervention for their myelopathy.

**OUTCOME MEASURES:** Spine and lower extremity of integrated electromyography (iEMG, mV). iEMG activity is a graphic representation of the sum total EMG activity over a defined period of time. Muscle onset was measured as percentage of the gait cycle (GC, 0 % equal to heel contact).

**METHODS:** Clinical gait analysis was performed the week before surgery (Pre) and 3 months after surgery (Post). Medial Deltoid (MD), External Oblique (EO), Multifidus (MF) at the level of L5, Erector Spinae (ES) at the level of L1, Rectus Femoris (RF), Semitendinosus (ST), Tibialis Anterior (TA), and Medial Gastrocnemius (MG) neuromuscular activity were measured and recorded during the gait analysis session. Each subject performed a series of over-ground gait trials at a comfortable, self-selected walking speed. Repeated measurements ANOVA analysis was used to determine difference in neuromuscular control during gait in CSM patients before and after surgical intervention.

**RESULTS:** Surgical intervention significantly reduced activation of the MD (Pre: 0.95±0.01 vs Post: 0.48±0.01 mV; p=0.049), ES (Pre: 1.57±1.8 vs Post: 0.40±0.3 mV; p=0.038), and ST (Pre: 4.50±4.4 vs Post: 1.64±1.3 mV; p=0.029) in patients with CSM. Muscle onset was significantly earlier in CSM patients before
surgery after surgery in the EO (Pre: 1.91±1.1 vs Post: 3.80±0.6 % GC; p=0.043), MD (Pre: 2.11±1.1 vs Post: 4.27±0.6 % GC; p=0.042), MF (Pre: 2.23±1.1 vs Post: 3.91±0.7 % GC; p=0.035), ES (Pre: 1.18±1.0 vs Post: 3.96±0.7 % GC; p=0.011), RF (Pre: 3.01±1.0 vs Post: 4.26±0.7 % GC; p=0.048), ST (Pre: 0.50±1.1 vs Post: 3.81±0.7 % GC; p=0.009), TA (Pre: 2.05±0.9 vs Post: 3.99±0.8 % GC; p=0.035), and MG (Pre: 2.36±1.0 vs Post: 3.93±0.8 % GC; p=0.050) muscles. CONCLUSIONS: Patients with CSM often present with gait disturbance, which has a significant impact on one’s quality of life but unfortunately is poorly understood. Preoperatively, CSM patients demonstrated over-activation of the MD, ES, and ST muscles. However, after cervical decompression surgery, the abnormal activity in these muscles was reduced to more normal levels. Furthermore, prior to surgery, CSM patients exhibited abnormally early activation of several muscle during gait, and, in some individuals, these muscle groups were continuously contracting throughout the entire gait cycle. However, following surgery, the timing of when each of the muscles became activated were more normal, allowing for a more fluid and coordinated gait pattern. FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.


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BACKGROUND CONTEXT: The associations between cervical alignment and patient outcomes have been reported but are not well established in a myelopathy cohort. The impact of deformity correction in this population also needs to be elucidated.

PURPOSE: To investigate the impact of cervical spine deformity on pre- and Postoperative outcomes in fusion surgeries for degenerative cervical myelopathy (DCM).

STUDY DESIGN/SETTING: Sub-analysis of the prospective AOSpine CSM North America and International studies.

PATIENT SAMPLE: A total of 757 surgical DCM patients were enrolled in two prospective international multicenter AOSpine studies.

OUTCOME MEASURES: Patient outcome measures included the modified Japanese Orthopaedic Association score (mJOA) for myelopathy severity, Neck Disability Index (NDI) and Short-form 36 (SF-36).

METHODS: Among those who underwent anterior or posterior fusion surgeries, preand 1-year Postoperative upright neutral lateral radiographs of cervical spine were investigated to measure C2-7 Cobb angle and C2-7 sagittal vertical axis (SVA). Patient outcome measures were compared between patients with and without cervical deformity, which was defined as 1) C2-7 Cobb > 10° kyphosis and/or 2) SVA > 40 mm.

RESULTS: A total of 178 patients were included with complete pre- and Postoperative radiographs. SVA significantly increased Postoperatively (27.4 vs. 30.7 mm, p = 0.004). All outcome measurement showed significant improvements above minimal clinically important differences. 23.6% of the patients had cervical deformity pre-operatively; preoperative deformity was associated with worse pre-operative NDI scores (45.7 vs. 38.9, p = 0.04). Postoperatively, those with deformity exhibited significantly lower SF-36 physical component scores (37.2 vs. 41.4, p = 0.048). However, when focusing on the pre-operatively deformed cohort, we did not find any significant differences in the Postoperative outcome scores between those with and without residual deformity.

CONCLUSIONS: There was a significant association between cervical deformity and both preoperative disease severity and Postoperative outcomes; however, no impact of deformity correction was shown. FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.

24. The Incidence of Postoperative Stroke after Anterior Cervical Discectomy and Fusion in Patients who have Carotid Stenosis

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BACKGROUND CONTEXT: Anterior cervical disectomy and fusion (ACDF) is a procedure used to treat cervical myelopathy and radiculopathy. During the surgical approach, the sternocleidomastoid muscle and the carotid sheath are retracted laterally. Complications related to compression and retraction of the artery is infrequent. However, to our knowledge, there have been no studies that have evaluated carotid artery retraction and the development of a postoperative stroke in patients who have carotid artery stenosis.

PURPOSE: The purpose of this study was to determine the incidence of postoperative strokes after ACDF in patients with carotid artery stenosis.

STUDY DESIGN/SETTING: This study utilized the Statewide Planning and Research Cooperative System (SPARCS) database from 2009 to 2013.

PATIENT SAMPLE: Patients who underwent ACDF between 2009 and 2013. Patients less than age 18 years and patients who had a previous history of a stroke that predated the ACDF were excluded.

OUTCOME MEASURES: Primary outcome was the incidence of postoperative stroke after ACDF in patients with and without carotid artery stenosis. Secondary outcomes included other postoperative complications, lengths of stay (LOS), and total hospital charges.

METHODS: Patient demographics included age, sex, race, insurance provider, Charlson/Deyo scores, and total hospital charges for each visit. Using the ACDF cohort, patients who had a preoperative diagnosis of carotid stenosis were identified, and were propensity score matched in a 1:1 ratio to those without a diagnosis of carotid stenosis based on age, sex, and Charlson/Deyo scores. We evaluated postoperative complications, including the incidence of a postoperative stroke. There were 61 patients in the carotid stenosis cohort and 61 patients without
carotid stenosis. In terms of the demographics, compared to the patients without carotid stenosis, the carotid stenosis cohort was older (68 vs. 60 years, p<0.001); however, none of the other demographics were significantly different.

**RESULTS:** The incidence of postoperative atrial stroke in the carotid artery stenosis cohort was significantly higher compared to those without carotid artery stenosis (6.6 vs. 0%, p<0.042). Moreover, in terms of the other postoperative complications, compared to patients without carotid artery stenosis, those with carotid artery stenosis had a higher rate of acute renal failure (27.9 vs. 4.9%, p<0.01), sepsis (18 vs. 4.9%, p=0.023), and blood transfusion (39.3 vs. 13.1%, p=0.001). Furthermore, compared to those without carotid artery stenosis, the carotid artery stenosis patients had a slightly shorter LOS (4.8 vs. 5.8 days, p=0.736) and higher total charges (58,568 vs. 50,025 USD, p=0.561), but these were not statistically significant.

**CONCLUSIONS:** Patients with carotid artery stenosis who underwent ACDF had a significantly greater incidence of developing a postoperative stroke, among other complications, compared to patients without carotid stenosis. These patients could potentially benefit from medical or surgical optimization of their carotid stenosis prior to undergoing ACDF.

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

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**BACKGROUND CONTEXT:** Anterior cervical discectomy and fusion (ACDF) is the most common surgical treatment for cervical disc pathology. However, recent evidence has demonstrated superior outcomes with cervical disc arthroplasty (CDA).

**PURPOSE:** This study aims to compare inpatient cost and length of stay (LOS) between cervical disc arthroplasty and anterior cervical discectomy and fusion.

**STUDY DESIGN/SETTING:** Retrospective cohort study.

**PATIENT SAMPLE:** A total of 676 patients were analyzed (338 ACDF and 338 CDA). The average patient ages for ACDF and CDA were 49.15 years and 49.11 years, respectively (p=0.957). Only elective hospital admissions were included in this sample. Patients in the ACDF group were limited to those with one to two level fusions.

**OUTCOME MEASURES:** This study compared the ACDF and CDA cohorts on high-end hospital charges and prolonged inpatient length of stay.

**METHODS:** This study screened over 35 million hospital discharges in the United States from 2010 to 2014 using the National Inpatient Sample and the Nationwide Inpatient Sample (NIS). The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes were used to identify 75,377 patients who underwent ACDF of two or three vertebrae (ICD 81.02 and 81.62), and 387 patients who underwent CDA (ICD 84.62). The ACDF and CDA groups were statistically matched based on age, year of procedure, sex, indication for surgery, race, hospital type, and comorbidities. Mean hospital charges and LOS for each cohort were calculated and compared using the Kruskal Wallis H test. Univariate and multivariate logistic regression were used to compare high-end cost and prolonged LOS between the cohorts, defined as patients with LOS and total hospital charges greater than the 75th percentile of the respective means.

**RESULTS:** We matched 338 (87.34%) CDA patients with patients who underwent ACDF. The average LOS was greater for CDA (X=1.56, SD=0.946) compared to ACDF (X=1.43, SD=1.12; p=0.001). Additionally, the average inpatient hospital charges for CDA were $21,320 (SD=10,854) compared to $16,123 (SD=8,499) for ACDF (p=0.001). A prolonged LOS occurred in 39.1% of patients in the CDA group compared to 27.5% of the ACDF group (p=0.002). Similarly, 34.9% of patients in the CDA group had high-end hospital charges compared to 14.2% of patients in the ACDF group (p<0.001). Multivariate analysis demonstrated that patients who underwent ACDF were significantly less likely to have a prolonged LOS compared to the CDA group (OR=0.678, 95% CI=0.469-0.980). Additionally, multivariate analysis revealed that patients in the ACDF group were a third as likely to have a high-end hospital charge as the CDA group (OR=0.391, 95% CI=0.256-0.599). Patients who underwent ACDF in the southern region of the United States were nearly four-times more likely to have a prolonged LOS than patients who underwent CDA in the same region (OR=3.745, 95% CI=1.450-9.672). Furthermore, patients who underwent ACDF at urban non-teaching hospitals were found to have lesser likelihood of both prolonged LOS (OR=0.588, 95% CI=0.366-0.946) and high-end hospital charges (OR=0.288, 95% CI=0.163-0.508) than patients in the CDA cohort.

**CONCLUSIONS:** Patients who underwent ACDF had significantly lower LOS and hospital charges than a statistically matched CDA cohort. This conclusion directly contradicts recent findings in the literature, although this study is the first to use a large cohort-matched analysis.

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

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26. Long-Term Outcomes of Lumbar Total Disc Replacement versus Spinal Fusion for the Treatment of DDD: A Novel Meta-Analysis of Randomized Controlled Trials

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**BACKGROUND CONTEXT:** To-date several meta-analyses of randomized trials have reported on the outcomes of lumbar disc replacement versus fusion, two surgical treatments for chronic low back pain following failure of conservative therapies. While several randomized trials have reported their 5-year outcomes, the results have yet to be pooled to assess the composite effectiveness of lumbar disc replacement and lumbar fusion as a whole.

**PURPOSE:** To evaluate the five year safety and efficacy outcomes of lumbar TDR compared with fusion.
STUDY DESIGN/SETTING: Meta-analysis of randomized controlled trials.

PATIENT SAMPLE: Adults with discogenic low back pain due to single-level DDD who have failed conservative treatment previously reported in published studies.

OUTCOME MEASURES: Oswestry Disability Index (ODI) success, back pain scores (i.e., Visual Analog Scale (VAS) or Numeric Rating Scale), patient satisfaction, and reoperations defined as device-related failures resulting in subsequent surgical intervention of reoperation, revision, removal or supplemental fixation.

METHODS: Selection criteria: RCTs comparing the treatment effects of lumbar TDR with fusion at 5 years in lumbar DDD patients. Databases searched included PubMed/MEDLINE and CENTRAL between the years of 2000 and 2015. Meta-analyses were conducted using a random-effects model; analyses were reported as relative risk ratios (RR) and mean differences (MD). Sensitivity analyses were conducted for different outcome definitions, high loss to follow-up and high heterogeneity.

RESULTS: The literature search yielded a total of 2,429 citations, with 180 full-text articles retrieved for eligibility assessment. After full-text review, a total of 4 studies with 1,325 patients were included in the meta-analysis. Pooled analysis demonstrated that lumbar TDR patients had a significantly greater likelihood of ODI success (RR 1.09; 95% CI 1.00, 1.19; p=0.05) and patient satisfaction (RR 1.13; 95% CI 1.03, 1.24; p=0.009) than patients having fusion. Furthermore, lumbar TDR patients demonstrated a significantly lower risk of reoperation (RR 0.52; 95% CI 0.35, 0.77; p=0.001) than those with fusion. While not statistically significant, total disc replacement had better improvement in back pain score than fusion (MD -2.79, 95% CI -8.09, 2.51; p=0.30). Heterogeneity was reported to be low in this meta-analysis i2 ranging from 0% to 39%. A sensitivity analysis was completed on all results. Results for ODI success and patient satisfaction were sensitive to different outcome definitions, but remained in favor of TDR.

CONCLUSIONS: The long-term analysis of the safety and efficacy profile of lumbar TDR versus fusion validates that TDR is an effective alternative to fusion for the treatment of discogenic low back pain in DDD patients.

FDA DEVICE/DRUG STATUS: Lumbar TDR (Approved for this indication)

27. Seven Year Outcomes of Lumbar Total Disc Replacement Systems on Patient Lifestyle and Quality of Life
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BACKGROUND CONTEXT: Degenerative disc disease (DDD) is a potentially debilitating condition resulting in pain and decreased functional ability in patients. Lumbar total disc replacement (TDR) helps to alleviate this pain and dysfunction and potentially allows for a return to pre-injury activities.

PURPOSE: The purpose of this study was to evaluate quality of life (QoL) at 7 years post-TDR compared to pre-operative status.

STUDY DESIGN/SETTING: Data for the analysis were collected from a Food and Drug Administration regulated prospective, randomized study conducted at multiple sites.

PATIENT SAMPLE: Patients were randomly allocated (2:1) to treatment with an investigational TDR device (activL®, n=218) or FDA-approved control TDR devices (ProDisc-L, n=65 or Charité, n=41). All were treated for single-level symptomatic disc degeneration unresponsive to at least 6 months of non-operative care.

OUTCOME MEASURES: The primary outcome measure was the SF-36. Secondary evaluations included work status, patient satisfaction, and use of pain medication.

METHODS: Follow-up occurred at 6 weeks and 3, 6, 12 and 24 months and every year thereafter up to 7 years post-surgery. Data from the pre-operative baseline and the 7 year follow-up are reported.

RESULTS: At 7 years, 77% and 73% of activL and Control patients (respectively) showed improvements in mental component scores (MCS) for the SF-36 compared to baseline. Similarly, physical component scores (PCS) improved for 92% and 86% of activL and Control patients at 7 years post-surgery. Clinically significant improvements in MCS and PCS scores (≥15% improvement from baseline) occurred in approximately 44% (MCS) and 62% (PCS) of all TDR patients combined at 6 weeks, increased to 61% (MCS) and 80% (PCS) at 12 months and remained constant through to 7 years. Approximately 53% of all TDR patients returned to work without restriction by 12 months, which increased to 64% and 54% for activL and Control patients at 7 years. Most activL patients were able to return to the same workload as before their back injury at 7 years, whereas more Control patients worked in sedentary jobs at 7 years than before their back injury. Patient satisfaction at 7 years post-surgery showed 97% of all TDR patients were “very satisfied” or “somewhat satisfied” with the procedure, and 93% indicated that they would “definitely” or “probably” undergo the procedure again for the same condition. 97% of activL and 89% of Control patients indicated that the treatment was “very” or “moderately” effective in eliminating their symptoms. Decreases in the proportion of patients utilizing pain medication were noted in both groups. At baseline, 90% and 92% of activL and Control patients were using medications for pain control, which decreased by half by 7 years.

CONCLUSIONS: The results of this analysis indicate that lumbar TDR is effective at helping to improve patient’s quality of life, potentially facilitating return to work and reducing pain medication usage.

FDA DEVICE/DRUG STATUS: ProDisc-L, Charité, activL (investigational during the study, currently approved) (Approved for this indication)

28. Should Decision Making for Lower Instrumented Vertebra Selection Go Beyond Traditional Classification of Adolescent Idiopathic Scoliosis? A Dynamic Three-Dimensional Gait Assessment
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BACKGROUND CONTEXT: Adolescent idiopathic scoliosis (AIS) poses many challenges in determining treatment methods for providers. Among these, selection of the optimal lowest instrumented vertebra (LIV) remains one of the most difficult. Currently, LIV selection is guided by Lenke classification, which is based on static radiographs. Our understanding of the postoperative effects of LIV selection on gait (function) is still very limited.

PURPOSE: This study explored the impact of LIV selection on
the postoperative walking patterns of AIS patients to identify any changes from pre- to postoperative phases based on the LIV. It is hypothesized that AIS patients will differ in their postoperative walking pattern based on the LIV.

**STUDY DESIGN/SETTING:** Prospective Study

**PATIENT SAMPLE:** 36 AIS patients undergoing thoracolumbar spinal fusion

**OUTCOME MEASURES:** Coronal and sagittal radiographic parameters, and temporal-spatial, kinematic, and kinetic parameters of gait analysis.

**METHODS:** Prior to their surgical treatment, patients underwent gait assessment and full spine radiography. Gait analysis was performed in a 6-DOF motion analysis laboratory at a sampling frequency of 100 Hz. Thirty-four reflective markers were placed on each patient, each of whom proceeded to perform straight-line walking trials at their own selected self-speed. Patients were grouped based on lower instrumented vertebra (LIV) into: Cephalad (LIV: T12, L1 or L2) and Caudal (LIV: L3 or L4). Demographics, radiographic and gait parameters were compared between LIV groups at baseline and one year follow-up. Logistic regression model controlling for age, gender, and scoliosis curve magnitude was utilized to identify independent characteristics of LIV groups. The level of significance was set at p<0.05.

**RESULTS:** Thirty-six patients were allocated into one of two groups: Cephalad LIV (n=15; mean age: 15.2 years; 87.5% female) vs. Caudal LIV (n=21; mean age: 15.1 y/o; 71.4% female), with no significant demographic differences identified (p>0.05). Mean upper thoracic (UT), thoracic (TH), and lower lumbar (LL) curves were similar between the groups (26, 53 and 28°, respectively; p>0.05). The thoracolumbar (TL) curve was smaller in the Cephalad group (33.1 vs. 55.2°, p<0.01). At one year follow-up, both groups had a similar magnitude of deformity correction, with Caudal LIV patients continuing to have larger TL curves (19.9 vs. 12.5°, p=0.025). Patients with Cephalad LIV had significantly different Postoperative walking patterns, with greater pelvic range of motion (ROM) in the horizontal plane (10.6° vs. 7°, p=0.017), knee flexion/extension ROM during the entire gait cycle (56.9° vs. 46.6°, p=0.043), and plantar flexion in the stance phase (-30.9° vs. -23°, p=0.006). Cephalad LIV patients also had higher walking speed (1.2 m/s vs. 1.1 m/s p=0.045) and spent significantly less time with knee extension in stance (33.1 ms vs. 39.5 ms, p=0.016), most likely to get more stability on the extended limb while transferring load to the contralateral limb. After controlling for confounders, increased plantar flexion (OR: 1.7 [95% Confidence Interval: 1.1-2.7]) and decreased hip horizontal range of motion (OR: 0.65 [95% CI: 0.43-0.96]) remained significant characteristics of Caudal LIV patients’ Postoperative walking patterns (R2 =0.670, p=0.004).

**CONCLUSIONS:** While traditional adolescent idiopathic scoliosis (AIS) classification provides the framework for surgical decision-making, lower instrumented vertebra (LIV) selection is currently based on static radiography. This study is the first known investigation to demonstrate the direct and significant impact LIV selection has on the Postoperative walking pattern of AIS patients. While the nature of the curve may indicate a more caudal LIV, its selection should account for the consequences on Postoperative gait dynamics.

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

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**29. Analysis of Lumbar Total Disc Replacement Removals and Revisions: A 17-Year Experience**

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**BACKGROUND CONTEXT:** One concern expressed about lumbar total disc replacement (TDR) has been safety. One measure of safety is the need for subsequent surgery to removal or revise an implant. This may be of particular importance considering TDR removal/revision generally requires re-operation through the anterior approach with the corresponding increased risk of vascular injury.

**PURPOSE:** The purpose of this study was to analyze the incidence of, and reasons for, removal or revision of lumbar TDR devices.

**STUDY DESIGN/SETTING:** Data were collected from a multi-site spine specialty practice.

**PATIENT SAMPLE:** A consecutive series of 1,707 lumbar TDR patients, beginning with the first case experience in 2000, was reviewed to identify those undergoing re-operation for TDR removal or revision. Only patients who were at least 6 months Postoperative were included. Among the 1,707 patients, the mean follow-up was 42.7 months with a median of 30 months and a maximum of 195 months.

**OUTCOME MEASURES:** The primary outcome measure was the occurrence of a surgery for the revision or removal of a lumbar TDR.

**METHODS:** For each case of device removal/revision, the reason, duration from index surgery, and procedure performed were recorded. Six different devices were used in the series.

**RESULTS:** In the series of 1,707 patients, there were 17 patients who underwent TDR removal (0.99%) and 3 additional patients underwent TDR revision (0.17%). The rates based on the total number of 2,023 TDR devices implanted in the 1,707 patients, were 0.89% removals and 0.15% revisions. The reasons and timing of removal/revisions were analyzed. Removals included: 8 for migration and/or loosening, 3 developed problems after a trauma, 1 had vertebral body fractures (osteoporosis), 1 TDR was too large and replaced with smaller device, 1 had ongoing pain, and 1 had an infection seeded from a chest infection at 146 month post-TDR. Revisions included 1 repositioning the core (technique error), 1 repositioned device after displacement, and 1 core replacement due to wear/failure. With respect to timing, 40% of removals/revisions occurred within one month after the index surgery, and a total of 85% occurred within 2 years. Of note, 40% of the revisions/removals occurred in the first 25 TDR cases performed by individual surgeons. There were no vascular complications causing clinical sequelae during the removal/revision surgeries.

**CONCLUSIONS:** In this large patient series, 1% of lumbar TDRs were removed/revised. Only one revision was related to device failure or wear. Many of the subsequent procedures were performed within a month of implantation. Also of note, many occurred within the first 25 TDR cases for individual surgeons, suggesting a learning curve. In cases of TDR removal/revision, as with any repeat anterior spine surgery, one should be acutely aware and prepared for vascular injury should it occur. The low rate of removal/revision in this large institutional experience over a 17 year period provides support for the safety of these devices.

**FDA DEVICE/DRUG STATUS:** Lumbar TDR, 1-level (Approved for this indication), Lumbar TDR 2-level (Not approved for this indication)
30. Do the Degenerative Changes on Lumbar Plain MRI Explain the Cause of Low Back Pain? The Wakayama Spine Study

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BACKGROUND CONTEXT: It is still controversial about the relationship between the degenerative changes on MRI and low back pain (LBP). Disc degeneration, endplate changes, vertebral deformity due to osteoporotic fracture, and spinal stenosis have been reported as possible causes of LBP. However, these degenerative changes are often coexisting and may confound each other as the cause of LBP.

PURPOSE: To elucidate the association of degenerative changes on MRI and LBP in a general population

STUDY DESIGN/SETTING: A cross-sectional study of an established population-based cohort in Japan

PATIENT SAMPLE: Of the 952 subjects who participated in the second survey of the Wakayama Spine Study, a total of 794 participants (male 239: female 555, mean age 63.6±13.1 years old) were subjected to the MRI evaluation.

OUTCOME MEASURES: Lumbar Disc degeneration (Phirrmann's classification: grade 1-5), endplate changes (Modic type 1, 2, and 3) and morphometric fracture of the vertebral bodies (semi-quantitative method: grade 0-3) were evaluated on the sagittal MRI. Percentage of fatty degeneration in the paravertebral muscle (PVM) at L1 upper end-plate level and cross-sectional area (CSA) of the dural tube at L1/2-L5/S1 levels were measured on the axial MRI using a DICOM software. Information on the presence of LBP within 1 month and visual analog scale (VAS) for current LBP were obtained via interviews.

METHODS: The relationship between the degenerative changes and the presence/intensity of LBP was determined using multivariable regression analysis models, after adjusting for age, sex, and body mass index.

RESULTS: The presence of LBP was 37% and 40% in men and women, respectively. Of these, 36% of the personnel experienced pain intensity more than 40 mm on VAS. Significant associated factors with the presence of LBP were disc degeneration (grades 4-5, odds ratio 2.6 [95% CI 1.3-5.6]), endplate change (Modic type 1, 1.6 [1.0-2.6]) and spinal stenosis (minimum CSA <100 mm2, 1.6 [1.2-2.2]). Area under curve of this logistic model was 0.61. Significant associated factors with the VAS of LBP were the percentage of fatty degeneration of PVM (standardized partial regression coefficient 0.11, p=0.0106), sum of the grades of DD (0.16, p=0.0009), and the minimum CSA (-0.13, p=0.0005).

CONCLUSIONS: Disc degeneration, Modic type 1 endplate change, spinal stenosis and PVM degeneration were significant associated factors of LBP in the general population.

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

31. Can Triggered Electromyography Thresholds Assure Accurate Pedicle Screw Placements? A Systematic Review and Meta-Analysis of Diagnostic Test Accuracy

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BACKGROUND CONTEXT: Pedicle screws are commonly used in thoracic and lumbar spine fixations. However, spine pedicle screw applications carry potential complications involving the great vessels, the spinal cord, and spinal nerve roots. Clinically, pedicle cortex screw violations have been reported at a rate of 8%. Debate has remained not only regarding the efficacy of t-EMG but also regarding its threshold value.

PURPOSE: The aim of this study was to estimate the sensitivity and specificity of t-EMG in assuring accurate pedicle screw placement and to compare threshold values with a systematic review and metaanalysis

STUDY DESIGN/SETTING: A meta-analysis of randomized controlled trials was carried out.

PATIENT SAMPLE: Adult patients undergoing triggered EMG during pedicle screw placement

OUTCOME MEASURES: True positive, true negative, false positive, and false negative were measured and stratified by response of triggered EMG.

METHODS: We searched MEDLINE, EMBASE, and the Cochrane Library, and 179 studies were identified. Among them, 11 studies were finally enrolled. The pooled sensitivity, specificity, diagnostic odds ratio (DOR), and summary receiver operating characteristics (SROC) plots were analyzed.

RESULTS: The enrolled studies included 13,948 lumbar and 2070 thoracic screws. The overall summary sensitivity/specificity/DOR values of t-EMG were 0.55/0.97/42.16 in the lumbar spine and 0.41/0.95/14.52 in the thoracic spine, respectively, indicating a weak diagnostic value. However, subgroup analysis by each threshold value showed that the cutoff value of 8 mA in the lumbar spine indicated high sensitivity (0.82), specificity (0.97), and DOR (147.95), thereby showing high diagnostic accuracy of identifying misplaced screws.

CONCLUSIONS: The most useful application of t-EMG may be as a warning tool for lumbar pedicle screw malpositioning in the presence of positive stimulation at a threshold of 68 mA. Significance: t-EMG by screw stimulation may be valuable in the lumbar region at a threshold of <8 mA.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
32. Categorizing the Hip-Spine Syndrome: A Step Toward a Collaborative Multidisciplinary Classification

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BACKGROUND CONTEXT: Recently, there has been increased recognition of the interplay between degenerative conditions of the hip and spine (Hip-Spine Syndrome, HiSS). Loss of lumbar lordosis (LL) of more than 10 degrees in proportion to the pelvic incidence (PI) is considered a marker of sagittal spinal malalignment. The impact of positive spinopelvic (PSA), pelvic incidence (PI), pelvic-LL mismatch (PI-LL), and sagittal spinal deformity on increased hip extension (pelvic posterior tilt in spinal literature) and subsequently the acetabular version is established. Communication between adult hip and spinal surgeons during reconstruction and spinal deformity surgery is ineffective without common language, an established definition, or mutual radiographic imaging protocols.

PURPOSE: This study aimed to characterize various presentations of HiSS and suggest a simple method to distinguish between them.

STUDY DESIGN/SETTING: Retrospective review of a prospectively collected adult spinal deformity database

PATIENT SAMPLE: 1,389 patients who presented to a single center with orthopaedic complaints between 2013 and 2016.

OUTCOME MEASURES: Demographics, parameters related to spinopelvic alignment (PI, PT, LL, PI-LL), global spinal alignment (TPA, SVA, GSA), and lower extremities (SFA, KF, pelvic shift) from full-body sagittal radiographic imaging, and Kellgren-Lawrence grade.

METHODS: Demographic information was collected and full-body (FB) sagittal radiographs were analyzed using dedicated software to measure spinopelvic, global sagittal spinal alignment, lower extremity, and FB sagittal radiographic parameters. FB coronal radiographs were analyzed by two reviewers to assess hip osteoarthritis (HOA) via Kellgren-Lawrence grade. Patients were grouped based on their sagittal spinal alignment (PI-LL mismatch) and HOA into: HiSS None (PI LL < 10°, HOA Grade 0; n = 444), HiSS Hip (PI-LL < 10°, HOA Grade 3-4; n = 75), HiSS Spine (PI-LL > 10°, HOA Grade 0; n = 297), or HiSS Hip-Spine (PI-LL > 10°, HOA Grade 3-4; n = 30).

RESULTS: 1,389 patients were included with a mean age of 62.5 ± 11.1 years and mean BMI of 27.6 ± 5.7 kg/m2. 62% of the study population was female. HiSS Hip-Spine (n = 30) had significantly less lumbar lordosis (40.9° vs. 57.0° and 54.2°, respectively), greater knee flexion (9° vs. 6.4° and 2.6°, respectively) and positive sagittal spinal malalignment (SVA) (57.2 vs. 28.4 and 7.8 mm, respectively) (all p < 0.001) than HiSS Hip and HiSS None. On the other hand, HiSS Hip-Spine Type had also distinctive measures in comparison to HiSS Spine. HiSS Hip-Spine had significantly lower pelvic posterior tilt (25.2° vs. 29.2°, p = 0.001), hip extension (23.1° vs. 28.4°, p = 0.001) despite having comparable spinopelvic PI-LL mismatch (21.4° vs. 24.2°, p = 0.05).

CONCLUSIONS: This study proposes a novel HiSS categorization system based on established spinal deformity and HOA classification methods. Radiographically, HiSS Hip-Spine Type patients can be distinguished by Adult Reconstructive Surgeons by measuring pelvic tilt angle. Increased PT > 25° in HOA patients is a marker for sagittal spinal deformity that has the potential to impact acetabular version.

33. The Influence of Diffuse Idiopathic Skeletal Hyperostosis on Physical Function in Elderly Populations

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BACKGROUND CONTEXT: DISH is associated with increasing age, obesity, and diabetes mellitus. However, little is known about the clinical impacts of DISH on physical function and spinal deformity in elderly populations.

PURPOSE: To elucidate the influence of Diffuse Idiopathic Skeletal Hyperostosis (DISH) on physical function, spinal deformity, and health-related quality of life (HRQOL) in elderly populations.

STUDY DESIGN/SETTING: A cohort study.

PATIENT SAMPLE: The study population included healthy Japanese volunteers over 50 years of age, who attended a local government’s basic health screening.

OUTCOME MEASURES: Height, weight, body mass index (BMI), blood pressure, grip strength, one-leg standing time, sit-and-reach, functional reach, and bone mineral density (BMD) were measured. Using whole spine standing x-rays, the prevalence, location, and numbers of fused vertebra of DISH, and spinopelvic parameters were measured. HRQOL measures, including the Oswestry Disability Index and the EuroQol-5D were also obtained.

METHODS: We compared DISH subjects (group D) with control subjects (group C), four times age and sex matched subject without DISH selected randomly. We compared the subjects with DISH in the thoracic spine (T-DISH) to those with DISH in the thoracic and lumbar spines (TL-DISH).

RESULTS: The study enrolled 504 volunteers (187 men and 304 women, mean age 74.0 years. DISH occurred more frequently
34. Factors Related to Spinal Sagittal Imbalance among an Elderly Population in a Japanese Suburban Community: The Shiraniwa Study

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BACKGROUND CONTEXT: Spinal sagittal imbalance induces low back pain, gastroesophageal reflux, and poor quality of life among elderly people. Even though corrective surgery has been sophisticated to treat spinal sagittal imbalance, it has not been a complete solution because of complications and medical cost. On the other hand, it seems plausible to argue that trunk muscle strength training may have the potential to improve postural alignment. However, there is still little known about the effect of trunk muscle mass and the strength on spinal sagittal imbalance.

PURPOSE: The purpose of this study was to clarify the factors related to sagittal imbalance among elderly people focusing on trunk muscle.

STUDY DESIGN/SETTING: This study was based on the results obtained from cross-sectional measurements of participants who enrolled in the Shiraniwa study. The Shiraniwa study, which began in a suburban community from 2016, is a population-based prospective cohort study that aims at investigating locomotive syndrome, sarcopenia, frailty, and spinal sagittal imbalance. It was also designed to elucidate risk factors for these conditions.

PATIENT SAMPLE: We enrolled 409 people aged 65 years or older (164 males, 245 females, mean age: 73.5 ± 5.4 years) living in suburban area Japan.

OUTCOME MEASURES: We investigated body mass index (BMI), trunk muscle mass (using bioimpedance analysis machine: MC780A, TANITA, Japan), back muscle strength (using T.K.K.5402, TAKEI, Japan), C7 sagittal vertebral axis (SVA), and prevalent vertebral fractures from lateral view of whole spine radiograph.

METHODS: We defined the people whose SVA > 95mm as sagittal imbalance group, and SVA ≤95mm as normal group. Each item was compared between two groups using Mann-Whitney U test and chi-squared test. Factors related to sagittal imbalance were assessed using multivariate logistic regression analysis.

RESULTS: Sagittal imbalance was present in 11.0% (45 people) of the study population. There was no significant difference in sex and BMI between two groups. Age (78.4 years vs 72.9 years) and the ratio of prevalent vertebral fracture (46.7% vs 10.7%) were significantly higher in sagittal imbalance group. Back muscle strength (male: 45.2kg vs 85.3kg, female: 26.7kg vs 46.5kg) and trunk muscle mass (male: 24.6kg vs 26.0kg, female: 18.1kg vs 19.5kg) was significantly lower in sagittal imbalance group. Back muscle strength indicated high accuracy in ROC curve analysis about sagittal imbalance (area under the curve: male 0.871, female 0.807) and the cutoff value were 58kg in male, and 34kg in female. Multivariate logistic regression analysis revealed that age (female: OR: 1.11, 95% CI 1.02-1.21), prevalent vertebral fractures (male: OR 9.19, 95% CI 1.16-72.9, female: OR 2.63, 95% CI 1.04-6.68), and decreased back muscle strength (male: OR 7.04, 95% CI 1.50-32.89, female: OR 4.24, 95% CI 1.55-11.55) were independently related to sagittal imbalance. On the other hand, BMI and trunk muscle mass were not independently related to sagittal imbalance.

CONCLUSIONS: Factors related to sagittal imbalance were aging, prevalent vertebral fractures, and decreased back muscle strength. It is not clear the causality due to the cross-sectional nature. However, this study support the possibility that prevention of vertebral fracture and maintenance of back muscle strength (male: >58kg, female: >34kg) are effective for prevention of sagittal imbalance.

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

35. Minimally Invasive Spinal Decompression Surgery for Degenerative Lumbar Spondylolisthesis and Stenosis Maintains Segmental Stability and May Avoid the Need for Fusion in Many Patients

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BACKGROUND CONTEXT: As a surgical treatment for lumbar degenerative spondylolisthesis (DS), there are differing opinions about decompression surgery with or without fusion based on the criteria of spinal instability for DS. There is also controversy regarding the necessity of the routine fusions. The best treatment for DS is not yet established because the progress of spinal instability is influenced by the age, nature, clinical conditions, and activities of each patient. Minimally invasive spinal (MIS) surgery using a microscope or endoscope is an effective treatment for a variety of common degenerative conditions of the lumbar, thoracic, and cervical spine. One would theorize that such an approach, with preservation of he facet joints, posterior ligament complex and soft tissues, would result in less destabilization of the vertebral segments as compared to a traditional open decompression. This concept is of particular importance in the context of preoperative spondylolisthesis, where there is some element of preexisting instability. One would presume that maintenance of these posterior stabilizing
structures may allow for successful decompression in patients with LSS and DS without precipitating instability, thus resulting in improved clinical outcomes.

**PURPOSE:** The goals of this study were: (1) to prospectively investigate the clinical and radiographic outcomes of MIS decompression surgery in patients with LSS and concurrent DS, and (2) to identify whether more advanced preoperative dynamic instability influences such clinical outcomes.

**STUDY DESIGN/SETTING:** This study design is a retrospective sub-group analysis of a prospectively collected cohort analysis.

**PATIENT SAMPLE:** 304 consecutive patients with single-level DS at L3/4 or L4/5 with concomitant stenosis who required surgical treatment were enrolled. All enrolled patients underwent microendoscopic laminotomy (MEL) without fusion. Based on the degree of spondylolisthesis and dynamic instability, patients were assigned to either the advanced DS (n=101) or DS (n=203) group.

**OUTCOME MEASURES:** All parameters were analyzed statistically (p<0.05). Differences in clinical outcomes, categorized by the recovery rate, were also compared using Student’s t-test.

**METHODS:** The Japanese Orthopaedic Association (JOA) score, JOA recovery rate and radiographic parameters were used to evaluate patients preoperatively and at ≥2 years postoperatively.

**RESULTS:** 242 patients met criteria (advanced DS, n=86; DS, n=156) and were included for analysis, with a mean follow-up of 3.6 years. No significant differences were found in the preoperative measurements between the groups. The mean slippage rate was 17.1% preoperatively and 17.7% at the final follow-up (p=0.35). The mean JOA recovery rate was 64.8%. Progressive spinal instability was noted in 6 patients (7.0%) with advanced DS and 13 patients (8.2%) with DS, respectively (p=0.81). Restabilization was demonstrated in 35% of patients with preoperative spinal instability. The success rate of MEL was good/excellent in 70%, fair in 20%, and poor in 10% of patients in both groups.

**CONCLUSIONS:** MEL is an effective treatment alternative for patients with DS and stenosis. Preservation of the stabilizing structures using this decompression technique prevents post-decompression instability and avoids the need for fusion, with less than 7% of patients requiring subsequent spinal fusion for instability.

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

### 36. The Role of Lumbar Retrolisthesis in Whole Spine Stability and Health-Related Quality of Life among Elderly Volunteers: Lumbar Retrolisthesis Compensates for Spinal Kyphosis

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**BACKGROUND CONTEXT:** Several studies have reported on lumbar retrolisthesis; however, the pathology of lumbar retrolisthesis is complicated and still unknown.

**PURPOSE:** To investigate the features of lumbar retrolisthesis among elderly volunteers.

**STUDY DESIGN/SETTING:** A large cohort study of volunteers.

**PATIENT SAMPLE:** Elderly volunteers who participated in a health screening study.

**OUTCOME MEASURES:** The prevalence, location, and number of cases of lumbar retrolisthesis were examined using whole spine X-ray. Spinopelvic parameters were also measured. Health-related quality of life (HRQOL) questionnaires were administered and evaluated.

**METHODS:** This study included 639 volunteers (257 men; 382 women; average age: 73 years). The exclusion criterion was a Cobb angle of at least 20° in the coronal plane. Sagittal vertical axis (SVA), maximum thoracic kyphosis (maxTK), lumbar lordosis (LL), pelvic incidence (PI), and pelvic tilt (PT) were measured using whole spine and pelvic radiographs that were taken in the standing position. MaxTK was measured from the upper to lower segments of the vertebrae that were involved in spinal kyphosis in the sagittal plane, according to Cobb’s method. The volunteers who experienced at least a 3 mm posterior lumbar vertebral slip were assigned to the R (+) group, whereas others were assigned to the R (-) group. Cases involving multiple retrolisthesis were excluded in order to simplify the study. HRQOLs were evaluated using the EuroQOL (EQ-5D) and Oswestry Disability Index (ODI).

**RESULTS:** Of the 558 patients, 178 (32%) were in the R (+) group (85 men, 93 women). Among them, 10 cases exhibited lumbar retrolisthesis at L1; 85 cases, at L2; 58 cases, at L3; 22 cases, at L4; and 3 cases, at L5. Among the 178 patients, 154 (87%) had experienced a posteriorly slipped vertebral disc that was consistent with the lower-end vertebra of maxTK or the vertebra adjacent to it. The mean ages of the R (+) and the R (-) groups were 74.9 and 71.4 years, respectively. The R (+) group included significantly older patients than did the R (-) group (P<0.0001). Lumbar retrolisthesis was more frequently observed in men compared to women (P=0.003). The mean values for SVA, maxTK, LL, PI, PT, PI-LL, and EQ-5D in the R (+) group were 60.0 mm, 43.8°, 34.5°, 46.8°, 19.5°, 12.2°, and 0.82, respectively, and 42.5 mm, 34.4°, 42°, 49.9°, 17.7°, 7.9°, and 0.84, respectively, in the R (-) group. The R (+) group had significantly greater SVA, maxTK, and PI-LL (P<0.0001, P=0.0001, P=0.004, respectively); smaller LL and PI (P=0.0001 and P=0.001); and worse EQ-5D scores (P=0.041), than did the R (-) group. Multivariate analysis revealed that age (P=0.013, odds ratio [OR]=1.027), sex (P=0.002, OR=1.887), maxTK (P<0.0001, OR=1.051), and LL (P<0.0001, OR=0.969) were independent predictors of lumbar retrolisthesis.

**CONCLUSIONS:** Among volunteers who were at least 50 years of age, 32% presented with lumbar retrolisthesis. Of these, 87% presented with posteriorly slipped vertebral disc that was consistent with the lower-end vertebral of maxTK or with the vertebra just below it. Lumbar retrolisthesis subjects exhibited worse spinal alignment and a poorer HRQOL. Lumbar retrolisthesis was more frequently observed in male and those with a low PI.

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

### 37. Supervised Exercise versus Unsupervised Exercise for Patients with Lumbar Spinal Stenosis: A Randomized Controlled Trial

Masakazu Minetama, PT; Mamoru Kawakami, MD, PhD; Masatoshi Teraguchi, MD, PhD; Ryohei Kagotani, MD, PhD; Masafumi Nakagawa, PT; Tomoko Kitano, CPT

**BACKGROUND CONTEXT:** Several studies have reported on lumbar retrolisthesis; however, the pathology of lumbar retrolisthesis is complicated and still unknown.
BACKGROUND CONTEXT: Exercise for patients with lumbar spinal stenosis (LSS) has been reported to lead to better short-term outcomes in terms of disability and back and leg pain than no exercise. However, no reports have compared supervised exercise with unsupervised exercise or quantified physical activity using a pedometer to confirm compliance with the home exercise program.

PURPOSE: To compare the effectiveness of supervised physical therapy with unsupervised exercise for patients with LSS.

STUDY DESIGN/SETTING: A randomized controlled trial of patients with LSS receiving exercise programs.

PATIENT SAMPLE: Seventy-two patients (32 men and 40 women, average age 72.6 years) presenting with LSS.

OUTCOME MEASURES: Zurich Claudication Questionnaire (ZCQ), self-paced walking test (SPWT), a numerical rating scale, the 36-Item Short-Form Survey (SF-36), Hospital Anxiety and Depression Scale, Pain Catastrophizing Scale, Tampa Scale for Kinesiophobia, and a pedometer.

METHODS: Patients presenting with symptoms of neurogenic claudication caused by LSS, which was confirmed by magnetic resonance imaging (MRI), were enrolled from September 2014 to August 2017. Patients were randomized to a physical therapy group (PT group), which performed supervised physical therapy twice a week for 6 weeks or a home exercise group (control group) using covariate adaptive randomization and online statistical computing web programming. Physical therapy sessions included manual therapy, stretching and strengthening exercises, cycling, and body weight-supported treadmill walking. All patients were asked to undertake a home exercise program. Patients in the control group visited a physical therapist to confirm whether they performed home exercise once a week for 6 weeks. The primary outcome was the difference in improvement in symptom severity scores on the Zurich Claudication Questionnaire (ZCQ) at 6 weeks. Secondary outcomes included: physical function and satisfaction on the ZCQ; self-paced walking test (SPWT) performance; pain indicated using a numerical rating scale; and scores on the 36-Item Short-Form Survey (SF-36), Hospital Anxiety and Depression Scale, Pain Catastrophizing Scale, and the Tampa Scale for Kinesiophobia. Compliance with the home exercise program was measured using a pedometer and self-report questionnaire. Scores and mean changes after 6 weeks were compared between the groups. A P-value <0.05 was considered significant.

RESULTS: Thirty-six patients (16 men and 20 women, average age 72.1 years) were allocated to the PT group and 36 patients (16 men and 20 women, average age 73.1 years) to the control group. At baseline, there were no significant differences in age, gender, body mass index, duration of symptoms, MRI findings and the outcome measures between groups (P>0.05). At 6 weeks, compared with the control group, the PT group showed significant improvements in ZCQ symptom severity (mean difference –0.4; 95% confidence interval [CI]: –0.7 to –0.1, P=0.003), ZCQ physical function (mean difference –0.4; 95% CI: –0.7 to –0.2, P=0.001), walking distance on the SPWT (mean difference 475 m; 95% CI: 305 to 646, P<0.001), physical functioning (mean difference 9.0; 95% CI: 0.8 to 17.2, P=0.031) and bodily pain (mean difference 10.0; 95% CI: 0.9 to 18.0, P=0.016) on the SF-36, and number of daily steps (mean difference 793 steps/day; 95% CI: 208 to 1378, P=0.009).

CONCLUSIONS: Supervised physical therapy for patients with LSS produced significant short-term improvements in pain, walking distance, disability, and physical activity compared with unsupervised exercise. The mean difference between groups in improved symptom severity scores on the ZCQ exceeded a minimal clinically important difference of 0.36. Future studies should focus on long-term outcomes and surgery rates after exercise programs.

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

38. The Degeneration of Adjacent Intervertebral Discs Negatively Influences Union Rate of Osteoporotic Vertebral Fracture: A Multicenter Cohort Study

Shinji Takahashi, MD; Masatoshi Hoshino, MD; Kazushi Takayama, MD, PhD; Hiromitsu Toyoda, MD, PhD; Hiroyuki Yasuda, PhD; Hiroaki Nakamura, MD, PhD

BACKGROUND CONTEXT: With the increasing aging population in developed countries, there has been an associated increased prevalence of osteoporotic vertebral fracture (OVF). Most cases of OVF can be sufficiently cured by conservative treatment; however, cases involving nonunion may present long-term intractable back pain, and/or neurological deficit. Such cases of nonunion may be in part due to insufficient early management and may be avoided with more careful or intensive treatments. Many previous reports have attempted to predict the risk of nonunion associated with OVF using MRI signal changes within the fractured vertebral body. However, the role of endplate failure and/or the degeneration of adjacent intervertebral discs, and their association with delayed or nonunion has received little attention.

PURPOSE: The aim of this study was to evaluate the degeneration rank and progression of the adjacent disc, the compression ratio of the anterior vertebral body wall, and endplate fracture as risk factors for delayed union associated with OVF.

STUDY DESIGN/SETTING: A multicenter cohort study

PATIENT SAMPLE: Patients with fresh OVF (less than 2 weeks old)

OUTCOME MEASURES: Delayed union was defined as a recognizable intravertebral cleft and apparent segmental motion as assessed on dynamic X-ray (+5 degrees between supine and weight-bearing positions) at the 6 month follow-up.

METHODS: Two hundred and eighteen consecutive patients with OVF (less than 2 weeks old) were enrolled in the study. MRI and X-ray were performed at the time of enrollment and at the 6 month follow-up. The degeneration grade of adjacent intervertebral discs on T2-weighted MRI images were assessed using the modified Pfirrmann grading system. T1-weighted images were used to assess endplate failure. Supine and weight-bearing radiographs were used to define angular motion and compression ratio of the anterior vertebral body wall. The odds ratio of each MRI finding for severe compression was adjusted for age, sex, posterior wall injury and level of OVF.

RESULTS: A total of 139 patients (112 female, 27 male) completed the 6 month follow-up (a 65.1% follow-up rate). The median age was 79 years. Most fractures (101 cases, 72.7%) occurred at the thoracolumbar spine (T10–L2). The study revealed 27 cases of delayed union (19.4%). Left table demonstrates that in the cases of delayed union, the OR of
Perspective

Injury: Road from Bench to Clinical Trial and Future

Intrathecal Administration of Recombinant Human Hepatocyte Growth Factor for Acute Spinal Cord Injury: Road from Bench to Clinical Trial and Future Perspective

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BACKGROUND CONTEXT: Hepatocyte growth factor (HGF) has been highlighted as a potent organotrophic factor in the central nervous system, as well as in other solid organs. We first revealed that endogenous up-regulation of HGF in injured spinal cord was insufficient, compared with sharp increase of c-Met (HGF receptor) expression during acute phase of spinal cord injury (SCI) and introduction of exogenous HGF into spinal cord by HSV injection significantly promoted the survival of neurons and oligodendrocytes, angiogenesis and axonal regeneration, thereby reducing the damaged area and promoting functional recovery after SCI. We have also reported efficacy of intrathecal infusion of recombinant human HGF (rhHGF) in thoracic SCI model of rats and cervical SCI model of non-human primate (common marmoset).

PURPOSE: The purpose of this study is to investigate its therapeutic time window, confirm its efficacy in clinically-relevant severe cervical SCI model of marmosets and establish novel treatment by conducting clinical trial.

METHODS: 1) To investigate therapeutic time window of intrathecal rhHGF, contusive SCI was induced at Th10 level in adult rats and 200 mg of rhHGF or PBS was infused intrathecally from Th12 level for 4 weeks from right after, 4 days, 2 or 6 weeks after SCI (n=6 for each group). 2) Contusive SCI was induced at C5 level and rhHGF or PBS was infused intrathecally from C7 level from right after SCI for 4 weeksin adult marmosets.

To examine efficacy of intrathecal rhHGF in clinically-relevant severe cervical SCI model as preclinical trial, marmosets without any recovery of forelimbs until 3 days after SCI were included (n=5 in HGF group, n=3 in PBS group). Motor function was evaluated by our original scoring scale which focuses on primate-specific upper limb function (flexion and extension of fingers, wrists, elbows and shoulders and pronation of forearms) in walking and grasp performance.

RESULTS: 1) Significant motor recovery of hindlimbs was observed when intrathecal rhHGF started from right after or 4 days after SCI, whereas no effects were observed when intrathecal rhHGF started from 2 or 6 weeks after SCI. 2) Original scoring scale revealed that more than one key muscle of forelimbs became useful in marmosets with intrathecal rhHGF infusion, whereas all key muscles remained useless thereafter in control marmosets.

CONCLUSIONS: Since we reported dynamism of endogenous HGF expression before and after SCI and therapeutic efficacy of introduction of HGF into spinal cord during acute phase of SCI, we have developed the current therapeutic strategy for people with SCI using rhHGF based on experiments using viral vector and rhHGF in rodent SCI models. Present study suggests evidence of therapeutic time window of intrathecal rhHGF and its efficacy in clinically-relevant severe cervical SCI in primates. In 2014, based on results of these consecutive studies, we launched phase I/II clinical trial (randomized, double-blinded, placebo-controlled) for people with cervical SCI who show modified-Frankel A/B1/B2 at 72 hours after onset. rhHGF is injected intrathecally at lumbar level once a week for 5 weeks, with primary injection within 6 hours after final registration at 72 hours after onset. We summarize the results of the phase I/II clinical trial in 2018 and proceed to the next step.

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

Wednesday, August 1, 2018
9:30–10:30 a.m.
Abstract Session: Trauma and Tumor

39. Intrathecal Administration of Recombinant Human Hepatocyte Growth Factor for Acute Spinal Cord Injury: Road from Bench to Clinical Trial and Future Perspective

40. Time Course of Respiratory Dysfunction and Motor Paralysis for 12 Weeks in Cervical Spinal Cord Injury without Bone Injury

Spine Across the Sea 2018 Proceedings

68
12 weeks, were selected. There were 49 men and 5 women, with a mean age of 65 years (range 39–85 years). The level of cervical spinal cord injury, identified at admission, included 38 cases at C3/4, 10 at C4/5, 2 at C5/6, and 4 at C6/7. By ModifiedFrankel Classification, 8 cases were classified as A, 2 cases as B1, one as B2, one as B3, and 23 as C1. Ossification of the posterior longitudinal ligament (OPLL) was observed in 18 cases. Conservative therapy was chosen in 12 cases, and surgical treatment in 42 cases. All patients were encouraged to pursue early mobilization on the second day after admission, and were trained in breathing to strengthen accessory respiratory muscles and in exhalation using a device. All patients were trained in stretching and squeezing movements to prevent chest contraction. The percent vital capacity (%VC), forced expiratory volume in one-second (FEV1.0)/forced vital capacity (FVC) ratio (hereafter, FEV 1.0%), and the American Spinal Injury Association (ASIA) motor score (hereafter, MS) were measured on admission and at weeks 4 and 12. The MS has a maximum score of 25 for each extremity, for a total possible score of 50 for the upper limbs and 50 for the lower limbs. Respiratory measurements were collected with a spirometer, with the patient in a supine position at admission and in a sitting position at weeks 4 and 12. The rate of change of the %VC and the improvement rate of the MS were calculated from admission to week 4, from admission to week 12, and from week 4 to week 12.

RESULTS: Of the 54 patients, 50 (92.6%) had restrictive ventilatory impairment at admission (average %VC: 56.7%; average FEV1.0%: 82.0%). Average of upper- and lower-limb MS were 15.2 and 22.8 at admission. The %VC was correlated with the MS of the upper (R=0.57) and lower (R=0.56) limbs at admission. The %VC was found to be correlated with both the upper-limb MS and the lower-limb MS. Significant improvement was found in the upper- and lower-limb MS and in the %VC at 4 and 12 weeks. Restrictive impairment was still present in 26 patients (48.1%) at week 12 (average %VC: 78.9%; average FEV1.0%: 83.9%). Improvement rate of %VC, upper- and lower-limb MS were 32.1, 39.1 and 47.8% from week 0 to 4, and 7.8, 21.3 and 12.0% from week 4 to 12, and 41.2, 51.8 and 60.3% week 0 to 12. Although the %VC rate of change was not correlated with the improvement rate of the upper-limb MS, it was significantly correlated with the improvement rate of the lower-limb MS over the entire period. These observations indicated that the lung capacity of SCIWOBI patients decreases due to upper- and lower-limb motor paralysis as well as respiratory-muscle paralysis, and is likely to improve as patients recover motor function in their lower limbs. There were no patients who had undergone mechanical ventilation or tracheotomy in this study.

CONCLUSIONS: 92.6% of cervical SCIWOBI had restrictive ventilatory impairment at admission. Although significant improvement was found in the upper- and lower-limb MS and in the %VC at 4 and 12 weeks, restrictive impairment was still present in 48.1% at week 12. Lung capacity improved as patients recovered lower-limb motor function over the entire period.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
6) subjects gained at least 1 motor level bilaterally and 67% (4 of 6) regained two motor levels on at least one side. The recovery of two motor levels in Cohort 2 has increased relative to the 6- and 9-month visits, at which 33% and 50% of subjects, respectively, had regained two motor levels. The percentage of subjects in Cohort 2 who recovered two motor levels compares favorably to the 26-29% rates in published reports of spontaneous recovery in this population and to a matched historical control group. The MRI results to date are consistent with the formation of a tissue matrix at the spinal cord injury site in all subjects in Cohorts 1 and 2, which suggests that AST-OPC1 cells have durably engrafted and contributed the prevention of cavitation at the injury site.

CONCLUSIONS: The results of the SIStar study continue to demonstrate a strong safety profile for AST-OPC1. In addition, the efficacy data for 2 and 10 million cells at 1 year of follow up indicate a dose-dependent increase in the recovery of upper extremity motor function.

FDA DEVICE/DRUG STATUS: FDA trial (Investigational/Not approved)

42. Balloon Kyphoplasty for Fresh Osteoporotic Vertebral Fractures with Poor Prognostic Factors: Multicenter Prospective Intervention Study

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BACKGROUND CONTEXT: BKP is a useful surgical procedure having evidence. However, there are some problems such as the cost and the surgical risk, when we apply BKP for all the patients of the fresh OV. We previously reported that characteristic magnetic resonance (MR) imaging findings (high-intensity or diffuse low-intensity area in the fractured vertebrae on T2-weighted MR images) predicted an increased risk of delayed union. Our treatment strategy for fresh OV is to decide BKP intervention depending on the presence or absence of a poor prognostic factor.

PURPOSE: The purpose of this study was to investigate the efficacy of balloon kyphoplasty (BKP) for treatment of fresh OVs in patients with poor prognostic factors.

STUDY DESIGN/SETTING: Multicenter prospective, single arm, intervention study, compared with historical control using propensity score matching

PATIENT SAMPLE: A total of 108 patients were enrolled in this multicenter prospective intervention study, who had a high-intensity or diffuse low-intensity area in the fractured vertebrae on T2-weighted MR images and underwent BKP within 2 months after injury. As controls, 121 patients with fresh OVs who had the same poor prognostic factors and had undergone conservative treatment were selected from the previous study database.

OUTCOME MEASURES: The primary outcome was a reduction in ADL by at least a single grade at 6 months after fracture, and the secondary outcomes were quality of life (physical and mental component summary scores on the Short Form 36), improvement in back pain (visual analog scale score), and vertebral body deformity (vertebral body wedging angle and percent vertebral body height). Complications of BKP were also investigated.

METHODS: The patients were matched according to calculated propensity scores in a logistic regression model adjusted for age, sex, and level of fracture and divided into the BKP and conservative treatment groups.

RESULTS: There were 93 patients in each group (mean ages: 78.5 and 77.5 years, respectively). A decrease in ADL occurred in 6.5% of patients in the BKP group and 43.0% of patients in the conservative treatment (control) group (P<0.01). The improvement in physical component summary score at 6 months after injury was 19.6 points in the BKP group and 21.7 points in the control group (no significant difference). The improvement in mental component summary score at 6 months after injury was 13.2 points in the BKP group and 8.1 points in the control group (P<0.01). Improvement in back pain was shown by a visual analog scale score of 45.0 in the BKP group and 52.0 in the control group (no significant difference). The improvement in vertebral body wedging angle in the BKP group was 6.0°, and that in the control group was -6.0° (P<0.01). The improvement in percent vertebral body height in the BKP group was 16.0%, and that in the control group was -20.0% (P<0.01). The rate of adjacent vertebral body fractures was 30.1% (28 of 93). With respect to complications in the BKP group, leakage of cement into the spinal canal occurred in 3 of 108 patients (2.8%), and additional surgery was needed in 3 of 108 patients (2.8%).

CONCLUSIONS: BKP intervention for fresh OV with poor prognostic factors was more effective than conservative treatment in terms of ADL, QOL, and vertebral deformity 6 months after injury.

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

43. Comparative Study of Spinal Reconstruction after Total En Bloc Spondylectomy

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BACKGROUND CONTEXT: Spinal reconstruction after total en bloc spondylectomy (TES) is important for long-term functional prognosis. However, an optimal reconstruction method has not been established.

PURPOSE: In present study, the largest case series of clinical outcomes of spinal reconstruction after TES performed using two different procedures is reported.

STUDY DESIGN/SETTING: Retrospective study

METHODS: This is a retrospective review of 75 cases who underwent TES between 2010 and 2016. Anterior reconstruction was performed using a titanium mesh cage filled with autograft. Posterior instrumentation was performed with two-above and two-below segmental fixation using pedicular screws and rods. Convventional cage and titanium alloy rod was used in 54 cases (group A) and more robust cage and cobalt chrome rod was used in 21 cases (group B). The mean age at the time of surgery was 53.6 years in group A and 49.9 years in
group B. The mean length of the cage was 38.9 mm (19.7-88mm) in group A and 32.3 mm (23-54mm) in group B. The incidence of instrumentation failure, the cage subsidence (>3 mm), and pedicle screw loosening were evaluated by radiography and CT with multiplanar reconstructions. Each parameter was evaluated at one, six, and twelve month after the surgery and then annually until the last follow-up point.

RESULTS: The mean follow-up period was 41.9 months in group A and 19.8 months in group B. Instrumentation failure occurred in 18 cases (33.3%) including 13 rod, three cage, and one screw breakage in group A with 28.7 months of the mean time to instrumentation failure. On the other hand, instrumentation failure occurred in one case (4.8%) in group B. Progression of the cage subsidence (>3 mm) was observed in 25 cases (46.3%) in group A and one case (4.8%) in group B. Radiolucent lines around the distal pedicular screws were observed in two cases in group A and one case in group B.

CONCLUSIONS: Cage subsidence is one of the important factors causing instrumentation failure. This study demonstrated that enhancing instrument strength led to reduction of cage subsidence. In particular, instrumentation failure could be prevented using cobalt chrome rod. More rigid posterior instrumentation presumed to reduce the instrumentation failure by reduction of the load to anterior column which is a cause of cage subsidence.

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

44. Surgery for Metastatic Epidural Spinal Cord Compression in Thoracic Spine: Anterior or Posterior Approach?

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BACKGROUND CONTEXT: The most commonly encountered tumor of the spine is metastasis, and thoracic spine is the most commonly metastatic spine. The goals of surgery for patients with metastatic spine are to provide mechanical support, to prevent further neurologic deterioration, which can markedly diminish a patient’s life quality. Controversy exists regarding the optimal surgical approach for this kind of patient.

PURPOSE: To report the survivorship and complications developed by surgery in patients with malignant epidural cord compression in the thoracic spine underwent anterior thoracotomy or posterior approach.

STUDY DESIGN/SETTING: A retrospective study.

PATIENT SAMPLE: Ninety-seven patients

OUTCOME MEASURES: Survival was defined as months since surgery to last tractable times. American Spinal Injury Association grade was used to assess preoperative and postoperative neurologic status. Days at intensive care unit (ICU) were compared. Every complication by surgery or during admission was documented.

METHODS: Patients with metastatic thoracic lesion underwent surgery at our department between January 2003 and December 2015 was reviewed. The patients were stratified into two groups according to different approach method to the lesion site. Group A mean anterior thoracotomy, decompression and fixation. Group P represented posterior decompression and fixation. The patients were evaluated preoperatively according to the revised Tokuhashi and Bauer stage. The survivorship in both groups was calculated. Comparisons between group A and group P included age, sex, surgical level, origin of tumor, operation time, blood loss, days at ICU, and number of complications.

RESULTS: 25 patients were in the group A, and 67 patients belonged to the group P. The distribution of sex and age was similar in both groups. The preoperative revised Tokuhashi stage and Bauer stage were 7.6 and 1.76 in the group A; and 8.4 and 1.83 in the group P. Lung cancer was the most commonly origin cancer in both groups. The most commonly surgical level was the 9th thoracic vertebrae in the group A and the 10th thoracic vertebrae in the group P. The preoperative neurologic status was also similar in both group (p=0.959). One patients in the group A and two in the group P sustained neurologic deterioration immediately after surgery, and needed immediate revision surgery. The group A took more operation time (213.0 vs 199.2 minutes, p=0.380) and had more blood loss (912.5 vs 834.4 ml, p=0.571). 6 patients in the group A (24%) and 10 patients in the group P (13.9%) developed complications immediately or postoperatively. Patients in the group A need more days of care at ICU (2.36 vs 0.19 days, p<0.001). The longer survival was seen in the group P (15.4 vs 11.2 months) but without significant difference.

CONCLUSIONS: Patients in the group P required significantly less days of care at ICU. Besides, posterior approach also had a longer survival time, took a shorter surgical time, and had a less blood loss during surgery, although there was no statistically significant difference. Based on the results of this study, we would recommend posterior approach by decompression and fixation for those with thoracic metastatic tumor with epidural compression.

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

45. Patients with Unknown Primary Tumor have Longer Expected Survival after Surgery for Spinal Metastatic Disease

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BACKGROUND CONTEXT: Metastatic spine disease is a common complication to several malignancies. Selecting surgical or non-surgical treatment for symptomatic patients is a challenge for the clinician and even more in cases of cancer with unknown primary (CUP). The aim of this study was to compare the survival after spinal surgery due to metastasis from known versus unknown primary tumors.

METHODS: 315 adult patients (213 men, 102 women, mean age 67 years) undergoing spinal surgery at Uppsala University Hospital due to metastatic spine disease 2006-2012 were included. 245 of the patients had known primary tumor before surgery and 70 had CUP. Data was collected prospectively for the Swedish Spine Register and retrospectively from the medical records. Actual survival data from the Swedish Population Register was compared for the two groups.

RESULTS: The mean estimated survival time after surgery for patients with known primary tumor was 12.0 months (CI 10-14) and median 5.7 months (CI 4-7). For patients with CUP, the mean estimated survival was 19 months (CI 13-26) and median 12 months (CI 5-21). Six months after surgery, 52% of the patients in the group with known primary tumor were alive while 67% were alive in the CUP group. The difference in survival was statistically significant (p=0.03).

CONCLUSIONS: To our knowledge, this is the largest single-center cohort where survival for patients with known and unknown primary tumors before surgery for metastatic spine
Abstract Session: Diagnostics/Imaging

Wednesday, August 1, 2018
12:15–1:15 p.m.
Abstract Session: Diagnostics/Imaging

46. The Poor Neck Disability Index Score is Associated with Cervical Spinal Malalignment: The Cutoff Values of Japanese NDI
Shin Oe, MD1; Daisuke Togawa, MD, PhD2; Tomohiko Hasegawa, MD, PhD2; Yu Yamato, MD, PhD2; Go Yoshida, MD, PhD2; Sho Kobayashi, MD, PhD2; Tatsuya Yasuda, MD3; Tomohiro Banno, MD3; Hideyuki Arima, MD, PhD2; Yuki Mihara, MD3; Hiroki Ushirozako, MD2; Yukihiro Matsuyama, MD2
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BACKGROUND CONTEXT: Neck Disability Index (NDI) is frequently used to evaluate patients with cervical spine disease. However, few reports have defined the cut-off values of NDI, especially using volunteers.

PURPOSE: To investigate the cut-off values of and factors with a negative influence on NDI.

STUDY DESIGN/SETTING: Large cohort study using data of volunteers

PATIENT SAMPLE: elderly volunteers who participated in health screening study.

OUTCOME MEASURES: Neck disability index score, radiographic parameters in whole spine X-ray and questionnaire.

METHODS: A total of 487 volunteers who participated in the health screening study were divided into three groups: no disability (group N); mild disability (group M); and disability (group D). The cut-off values of NDI were then determined using receiver-operating characteristic (ROC) curves. These groups were divided into male and female groups and age adjustment was done, the factors with a negative influence on NDI were investigated using multiple logistic regression analysis.

RESULTS: Groups N, M, and D contained 207, 186, and 94 volunteers. The cut-off values of NDI in each group were 0–5%, 6–17%, and ≥ 18%. After adjusting for age, there were 65, 56, and 23 males in groups N, M, and D (mean age 77) and 92, 103, and 56 females in groups N, M, and D (mean age 75). In multiple logistic regression analysis, the factors with a negative influence on NDI were investigated using multiple logistic regression analysis.

CONCLUSIONS: Poor NDI score is associated with cervical spinal malalignment on whole-spine radiographs and manual labor in males and a lack of sports activity and sarcopenia in females.

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

47. Spinal Cord Swelling after Surgery in Cervical Spondylotic Myelopathy: Relationship with Intramedullary Gd-DTPA Enhancement on MRI
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BACKGROUND CONTEXT: Several cases regarding on the postoperative spinal cord swelling in cervical myelopathy have been reported. In the cases of the spinal cord swelling, the involvement in the intramedullary Gadolinium diethylenetriamine pentaacetic acid (Gd-DTPA) enhancement on MRI was mentioned. The clinical relevance of the spinal cord swelling remains still controversial. Baba et al (J Neurol 1997) reported that spinal cord swelling during the early postoperative period correlated significantly with the late postoperative neurological status. In contrast, Mastronardi et al (J Neurosurg Spine 2007) reported a nonsignificant correlation between postoperative swelling of the spinal cord and the postoperative JOA score and Nurick grade.

PURPOSE: Since there have been no systemic studies regarding the postoperative spinal cord swelling and the intramedullary Gd-DTPA enhancement, we investigated the prevalence and clinical relevance of the postoperative spinal cord swelling and the relationship with the intramedullary Gd-DTPA enhancement.

STUDY DESIGN/SETTING: Prospective multicenter study/4 hospitals in Japan

PATIENT SAMPLE: A total of 683 patients with cervical myelopathy who underwent laminoplasty were consecutively examined.

OUTCOME MEASURES: The prevalence of the intramedullary Gd-DTPA enhancement, the prevalence of the postoperative spinal cord swelling, the changes of the swelling at 1 year after surgery and the change of the Japanese Orthopedic Association (JOA) score for cervical myelopathy were investigated.

METHODS: T1, 2 and Gd-DTPA enhanced MRI were taken before surgery. The cases of intramedullary Gd-DTPA enhancement were allocated in enhancement group. Fifty consecutive cases without intramedullary Gd-DTPA enhancement were allocated in non-enhancement group. The both groups underwent MRI examination in 1 month after surgery. The definition of the spinal cord swelling was that the AP diameter of the spinal cord at the decompression level was larger than that of the normal spinal cord at the head and caudal level at 1 month after surgery in the mid-sagittal T1 weighted image of the MRI.

RESULTS: Prevalence of the intramedullary Gd-DTPA enhancement (intramedullary enhancement was observed in 50 cases (7.3%) out of 683 cases of cervical myelopathy. In 24 cases (60%) out of the 40 cases that underwent Gd-DTPA enhanced MRI examination, the enhancement disappeared. In 15 cases, the enhancement still remained, but decreased in area and intensity. Prevalence of the spinal cord swelling at 1 month after surgery and changes of the swelling at 1 year after surgery The postoperative spinal cord swelling was observed in 2 cases (4%) in non-enhancement group and 13 cases (26%) in enhancement group at 1 month after surgery. The prevalence of
the spinal cord swelling was significantly higher in enhancement group (p=0.0038). The spinal cord swelling disappeared in all cases in non-enhancement group and remained in 3 of 13 cases (23%) in enhancement group at 1 year after surgery. Relationship between the spinal cord swelling and the JOA score in 1 year after surgery. In comparison among the 4 groups (the swelling cases and non-swelling cases in enhancement group, the swelling cases and non-swelling cases in non-enhancement group), there were no significant differences of the JOA score among groups before surgery. By multiple regression analysis, the intramedullary Gd-DTPA enhancement (t ratio: 3.02, p<0.01) rather than the spinal cord swelling (t ratio: 0.68, p=0.5) made a significant influence in deterioration of the recovery rate of the JOA score.

CONCLUSIONS: The spinal cord swelling was observed more frequently and remained longer in the Gd-DTPA enhancement cases; on the other hand, the swelling was rarely observed in non-enhancement cases, and it disappeared later. The intramedullary Gd-DTPA enhancement rather than the spinal cord swelling significantly revealed the deterioration of the recovery rate of the JOA score after surgery.

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

48. Foraminal Stenotic Ratio to Identify Lumbar Foraminal Stenosis Requiring Surgery or Not: MRI Study Using 3D T1 SPACE Sequence

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BACKGROUND CONTEXT: Lumbar foraminal stenosis (LFS) is still difficult to diagnose. Obliteration of the perineural fat on parasagittal images on magnetic resonance imaging (MRI) has long been the recommended methods for diagnosing LFS. However, several authors have been reported there were many false-positive cases in that method. Moreover, no study has investigated the radiological differences between patients requiring surgery and those with successful conservative treatment.

PURPOSE: We focused on stenotic length in the neural foramen to diagnose LFS, and proposed novel diagnostic parameter, foraminal stenotic ratio (FSR). The purpose of this study was to investigate the diagnostic accuracy of a FSR, using 3D-MRI for LFS at L5-S by comparing patients requiring surgery, those with successful conservative treatment, and asymptomatic patients.

STUDY DESIGN/SETTING: Retrospective radiologic comparative study

PATIENT SAMPLE: This study included patients who were aged ≥ 40 years and taken MRI of 3D T1 Sampling Perfection sequence using MRI. Application optimized Contrasts using different flip angle Evolution (SPACE) sequence to diagnose of lower leg radicular pain. Exclusion criteria were patients with prior lumbar surgery, or acute trauma. Patients who exhibited intra-canal stenosis at L4-5 were also excluded according to Schizas classification. A total of 84 patients, 168 L5-S foramina, were included in this study. Foramina were divided into three groups following standardized treatment: stenosis requiring surgery (20 foramina), stenosis with successful conservative treatment (26 foramina), and asymptomatic stenotic foramen (122 foramina).

OUTCOME MEASURES: Obtained images of 3D-MRI were reconstructed to the oblique coronal and sagittal images along L5-S foramen. A slice of perineural fat obliteration at the oblique sagittal images was defined as positive for LFS. The FSR was calculated as the ratio of the length of the stenosis to the length of the foramen on the reconstructed oblique coronal image, referring to perineural fat obliterations in whole oblique sagittal images. We also evaluated foraminal nerve angle and minimum nerve diameter on reconstructed images, and Lee classification on conventional T1 images.

METHODS: The differences in each parameter of MRI between the groups were investigated. Receiver operating characteristic (ROC) curves were plotted and calculated the area under the curve (AUC) to predict patients requiring surgery.

RESULTS: FSR showed a stepwise increase when comparing asymptomatic, conservative, and surgical groups (mean, 8.6±13.9%, 38.5±18.5%, 54.9±21.4%, respectively). Only FSR was significantly different between the surgical and conservative group (p = 0.002), whereas all parameters were significantly different comparing the symptomatic and asymptomatic groups. The ROC curve showed that the area under the curve for FSR was 0.742, and the optimal cutoff value for FSR for predicting a surgical requirement in symptomatic patients was 50% (sensitivity, 75%; specificity, 80.7%).

CONCLUSIONS: FSR was useful parameter to identify LFS requiring surgery among symptomatic patients, with moderate accuracy. Foramina occupied ≥ 50% by fat obliteration were likely to fail conservative treatment, with a positive predictive value of 75%. This information is useful to predict surgical requirement on LFS.

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

49. Prevalence of Cervical Myelopathy and Symptomatic Lumbar Spinal Stenosis among Participants with Radiographic Tandem Spinal Stenosis

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BACKGROUND CONTEXT: The term ‘tandem spinal stenosis’ (TSS) was first introduced by Dagi to describe concurrent symptomatic cervical and lumbar spinal stenosis. The number of concurrent cervical myelopathy and lumbar spinal stenosis cases will be expected to increase more and more in the aging society. In patients with both cervical myelopathy and lumbar spinal stenosis, it is sometimes difficult to discriminate between the independent and merger presentation.

PURPOSE: The first purpose of this study was to determine the prevalence of radiographic TSS using MRI and its association with developmental canal stenosis. The second purpose was to investigate the extent to which radiographic TSS is associated with cervical myelopathy and symptomatic LSS.

STUDY DESIGN/SETTING: Cross sectional study

PATIENT SAMPLE: We recruited 1,011 (336 men and 675 women) participants in this population-based study.

OUTCOME MEASURES: Cervical myelopathy and symptomatic LSS made by presentation of both symptoms and radiographic compression using MRI.
METHODS: After excluding those with a pacemaker, a history of cervical or lumbar surgery, disqualification, the MRI data of whole spine was analyzed in 931 (mean, 67.3 years) participants. Cervical cord compression (CCC) and radiographic lumbar spinal stenosis (LSS) was evaluated by MRI. The canal-to-body ratio was also measured by plain X-ray. DCS was diagnosed as canal-to-body ratio < 0.75.

RESULTS: The prevalence of CCC was 24.7%, that of radiographic LSS was 30.2%, and that of radiographic TSS was 11.0% (men, 14.1%; women, 9.4%). The prevalence of CCC was 45.3% in men and 31.7% in women in the LSS group and significantly higher compared to that of the non-LSS group (p < 0.001). The prevalence of TSS was significantly higher in the DCS group than in the non-DCS group (p < 0.001). Among the participants with radiographic TSS, the prevalence of cervical myelopathy and symptomatic LSS was 9.8% and 18.6%, respectively. The coexisting cervical myelopathy and symptomatic LSS was 6.1% in the participants with LSS.

CONCLUSIONS: The present study is the first population-based study to clarify TSS characteristic using whole-spine MRI. This study also confirmed a significant association between TSS and developmental canal stenosis in a population-based cohort. Among the participants with radiographic TSS, the prevalence of cervical myelopathy and symptomatic LSS was 9.8% and 18.6%, respectively. These characteristics should be considered for management of LSS.

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

50. Relationship Between Cauda Equina Conduction Time and Type of Neurogenic Intermittent Claudication Due to Lumbar Spinal Stenosis
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BACKGROUND CONTEXT: Lumbar spinal stenosis (LSS) is a degenerative disease of the spine and the most common reason for spinal surgery in elderly people. The opportunities and the need for the diagnosis of LSS are increasing. Magnetic resonance imaging (MRI) is the most popular method for evaluating patients with LSS. Radiological findings for LSS patients include a small dural sac cross-sectional area (DSCA) in the cauda equina on MRI. However, LSS may be asymptomatic, and it is difficult to assess quantitatively. The previous studies reported that the cauda equina conduction time (CECT) measured using magnetic stimulation over the lumbosacral spine was useful for diagnosing cauda equina dysfunction; CECT may have been prolonged due to demyelination of the cauda equina caused by severe stenosis of the dural sac. Measuring CECT would be a useful method for evaluating dysfunction of the cauda equina, rather than radiculopathy, for LSS patients.

CONCLUSIONS: The values of CECT differed significantly between the three types of NIC: CE-type, 5.6 ± 1.1 ms; MX-type, 5.1 ± 0.9 ms; and R-type, 4.0 ± 0.9 ms. CECT for patients with cauda equina symptoms (i.e., CE-type and MX-type) was prolonged significantly compared to that for the R-type patients. The mean values of DSCA were as follows: CE-type, 42.8 ± 18.7 mm2; MX-type, 49.6 ± 20.9 mm2; and R-type, 75.3 ± 19.1 mm2. There were significant negative correlations between CECT and DSCA for the two patient groups with cauda equina symptoms (CE-type, P < 0.01, R = -0.44 and MX-type, P < 0.01, R = -0.49), but no significant correlation was found for the R-type patient group (P = 0.66).

51. Thoracic Spine Translation and Angular Motion: An Analysis Using Thoracic Spine Kinematic MRI (kMRI)
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BACKGROUND CONTEXT: Thoracic spine is the stiffest and least segmentally mobile region of the spine. Only few studies have analyzed the angular segmental range of motion in the thoracic spine, and most of them were cadaveric studies. No study has evaluated thoracic segmental mobility and thoracic disc degeneration using weight-bearing kinematic analysis in patients.

PURPOSE: To evaluate the disc degeneration and kinematic changes in translation and angular motion of the thoracic spine.
(T4-T12) using kinematic MRI (kMRI).

**STUDY DESIGN/SETTING:** Retrospective study

**PATIENT SAMPLE:** 105 patients (62 male) who underwent thoracic spine kMRI.

**OUTCOME MEASURES:** Translation motion, angulation motion, disc space height, and disc degeneration were measured at each spinal segment from T4-5 to T11-12 in flexion, neutral, and extension positions

**METHODS:** The MRAnalyzer3 (TrueMRI Corp., Bellflower, CA) was used to evaluate the kinematic translation and angulation motion among three positions at each thoracic spinal segment. The disc height was measured as a vertical line at the midpoint of inferior vertebral endplate of cephalad vertebra and the mid-point of the superior vertebral endplate of the vertebra below at each intervertebral disc level. Disc degeneration was graded according to the Pfirrmann grading system. The Friedman test was used to test the significant difference in each measurement parameter between T4-5 to T11-12, the p-value of less than 0.05 was considered statistically significant. The Wilcoxon-signed rank test was used for post-hoc analysis at each significant level from Friedman’s test with a Bonferroni correction. A p-value of 0.00625 was used to establish a statistically significant difference in post hoc analysis. The Spearman rank correlation tests was used to analyzed the correlation between disc degeneration grading and the translation and angulation motion at each thoracic segment.

**RESULTS:** T4-5 had the least of translational motion, while T10-11 had the most of translational motion. The lower thoracic levels (T8-9 to T11-12) showed significantly more translational motion, more advanced disc degeneration, and higher disc height than the upper thoracic levels (T4-5 to T7-8, p<0.0001). T11-12 showed the most advanced disc degeneration. There was an increase in the angular motion in lower thoracic spine levels (p=0.394). There was a statistically significant negative correlation between disc degeneration and translational motion at upper thoracic levels (p = 0.013), but there was no significant correlation in lower thoracic levels.

**CONCLUSIONS:** The thoracic spine revealed kinematic changes in response to positional changes. Lower thoracic levels (below T8) had significantly more translational motion, more advanced disc degeneration, and greater disc height. This information is crucial in understanding thoracic spine kinematics and may help in determine a stopping level in fusion surgeries.

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

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52. Voxel-Based Morphometric Values of the Brain in Patients with Chronic Low Back Pain

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**BACKGROUND CONTEXT:** Voxel-based morphometry (VBM) is a diagnostic imaging technique to analyze brain morphology. Changes of gray matter volumes in the brain in patients with chronic low back pain (cLBP) is still unclear.

**PURPOSE:** Our purpose is to examine characteristic morphological changes in the brain in patients with cLBP using VBM.

**STUDY DESIGN/SETTING:** Cross-sectional study in single pain management center.

**PATIENT SAMPLE:** We included 53 patients older than 20 years with cLBP in single pain management center using consecutive sampling method from November 25, 2010 to December 13, 2015.

**OUTCOME MEASURES:** The Z-score for each voxel was computed by comparison with data regarding the mean and standard deviation (SD) of images of age-matched healthy volunteers stored in normal database, IXI dataset, adjusting for East-Asian.

**METHODS:** VBM-based brain anatomical analysis was performed using a 3-T MRI device and analytical software (DARTEL with SPM8). For region-of-interest (ROI) examination, an anatomical model, developed by the Montreal Neurological Institute (MNI) in Canada, was adopted.

**RESULTS:** In patients with cLBP, VBM analysis showed gray matter volumes are significantly decreased in the amygdala (Z-score mean±SD; Right 3.44±1.61 Left 3.05±1.40), the posterior entorhinal cortex (BA: Brodmann area-28) (Right 2.75±1.53 Left 2.22±1.38) and the anterior entorhinal cortex (BA-34) (Right 3.00±1.54 Left 2.85±1.55) on both sides after adjusting age and total intracranial volume. It is also observed that gray matter volumes are significantly decreased in the amygdala (p-value=0.0038) and the posterior entorhinal cortex (BA-28) (p-value=0.0001) on right hemisphere than left hemisphere. On the other hands, it is not observed significant difference in decrease of gray matter volumes in the anterior area (BA-34) (p-value=0.1738) on both sides.

**CONCLUSIONS:** In the present study, we detected that gray matter volumes in the amygdala, the posterior entorhinal cortex (BA-28), and the anterior entorhinal cortex (BA-34) are significantly decreased in patients with cLBP. There also were lateral differences in the volume reduction of the amygdala and BA-28 in patients with cLBP. Volume reductions of gray matter and lateral differences in specific area in patients with cLBP might be associated with the cLBP mechanisms.

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

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53. Preventing Perioperative Complications in Adult Spinal Deformity Surgery Using a Simple Sliding Scale

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**BACKGROUND CONTEXT:** Surgical treatment for adult spinal deformity may have high perioperative complication rates, which is associated with increased morbidity and mortality. Recent studies have shown the incidence of perioperative complications of ASD surgery and its risk factors, such as patients age, past
medical history and comorbidities, medication, American Society of Anesthesiologists (ASA) score, or operative invasiveness. Despite the great number of identified predictors, there is no simple evaluation tool to quickly assess the likelihood of perioperative complications.

**PURPOSE:** To develop and validate a sliding scale for preventing perioperative complications associated with adult spinal deformity surgery.

**STUDY DESIGN/SETTING:** Retrospective database study

**PATIENT SAMPLE:** Data on consecutive ASD patients undergoing posterior corrective surgery over a six-year interval were collected from a prospective database. ASD was defined as the presence of at least one of the following indicators: degenerative or idiopathic scoliosis with spinal curvature greater than 20 degrees in the coronal plane, C7 sagittal vertical axis greater than 50 mm, pelvic tilt greater than 25 degrees, and/or thoracic kyphosis greater than 60 degrees. The inclusion criteria were age 18 years or older, number of fused vertebra totalling four or more segments, availability of standing whole-spine and pelvic radiographs, and informed consent for participation in the present study. The patients who were not followed up for at least one year were excluded.

**OUTCOME MEASURES:** Patients demographic variables included age, sex, height, weight, body mass index (BMI), current intake of alcohol and tobacco, medication, comorbidities, ASA grade, Charlison comorbidity index, and the pathology of the deformity. The pathology of deformity was divided into the following categories: degenerative scoliosis, degenerative kyphosis, adult idiopathic scoliosis, deformity after vertebrectomy, iatrogenic deformity, deformity after Parkinson disease, and post-infection deformity. Perioperative complications were defined as any event for which the patients required a specific intervention or treatment within 30 days of surgery. A complication was categorized as either neurological, operative, infection, cardiac, respiratory, pulmonary or deep venous thrombosis, gastrointestinal, or delirium. In this study we excluded implant related complications, adjacent problems, as well as radiographic changes.

**METHODS:** To perform a train-test sample cross-validation, the data set was randomly divided into a training set (66.8%, n=203) and validation set (33.2%, n=101). Univariate logistic regression analysis (ULRA) was applied in the training dataset to separately identify potential risk factors for perioperative complications. The significant continuous variables and significant variables with multiple responses in the ULRA were redefined and dichotomized using receiver operating curve (ROC) analysis. Those variables that remained significant together with significant categorical variables in the ULRA were entered into a multiple logistic regression analysis (MLRA) to identify independent risk factor for perioperative complications.

**RESULTS:** Included were 304 patients with a mean age of 62.9 years. Of those, 108 patients (35.5%) were affected by at least one perioperative complication with a total of 195 perioperative complications including neurological (12.8%), excessive blood loss (11.2%), delirium (11.2%), and infection (3.6%). Total independent predictors were age (OR: 1.042), operative time (OR: 2.015), and estimated blood loss (OR: 4.885) with cut off values of approximately 70 years, 6 hours and 2000ml, respectively. Fusion of more than 10 segments (OR: 2.262), three column osteotomy (OR: 1.860), current intake of antihypertensives (OR: 2.595) and anticoagulants (OR: 7.013) and body mass index (OR: 1.160) were risk factors for neurological complications, infection, and deep vein thrombosis/pulmonary thrombosis. Using our proposed sliding scale, the incidence of perioperative complication in the validation dataset was quite smaller than that without this scale (p<0.05).

**CONCLUSIONS:** Patients age, current medication, and degenerative pathology might be independent preoperative as well as operative predictors in addition to blood loss and operative time. An age and comorbidities based sliding scale with classifications of blood loss and operative time may be useful for risk prevention in high risk ASD surgery.

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**54. Does Excessive Distraction of Disc Space with Lateral Lumbar Interbody Fusion Induce Risk of Adjacent Segment Degeneration?**

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**BACKGROUND CONTEXT:** In lateral lumbar interbody fusion (LLIF), a large cage is inserted between vertebral bodies to open up disc space to provide local correction and indirect decompression effects. However, several studies reported that excessive disc space distraction during posterior approach interbody fusion induce risk of adjacent segment degeneration (ASD).

**PURPOSE:** Purpose of this study is to investigate the distracted disc height of the fused segment caused by large cage insertion during LLIF induce risk of ASD as well as other posterior approach interbody fusion.

**STUDY DESIGN/SETTING:** Retrospective study.

**PATIENT SAMPLE:** A total 44 consecutive patients with lumbar degenerative spondylolisthesis and disc degeneration were treated single (L4-5) or 2 levels (L3-4-5) LLIF with posterior percutaneous pedicle screw fixation.

**OUTCOME MEASURES:** The proximal ASD was evaluated before surgery, just after surgery, and at the 1 and 2 years after surgery on the lateral functional radiograph. Radiographic ASD after LLIF is defined by development of spondylolisthesis greater than 3 mm, a decrease in disc height of more than 20%, or inter vertebral angle at flexion smaller than -5°.

**METHODS:** The L4-5 disc space after single level LLIF and L3-4 disc space after 2 levels LLIF was measured before surgery and just after surgery on the lateral radiograph in neutral position. The disc spaces were measured the distance between the anterior edge of the upper and lower endplate and posterior edge of them. A mean of anterior and posterior disc space was defined as disc height and change of disc height between before and just after surgery were defined as opening distance. Fourteen patients were evaluated as radiographic ASD(+) and 30 patients were ASD(-) at the 2 years after surgery. We assessed opening distance of disc space retrospectively and compared them between ASD(+) and ASD(-).

**RESULTS:** In ASD(+) group, mean age was 70.9 years, single level LLIF was performed for 9 patients and 2 levels LLIF was performed for 5 patients. In ASD(-) group, mean age was 69.6 years, single level LLIF was performed for 16 patients and 2 levels LLIF was performed for 14 patients. A mean opening distance was 3.5 ± 2.8mm in ASD(+) group and 1.7 ± 3.5 in the ASD(-) group. There is statistically significant deference between two groups (p= 0.04).

**CONCLUSIONS:** We investigated that distracted disc height of the fused segment caused by large cage insertion during LLIF induce risk of radiographic ASD as well as posterior...
approach interbody fusion. Therefore, excessive distraction of disc space with LLIF might be a considerable risk factor for the development of clinically symptomatic ASD.

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### 55. The Incidence of Proximal Junctional Kyphosis Increases in Patients with Large Change of Thoracic Kyphosis after Surgery

Shin Oe, MD; Daisuke Togawa, MD, PhD; Tomohiko Hasegawa, MD, PhD; Yu Yamato, MD, PhD; Go Yoshida, MD, PhD; Sho Kobayashi, MD, PhD; Tatsuya Yasuda, MD; Tomohiro Banno, MD; Hideyuki Arima, MD, PhD; Yuki Mihara, MD; Hiroki Ushirozako, MD; Yukihiro Matsuyama, MD, PhD

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**BACKGROUND CONTEXT:** The preoperative risk factors and mechanism of proximal junctional kyphosis (PJK) is still unclear in ASD surgery. However, it is important to identify the risk factors and the mechanism because PJK is common and severe complication.

**PURPOSE:** The purpose of this study is to investigate the preoperative risk factors for PJK in adult spinal deformity (ASD) surgery.

**STUDY DESIGN/SETTING:** Retrospective study in single institution

**PATIENT SAMPLE:** The patients who underwent ASD surgery in our hospital.

**OUTCOME MEASURES:** The evaluation items were radiographic parameters in whole spine X-rays, Oswestry Disability Index, and SRS-22.

**METHODS:** A total of 185 patients who were followed up over two years and underwent ASD surgery were recruited. PJK was defined as proximal junctional angle ≥20° or re-operation due to PJK within 2 years after the surgery. These patients were divided into the PJK and non-PJK groups. Whole-spine standing X-ray was performed before, immediately, 1 year, and 2 years after the surgery.

**RESULTS:** The PJK and non-PJK groups had 58 and 127 cases, respectively. The incidence of PJK according to preoperative thoracic kyphosis (TK) had significant difference, which were 37% (TK 19°), 33% (TK of 20-29°), 9% (TK of 30-39°), 32% (TK of 40-49°), and 41% (TK ≥50°), respectively (P<0.05). The logistic regression analysis suggested that ΔTK (amount of change in TK before and just after the surgery) was significant risk factor for PJK (P<0.001, Odds ratio 1.062).

**CONCLUSIONS:** The ΔTK was smaller in group of TK of 30-39° because TK of patients who underwent ASD surgery converged to 34.5° just after the surgery. As a result, the patients with lower TK or higher TK was likely to get large ΔTK just after the surgery. The patients who had optimal TK (30-39°) had less risk for PJK because the mechanism of PJK was amount of change in TK before and just after the surgery.

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### 56. Psychiatric Disorders Increase the Rate of Postoperative Infection and Wound Complications after Lumbar Spine Surgery

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**BACKGROUND CONTEXT:** There has been an increase in the prevalence of psychiatric disorders with the depression and anxiety being the most common diagnoses. Poor treatment outcomes and higher medical expenses for the patients with psychiatric disorders have been reported in various medical subspecialties including orthopaedics. To the best of our knowledge, there is no study focusing on the effect of psychiatric disorder on the incidence of Postoperative infection and wound complications following major lumbar spine surgery.

**PURPOSE:** To evaluate the effect of psychiatric disorders on the development of Postoperative infection and wound complications at one and three months following major lumbar spine surgery.

**STUDY DESIGN/SETTING:** Retrospective Study using Humana database from 2007-2016 (PearlDiver® Technologies).

**PATIENT SAMPLE:** Patients who underwent anterior or posterior lumbar surgery, from 2007 to the first quarter of 2016.

**OUTCOME MEASURES:** Presence of Postoperative infection and surgical wound complication at one and three months. The Postoperative infections were defined as surgical site infection, urinary tract infection, catheter related infection, and sepsis related infection. The surgical wound complications were defined as wound disruption, hematoma or seroma at surgical wound, and non-healing surgical wound.

**METHODS:** The nationwide Humana private insurance database was queried using International Classification of Diseases 9th edition and Current Procedural Terminology codes. Patients who underwent primary lumbar spine surgery were subdivided into two groups: patients who had a diagnosis of psychiatric disorders and patients who did not have a psychiatric disorder prior to surgery. Regarding psychiatric disorders, Major Depressive Disorder, Bipolar, Anxiety, and Schizophrenia were used in this study. The occurrence of infection and wound complications were investigated at one and three months Postoperatively. The Chi-Square test was used to calculate the p-value, Odd-ratio (OR), and 95% Confidence Interval (95%CI).

**RESULTS:** A total of 66,102 patients were included in this study, with 9.5% (6,279) of the patients having a psychiatric disorder. Patient with psychiatric disorder had a significantly higher rate of Postoperative infection compared to the patients without psychiatric disorder at one (2.5% vs. 0.8%; OR 3.266, 95%CI 2.728-3.912, p-value < 0.001) and three months (3.75% vs. 1.12%; OR 3.427, 95%CI 2.984-3.984, p-value < 0.001) Postoperatively. Furthermore, the incidence of wound complication was significantly higher in patients with mental disorder than in patients without psychiatric disorder at one and three months (3.04% and 4.4% vs. 1.1% and 1.44%, respectively). Patients with psychiatric disorder were significantly more prone of having Postoperative wound complication at both one and three months Postoperatively (1 month: OR 2.89, 95%CI 2.452-3.401, p-value < 0.001; 3 month: OR 3.149, 95%CI 2.744-3.615, p-value < 0.001).

**CONCLUSIONS:** Patients with psychiatric disorders had...
significant] higher rate of Postoperative infection and surgical wound complications at one and three months Postoperatively. Psychiatric disorders play an important role in the onset of Postoperative complications and patients with those disorders should be carefully evaluated and informed about the potential risk of complications.

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### 57. Robotic-Assisted Lumbar Fusion Fails to Reduce Perioperative Complications

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**BACKGROUND CONTEXT:** Surgeons have increasingly adopted robotic-assisted lumbar spinal fusion due to indications that robotic-assisted surgery can reduce the percentage of misplaced screws. However, the impact of robotic-assisted spinal fusion on patient outcomes is less clear.

**PURPOSE:** This study aims to compare rates of perioperative complications between robotic-assisted and conventional lumbar spinal fusion.

**STUDY DESIGN/SETTING:** Retrospective Cohort Study.

**PATIENT SAMPLE:** A total of 520 patients undergoing lumbar fusion were analyzed. The average ages of patients in the robotic-assisted versus conventional groups were 60.33 and 60.31, respectively (p=0.987). Patients with a diagnosis of fracture, traumatic spinal cord injury, spina bifida, neoplasia, or infection were excluded.

**OUTCOME MEASURES:** This study compared the rates perioperative major and minor complications for elective lumbar fusion between each cohort.

**METHODS:** This study screened over 35 million hospital discharges in the United States from 2010 to 2014 using the National Inpatient Sample and the Nationwide Inpatient Sample (NIS). The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes were used to identify 209,073 patients who underwent conventional lumbar fusion (ICD 81.04-8) and 279 patients who underwent robotic-assisted lumbar fusion (ICD 81.04-8 and ICD 17.41, 17.49). Major and minor perioperative complications were identified using ICD-9-CM diagnosis codes. Patient mortality was determined using the Uniform Bill patient disposition. The robotic-assisted and conventional fusion groups were statistically matched on age, year of procedure, sex, surgical indication, race, hospital type, and comorbidities. Mean hospital cost and length of stay (LOS) for each cohort were calculated and compared using the Kruskal Wallis H test. Univariate and multivariate logistic regression were used to compare risks of major and minor complications between the cohorts.

**RESULTS:** We matched 260 (93.19%) robotic-assisted patients with patients undergoing conventional lumbar fusion. Too few patients in each cohort died to report the mortality rate based on NIS minimum reporting standards. Minor complications occurred in 16.9% of the conventional group and 32.7% of the robotic-assisted group (p<0.001). Major complications occurred in 4.62% of the conventional patients compared to 6.15% of robotic-assisted patients (p=0.436). Multivariate analysis revealed that for robotic-assisted fusion patients, there was no difference in the likelihood of experiencing major complication (OR=0.467, 95% CI=0.113-1.929) or minor complication (OR=1.157, 95% CI=0.525-2.552). The average LOS was greater for robotic-assisted fusion (x=4.30, SD=2.555) compared to conventional fusion (x=3.90, SD=2.823, p=0.009). Additionally, the average inpatient hospital cost of robotic-assisted fusion was $59,514 (SD=44,105) compared to $35,858 (SD=24,012) for the conventional procedure (p<0.001).

**CONCLUSIONS:** In a statistically matched cohort, patients undergoing robotic-assisted elective lumbar fusion had similar rates of major and minor complications compared to patients who underwent conventional lumbar fusion. Additionally, patients in the robotic-assisted cohort had significantly longer LOS and incurred greater hospital costs.

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### 58. Sarcopenia Predicts Overall Survival in Patients with Lung, Breast, Prostate, or Myeloma Spine Metastases, Regardless of Histology

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**BACKGROUND CONTEXT:** Creating accurate markers of survival for patients with cancer could lead to improvements in treatment strategy recommendations, which may include chemotherapy, radiation, surgery, and/or palliation. This is especially relevant for patients with spinal metastasis as they may benefit from surgery but are also at high risk for morbidity. The current available scoring systems designed to guide surgical decision making in this population have shown to be inaccurate. Frailty and sarcopenia are emerging as novel predictors of postoperative morbidity, as well as overall survival in oncologic patients. We have previously shown that sarcopenic patients with lung cancer spinal metastasis have decreased overall survival. This study expands on our prior method and investigates other histologies.

**PURPOSE:** Our hypothesis is that sarcopenia can be used to predict overall survival in patients with lung, breast, prostate, or multiple myeloma metastasis to the spine. We predict that survival will be irrespective of histology.

**STUDY DESIGN/SETTING:** This was a retrospective cohort study.

**PATIENT SAMPLE:** There were 417 patients with lung, breast, prostate, or multiple myeloma metastases to the spine. We have previously shown that sarcopenic patients with lung cancer spinal metastasis have decreased overall survival. This study expands on our prior method and investigates other histologies.

**RESULTS:** There were 417 patients with spinal metastases. The average age was 66.3, with an equal proportion of males and females. Ethnicities were 52% Caucasian, 40% African American, and 4% other. 40% received single level SBRT; the
median SBRT target volume was 53.1cc. The median survival for all patients was 173 days (95% CI=140 to 204 days). Patient age, gender, ethnicity, number of levels treated with SBRT, and SBRT target volume did not affect overall survival. Patients with myeloma had longer survival (p=0.05) compared to patients with lung, breast, or prostate cancer. There was no survival difference between patients with lung, breast, or prostate cancer. Multivariate analysis showed that average psoas size significantly predicted overall survival. Patients in the 1st tertile (smallest muscle area) for average psoas size had significantly shorter survival as compared to the 3rd tertile (largest muscle area): 115 vs 299d (hazard ratio (HR) 1.90, p<0.001). The shorter survival was also true for the 1st tertile versus the 2nd tertile: 115 vs 154d (HR=1.37, p=0.013). Patients in the 2nd tertile also had significantly shorter survival than the 3rd tertile (HR=1.39, p=0.015). Patients who had an average psoas size below the mean also had a statistically significant decrease in survival (HR=1.66, p<0.001). Kaplan-Meier survival curves illustrate the differences in survival between different tertiles (Log-Rank p<0.001).

CONCLUSIONS: Sarcopenia as measured by psoas size can accurately predict survival in patients with lung, breast, prostate, or multiple myeloma metastasis to the spine, regardless of cancer histology.

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

59. Is Chronic Kidney Disease Associated with Postoperative Complications after Spinal Fusion Surgery?

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BACKGROUND CONTEXT: Renal osteodystrophy is a known sequela of CKD. Chronic kidney disease patients who undergo spine surgery, specifically spinal fusions, may be at increased odds for postoperative complications. The current literature that has reported on the postoperative complications in this patient cohort is sparse.

PURPOSE: This study evaluated the: (1) demographics; (2) complications (medical and surgical); (3) LOS; and (4) re-operations. We hypothesize that patients who have chronic kidney disease (CKD) will experience an increased odds of medical and surgical complications after undergoing 2-3-level spinal fusions.

STUDY DESIGN/SETTING: Retrospective review of a prospectively collected database

PATIENT SAMPLE: All patients who underwent 2-3-level spinal fusions between 2009 and 2013 and were eligible for at least a 2-year follow-up were identified from the New York State Statewide Planning and Research Cooperative System (SPARCS) database. A total of 1,644 propensity score matched patients and propensity score matched on age, sex, race, and Charlson/Deyo score. Demographic information including age, sex, race, and Charlson/Deyo score were collected, in addition to hospital lengths of stay (LOS) and total charges. Univariate analysis was used to compare demographics, complications (medical and surgical), and re-operations between CKD and non-CKD cohorts. Using multivariate logistic regression, the factors independently associated with medical and surgical complications were identified (covariates: age, gender, and Charlson/Deyo score).

RESULTS: A total of 1,644 propensity score matched patients were included (CKD: n= 822; non-CKD: n= 822). Overall, whites comprised a majority (74.6%) of patients with CKD who received 2-3-level spinal fusions. The next two most common races were black (14.8%) and Hispanic (5.1%). In these patients, 51.8% were male and 48.2% were female (p=0.02). Regression analysis revealed that compared to non-CKD patients, CKD patients had a greater than 400% increased odds of having a postoperative medical complication (OR= 4.30, p<0.001). Additionally, medical complications were independently associated with patient age, sex, and race at admission. Older individuals were more likely to have medical complications (OR= 1.015, p=0.003), female sex was protective (OR= 0.803, p=0.039), and black patients were 38% more likely to have medical complications compared to other races (OR= 1.377, p=0.049). The Charlson/Deyo score was not associated with the development of complications (p=0.197). However, there was no significantly increased odds in surgical complications (p=0.136). Compared to the non-CKD cohort, the CKD cohort had a longer LOS (5.07 vs. 4.13, p=0.003). There were no significant differences in rates of re-operations between CKD and No-CKD groups (15.5 vs. 18.6%; p=0.88).

CONCLUSIONS:Patients who had CKD and underwent 2-3-level spinal fusions were at an increased odds for postoperative medical complications compared to patients without CKD. Moreover, there was no significant difference in re-operation rates between these two cohorts. This was the first study, to the best of our knowledge, to analyze postoperative complications at two-year follow-up for spinal fusion patients with or without CKD.

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

60. The Risk of Recurrent Laryngeal Nerve Injury with Laterality of Approach in Anterior Cervical Discectomy and Fusion Procedures: A Randomized, Prospective Study Over 10 Years

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BACKGROUND CONTEXT: Recurrent laryngeal nerve (RLN) injury is a well known, but potentially devastating injury after anterior cervical discectomy and fusion (ACDF) procedures. Although RLN injury is most often transient in nature, there are the associated clinical consequences of dysphonia, impaired phonation or cough reflex, airway obstruction, hoarseness, vocal fatigue, and in some cases, tracheotomy. There has been debate regarding the risk of RLN injury in relation to laterality of approach. There are numerous papers reviewing the complication, but there is no large-scale, randomized prospective single surgeon, single study investigating
PURPOSE: Determine whether laterality of approach in anterior cervical discectomy and fusion procedures correlates with risk of injury to recurrent laryngeal nerve

STUDY DESIGN/SETTING: A fellowship trained spine surgeon prospectively performed ACDFs between the years of 2003-2012. Side of approach was chosen based on contralateral to side of symptoms (i.e. right sided radicular symptoms approached from left side). Patients were monitored postoperatively for development of recurrent laryngeal nerve palsy symptoms. Patients found to have signs of recurrent laryngeal nerve injury were sent to ENT for evaluation and monitored for recovery.

PATIENT SAMPLE: 411 patients met inclusion from study in central Pennsylvania

OUTCOME MEASURES: Evidence of RLN injury (Dysphonia or dysphagia)

METHODS: A fellowship trained spine surgeon prospectively performed ACDFs between the years of 2003-2012. Side of approach was chosen based on contralateral to side of symptoms. Patients were monitored postoperatively for development of recurrent laryngeal nerve palsy symptoms and if suspected were sent to ENT for evaluation and monitored for recovery.

RESULTS: 411 ACDFs were performed during the 10-year period. 190 right sided and 221 left sided procedures were done. The incidence of recurrent laryngeal nerve injury was 14 (13 primary procedures and 1 revision). 7 nerve injuries were in a right sided approach and 7 were in a left sided approach. The risk of injury was 3.18% in a left sided approach and 3.70% in a right sided approach with a p-value of 0.7723 indicating that there is no significant difference between the sides of the approach.

CONCLUSIONS: In a single surgeon randomized prospective study there was no significant difference noted between the side of approach and the risk of recurrent laryngeal nerve palsy. Therefore, we recommend that surgeon approach anterior cervical spine from side they feel most comfortable at their own discretion, without any particular increased risk of RLN injury

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

61. Intraoperative Navigation Decreases the Risk of Reoperation for Implant-Related Complication Following Spinal Fusion Surgery

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BACKGROUND CONTEXT: Although spinal fusion surgery with intraoperative navigation is thought to have advantages on the accuracy for placement of spinal instruments, few large-scale study regarding the impact of intraoperative navigation on clinical outcomes following spinal fusion surgery has been reported.

PURPOSE: The purpose of this study was to elucidate impact of navigation on reoperation for implant-related complication or surgical site infection (SSI).

STUDY DESIGN/SETTING: Retrospective study using nationwide database.

PATIENT SAMPLE: The data of patients who underwent elective spinal fusion surgery from July 2010 to March 2013 were abstracted from the Diagnosis Procedure Combination database, a nationwide administrative inpatient database in Japan.

OUTCOME MEASURES: Reoperation for implant-related complication and SSI.

METHODS: The authors examined patient age, sex, body mass index (BMI), smoking status, Charlson Comorbidity Index (CCI), renal dialysis, blood transfusion, duration of anesthesia, hospital type, hospital volume, surgical site and use of intraoperative navigation. Multivariate analysis was performed to calculate the odds ratio (OR) for the occurrence of reoperation for implant-related complication and SSI, with adjustment for patient background characteristics.

RESULTS: A total of 42,878 eligible patients were identified. The mean age was 65.1 years (SD 13.2 years). Among all patients, 21,370 patients (49.8%) were male and 3,263 patients (7.6%) underwent spinal fusion surgery with intraoperative navigation. Overall, reoperation for implant-related complication occurred in 292 patients (0.68%), while reoperation for SSI in 383 patients (0.9%). Multivariate analysis showed reoperation for implant-related complication was associated with BMI, blood transfusion, duration of anesthesia, surgical site, and use of intraoperative navigation. Also, it revealed that reoperation for SSI was associated with age, sex, BMI, blood transfusion, duration of anesthesia, surgical site, hospital type and CCI. The risk of reoperation for implant-related complication was significantly lower in patients with intraoperative navigation compared to those without navigation (OR 0.613, 95% confidence interval 0.387-0.971), while use of navigation was not significant risk factor of the risk of reoperation for SSI.

CONCLUSIONS: In this nationwide database analysis, intraoperative navigation decreased the risk of reoperation for implant-related complication following spinal fusion surgery.

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

62. Readmissions, Length of Stay and Mortality after Primary Surgery for Adult Spinal Deformity: A 10-Year Follow-Up Study

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BACKGROUND CONTEXT: Adult spinal deformity (ASD) includes deformities in both the coronal and sagittal plane, with potential severe impact on health related quality of life. With increasing burden of ASD surgery data on postoperative morbidity and mortality are highly relevant.

PURPOSE: To provide detailed information on postoperative morbidity measured by length of stay (LOS), readmissions and mortality within 90 days after instrumented surgery for ASD.

METHODS: A 10-year cohort study on all patients >18 years undergoing primary instrumented surgery for ASD in the Capital Region of Denmark. Patients were identified in the Danish National Patient Registry using procedure codes for instrumented spine surgery and concurrent diagnosis of either kyphosis/lordosis or scoliosis. Medical records were reviewed for all patients.

RESULTS: 366 patients were identified, with a mean age of 48.5
years (range 18 – 83) and a median LOS of 8 days (Interquartile range 6 – 11). LOS >11 days was observed in 104 procedures (28.4%) and was mainly caused by “medically” related issues (68.3%), primarily pain/mobilization difficulties. 15 patients (4.1%) were discharged to a rehabilitation unit. The 90-days readmission rate was 18.0%. 68.2% of readmissions were “medically” related, most frequently due to opioid related side effects (18.2%) and pain/mobilization issues (15.2%). 31.8% of readmissions were “surgically” related and 16.7% required revision surgery. 90-days mortality was 0.8%, 2 patients died from cardiac arrest and 1 from surgical trauma.

CONCLUSIONS: We observed prolonged LOS and high 90-day readmission rate indicating room for improvement regarding postoperative morbidity. A future focus on implementation of fast-track principles with early mobilization and opioid sparing analgesia may reduce LOS and postoperative morbidity as shown in hip and knee arthroplasty surgery.

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

63. Clinical Correlations and Time-Dependent Changes in Trunk Muscle Size Reduction and Fatty Degeneration on Prognosis for Osteoporotic Vertebral Fracture

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BACKGROUND CONTEXT: Identification of risk factors associated with a poor prognosis for OVFs is important, but has not yet been clearly established. Despite paraspinal muscles could play an important role in the etiology of OVF, what influence time-dependent changes in paraspinal muscles after OVF, and the outcomes of conservative treatments for patients who have an OVF remain largely unknown.

PURPOSE: To evaluate time-dependent changes of the paraspinal musculature using MRI after injury in patients with osteoporotic vertebral fractures (OVFs), and compare paraspinal muscles between conservatively treated patients with OVF who have successful union and those with insufficient union.

STUDY DESIGN/SETTING: This is retrospective cohort study using consecutive patients.

PATIENT SAMPLE: A total of 115 consecutive patients older than 65 years who had sustained a recent OVF injury in the thoracolumbar region were assessed for eligibility using medical records. Patients who needed to undergo surgery and patients who were diagnosed as having insufficient union after 6-months of follow-up were assigned to a group with insufficient union. Insufficient union was diagnosed based on intravertebral vacuum clefts seen on plain radiography or CT, and apparent segmental motion on plain X-ray dynamic images after 6-month follow-up. Surgical treatment was indicated for patients with progressive neurological deficits or continuous severe lower back pain caused by insufficient vertebral bone union.

OUTCOME MEASURES: Lumbar trunk parameters, relative cross-sectional area (rCSA) and proportion of fat infiltration (FI%) were calculated from MRI. To evaluate the time-dependent changes in the paraspinal muscle in patients after OVF injury, correlations between the timing of MRI and rCSA/FI% were determined.

METHODS: To clarify the impact of paraspinal muscles on the outcome of conservative treatments of patients with OVF, we compared rCSA between the groups.

RESULTS: Patients who needed to undergo surgery and patients who were diagnosed as having insufficient union after 6-month follow-up were assigned to a group with insufficient union (n = 65) and the rest of the patients were assigned to a group with successful union (n = 25). The present study showed that rCSAs of total paraspinal muscles were positively correlated with BMD (YAM%) of patients with OVF. The timing of MRI after injury was not controlled because of the retrospective nature of the present study, but the average timing of MRI was 64.1 ± 13.71 days after the initial injury. We found a correlation between rCSA and FI% of paraspinal muscles and the timing of MRI after injury, and found FI% of the multifidus and erector muscles was positively correlated with the timing of MRI after initial injury. Interestingly, the rCSA of paraspinal muscles was not correlated with the timing of MRI after the initial injury. We found that the rCSA of the erector spinae of patients in the group with successful union was significantly larger than that in patients in the group with insufficient union.

CONCLUSIONS: Fatty degeneration of paraspinal muscles occurred after injury before muscle atrophy in patients with OVF and larger rCSAs of spinal erectors may play a role in reducing the risk of insufficient union in patients with OVF.

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

64. The Fate Thoracolumbar Surgeries in Patients with Parkinson Disease, and Analysis of Risk Factors for Revision Surgeries

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BACKGROUND CONTEXT: Parkinsons disease (PD) emerges a second common neurodegenerative condition after Alzheimer disease. Patients with PD usually present with poor bone quality, severe muscular dysfunction and abnormal posture. A few literatures reported the outcomes of these patients after spine surgeries were not satisfied because of a high complication rate. However, the study for analyzing risk factors in this kind of patients underwent spine surgeries is still limited.

PURPOSE: To evaluate what kind of complications in PD patients underwent thoracolumbar surgeries. And analysis of risk factors which leaded to revision surgeries.

STUDY DESIGN/SETTING: A retrospective study assessing clinical and radiographic outcomes.

PATIENT SAMPLE: Sixty-six patients.

OUTCOME MEASURES: Any reason for revision surgery was recorded. Risk factors including patients’ factors, surgical factors, and lumbo-pelvic radiographic parameters were analyzed.

METHODS: From October 2004 to April 2015, patients with PD underwent thoracolumbar instrumented surgery were evaluated. Patients’ factors included patients’ underlying diseases, body mass index (BMI), osteoporotic status, and PD’s severity using modified Hoehn and Yahr stage for representation. Surgical factors included surgical levels, extending to thoracic spine or not, corrective osteotomy, with anterior approach or not,
and interbody device. Radiographic parameters included lumbar lordosis (LL), sacral slope (SS), pelvic tilting (PT), pelvic incidence (PI), coronal Cobb’s angles, score for spino-pelvic realignment achievement.

**RESULTS:** A total of 66 patients with PD were treated with instrumented thoracolumbar spinal surgery at our department during this period. The mean patient age at surgery was 69 years old. The mean follow-up time was 51.2 months. Twenty-six revision surgeries were required in 19 patients (29%), with the most common type of hardware failure (8 surgeries, 31%). Risk factors for revision surgery included modified Hoehn and Yahr stage ≥3 (P=0.000), cancer history (P=0.024), osteoporosis (P=0.012) and underwent corrective osteotomy (P=0.035). In binary logistic regression analysis, the modified Hoehn and Yahr stage ≥3 (P<0.001) was the only one independent risk factor. The Kaplan-Meier analysis revealed the trend of earlier revision in those with longer instrumentation (surgical levels > 3), T-spine instrumentation, and lower score of spino-pelvic realignment achievement.

**CONCLUSIONS:** Equal to or greater than three of themodified Hoehn and Yahr stage was the most risk factor leading to revision surgery. For a PD patient who would undergo an elective thoracolumbar surgery, aggressive control status of PD before or after surgery is necessary to prevent surgical complications. Longer surgical levels and corrective osteotomy also trended on earlier revision. A better spino-pelvic realignment after surgery could reduce occurrence of revision.

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

**65. Weekly Teriparatide Administration and Preoperative Anterior Spondylolisthesis of Upper Adjacent Vertebra: Independent Predictors of Osseous Union Enhancement**

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**BACKGROUND CONTEXT:** Posterior lumbar interbody fusion (PLIF) is usually performed to treat lumbar degenerative diseases in elderly patients. However, some patients exhibit pseudo-arthritis after undergoing such procedures. The anabolic agent teriparatide is an approved treatment option for promoting bone formation in patients with osteoporosis. Our previous multicenter, prospective randomized study assessed the effect of once-weekly teriparatide administration on patient outcomes after interbody fusion.

**PURPOSE:** The present retrospective study investigated predictors of osseous union enhancement within 6 months after PLIF in elderly patients with osteoporosis.

**STUDY DESIGN/SETTING:** A retrospective study of 66 patients at three institutions.

**PATIENT SAMPLE:** The study was conducted in women aged >50 years who had a bone mineral density (BMD) of <80% of the young adult mean and had a lumbar degenerative disease. Patients were randomly allocated to weekly treatment with teriparatide that was administered subcutaneously, starting at week 1 for 6 months postoperatively; others received no teriparatide. From 2011 to 2014, 75 patients were randomized to receive treatment, of whom 66 (mean age, 71 years) completed the treatment.

**OUTCOME MEASURES:** A multivariate logistic regression analysis was used to assess the predictors of osseous union enhancement after PLIF.

**METHODS:** Preoperative lumbar spine radiographs were obtained and examined for the presence of spondylolisthesis (amount of spondylolisthesis, >0 mm). Osseous union was assessed by 4 independent, blinded physicians by using dynamic radiography and computed tomography (CT) 6 months postoperatively. Osseous union was said to be present when upper and lower fusions were observed in both the sagittal and coronal center CT slices. The Oswestry Disability Index (ODI) was used to quantify the disability associated with preoperative and postoperative low back pain or clinical symptoms. The patients were retrospectively divided into two groups based on the presence of osseous union.

**RESULTS:** Thirty-three patients in the group showed osseous union (50%), whereas the other 33 did not. Teriparatide was administered in 19 (58%) of the patients who showed osseous union and in 9 (27%) of those who did not (p=0.01). Preoperative anterior spondylolisthesis of the upper adjacent vertebra was observed in 19 patients (58%) in the osseous union group and in 8 (24%) in the non-osseous union group (p=0.01). The multivariate logistic regression analysis showed that administration of teriparatide (odds ratio, 4.8; 95% confidence interval: 1.546–14.603; p<0.01) and preoperative anterior spondylolisthesis of the upper adjacent vertebra (odds ratio, 3.7; 95% confidence interval: 1.185–11.821; p=0.05) were independently associated with osseous union within 6 months after surgery. Six months after operation, the mean femoral neck BMD had increased by 1.5% (from 74.4% to 75.9%) in the group that showed osseous union and decreased by 2.3% (from 73.5% to 71.2%) in the group that did not show osseous union. ODI scores showed improvement postoperatively in both groups (p=0.19).

**CONCLUSIONS:** Weekly administration of teriparatide and preoperative anterior spondylolisthesis of the upper adjacent vertebra were independent predictors of osseous union 6 months after operation. Our findings suggest that PLIF and teriparatide treatment are an effective option for managing lumbar degenerative diseases in elderly patients with osteoporosis.

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

**66. Radiological Features and Clinical Outcomes of Concomitant Decompression Surgery to Adjacent Segment and Posterior Lumbar Interbody Fusion at Five Years**

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**BACKGROUND CONTEXT:** Multilevel stenosis with degenerative spondylolisthesis (DS) is a common problem. However the proper operative methods for multilevel stenosis with DS is remains to be established. Some surgeons surgically treat these patients with a fusion at only the level of current instability and only decompress the other levels. While it was concerned with the progression of degeneration and instability for decompressed segment in the long term, when decompression
surgery was performed concomitantly at adjacent segment to the PLIF segment.

**PURPOSE:** The purpose of this study was to examine the clinical outcomes and radiological features at L3/4 of concomitant decompression surgery to adjacent segment and PLIF at L4/5 compared with PLIF at L4/5 alone for L4DS.

**STUDY DESIGN/SETTING:** This was a retrospective 1:1 matched case-control study.

**PATIENT SAMPLE:** Forty five patients who had undergone L3/4 decompression with L4/5 PLIF for multilevel spinal stenosis with DS and were followed for 5 years were enrolled from 2005 to 2011 (group D). As a control group, 45 age- and sex-matched patients who had undergone L4/5 PLIF for L4 DS and were followed for 5 years were selected (group A). The average age was 70 in group D and 69 in group A. Each group consisted of 25 men and 20 women.

**OUTCOME MEASURES:** Disc height, range of motion, posterior opening angle, segmental lordosis, slippage and presence of vacuum phenomenon at L3/4 level, and lumbar lordosis at L1-S were measured on lateral radiographs. Additionally, anterior-posterior radiograph was measured lateral slippage and wedging angle at L3/4 level.

**METHODS:** Radiological factors were evaluated before and 5 years after surgery and were compared between the two groups and within the groups. In terms of clinical outcomes, Japanese Orthopaedic Association (JOA) score and requirement of L3/4 additional surgery were investigated.

**RESULTS:** Pre/postoperative disc height was 9.4mm/7.4mm in group D and 9.9mm/9.0mm in group A respectively. Newly appearance of vacuum phenomenon were observed in 15 patients (33%) of group D and 4 (9%) of group A on postoperative radiographs. Disc height decrease and appearance of vacuum phenomenon in group D were significantly more often than that in group A (P<0.05). No significant differences were found between the groups in other pre- and Postoperative radiological changes (progression of slippage, range of motion, posterior opening angle, segmental lordosis, lumbar lordosis, lateral slippage and wedging angle). The JOA score improvement ratio was 58.0% for patients in group D and 61.4% for those in group A (P=0.55). The reoperation rate at L3/4 level was 2.2% (1 of 45) in Group D, 6.7% (3 of 45) in Group A (P=0.30).

**CONCLUSIONS:** Concomitant adjacent segment decompression with PLIF accelerated adjacent disc degeneration in comparison to PLIF alone, but didn’t predispose the development of instability and vertebral slippage. Moreover JOA score and reoperation rate were not significant difference between Group D and Group A. The results also suggested the possibility that concomitant adjacent segment decompression with PLIF is one of effective operative methods for multiple stenosis with DS.

**FDA DEVICE/DRUG STATUS:** This abstract does not discuss or include any applicable devices or drugs.
68. Over 10 Years Follow Up Results of MIS-TLIF for Patients with Degenerative Spondylolisthesis of the Lumbar Spine: Preservation of Posterior Structures Might Reduce Adjacent Segment Degeneration

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BACKGROUND CONTEXT: Minimally invasive transforminal lumbar interbody fusion (MIS-TLIF) has become widely performed for the last decade, but long-term advantages in patients undergoing MIS-TLIF compared to conventional transforminal lumbar interbody fusion (C-TLIF) have not been well documented.

PURPOSE: The objective of this study is to investigate the long-term outcomes of MIS-TLIF, especially focused on adjacent segment degeneration (ASD).

STUDY DESIGN/SETTING: A retrospective analysis of prospectively collected clinical and radiographical data of patients who underwent MIS-TLIF for single-level symptomatic degenerative spondylolisthesis of the lumbar spine, and compared them to patients treated with C-TLIF.

PATIENT SAMPLE: A total of 91 consecutive surgical degenerative lumbar spondylolisthesis patients with refractory low back pain, leg pain, and neurogenic claudication from 2004 to 2007 at our institution, 66 (27 males, 39 females) patients aged 48-81 years that underwent single-level MIS-TLIF (32 cases) and C-TLIF (34 cases) were included with minimum follow-up of 10 years. Mean follow-up duration was 13.6 years for MIS-TLIF cases and 13.2 years for C-TLIF cases, with overall follow up rate is 72.5%.

OUTCOME MEASURES: Clinical outcomes were evaluated according to the Japanese Orthopedic Association score (JOA score). Data were collected pre- and at latest follow-up postoperatively. Postoperative lumbar stiffness was asked using Taneichi’s scoring system for the evaluation of “so called fusion disease”. Clinical ASD was defined as patients who required additional surgery due to adjacent segment pathology. Radiographical ASD, multifidus muscle atrophy, and fat degeneration were assessed using flexion-extension radiographs, CT scan, and MRI T2 axial images. For statistic analysis, an unpaired Student’s t-test, Mann-Whitney U-test, and Chi-square test were used.

METHODS: MIS-TLIF was performed via a unilateral dorsal approach with the use of METRx 22 mm tubular retractor system (Medtronic Sofamor Danek) and surgical microscope. Unilateral facetectomy and discectomy followed by bone grafting was achieved with local autologous bone. Structural interbody support was accomplished with titanium interbody cage. Percutaneous pedicle screw fixation was added bilaterally with Sextant system (MSD). C-TLIF was performed via a mid-sagittal dorsal approach by approximately 5 inches skin incision, followed by stripping the paravertebral muscle from the posterior elements. After removal of the spinous process, standard laminomomy, unilateral facetectomy and disectomy followed by interbody fusion and pedicle screw placement was accomplished using a conventional technique.

RESULTS: Cohorts were well matched based on patient age (MIS: 64.4 yrs. C: 62.7 yrs.), duration of symptoms (MIS: 15.7 mo. C: 17.5 mo.), and JOA score (MIS: 15.8 points. C: 14.7 points.) before surgery. The mean JOA scores in MIS group and C group were both significantly improved to 25.1 and 24.2 respectively at the latest follow-up with no significant difference between the two groups. Postoperative lumbar stiffness complaints were significantly less in the MIS group than C group (P<0.05). Clinical ASD was observed in 1 case (3.1%) with MIS group and in 7 cases (20.6%) with C group (P=0.05). Also radiographical ASD was observed in 4 cases (12.5%) with MIS group and in 12 cases (35.2%) with C group (P=0.04). Postoperative multifidus muscle atrophy ratio compared to each preoperative in MIS group and C group were 12.5 % and 27.1 % at the latest follow-up, respectively.

CONCLUSIONS: Results from this study demonstrates that MIS-TLIF obtained the same clinical improvements and as C-TLIF over ten years period. Preservation of posterior structures using MIS technique including minimizing approach related soft tissue trauma, posterior weight bearing might reduce adjacent segment degeneration.

FDA DEVICE/DRUG STATUS: METRx system (Approved for this indication), Sextant system (Approved for this indication)

69. Comparison of Decompression, Decompression Plus Fusion, and Decompression Plus Stabilization for Degenerative Spondylolisthesis: A Prospective, Randomized Study

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BACKGROUND CONTEXT: Symptoms of lumbar spinal stenosis due to degenerative spondylolisthesis originate from compression of the dural sac or nerve root. Essentially, this condition is treated by performing decompression of neural structures. Posterolateral lumbar fusion and posterior pedicle-based dynamic stabilization are additional techniques performed to ensure improved prognosis. However, to date, the selection of a surgical procedure for lumbar spinal stenosis due to degenerative spondylolisthesis is still under debate, especially in terms of the addition of instrumentation because of the few prospective, randomized studies.

PURPOSE: To prospectively assess the long term clinical results of decompression alone, decompression plus fusion, and decompression plus stabilization for degenerative spondylolisthesis.

STUDY DESIGN/SETTING: Prospective randomized controlled trial.

PATIENT SAMPLE: 87 patients from two hospitals who underwent spinal operation for one level lumbar spinal stenosis with degenerative spondylolisthesis at the L4/5 level were screened. We excluded patients with a previous history of lumbar spinal operation, multilevel stenosis, or foraminal stenosis.

OUTCOME MEASURES: Outcomes were assessed by the Japanese Orthopaedic Association score and Visual Analogue Scale.

METHODS: We randomly assigned patients who had one level lumbar spinal stenosis due to degenerative spondylolisthesis at the L4/5 level to undergo either decompression alone, decompression plus fusion, or decompression plus stabilization.

RESULTS: Eighty-five patients underwent randomization. The follow-up rate at 5 years was 86.4%. The fusion and stabilization groups showed higher blood loss and a longer operative time than the decompression group. The fusion group showed longer postoperative hospital stay than the decompression group. In terms of clinical outcomes, all scores were significantly
improved postoperatively, and these outcomes were maintained at 5 years postoperatively in each group. There were no significant differences among the groups at 1 year and 5 years postoperatively.

CONCLUSIONS: Additional instrumentation operation for low grade (<30%) degenerative spondylolisthesis did not result in superior results to decompression alone at 1 year and 5 years postoperatively.

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

70. Retrospective Multicenter Study of Perioperative Complications in 1,015 Patients Who Underwent Oblique Lateral Interbody Fusion Surgery

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BACKGROUND CONTEXT: Lateral lumbar interbody fusion (LLIF) has been widely performed and is attracting attention. LLIF is divided into two major techniques according to the approach: oblique lateral interbody fusion (OLIF) and transpsoas LLIF (direct/extreme LIF: D/XLIF). Perioperative complications associated with D/XLIF have been previously reported, such as transient thigh pain and muscle weakness resulting from the transpsoas approach. On the other hand, OLIF has been reported to have less perioperative complications owing to its mini-open and non-psoas splitting retroperitoneal approach (Abe K, Orita S, et al. Spine 2017; Fujibayashi S, et al. Spine 2017). However, there were issues in these reports such as combined incidence with XLIF or a smaller amount of subjects.

PURPOSE: We aimed to investigate and report the perioperative complications limited to OLIF surgery by performing a retrospective multicenter survey.

STUDY DESIGN/SETTING: The present study was a retrospective review of operative data collected from 14 orthopaedic institutions all over Japan under the approval of each institutions ethics committee. Each institution included more than 100 OLIF cases at the time of the survey. These study subjects were patients with low back pain (LBP) who underwent surgery under the diagnosis of degenerative lumbar disease such as spondylolisthesis and degenerative lumbar kyphoscoliosis from April 2012 to March 2017. In addition to the basic data such as diagnosis, age, gender, surgical method, intraoperative blood loss, and operative time, the perioperative complication-related collected data was analyzed and arranged according to the following major categories: intraoperative and early-stage postoperative (≤1 month) complications. The intraoperative complications were then subcategorized into organ damage (neural, vertebral, vascular, and others) and other complications, mainly related to the instrumentation failure.

METHODS: The present study was a retrospective review of operative data collected from 14 orthopaedic institutions all over Japan under the approval of each institutions ethics committee. Each institution included more than 100 OLIF cases at the time of the survey. These study subjects were patients with low back pain (LBP) who underwent surgery under the diagnosis of degenerative lumbar disease such as spondylolisthesis and degenerative lumbar kyphoscoliosis from April 2012 to March 2017. In addition to the basic data such as diagnosis, age, gender, surgical method, intraoperative blood loss, and operative time, the perioperative complication-related collected data was analyzed and arranged according to the following major categories: intraoperative and early-stage postoperative (≤1 month) complications. The intraoperative complications were then subcategorized into organ damage (neural, vertebral, vascular, and others) and other complications, mainly related to the instrumentation failure.

RESULTS: The most frequent complication was transient psoas weakness and thigh numbness (8.67%), followed by segmental artery injury (0.49%), dural injury (0.20%), vertebral fracture including endplate injury and cage subsidence (8.37%), ALL injury (2.76%), retroperitoneal hemorrhage (0.59%), wrong level (0.30%), peritoneal injury (0.39%), ureteral injury (0.10%), and intraoperative implant breakage (1.08%). Severe and permanent damage included only the ureteral injury. There was a significant increased complication occurrence with increasing number of levels included in the fusion. (mean 1.89 levels vs. 1.58, p = 0.04). Increasing Intraoperative blood loss and operative time during the anterior OLIF approach was associated with higher complication cases.

CONCLUSIONS: The overall incidence of perioperative complications of OLIF surgery amounted to 26.5%, of which only 0.10% resulted in permanent damage in a ureteral. The overall incidence was lower compared with the previous reports of transmuscular LLIF, most of which are transient such as thigh numbness. Increased number of fusion levels was associated with increased Intraoperative blood loss and increased operative time. Considering the lower incidence of complications compared with other approaches including posterior interbody fusion, the present study suggests that OLIF may be one if not the most MIS and safe spinal fusion options.

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P1. Significance of Serum Homocysteine Level for the Prevention of Osteoporotic Vertebral Fracture
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BACKGROUND CONTEXT: Bone strength is composed of bone mineral density (BMD) and bone quality. Degradation of collagen cross-links is said to be involved in the deterioration of bone quality, and an increase in homocysteine is attributed to this.

PURPOSE: This study was performed to examine the clinical significance of the homocysteine level in patients with osteoporotic vertebral fracture.

STUDY DESIGN/SETTING: A prospective study

PATIENT SAMPLE: One hundred sixty five patients with spinal osteoporosis were included in this study. The age of patients ranged from 49 to 95 years with an average age of 75.3 years.

METHODS: We investigated the relationship between the serum homocysteine level and BMD, bone metabolism marker and vertebral fractures. BMD was determined by DXA. Serum homocysteine was measured using a high performance liquid chromatography. TRAP-5b and intact P1NP as bone metabolism markers were measured using an immunoassay. Vertebral fracture was diagnosed on a plain radiogram and classified into 3 grades by the severity.

RESULTS: The homocysteine level increased with age. The homocysteine level was not related to BMD, TRAP-5b and intactP1NP. In the relationship between the homocysteine level and vertebral fractures, homocysteine levels increased with the increase in the number of vertebral fractures, showing a significant difference in two or more vertebral fractures. Also in relation to the severity of vertebral fracture, homocysteine levels increased as the severity increases, revealing a significant difference in moderate or severe grade. When multiple logistic regression analysis was performed for the involvement of each factor for vertebral fractures, it was in the descending order of bone density, age, bone metabolism markers and homocysteine level.

CONCLUSIONS: Homocysteineis a substance that is produced from methionine that is metabolized in the liver. The homocysteine reverts back to methionine in the liver again under the action of vitamin B6, B12 and folic acid. On the other hand, it is said that the serum homocysteine level increases due to lifestyle-related disease, which adversely affects the bone collagen due to increased oxidative stress. When the Advanced Glycation End Products that are bad collagen cross-links increase, the physiological cross-links are reduced. Deterioration of bone quality occurs as the collagen links are degraded. The results of this study indicate that a high level of homocysteine is a risk factor for osteoporotic vertebral fracture.

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P2. Thrombin Induces PAR1-Dependent MCP-1 Expression and Macrophage Migration in Mouse Intervertebral Disc
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BACKGROUND CONTEXT: Intervertebral disc (IVD) degeneration involves structural changes in nucleus pulposus (NP) cells caused by changes in cytokine expression and the surrounding microenvironment, as well as responses to biochemical products. We previously showed that inflammatory cytokines (MCP-1, TNF-α, TWEAK and TSLP) induced angiogenesis and macrophage cell migration in IVD. Moreover, these reactions play a role in degeneration of herniated discs. The serine protease thrombin (coagulation factor IIa) is encoded by the F2 gene and is known as a proinflammatory factor. We previously reported that MCP-1 expression was induced by thrombin treatment during fracture healing and that MCP-1 expression induced macrophage migration to the bone fracture site. Although thrombin is known to induce cytokine production in IVDs, the precise mechanism of cell migration in IVD remains unclear.

PURPOSE: To investigate the mechanism of MCP-1 production following thrombin treatment in a mouse IVD tissue culture system.

METHODS: Homozygous wild-type C57BL/6J mice (5-6-weeks old) were purchased fromCLEA Japan. Coccygeal IVD tissue specimens were obtained from the mouse tail bone using a dissecting microscope after removal of skin and soft tissue. Whole IVD tissue specimens were cultured in the presence or absence of various doses of thrombin or mouse TNF-α. Thrombin, Tissue factor (TF) and PAR1 expression was analyzed by western blot (WB) and immunohistochemical (IHC) staining with specific antibodies. A cytokine protein array was generated to analyze cytokine production following thrombin treatment. Quantitative PCR was performed using the ABI7500 real-time PCR system. MCP-1 concentrations in conditioned media were determined using Enzyme-Linked ImmunoSorbent Assay (ELISA). Statistical analysis was performed using ANOVA or Student’s t-test with significance of P<0.05.

RESULTS: WB analysis showed that both thrombin and TF are expressed in mIVD. IHC staining confirmed that thrombin was localized to the cytoplasm of annulus fibrosus (AF) and cartilage endplate (CEP) cells, whereas TF was localized in the cytoplasm of NP, AF and CEP cells. Quantitative PCR and WB detected expression of the thrombin receptor PAR1 in mIVD and IHC staining confirmed PAR1 was localized in the cytoplasm of NP, AF and CEP cells. Thrombin exclusively induced MCP-1 expression in a protein array. Increasing MCP-1 mRNA and protein expression levels in mIVD were confirmed with quantitative PCR, WB and IHC. MCP-1 produced by mIVD induced migration of mouse macrophages. Thrombin-induced MCP-1 production by mIVD was suppressed by both LY294002 (PI3K/AKT inhibitor) and PD98059 (MAPK-ERK inhibitor).

CONCLUSIONS: Thrombin and TF are endogenously expressed in mIVD. Thrombin/PAR1 interactions regulated MCP-1 production by mIVD via MAPK-ERK and PI3/AKT pathways. MCP-1 in turn enhanced mouse macrophage migration. Thrombin may thus be a novel cytokine that regulates IVD function. These observations could contribute to increased understanding of IVD degeneration and homeostasis regulated by thrombin/PAR1 interactions.

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P3. Age-Related Changes of the Spinal Cord: A Biomechanical Study

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BACKGROUND CONTEXT: Although it is known that aging plays an important role in the incidence and progression of cervical spondylotic myelopathy (CSM), the underlying mechanism is unclear. Studies that used fresh bovine cervical spinal cord report the gray matter of the cervical spinal cord as being more rigid and fragile than the white matter. However, there are no reports of tensile and Finite Element Method (FEM) that consider aging.

PURPOSE: We used FEM based on the data pertaining to the mechanical features of older bovine cervical spinal cord to explain the pathogenesis of CSM in elderly patients.

STUDY DESIGN/SETTING: Experimental study

PATIENT SAMPLE: The experiment involved the use of bovine spongiform encephalopathy (BSE)-negative spinal cords that were sourced within six hours of slaughter, and the experiment was completed within 10 hours of slaughter. The spinal cords were sourced from two groups of animals, three young animals (young bovine spinal cords; mean age, 46.3±1.15 months) and three old animals (old bovine spinal cords; mean age, 208±14.8 months).

OUTCOME MEASURES: Outcome measures were mechanical features in tensile test, internal stress distribution changes of the spinal cord in FEM.

METHODS: We conducted tensile tests for white and gray matter separately in young and old bovine cervical spinal cords, and compared their respective mechanical features. Based on the data obtained, we further performed FEM analysis that included static and dynamic factors to describe the internal stress distribution changes of the spinal cord.

RESULTS: Our results demonstrated that the mechanical strength of young bovine spinal cords is different from that of old bovine spinal cords. The gray matter of the older spinal cord was softer, and more resistant to rupture compared to that of younger spinal cords (P<0.05). Among the old, although the gray matter was more fragile than the white matter, it was similar to the white matter in terms of its rigidity (P<0.05). The in-vitro data were subjected to three compression patterns. The FEM analysis demonstrated that the stress level rises higher in the old spinal cords in response to similar compression, when compared to young spinal cords.

CONCLUSIONS: Our results demonstrate that in analyzing the response of the spinal cord to compression, the patient’s age is an important factor to be considered in addition to the degree of compression, compression speed, and parts of the spinal cord compression factor.

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PURPOSE: Screw loosening leading to lumbar pseudoarthrosis is a costly complication which can cause pain and lead to revision surgeries which have a higher risk of complication than index lumbar fusion surgeries. Biomechanical measurements of screw fidelity, such as peak insertional torque, have been evaluated, but have not been shown to be relevant in the clinical realm. Recent studies following patients failed to demonstrate a correlation with screw insertional torque and eventual radiographic failure of the screws. The torque itself is a technically suboptimal number representing only one point in time. The insertion energy is the integral of force applied over time and may provide a more complete picture of resistance to failure. In order to better understand screw failure, we assess pedicle as well as cortical trajectory screws for correlation between insertional energy and pull-out strength.

STUDY DESIGN/SETTING: 12 cadaveric specimens from T12-Sacrum were obtained and divided into CS and PS groups which underwent L2-5 PSF according to group assigned. Screws were placed using direct visualization with a special instrument designed to measure force during pedicle tapping and screw placement. Specimens were then cycled through 21 cycles of bending to 8Nm in flexion/extension, lateral bending, and axial rotation. The specimens were then sectioned into individual vertebral bodies and secured in a custom spherical clamp for pull-out testing. Screws were pulled under displacement control at 10mm/min and force and displacement were recorded at 100hz.

RESULTS: PS and CS had significant differences in mean insertional torque (0.21±0.14 Nm, 0.38±0.17Nm) as well as peak insertional torque (1.13±0.54 Nm, 1.68±0.36 Nm). Insertional power was significantly higher when tapping compared to placing a PS (1.12±1.00 W vs. 2.16±1.66 W), in contrast to CS, where tapping required significantly more energy than screw placement (2.46±1.01 W vs. 1.80±0.92 W). Additionally, insertional energy was similar between PS and CS (26.37±21.70 W vs. 25.39±9.48 W). During screw pullout tests, the CS group exhibited 25% higher elastic stiffness as well as higher yield force compared to PS (879±306 N vs. 667±397 N). Overall, PS pullout force had strong positive correlation coefficients with peak torque and insertional energy (0.94 and 0.91). For CS, the correlation coefficients with pullout force were 0.70 and 0.79 for peak torque and peak energy respectively.

CONCLUSIONS: As external pressures for quality in spine surgery continue to mount, quantitative methods for evaluating construct strength are needed. Insertional torque has long been evaluated as a potential measurement, however because it is a discrete point in time, it does not capture the entire screw placement energy. Herein we evaluated insertional energy as well as peak torque and found them to be essentially equivalent predictors of linear pullout force in pedicle and cortical screws. What remains to be seen is which measurement is the better predictor of long-term hardware failure when the instrumentation is cycled through rounds of flexion/extension, lateral bending, and axial rotation.

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P5. Risk Factors for Delirium after Spine Surgery: An Age-Matched Analysis

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BACKGROUND CONTEXT: Postoperative delirium is a complication that should be prevented, which may deteriorate postoperative results, however, there have been no preventive method. In order to investigate a preventive method, it is necessary to identify risk factors. More than 30 risk factors for delirium after spine surgery have been reported, which makes it challenging to identify which factors should be prioritized. Among previously reported risk factors of postoperative delirium, greater age was identified as a risk factor of postoperative delirium in all studies. This fact suggests that greater age is already established as a strong risk factor.

PURPOSE: To eliminate the influence of greater age, we performed an age-matched group comparison analysis in order to investigate other risk factors of postoperative delirium after spine surgery.

STUDY DESIGN/SETTING: Retrospective study

PATIENT SAMPLE: This study involved 532 patients who underwent spine surgery at our university hospital from 2012 to 2014. There were 283 males and 249 females with an average age of 64.2 years (range 10–92). None of the patients had delirium or a history of delirium before surgery. All operations were performed by one of four senior spine surgeons who have more than 10 years of clinical experience.

OUTCOME MEASURES: The presence of delirium was determined by Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria, which is the gold standard for psychiatric evaluation. Medical stuffs including nurses and doctors observed patients who had or did not have symptoms of delirium during regular postoperative care from immediately to 7 days after surgery. The presence of delirium and symptoms were recorded in the medical record after the decision. The clinical records of all 532 patients were retrospectively reviewed, and patients were divided into two groups, delirium positive and delirium negative groups.

METHODS: The incidence of delirium overall was calculated, and statistical analysis was performed to compare the age between delirium positive and negative groups. After the evaluation of incidence in all patients, two patients of the same age who did not have delirium (age-matched delirium negative group) were matched to each patient with delirium (age-matched delirium positive group). Differences between the two groups in suspected risk factors for postoperative delirium from previous reports were analyzed. Multivariable logistic regression analysis was used to evaluate the various factors which were significant difference by univariate analysis related to postoperative delirium.

RESULTS: Fifty-eight (11.1%) of 532 patients developed postoperative delirium after spine surgery. In age-matched analysis, large amount of intraoperative bleeding, low preoperative concentration of serum sodium, high postoperative (day after surgery) value of serum C-reactive protein, low hematocrit, low concentration of albumin, and high body temperature were detected as significant risk factors in the univariate analysis. Large amount of intraoperative bleeding remained a risk factor for postoperative delirium in the multivariable analysis.

CONCLUSIONS: We should pay attention and take precautions against the occurrence of postoperative delirium in patients undergoing spine surgery with greater age and a large amount of intraoperative bleeding.

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have an increased risk for readmission (p=0.698), while 65-79yo were more likely to be readmitted (OR1.29, p=0.013); readmission was better associated with ASA ≥2 (OR1.72, p=0.001) and preoperative ambulation (OR0.69, p=0.002). Age ≥80yo (p=0.239) and 65-79yo (p=0.056) did not increase postoperative dysphagia; dysphagia was associated with multiple level surgery (OR 1.64, p<0.001) and POD0 ambulation (OR 0.54, p<0.001). While 65-79yo was associated with urinary retention (OR 2.14, p<0.001), ≥80yo was not (p=0.055); Predictors of urinary regrowth include myelopathy (OR 1.5, p=0.001) and PODO ambulation (OR 0.67, p=0.002).

CONCLUSIONS: Age alone is not the best predictor of readmission and dysphagia. Octogenarians and older are not necessarily at higher risk for postoperative adverse events after cervical spine surgery. More analysis is needed to delineate the relationship between age and postoperative morbidity.

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P7. Error Propagation in Spinal Intraoperative Navigation from Non-Segmental Registration: A Prospective Cadaveric and Clinical Study
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BACKGROUND CONTEXT: Computer-assisted navigation may guide spinal instrumentation. Current systems rely on a dynamic reference frame (DRF) for image-to-patient registration and tool tracking. Displacement of levels distant to the DRF may generate inaccuracy from intersegmental mobility.

PURPOSE: To quantify navigation inaccuracy due to distance from the registered level, due to surgical manipulation, and due to intra-operative patient respiration-induced vertebral motion.

STUDY DESIGN/SETTING: Prospective laboratory + clinical study.

PATIENT SAMPLE: 4 human formalin-fixed cadavers + 13 human clinical patients.

OUTCOME MEASURES: Quantitative navigation error (translational) with increasing distance from a dynamic reference frame, with surgical manipulation of bony elements, and with in-vivo patient respiration-induced vertebral motion.

METHODS: Navigation error due to distance from the DRF, and vertebral motion during screw tract formation, were quantified in 4 human cadavers. An optical navigation system was registered through a posterior midline exposure. Bone screws were implanted into the laminae bilaterally from C2 to S1. The tip of a tracked awl was placed into the screw head at each level, at 0-5 levels distant from the registered level, and the tool tip position on the navigation system was compared to that of the screw head on post-procedure CT imaging. To quantify vertebral motion from surgical manipulation, the position of the tracked awl was quantified before and after exertion of force to create pilot holes for pedicle screw tracts, from C2-S1. Respiration-induced vertebral motion was quantified from 13 in-vivo clinical cases of open posterior instrumented fusion. Patients were positioned prone on a Wilson frame, with Mayfield head clamp for cervical fusions. The 3D position of a spine-motion process clamp was tracked by OBI navigation over 12 respiratory cycles.

RESULTS: Significant increases in translational navigation error were seen with increasing distance from the registered level, with an increase in overall 3D error greater than 2mm at 3 or more levels distant from the DRF. The increase in 3D error was predominantly in the medio-lateral axis (1.78±0.86mm, 2.78±0.86mm, 2.19±0.92mm, and 3.08±0.89mm, at 2, 3, 4 and 5 levels distant to the DRF, respectively) and antero-posterior axis (1.40±0.81mm, 1.79±0.81mm, 2.18±0.87mm, and 4.30±0.84mm, at 2, 3, 4 and 5 levels distant to the DRF). Manipulation during screw tract formation caused displacement predominantly in the medio-lateral (0.71±0.84mm) and cranio-caudal planes (1.02±0.92mm) at 3 or more levels distant from the DRF. While respiration- and manipulation-induced vertebral motion was maximal in the antero-posterior (2.42±1.77mm) and cranio-caudal axes (0.92±0.69mm) at 3 or more levels distant from the DRF. Surgeons may mitigate these errors intra-operatively by placing the DRF adjacent to the registered level; temporary apnea may be warranted at critical stages of the procedure.

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BACKGROUND CONTEXT: Nerve root anomalies are relatively uncommon. However, they are frequently undiagnosed on preoperative imaging studies including conventional MRI. The presence of those root anomalies represents a significant potential for neurologic injury when the nerve root is required to be mobilized during spinal procedures.

PURPOSE: The purposes of this study were to examine morphological changes of the lumbar nerve roots such as anomalies and high take-off angles using the DW-MRN, and evaluate its utility.

PATIENT SAMPLE: All DW-MRN images taken during 10 months’ period of consecutive symptomatic 366 patients (175 men and 191 women, mean age: 59.8 years old) were retrospectively analyzed. All patients complained LBP and/or LP.

OUTCOME MEASURES: We investigated (1) the congenital variations of the lumbar nerve roots and classified them by Neidre & Mac Nab criteria, and (2) prevalence of patients with nerve roots with the taken-off angle of 60 degrees or more.

METHODS: All images were obtained using a clinical 1.5 T MRI system (Intera, 1.5 T; Philips Healthcare, Best, The Netherlands; Motion probing gradient single plane (A-P), B-value (s/mm²) =
P9. Supine versus Weight-Bearing MRI in the Evaluation of Patients with Lumbar Spondylolisthesis

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BACKGROUND CONTEXT: The severity of the slip in patients with spondylolisthesis is often evaluated with imaging studies, including MRI. One potential problem is the imaging being performed with the patient lying supine in the scanner, usually with a support under the legs. This creates imaging the spine in a somewhat unnatural and unloaded position. Use of upright MRI provides imaging in a weight bearing, normal position.

PURPOSE: The purpose of this study was to determine if there were differences in the severity of spondylolisthesis seen on MRIs made in the supine vs. weight bearing positions.

STUDY DESIGN/SETTING: This was a prospective study performed in a spine specialty clinic.

PATIENT SAMPLE: MRIs in the supine and upright weight bearing positions were made on 28 patients with spondylolisthesis.

OUTCOME MEASURES: Measurements made for the current study included as the primary measure, the listhesis at level of the spondylolisthesis (difference in the inferior posterior margin of the superior vertebrae). Also analyzed were the vertebral body translation (difference in the location of the midpoint of the vertebral body), segmental angle (angle of the disc space at the level of the slip), and the overall lumbar lordosis (L1-L5).

RESULTS: Among the 366 images, three images were excluded due to the metal artifacts and/or low signal intensity. A total of 363 images of 363 patients were analyzed in this study. (1) Lumbar nerve root anomalies were identified in 7 images (2.0%). All anomalies were conjoined nerve root (Type 1 of the Neidre & MacNab criteria). (2) 171 patients (47.1%) had nerve roots with the taken-off angle of 60 degrees or more. In addition, those patients were significantly older compared with patients with the taken-off angle of less than 60 degree.

CONCLUSIONS: Based on the results of this study using DW-MRN, 2.0% prevalence of lumbar nerve root anomalies in symptomatic patients were identified though it was unclear whether the anomalies were corresponded to their symptoms. Neve root anomalies are well-known to be easily damaged by intraoperative manipulation compared with normal nerve root due to poor mobility. In this point, preoperative identification of them using is very important. DW-MRN can be provided in approximately 3 minutes using 1.5T MRI system. Thus, we recommend it should be taken routinely in addition to the conventional images. In the present study, 47.1% prevalence of the nerve roots with the taken-off angle of 60 degrees or more were found, which indicates those MRI findings are commonly seen and may be unreliable in old patients. However, once they are overlooked due to difficulty of diagnosis by conventional MRI, they may cause postoperative failed back syndrome. Thus, in addition to the non-invasiveness, there are several advantages on the DW-MRN such as clear visualization of the nerve roots, and short exposure time. DW-MRN is recommended to examine the preoperative nerve root.

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P10. Anatomical Study of the Lumbar Segmental Artery and Vein to Prevent Vascular Complications during Lateral Lumbar Interbody Fusion

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BACKGROUND CONTEXT: Lateral Lumbar Interbody Fusion(LLIF) is getting popular to acquire strong correction and reduce operation time and bleeding. However, potential complications due to the specificity of this technique have been arising. One of the common complication of this technique is the segmental artery or vein injury. In Japan, the segmental artery injury has been reported in 0.4% of 2932 LLIF cases. Once the segmental artery or vein is damaged, it is difficult to stop bleeding in a small field of view, so it is important to understand its pathway and anatomical characteristics before surgery to prevent complication.

PURPOSE: The purpose of this study is to investigate anatomical features of lumbar segmental artery and vein by using CT angiography to prevent segmental artery or vein injury.

STUDY DESIGN/SETTING: Sixty patients who underwent CT angiography for the purpose of the preparation of spine surgery or detailed examination of digestive tract tumor were included in this study. Twenty-eight was male and 32 was female. Age was 68.4 years old in average. CT angiography was reconstructed to 3D image to detect the pathway of the segmental artery and vein at the vertebral body and disc.

OUTCOME MEASURES: Each vertebral height and distance from the caudal endplate to segmental artery were measured at the anterior 1/3 of vertebral, center of vertebral and the posterior 1/3 of the vertebra. The anomaly of the pathway of the
segmental artery and vein was also studied.

**RESULTS:** L1 segmental artery was located at 8.8mm (at anterior 1/3), 12.2mm (at the center) and 12.2mm (at posterior 1/3) from caudal endplate in average. L2, L3, L4 and L5 segmental artery were located at 8.2mm, 11.2mm,10.5mm and 11.4mm, 12.0mm,9.4mm and 14.9mm, 12.4mm, 6.8mm and 10.6mm, 7.7mm, 5.5mm in each. L1 and L2 segmental artery run from caudal to cranial, L3 runs in paralel and L4, L5 run from cranial to caudal. L1 and L2 segmental artery were close to caudal endplate at minimum 1.7mm. L4 segmental artery was close to cranial endplate at minimum 2.7mm. So there is a risk of vascular injury by OLIF’s pin at those levels in some cases. Three segmental arteries(5%) and 4 segmental veins (6%) run on disc vertically which has a risk of direct or contralateral vascular injury at L2/3, L4/5. Twenty eight segmental artery at L1/2 and L2/3 run very close to the anterior disc that has a risk of injury by anterior retractor.

**CONCLUSIONS:** The segmental artery of L1, L2 caudal and L4 cranial runs so close to the end plate that have risk of segmental artery injury by OLIF’s pin at those levels. At L2/3, L4/5, segmental artery or vein were located on disc in some cases, so that have a risk of direct or contralateral injury by sim or cobb. At L1/2 and L2/3 anterior retractor has risk of segmental artery injury because segmental artery run very close to the disc. It is important to evaluate the pathway of the segmental artery and vein by using CT angiography before the operation to perform LLIF safely.

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

**P11. Electrophysiological Assessment and Classification of Motor Pathway Function in Patients with Spinal Dural Arteriovenous Fistula**

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**BACKGROUND CONTEXT:** The diagnosis of spinal dural arteriovenous fistula (SDAVF) is difficult and often delayed because clinical features are often nonspecific. Electrophysiological methods may be useful to examine motor pathway function in patients with SDAVF.

**PURPOSE:** The aim of this study was to assess the motor function electrophysiologically in patients with SDAVF.

**STUDY DESIGN/SETTING:** Consecutive case study.

**PATIENT SAMPLE:** The study included 14 patients (3 women and 11 men) with SDAVF (SDAVF group) who were treated in our department between 2010 and 2016. The mean age of the patients was 64 ± 8.4 years (range, 44–75 years) in the SDAVF group. We also examined 16 normal subjects (5 women and 11 men; Control group) in this study. In the Control group, the mean age was 59 ± 9.9 years (range, 38–72 years).

**OUTCOME MEASURES:** The peripheral conduction time (PCT), the central motor conduction time (CMCT), neurological findings, and the Japanese Orthopaedic Association (JOA) score for thoracic spine were evaluated.

**METHODS:** Motor-evoked potentials following transcranial magnetic stimulation and compound muscle action potentials and F-waves following electrical stimulation in the ulnar and tibial nerves were measured from the abductor digiti minimi (ADM) and abductor hallucis (AH) muscles. The PCT and CMCT were calculated. According to the neurological findings, patients in the SDAVF group were classified to upper motor neuron sign (UMN) and lower motor neuron sign (LMN) categories. The JOA score for thoracic spine, that was excluded the upper extremity points from the JOA score for cervical spine, was used as a clinical measure of neurologic impairment. A full JOA score for thoracic myelopathy is 11 points.

**RESULTS:** CMCT-AH in the SDAVF was significantly longer than those in the Control group (p=0.000-0.015). PCT-AH in the SDAVF group was significantly longer than that in the Control (p=0.000) groups. Twelve patients in the SDAVF group showed abnormal CMCT and/or PCT. Abnormal CMCT and PCT were detected in 5 cases that exhibited UMN and/or LMN. Three cases with abnormal CMCT and normal PCT exhibited UMN. LMN without UMN was observed in four cases with abnormal PCT and normal CMCT. The JOA score and motor score were 5.9 ± 2.0 (2.5-9.5) and 1.9 ± 1.4 (0-4) before surgery, respectively. A clipping and release of the feeder artery was performed under spinal functional monitoring for all patients, and the JOA score and motor score were improved significantly to 7.4 ± 2.3 (4-11; p<0.000) and 2.6 ± 1.3 (0-4; p=0.008), respectively, at 1 year after surgery.

**CONCLUSIONS:** Our results showed that CMCT and PCT study for the patients with SDAVF could reveal abnormalities in the corticospinal tract and/or lower motor neurons, respectively, suggesting the pathology of SDAVF includes acute and/or chronic ischemic condition in the spinal cord. The measurements of CMCT and PCT can classify the patients with SDAVF into UMN type, LMN type, and Mixed type. These anomalies may present non-specific clinical features resulting in difficulty or delay of diagnosis in patients with SDAVF.

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

**P12. Dropped Head Syndrome Caused by the Thoracolumbar Kyphosis**

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**BACKGROUND CONTEXT:** Cervical sagittal alignment is affected by global sagittal spinal alignment. Previously, dropped head syndrome (DHS) was studied as a local cervical deformity, however, DHS could be divided into two types through the global sagittal spinal alignment, which were localized to the only cervicothoracic deformity (cervical thoracic type DHS) and combining thoracolumbar kyphosis (thoracolumbar type DHS). We had experienced the recovery of DHS by only thoracolumbar operation.

**PURPOSE:** We analyzed the characteristics of the global sagittal spinal alignment in patients with thoracolumbar type DHS

**STUDY DESIGN/SETTING:** Retrospective case series.

**PATIENT SAMPLE:** The subjects was 28 consecutive DHS patients (DHS group: 9 men and 19 women; average age 75.2 ± 10.4 years) who presented with correctable chin-on-chest deformity clinically, as a control, 56 age-matched control
patients by selected the mean age ± standard deviation.(age 65-85 years) who visited our facility between 2014 and 2016 with a diagnosis of cervical spondylolisthesis (CS) without neck motion pain and cervical spine deformity (CS group: 31 men and 25 women; average age 72.4 ± 5.9 years). DHS was defined as follows: 1) the patient showed a chin-on-chest deformity at the up-wrigh position, and 2) the deformity was correctable at the supine position. The correction of the dropped head was examined by cervical CT at the supine position. Subjects with ossification of the posterior longitudinal ligament, with neuromuscular disease, with coronal deformity >30º, who have a history of previous spinal operation, who could not maintain an upright position without assistance were excluded.

OUTCOME MEASURES: The following parameters were measured on lateral global spine standing radiographs: cervical sagittal vertical axis (C2-C7SVA), C2 slope (C2S), C2-C7 angle, T1 slope (T1S), C7SVA, thoracic kyphosis (TK), lumbar lordosis (LL), pelvic tilt (PT), and pelvic incidence (PI).

METHODS: The subjects were 28 patients with neck descent exhibiting chin-on-chest at up-wrigh position. We classified DHS into two groups according to C7SVA: Cervicothoracic type: C7SVA ≤ 50 mm and Thoracolumbar type: C7SVA > 50 mm. Among of the subjects, the thoracolumbar type was in 13 and 4 out of them were performed the thoracolumbar operation. Those surgical results were analyzed retrospectively.

RESULTS: In the thoracolumbar type DHS group, the mean parameters were as follows; C2S 52.5°, C2-7 angle 3.8°, C2-7 SVA 47.3 mm, T1S 38.5°, SVA 110.3mm, LL8°, PT63°, PI-LL 31.8°. In thoracolumbar type, dropped neck symptoms improved with the use of the rigid thoracic lumbar corset, and the thoracolumbar surgery was performed in four cases. The three cases were successfully interbody fusion and 1 case had only decompression surgery in the lumbar spine. After the operation, the mean parameters were as follows; C2S 46.8°, C2-7 angle 18.3°, C2-7 SVA 18.5mm, T1S 40.8°, SVA 49.8mm, LL46.3°, PT34.8°, PI-LL 10.5°. Considering the operative strategy, the cervical or cervico-thoracic surgery is better to be performed for the cervicothoracic type. However, thoracolumbar type DHS is not suitable for the same operative strategy because the neck symptoms would be induced by the loss of lumbo-pelvic lordosis.

We encountered 4 cases of thoracolumbar DHS which showed successful recovery from the dropped head condition after thoracolumbar operation. In cases whose SVA is extended, the rigid thoracolumbar corset would be an important screening for the decision of thoracolumbar operation for the DHS.

CONCLUSIONS: When evaluating the cervical sagittal alignment in DHS patients, the global sagittal spinal alignment should be taken into consideration. Some of the thoracolumbar type DHS would be recovered from their dropped head condition by thoracolumbar surgery.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
P14. Application of Neurite Orientation Dispersion and Density Imaging and Diffusion Tensor Imaging to Quantify the Severity of Cervical Spondylotic Myelopathy and to Assess Postoperative Neurologic Recovery

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BACKGROUND CONTEXT: Surgical outcome and the severity of cervical spondylotic myelopathy (CSM) are unpredictable and cannot be estimated by conventional anatomical MRI. The utility of diffusion tensor imaging (DTI) to quantify the severity of CSM and assess postoperative neurological recovery has been investigated. However, whether conventional DTI should be applied in a clinical setting remains controversial. Neurite orientation dispersion and density imaging (NODDI) is a recently introduced model-based diffusion-weighted MRI technique that quantifies specific microstructural features related directly to neuronal morphology. However, there are as yet few clinical applications of NODDI reported. Indeed, there are no reports to indicate NODDI is useful for diagnosing CSM.

PURPOSE: To evaluate the utility of NODDI and conventional DTI for detecting changes in spinal cord microstructure. In particular, to quantify the preoperative severity of CSM and assess postoperative neurological recovery from this myelopathy.

STUDY DESIGN/SETTING: Retrospective cohort study using consecutive patients.

PATIENT SAMPLE: We included 27 consecutive patients with a nontraumatic cervical lesion from CSM who underwent laminoplasty at a single institution between April 2012 and April 2015. Patients underwent MRI before and approximately 2 weeks after surgery.

OUTCOME MEASURES: In addition to conventional DTI metrics, we evaluated intracellular volume fraction (ICVF) and orientation dispersion index (ODI), which are metrics derived from NODDI. The 10-s grip and release test and the Japanese Orthopedic Association scoring system were used before and one year after surgery to assess neurological outcome.

METHODS: NODDI and conventional DTI values were measured at the C2-C3 intervertebral level (control value) and the most compressed levels (C3-C7 intervertebral levels) were measured. The changes of these values pre- and postoperative were demonstrated. Correlations between NODDI and conventional DTI values and clinical outcome were determined.

RESULTS: Preoperative fractional anisotropy (FA) was significantly correlated with the severity of neural damage, but not with postoperative neurological recovery. No significant correlation could be found between preoperative ICVF, ODI, apparent diffusion coefficient, and the severity of preoperative neurological dysfunction. Preoperative ICVF was most strongly correlated with the severity of neurological dysfunction and postoperative neurological recovery.

CONCLUSIONS: Preoperative fractional anisotropy (FA) was significantly correlated with the severity of neural damage, but not with postoperative neurological recovery. No significant correlation could be found between preoperative ICVF, ODI, apparent diffusion coefficient, and the severity of preoperative neurological dysfunction. Preoperative ICVF was most strongly correlated with the severity of neurological dysfunction and postoperative neurological recovery.

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

P15. Diffuse Idiopathic Skeletal Hyperostosis is Associated with Lumbar Spinal Stenosis Required Surgery

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BACKGROUND CONTEXT: Many patients with radiological lumbar spinal stenosis (LSS) are asymptomatic despite radiographic evidence of the disease. Factors related to the onset and progression of LSS have not yet been identified. Diffuse idiopathic skeletal hyperostosis (DISH) increases mechanical loading on the non-fused lumbar levels, and may therefore lead to LSS. However, the associations between DISH and LSS have not been investigated in detail.

PURPOSE: To investigate associations between DISH and LSS required surgery using multivariate analysis.

STUDY DESIGN/SETTING: Cross-sectional comparative study

PATIENT SAMPLE: This study included 2363 patients undergoing surgery for symptomatic LSS and 787 general inhabitants without symptoms of LSS. Patients undergoing surgery were consecutive patients and without prior lumbar surgery. The general inhabitants were participants of part of the population-based cohort study, Research on Osteoarthritis/Osteoporosis Against Disability (ROAD), and included participants without LSS symptom by direct assessment of a spine surgeon.

OUTCOME MEASURES: Standing whole-spine radiographs were used to diagnose DISH based on the criteria proposed by Resnick et al.

METHODS: The association between DISH and LSS was analyzed using multiple logistic regression adjusted for age, sex, body mass index (BMI), diabetes mellitus (DM) to obtain an adjusted odds ratio (aOR).The association DISH and decompression levels in patients with LSS were also investigated.

RESULTS: DISH was significantly more prevalent in LSS patients required surgery than in asymptomatic inhabitants (750 [31.7%] vs. 128 [16.3%]). p<0.001). The distribution of vertebrae involved by DISH was similar between the two groups, exhibiting a platykurtic distribution. However, fused vertebrae by DISH observed significantly caudal in symptomatic LSS patients than general inhabitants (median T9 and T8, respectively, p <0.001). Multivariate analysis showed DISH was independent associated factor for LSS required surgery (aOR 1.65, 95% confidence interval [CI] 1.32-2.07), other than male sex, higher BMI, and DM. In patients with LSS required surgery, decompression of upper lumbar level and multilevel decompression were performed more frequently in patients with DISH than those without DISH.

CONCLUSIONS: DISH is independently associated with LSS required surgery. DISH also associated with LSS at upper lumbar
levels or multilevel. An awareness of the high prevalence of LSS in patients with DISH can lead to early diagnosis and treatment for LSS.

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

**P16. Accuracy of Three Scoring System for Prediction of Metastatic Spine Tumor Prognosis: Analysis of Revised Tokuhashi, Katagiri, and Tomita Scores**

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**BACKGROUND CONTEXT:** Revised Tokuhashi (Tokuhashi), Katagiri, and Tomita scores have been used to predict the prognosis in patients with metastatic spine tumor. Because the prognosis has improved in recent years, we suspected that these scores are unsuitable for current treatments.

**PURPOSE:** To investigate the accuracy of these three scores in patients with metastatic spine tumor who underwent spine surgery.

**STUDY DESIGN/SETTING:** A retrospective study.

**PATIENT SAMPLE:** Study subjects included 84 patients with metastatic spine tumor who underwent spine surgery from May 2009 to April 2017. Of these, 22 patients with unknown prognosis, 15 who remained alive and one who underwent Kyphoplasty were excluded. 48 patients (male, 26 and female, 22) were included in the final analysis. The average age was 61.1 (range, 26-79) years and average time between spine surgery and death was 397.2±481.3 days. The regions of primary tumor were breast cancer in 12 patients, lung cancer in 7, renal cell carcinoma in 6, and the others in 23.

**OUTCOME MEASURES:** The accuracies of these three scores were investigated.

**METHODS:** These patients were classified into three groups in Tokuhashi and Katagiri scores; and four groups in Tomita score. For the Tokuhashi score, the short-term group (0-8 points) comprised 32 patients, the mid-term group (9-11 points) comprised 14 patients, and the long-term group (12-15 points) comprised two patients. For the Katagiri score, the short-term group (6-10 points) comprised 26 patients, the mid-term group (11-15 points) comprised 19 patients, and the long-term group (16-20 points) comprised three patients. For the Tomita score, the terminal group (8-10 points) comprised 13 patients, the short-term group (2-4 points) comprised 22 patients, and the long-term group (3 points) comprised 2 patients. The accuracies of these scores were investigated in three or four groups. Statistical data were analyzed using analysis of variance and the level of significance was set at 5%.

**RESULTS:** The overall accuracy of the Tokuhashi score was 64.6%, and the inaccuracy was due to 11 patients (22.9%) who lived longer and 6 patients (12.5%) who lived shorter than predicted. No significant difference was observed among the groups in the accuracies of Tokuhashi score (short-term: 65.6%, mid-term: 57.1%, long-term: 100%, P=0.70). The overall accuracy of the Katagiri score was 54.2%, and the inaccuracy was due to 16 patients (33.3%) who lived longer and 6 patients (12.5%) who lived shorter than predicted. A significant difference was observed among the groups in the accuracies of the Katagiri score (short-term: 80.8%, mid-term: 10.5%, long-term: 100%, P<0.01). The overall accuracy of the Tomita score was 41.7%, and the inaccuracy was due to 10 (20.8%) patients who lived longer and 19 (39.6%) patients who lived shorter than predicted. A significant difference was observed among the groups in the accuracies of Tomita score (terminal: 10.5%, short-term: 12.5%, mid-term: 12.5%, long-term: 75%, P<0.01).

**CONCLUSIONS:** The accuracies of predictions were 64.6%, 54.2% and 41.7% for the Tokuhashi, Katagiri, and Tomita Scores, respectively. Thus, these scoring systems were impractical. Because of rapid progress in cancer therapy in the recent years, patients have lived longer than predicted by these systems. Thus, our study suggests that patients with metastatic spine tumor live longer than predicted by scoring systems, and particularly in surgically treated patients.

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

**P17. Clinical Features and Treatments of Pyogenic Spondylodiscitis with Severe Paralysis**

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**BACKGROUND CONTEXT:** Pyogenic spondylodiscitis (PSD) is the most common spinal infectious disease, which affects adjacent intervertebral bodies with subsequent involvement of the intervertebral disc. One of the clinical manifestations is severe back pain over the infected area of the spine. It may progress to complications including epidural abscess, collapse of the infected vertebra, and severe paralysis, but the exact pathophysiology is still unknown.

**PURPOSE:** This study was designed to identify the optimal treatment for PSD with severe paralysis by examining patients’ conditions and outcomes.

**METHODS:** We retrospectively analyzed 75 consecutive cases of PSD treatments from 2007 to 2017. Patients were divided into two groups based on the Frankel classification, severe paralysis (unable to walk) and mild/no paralysis (able to walk), and were followed until normalization of C-reactive protein (CRP) levels. The patients’ medical records were reviewed for the number of systemic inflammatory reaction syndrome (SIRS) criteria met, the score of Eastern Cooperative Oncology Group Performance Status (PS), type of onset (Kulowski’s classification), type of causative microorganism, whether the host was immunocompromised, the serum levels of CRP/WBC/albumin, presence of the spinal epidural abscess, types of treatments, and prognosis.

**RESULTS:** Of the 75 patients reviewed, 46 were male and the age range was from 45 to 95 (average 70). Majority (63%) of the patients had lumbar lesion, and 10% had multi-level localization of PSD. The causative microorganism was identified in 68% of the cases with staphylococcus aureus being the most common (38%). Thirty-six patients had conservative treatments, 14 patients underwent posterior decompression surgery, and 25 patients underwent spinal stabilization surgery. Compared to the mild/no paralysis group (54 patients), the severe paralysis group (21 patients) had a significantly higher number of SIRS criteria met, PS grade, and WBC counts at the first visit to our hospital. Moreover, the percentage of patients who had bacteremia, acute onset, cervical lesion, or transfer to different hospitals were significantly higher among the severe paralysis group compared to mild/no paralysis group. There were 29 cases of epidural abscess complications, but there was no significant difference between the two groups. Eighteen of the 21 patients
in the severe paralysis group underwent a surgical procedure, of which 12 had improvement in their paralysis. Patients without improvement in their paralysis had significantly lower albumin levels compared to those with improvement. Only the spinal stabilization surgery showed significant relationship with recovery from severe paralysis.

**CONCLUSIONS:** Indications for surgical intervention among patients with PSD are compression of neurological structures, mechanical instability, and failure of conservative treatments. However, it is still controversial whether decompression of the spinal cord or surgical stabilization with instruments is the optimal strategy for treating PSD with paralysis. The present study shows that unlike decompression of the spinal canal, spinal stabilization surgery is associated with better recovery of neural function among patients with PSD and severe paralysis. PSD with acute onset, bacteremia, low level of serum albumin, and cervical PSD is associated with a greater risk of severe neurological deficit. Therefore, if conservative treatments fail, spinal stabilization surgery may be suggested. Prior to the surgery, restoring a patient's serum albumin level may be important as lower level was associated with less improvement in paralysis.

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

**P18. The Sex and Age Distribution of Indices for Muscle Evaluation and Their Association with Spinal Sagittal Alignment: The Wakayama Spine Study**

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**BACKGROUND CONTEXT:** A forward shift of the sagittal vertical axis (SVA) is reported to be a radiographic predictor of low back pain as well as disability for activities of daily living in the elderly. The relationship between postural change and sarcopenia remains unclear.

**PURPOSE:** This study considered the following questions. 1) Do the degeneration in limb skeletal muscles and paraspinal muscles proceed in parallel with age? 2) Among multiple muscle evaluation indices, what is most relevant to postural change?

**STUDY DESIGN/SETTING:** A cross-sectional study of an established population-based cohort in Japan

**PATIENT SAMPLE:** This study included 952 subjects who had participated in the second survey of the Wakayama Spine Study; of these, 794 (male, 239; female, 555; mean ± SD age, 63.6 ± 13.1 years) underwent sagittal whole-spine radiography in a standing position, whole-spine magnetic resonance imaging (MRI), and bioelectrical impedance analysis (BIA).

**OUTCOME MEASURES:** The C7 SVA (mm) was measured in the radiograph. The fatty infiltration ratio (FIR, %) in the erector spinae and multifidus at L1 upper end-plate level was measured on axial MRI using Digital Imaging and Communications in Medicine software. Appendicular skeletal muscle mass index (ASMl) was calculated from the sum of the muscle masses of the four limbs after adjusting for height (kg/m²).

**METHODS:** 1) Participants were grouped into five classes based on age (years): <50, 50-59, 60-69, 70-79, and >80; the change in each measurement item based on sex and age was determined. 2) Multiple regression analysis with C7 SVA as the objective variable, and age, ASMl, and FIR of the erector spinae and multifidus as explanatory variables were conducted based on sex.

**RESULTS:** In men, C7 SVA increased significantly starting at age 70 and ASMl significantly decreased starting at age 50. The multifidus FIR increased significantly starting at age 60 and the erector spinae FIR increased significantly starting at age 70. The erector spinae FIR at L1 alone was significantly associated with C7 SVA (p < 0.0001, standard β = 0.33). In women, C7 SVA increased significantly starting at age 60 and ASMl decreased significantly starting at age 60. The multifidus FIR increased significantly starting at age 50 and the erector spinae FIR increased significantly starting at age 60. Factors significantly associated with C7 SVA were age (p < 0.0001, standard β = 0.32), erector spinae FIR (p < 0.0001, standard β = 0.19), and multifidus FIR (p < 0.01, standard β = 0.13).

**CONCLUSIONS:** The degeneration in limb skeletal muscles and paraspinal muscles did not proceed in parallel with age. ASMl, which is included in the criteria for sarcopenia, decreased starting at age 50 in men, i.e., 10 years earlier than in women. Paraspinal muscle degeneration began in women 10 years earlier than in men. Thus, significant multifidus changes began at age 50 and erector spinae changes at age 60 in women. The association with C7 SVA was not observed in ASMl, and changes in the erector spinae were found to be important. Although this study is limited by the cross-sectional design, it provides important data for use in preventing postural change in the elderly.

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


Hiroshi Hashizume, MD, PhD; Hiroshi Yamada, MD, PhD; Hiroyuki Oka, MD; Shunji Tsutsui, MD, PhD; Yasutsgu Yuwaka, MD, PhD; Akihito Minamide, MD, PhD; Yukiiro Nakagawa, MD, PhD; Hiroshi Iwasaki, MD, PhD; Masanari Takami, MD, PhD; Hiroi Iwashashi, MD; Munehito Yoshida, MD, PhD

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**BACKGROUND CONTEXT:** A forward shift of the sagittal vertical axis (SVA) is reported to be a radiographic predictor of low back pain as well as disability for activities of daily living in the elderly. Disc degeneration, vertebral deformity due to osteoporotic fracture, and spinal stenosis have been reported as possible causes of sagittal malalignment. However, these degenerative changes are often coexisting and may confound each other as the cause of sagittal malalignment.

**PURPOSE:** To elucidate the association of degenerative changes on MRI and sagittal malalignment in a general population

**STUDY DESIGN/SETTING:** A cross-sectional study of an established population-based cohort in Japan

**PATIENT SAMPLE:** Of the 952 subjects who participated in the second survey of the Wakayama Spine Study, a total of 794 participants (male 239; female 555; mean age 63.6 ± 13.1 years old) were subjected to a sagittal radiograph of the whole spine in a standing position and whole spine MRI.
OUTCOME MEASURES: The C7 sagittal vertical axis (SVA, mm) and pelvic tilt (PT) was measured in the radiograph. Disc degeneration (Phirrmann’s classification: grade 1-5), and morphometric fracture at the T1-L5 vertebral bodies (semi-quantitative method: grade 0-3) were evaluated on the sagittal MRI. Percentage of fatty degeneration in the paravertebral muscle (PVM) at L1 upper end-plate level and cross-sectional area (CSA) of the dural tube at L1/L2-L5/S1 levels were measured on the axial MRI using a DICOM software. Information on the presence of LBP within 1 month and visual analog scale (VAS) for current LBP were obtained via interviews.

METHODS: The sagittal malalignment was defined as C7 SVA ≥50 mm. The logistic regression analysis was conducted to determine the association between the spinal malalignment and LBP. Also, the multivariable logistic regression analysis was conducted to determine the association between the C7 SVA and radiographic parameters. Age, sex and body mass index were used as adjusting variables in both models. The significance level was set at p < 0.05.

RESULTS: The spinal malalignment was significantly associated with the presence of LBP and intensity of the pain more than 25mm. Significant associated factors with the spinal malalignment were the percent area of fatty degeneration of PVM (≥10.6%, odds ratio 4.8 [95% CI 2.6-9.0]), sum of the grades of morphometric vertebral fracture (≥4, 1.8 [1.1-3.2]), pelvic tilt (≥20°, 2.0 [1.2-3.5]). The area under curve of this model was 0.85, sensitivity and specificity were 0.73 and 0.83, respectively.

CONCLUSIONS: Degeneration of the PVM, morphometric fractures and PT were significant associated factors of sagittal malalignment. Physicians need to take this result into account when they treat the patients with spinal malalignment.

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

P20. Lower Lumbar Retrolisthesis Indicates Worse Spine Alignment and Health-Related Quality of Life
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BACKGROUND CONTEXT: Several studies have reported on lumbar retrolisthesis; however, there are no reports regarding the differences in its features based on the vertebral level at which it manifests.

PURPOSE: To investigate whether the features of lumbar retrolisthesis change according to the vertebral levels at which it manifests.

STUDY DESIGN/SETTING: A large cohort study of volunteers.

PATIENT SAMPLE: Elderly volunteers who participated in a health screening study.

OUTCOME MEASURES: The prevalence and location of and number of vertebrae involved in lumbar retrolisthesis were examined using whole-spine X-rays. Spino-pelvic parameters were also measured. Health-related quality of life (HRQOL) questionnaires were administered.

METHODS: This study included 639 volunteers (257 male; 382 female; average age: 73 years). The exclusion criterion was a Cobb angle of at least 30°in the coronal plane. Sagittal vertical axis (SVA), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), and pelvic tilt (PT) were measured using whole-spine and pelvic radiographs taken in the standing position. HRQOL was evaluated using EuroQOL (EQ-5D) and the Oswestry Disability Index (ODI). Participants who experienced a vertebral slip of at least 3 mm were assigned to the R (+) group. The remaining participants were assigned to the R (-) group. We designated cases of lumbar retrolisthesis involving segments L3 or above as the superior group and cases of lumbar retrolisthesis involving segments L4 or below as the inferior group. Cases with multiple segments exhibiting retrolisthesis were excluded in order to simplify the study.

RESULTS: There were 178 cases (32%) in the R (+) group (85 male, 93 female). The levels of the vertebrae exhibiting lumbar retrolisthesis were as follows: 10 cases at L1, 85 cases at L2, 58 cases at L3, 22 cases at L4, and 3 cases at L5. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. In the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group. There were 380 participants in the R (-) group, 153 in the superior group, and 253 in the inferior group.

CONCLUSIONS: Subjects with lumbar retrolisthesis involving lower vertebral segments exhibited worse sagittal alignment of the spine and a worsened HRQOL compared with subjects with lumbar retrolisthesis involving superior lumbar vertebral segments.

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

P21. Percutaneous Endoscopic Radiofrequency Treatment for Chronic Low Back Pain: Technique Description and Clinical Outcomes
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BACKGROUND CONTEXT: The lifetime prevalence of low back pain is estimated to range from 60% to 80%, and low back pain that persists for 3 months or more is reported to have a lifetime prevalence of 4% to 10%, this pain is called chronic low back pain (CLBP). Identifying the source of CLBP and selecting proper treatment for it is an issue of great concern for spine surgeons. The facet joint is a significant source of CLBP and is reported to be responsible for 15% to 45% of the total number of population suffering CLBP. The modalities for its treatment are intra-articular anesthetic steroid injection, medial branch block (MBB), and radiofrequency (RF) medial branch denervation. However, recurrence, drug-associated complications, anatomical variations of the target point, extensive damage to other structures such as bone, ligaments or muscles, have been associated with these treatments. Endoscopic RF denervation of the medial branch was reported in the literature by the principal author on 2014 since then selected cases have been treated by this method.

PURPOSE: This study aims to evaluate the clinical outcomes of endoscopic radiofrequency ablation of the medial branch in patients with chronic low back pain originating from facet joints.
STUDY DESIGN/SETTING: Retrospective revision of clinical outcomes in patients treated using this endoscopic RF denervation method.

PATIENT SAMPLE: The clinical data of 52 consecutive patients with CLBP arising from facet joints which were treated with endoscopic RF denervation of the medial branch were reviewed. All patients had a Visual Analog Scale (VAS) score of 7 or more and refractory pain for at least 2 months. Two medial branch blocks (MBBs) were performed to rule out false positive results on different occasions. If patient responded two MBBs, endoscopic RF ablation was performed. Excluded criteria were lumbar instability, radicular pain, severe deformity, sagittal misalignment, metabolic bone disease, vertebral fractures, tumors, and infection.

OUTCOME MEASURES: All patients were assessed using the VAS for back pain and the Oswestry Disability Index (ODI) preoperatively and immediately after surgery, and at 6, 12, and 24 months of the follow-up.

METHODS: Mean VAS and ODI scores after procedures at 6, 12, and 24 months follow-up visit were compared with those before the procedure. Two-tailed “t” test value was employed to evaluate the statistical significance, and p<0.05 was considered as statistically significant.

RESULTS: The VAS for back pain improved significantly from a preoperative mean of 7.1 to a postoperative mean of 2 at the end of follow-up (p<0.001). Clinical outcomes based on ODI score also improved significantly from a preoperative mean of 26.5% to postoperative mean of 7.7% at the last follow-up (p<0.001).

No complications were associated with this procedure.

CONCLUSIONS: The results demonstrate that endoscopic RF denervation of the medial branch could be a useful alternative treatment modality for chronic low back pain sourced by facet joints with long-term pain relief.

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

P22. Cervical Artificial Disc Replacement with Prodisc-C: 10 Year Clinical and Radiographic Results of Prospective Observational Study in a Single Institute

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BACKGROUND CONTEXT: Cervical artificial disc replacement (ADR) is indicated for the treatment of severe radiculopathy permitting neural decompression and maintenance of motion. Previous reports of short and mid-term results have shown that cervical ADR using Prodisc-C is safe and effective in symptomatic CDD between C3 and C7.

PURPOSE: The objective of this study is to evaluate long-term clinical and radiologic results of ADR using the Prodisc-C in patients with single-level cervical disc disease (CDD) in minimum 10-year follow-up.

STUDY DESIGN/SETTING: This study is prospective observational analysis of prespective registry

PATIENT SAMPLE: Data were collected through a prospective registry, with retrospective analysis performed on 79 consecutive patients treated with cervical ADR with the Prodisc-C device (DePuy Synthes, West Chester, PA, USA) in a single institution.

OUTCOME MEASURES: Clinical outcome measures included visual analogue scale (VAS) for neck and arm pain and Oswestry disability index (ODI). Serial flexion-extension cervical radiographs and CT scans were performed to assess range of motion (ROM) of index segment, adjacent segment degenerations (ASD), implant-related complications (migration, subsidence, lucency) and heterotopic ossification (HO) using McAfee classification system.

METHODS: All enrollees were evaluated pre- and Postoperatively at regular intervals using both clinical and radiologic parameters.

RESULTS: Out of 79 patients enrolled, 79.7% (63/79) of patients continued regular outpatient visit at the 5-year follow-up period. However, after 10 years, only 22.9% (17/71) of patients remained with the study. Average follow-up was 10.7 years. After 5-year follow-up, neck and arm pain improved 68.6% and 86.8%, respectively, and ODI had an improvement of 85.7%. However, after the last visit, neck pain improvement decreased to 29.7%, whereas arm pain and ODI remained at 74.6% and 68.9%, respectively. Neurologic success rate was 82.3% after final assessment. There were no episodes of device failure except one case of subsidence. Mean ROM of the device decreased from 6.7°at 5-year to 5.4°at final assessment. Radiographic ASD developed in 58.8% of patients (mild; 29.4%, moderate; 23.5%, severe; 5.8%, respectively) and 58.8% demonstrated HO at the final follow-up, however, only 17.6% were symptomatic requiring second surgery.

CONCLUSIONS: The Prodisc-C device for cervical ADR appears to be safe and effective for the treatment of CDD after long-term follow-up. Despite radiographic evidence of ASD and HO on final assessment, Prodisc-C ADR provided maintenance of segmental motion at the index level and good neurologic success rate.

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

P23. Utility of Mobile Apps for Video Conferencing to Follow Patients at Home after Outpatient Surgery

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BACKGROUND CONTEXT: The role of technology in medicine has been limited to patient use in decision making for finding and assessing physicians. Teleconference is real time and live interactive program in which one set of participants are at one or more locations and the other set of participants are at another location. The teleconference allows for interaction, including audio and/or video, and possibly other modalities, between at least two sites. A study by Augestad et al has demonstrated from the literature the use of video conferencing for surgeons and its benefits especially in rural areas. Newer technology has allowed mobile video conferencing with encryption specific to the application or mobile phone. Outpatient surgery has a great opportunity to demonstrate the role of utilizing video conference (VC) in the follow up of patients postoperatively.

PURPOSE: The authors aim to assess patient’s perception to the use of mobile app for video conference (VC) with surgeon and/or staff.

STUDY DESIGN/SETTING: Prospective questionnaire

PATIENT SAMPLE: 120 patients preoperatively, 36 patients postoperatively

METHODS: Patients who presented to an orthopedic institute were presented with a questionnaire. To determine patient attitudes regarding surgery and the use of mobile VC app, we asked the surveyed participants using a 5 point Likert scale. Consenting patients completed a questionnaire of 10 questions

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BACKGROUND CONTEXT: Intraoperative neuromonitoring using MEP detects motor tract integrity changes satisfactorily during spinal surgery but is affected by “anesthetic fade,” in which the waveform amplitude decreases with the accumulation of propofol. Therefore, when a decrease in MEP occurs, spine surgeons need to determine whether it is caused by the surgical procedure or anesthetic fade. To our knowledge, the magnitude of the amplitude decrease over time due to the anesthetic fade has not been quantified in spinal surgery.

PURPOSE: To clarify the effect of anesthetic fade on transcranial motor evoked potentials (MEP) by investigating the time-dependent changes of amplitude during spinal deformity surgeries.

STUDY DESIGN/SETTING: Retrospective study.

PATIENT SAMPLE: We reviewed the records of 146 patients who had undergone surgical correction of spinal deformities at our institution. The average age was 28 (5 to 81) years. All patients’ anesthesia was maintained with total intravenous anesthesia during the period of MEP monitoring.

METHODS: We reviewed the MEP records and investigated the time when baseline was obtained (the course from the initial infusion of propofol). Then, we reviewed the time-dependent changes of amplitude after initial infusion of propofol. MEPs were recorded from the bilateral abductor digiti minimi muscles (ADM) and bilateral abductor hallucis muscles (AH) during spinal deformity surgeries.

RESULTS: The average time to baseline was 116 (45 to 274) minutes from initial propofol infusion. In the ADM, the amplitude was 53% at 1 hour after initial propofol infusion, 102% at 2 hours, 105% at 3 hours, 101% at 4 hours, and 86% at 5 hours. MEP decreased significantly from baseline by 16% at 5 hours (P < 0.001). In the AH, the amplitude was 49% at 1 hour after initial infusion of propofol, 104% at 2 hours, 103% at 3 hours, 92% at 4 hours, and 71% at 5 hours. MEP decreased significantly from baseline by 12% at 4 hours (P < 0.01) and by 34% at 5 hours (P < 0.000001).

CONCLUSIONS: MEP amplitude significantly decreased in the lower and upper limbs at 4 and 5 hours after initial infusion of propofol, respectively. These results may be helpful to reduce the incidence of false positives in MEP monitoring since the influence of anesthetic fade on MEP is inevitable during a long spinal surgery.

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P25. Treatment of the Fractional Curve Only in Adult Scoliosis: Comparison to Lower Thoracic and Upper Thoracic Fusions

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BACKGROUND CONTEXT: Significant variability in strategies for surgical management of adult spinal deformity. Radiculopathy from the fractional curve, typically L4-S1, is frequently a reason for scoliosis patients to pursue surgical intervention.

PURPOSE: The purpose of this paper is to evaluate treatment outcomes of limited fusion of the fractional curve (FC) only compared to treatment of the entire deformity with long fusion.

STUDY DESIGN/SETTING: Retrospective cohort study design

PATIENT SAMPLE: 99 consecutive adult scoliosis patients from 2012-2016 at a single institution. All patients had fractional curves from L4 to S1 >10° and minimum 1 year follow up.

OUTCOME MEASURES: Complication rate, rate of extension surgery, estimated blood loss, length of hospital stay, rate of discharge to acute rehabilitation

METHODS: 99 consecutive adult scoliosis patients from 2012-2016 were retrospectively studied at our institution. Patients with fractional curves from L4 to S1 >10° underwent 3 categories of surgeries: 1) fractional curve only (FC, n=27), 2) lower thoracic to sacrum (LT, n=46), or 3) upper thoracic to sacrum (UT, n=26). Primary outcomes were the rates of surgical revision surgery and complications. Secondary outcomes were estimated blood loss, length of hospital stay, and discharge destination.

RESULTS: There were no significant preoperative differences in age, gender, smoking status, prior operation, fractional curve degree, pelvic tilt (PT), sagittal vertical axis (SVA), coronal balance, pelvic incidence/lumbar lordosis mismatch (PI-LL), or the proportion of balanced spines (SVA<5cm, PI-LL<10° and PT<10°) between the three treatment groups. Mean follow-up was 30.3 (range 12-101) months. The FC group had a lower complication rate (22% [FC] vs 57% [LT] vs 58% [UT], p=0.009), but a higher rate of extension surgery (26% [FC] vs 13% [LT] vs 4% [UT], p=0.068). The respective (FC, LT, UT) average estimated blood loss (593cc vs 1950cc vs 2634cc, p<0.001), length of hospital stay (5.7 vs 8.3 vs 8.3 days, p=0.002) and rate of discharge to acute rehabilitation (30% vs 45% vs 85%, p=0.001) were all lower for FC and highest for UT.

CONCLUSIONS: Treatment of the FC only is associated with a lower complication rate, shorter hospital stays and lower blood loss.
loss than complete scoliosis treatment. However, there is a higher associated rate of extension of the construct to the LT or UT levels, and patients should be counseled when considering their options.

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P26. Pulmonary Function in Adolescent Idiopathic Scoliosis after Harrington Instrumentation

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BACKGROUND CONTEXT: Although both spinal deformity and thoracic cage deformity are believed to affect pulmonary function, there are no long-term follow-up reports on the association between pulmonary function and thoracic cage deformities in patients with adolescent idiopathic scoliosis (AIS).

PURPOSE: To survey pulmonary function outcomes of AIS patients many years after spinal fusion with Harrington instrumentation (HI).

STUDY DESIGN/SETTING: A retrospective cohort study.

PATIENT SAMPLE: Study subjects comprised 194 patients diagnosed with AIS and treated with spinal fusion using HI between 1968 and 1987.

OUTCOME MEASURES: Standing whole spine X-ray, chest CT, and pulmonary function tests.

METHODS: Using a list of patients who had undergone spinal fusion with HI, people were contacted by letter. Patients who gave their informed consent were subjected to a complete standing whole spine X-ray, chest CT, and pulmonary function tests. Eighteen patients were eligible for inclusion. Mean age at the time of follow-up was 49.9 (range: 40 to 60) years, and the mean duration of follow-up was 35.3 (range: 27 to 44) years. There were 16 patients with right thoracic curve and 2 with double major curve (right thoracic and left lumbar curve). Apical vertebra of the thoracic curve was T8 in 6 patients, T9 in 8, and T11 in 4. For pulmonary function tests, forced vital capacity (%FVC), forced inspiratory volume in 1 second (FEV1.0), and forced expiratory volume % in one second (FEV1.0%) were measured. CT axial image was used at the apex of the main thoracic curve. Apical vertebral rotation was determined from RA sag measured by the method of Aaro et al. (Spine 1981). Thoracic cage deformities were measured as follows: Rib hump index (RHi) according to the method of Aaro et al. and posterior hemithoracic symmetry ratio (PHSr) according to the method of Campbell et al. (J Bone Joint Surg Am 2003).

RESULTS: Pulmonary function tests revealed mean FVC of 2.28 (range: 1.00 to 3.04) L and mean %FVC of 83.5% (range: 35.6% to 117.8%). Mean FEV1.0 was 1.88 (range: 0.78 to 2.48) L and mean FEV1.0% was 81.3% (range: 58.2% to 92.2%). Restrictive ventilation disorder with %FVC <80% was seen in 5 patients (27.7%), while 1 patient had mixed ventilation disorder (5.5%). %FVC had strong negative correlations with RA sag (r=-0.798, p<0.001), RHi (r=-0.820, p<0.001), PHSr (-0.705, p<0.001), and proximal thoracic curve (r=-0.721, p=0.001, p=0.002). Main thoracic curve (r=-0.674, p=0.002) and apical vertebral rotation of thoracic curve (r=-0.685, p=0.002) showed moderate negative correlations. Multiple regression analysis using the stepwise method was performed with %FVC as the objective variable, and RA sag, RHi, PHSr, PT curve, MT curve, and AVT of thoracic curve as the explanatory variables. RHi was a factor with a significant effect on %FVC (p<0.001).

CONCLUSIONS: In AIS patients examined many years after HI, restrictive ventilation defects were observed in 27.7%. Factors aggravating %FVC were large rib humps and large vertebral rotations. Since HI corrections primarily involve distraction force, it succeeded to sufficiently correct three-dimensional deformations. Three-dimensional correction of the spine and thoracic cage deformities is important in order to avoid pulmonary function impairment many years after surgery.

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P27. Minimally Invasive Decompression Surgery for Lumbar Spinal Stenosis with Degenerative Scoliosis: Predictive Factors of Radiographic and Clinical Outcomes

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BACKGROUND CONTEXT: There is ongoing controversy regarding the most appropriate surgical treatment for lumbar spinal stenosis (LSS) with concurrent degenerative lumbar scoliosis (DLS): decompression alone, decompression with limited spinal fusion, or long spinal fusion for deformity correction. The coexistence of degenerative stenosis and deformity is a common scenario; Nonetheless, selecting the appropriate surgical intervention requires thorough understanding of the patients clinical symptomatology as well as radiographic parameters. Minimally invasive (MIS) decompression surgery was performed for LSS patients with DLS.

PURPOSE: The aims of this study were (1) to investigate the clinical outcomes of MIS decompression surgery in LSS patients with DLS, and (2) to identify the predictive factors for both radiographic and clinical outcomes after MIS surgery.

STUDY DESIGN/SETTING: This study design is a retrospective sub-group analysis of a prospectively collected cohort analysis.

PATIENT SAMPLE: 438 consecutive patients were enrolled in this study. Inclusion criteria was evidence of LSS and DLS with coronal curvature measuring greater than 10°. Subsequently, all enrolled patients underwent microendoscopic laminotomy (MEL) or microendoscopic foraminotomy (MEF) for LSS at authors’ institution.

OUTCOME MEASURES: The patients’ preoperative, 2-year follow-up, and latest follow-up functions were evaluated using the Japanese Orthopaedic Association (JOA) score, JOA recovery rate, visual analog scale (VAS) for low back pain, Roland-Morris Disability Questionnaire (RDQ) and satisfaction for the surgical treatment. Radiographic parameters were measured by three independent researchers blinded to outcomes. Spino pelvic parameters, including lumbar lordosis (LL), sacral slope (SS), pelvic tilt (PT), and pelvic incidence (PI) were measured on lateral standing radiographs of the entire spine that were
obtained before surgery and at the latest follow-up. METHODS: Demographic items were compared between clinical outcomes preoperatively and at the latest follow-up. Values were compared using the paired t test, chi-square test, and Student’s t test. Student’s t-test was used to compare preoperative and postoperative recovery as well as JOA,VAS and RDQ. To assess predictors of JOA recovery, multivariate logistic regression analysis was performed using variables that had P < 0.20 on univariate analysis. A probability level of less than 0.05 was considered significant.

RESULTS: Of the 438 patients, 122 were included in final analysis, with a mean follow-up of 2.4 years. The JOA recovery rate was 47.6%. VAS and RDQ for low back pain was significantly improved at final follow-up. Cobb angle was maintained for 2 years postoperatively (p=0.159). Clinical outcomes in foraminal stenosis patients were significantly related to sex, preoperative high Cobb angle and progression of scoliosis (p=0.008). In the severe scoliosis patients, the JOA recovery was 44%, and was significantly dependent on progression of scoliosis (Cobb angle: preoperation 29.6°, 2-years follow-up 36.9°) and mismatch between the PI and the LL(preoperative PI-LL 35.5±21.2°) (p=0.028).

CONCLUSIONS: This study investigated clinical outcomes of MIS decompression surgery in LSS patients with DLS. The predictive risk factors of clinical outcomes were severe scoliosis, foraminal stenosis, progressive scoliosis and large mismatch of PI-LL.

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P28. Reciprocal Relationship Between Thoracic Kyphosis and Lumbo-Sacro-Pelvic Sagittal Alignment in Adolescent Idiopathic Scoliosis

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BACKGROUND CONTEXT: Analysis of the relationship between thoracic kyphosis and lumbo-sacro-pelvic sagittal alignment in thoracic adolescent idiopathic scoliosis (T-AIS) showed that thoracic sagittal plane alignment of AIS may be affected by lumbar, sacrum and pelvic alignment.

PURPOSE: The thoracic sagittal plane alignment in patients with T-AIS is important from the treatment strategy due to the influence on respiratory function. We aimed to clarify reciprocal relationship between thoracic kyphosis and lumbo-sacro-pelvic sagittal alignment in T-AIS.

STUDY DESIGN/SETTING: Retrospective cross-sectional study

METHODS: 83 patients (average age, 16 years old; male, 10; female, 73) with T-AIS were enrolled. Radiographic parameters are as follows: thoracic Cobb angle, 41±16 degrees; TK (T5-12), 16±9 degrees; LL, 53±11 degrees; max-LL (Cobb angle at which the maximum lordosis from S1), 56±11 degrees; SVA, −0.4±4mm; PI, −0.1±12 degrees; PT, 9±7 degrees; SS, 39±9 degrees; the inflexion point between thoracic kyphosis and lumbar lordosis (This was also recorded denoting 0 when this point was at L1, and positive number when this goes down caudally, i.e., +1 at L2, +2 at L3, −1 at T12, −2 at T11, −0.5±1.3; The SVA of this inflexion point (the max-LL SVA), 5.5±17.0mm. To determine important factors related to decrease of TK, stepwise logistic regression analysis was conducted. In addition, cluster analysis based on the identified related factors was performed to classify T-AIS according to the characteristics of global sagittal plane alignment.

RESULTS: The most important factor associated with decrease of TK was increase of SS (OR: 1.16, p=0.0003). Decrease of max-LL (OR: 0.89, p=0.0005) was followed. T-AIS can be classified into following types in terms of global sagittal alignment by cluster analysis: Type 1 (low SS low max-LL, n=28); Type 2 (high SS low max-LL, n=22); and Type 3 (high SS high max-LL, n=33). There was statistically significant deference in the average TK in each type of T-AIS: 15 degrees in Type 1; 6 degrees in Type 2; and 23 degrees in Type 3 (p <0.01, Tukey-Kramer HSD). The average the level of the inflexion point was −0.4 in Type 1, was −0.5 in Type 2 and −0.7 in Type 3. There was not statistically significant deference between the average the level of the inflexion point of each type. The average max-LL SVA was 2.2mm in Type 1, was 16.7mm in Type 2 and 0.8mm in Type 3. The max-LL SVA was significantly large in type 2, compared to type 1 and type 3 (p <0.01).

CONCLUSIONS: Reciprocal relationship between thoracic kyphosis and lumbo-sacro-pelvic sagittal alignment in adolescent idiopathic scoliosis was clarified. T-AIS with high SS and high max-LL showed normal sagittal profile (TK: 23 degrees). T-AIS with low SS and low max-LL, the thoracic kyphosis was also small, showed flat sagittal profile (TK: 15 degrees). On the contrary, T-AIS with high SS, low max-LL showed very small TK (TK: 6 degrees) and the inflexion point from TK to LL was significantly anterior compared to the other types. These were consistent with minus sagittal thoracic modifier of Lenke classification. The thoracic sagittal plane alignment of AIS may be affected by lumbar, sacrum and pelvic alignment.

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

P29. Gait Assessment is Important for Postoperative Evaluation of Corrective Fixation Surgery for Adult Spinal Deformity: Two Years Postoperative Evaluation

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BACKGROUND CONTEXT: We performed thoracolumbar corrective surgery to improve abnormal posture in patients with adult spinal deformity (ASD). Standing radiographic parameters and health related QOL are typically used to evaluate ASD patients. It is also important to investigate how patients’ gait actually improves.

PURPOSE: To investigate walking posture and speed before surgery, 1 year and 2 years after surgery, and make clear the relationship between walking parameters and health-related QOL.

STUDY DESIGN/SETTING: Longitudinal cohort

PATIENT SAMPLE: 31 patients with ASD (5 men, 26 women; mean age, 71 years (range, 58-82 years)) who underwent extensive corrective fixation surgeries between 2011 and 2013 were included among 151 ASD cases if they also underwent gait
OUTCOME MEASURES: Gait-trunk tilt angle, maximum knee extension angle during 1 gait cycle, step length (cm) and walking speed (m/s). Radiographic parameters [lumbar lordosis (LL), pelvic tilt (PT), pelvic incidence (PI) and sagittal vertical axis (SVA)]

METHODS: A 4-meter walk was recorded and analyzed using motion analysis software. Sagittal balance while walking was calculated as the angle between the plumb line on the side and the line connecting the greater trochanter and pinna while walking (i.e., the gait-trunk tilt angle). We also measured maximum knee extension angle during 1 gait cycle, step length (cm) and walking speed (m/s).

RESULTS: The mean LL, PT, PI minus LL, and SVA significantly improved from 13° to 42°, 35° to 26°, 39° to 12°; and 122 mm to 52 mm, respectively (all P<0.01). Mean preoperative SRS-22r function score was 2.50 pre-operatively, and improved to 3.32 postoperatively. The mean preoperative SRS-22r pain score was 2.84 pre-operatively, and improved to 3.82 postoperatively. The mean preoperative SRS-22r self-image score was 2.20 pre-operatively and improved to 3.54 postoperatively. In addition, the mean preoperative ODI score was 50% pre-operatively and improved to 31% postoperatively (all P<0.01). In gait analysis, the mean preoperative gait-trunk tilt angle was 13°; significantly improving to 6° and 6° at one year and two years postoperatively (P<0.01). The mean preoperative maximum knee extension angle was -13.3°; significantly improving to -9° and -9° at one year and two years postoperatively (P<0.01). The mean preoperative step length was 40cm improving to 44cm and 42cm at one year and two years postoperatively. The mean preoperative walking speed was 38m/s improving to 42m/s and 42m/s at one year and two years postoperatively. Although ODI at two years after surgery didn’t correlate with SVA, PI - LL, and PT at 2 years after surgery, ODI correlated with the walking speed at 2 years after surgery (r = -0.19, P = 0.021). In addition, the ODI change didn’t correlate with SVA change and PI - LL change, but correlated with walking speed change (r = -0.51, P = 0.001).

CONCLUSIONS: Corrective fixation surgery for ASD improved walking posture and restriction of knee extension, and maintained as of 2 years after surgery. The Postoperative health-related QOL is related to the walking speed rather than the radiographic parameters. It is important to assess not only radiograph but also the patient’s walking state properly.

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P31. Effect of Fixation to Pelvis on Rigid Kyphosis Patient Due to Osteoporotic Vertebral Fracture with Poor Sagittal Alignment

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BACKGROUND CONTEXT: Even if fracture sites perform fusion in the osteoporotic vertebral body fracture patients, remaining local rigid kyphosis induce posture abnormality, walk disorder, horizontal gaze disturbance, fatigue low back pain and compression of organs in the abdomen. Some papers said over 30 degrees local kyphosis cause the pain. So the osteoporotic vertebral fracture kyphosis patients need to receive correction and fusion surgery. However these patients have some problems as elder age, osteoporosis and global malalignment not only local malalignment, fusion area and methods are different from young or middle aged post traumatic kyphosis patients.

PURPOSE: The purpose of this study was to investigate the impact of the pelvic fusion and setting additional rod on severe rigid kyphosis due to osteoporotic vertebral fracture.

STUDY DESIGN/SETTING: Case Series in a Single Center

PATIENT SAMPLE: A consecutive 46 patients with rigid kyphosis due to osteoporotic vertebral fracture who underwent 3-column osteotomy were included in this study. All patient had sagittal malalignment as follow over 100mm sagittal axis(SVA), over 60 degrees thoracic kyphosis(TK), over 10 degrees pelvic incidence with lumbar lordosis(LL) mismatch or over 20 degrees pelvic tilt. They were followed at least for two years. 24 patients (local group) were performed deformity site osteotomy and 2 or 3 vertebrae cranial and caudal fixation avoid pelvic fixation from 2010 to April 2012. 22 patients (pelvic group) were performed deformity site osteotomy and fixation to the pelvis regardless of fracture level from May 2012 to August 2015. 11 patients were set one or two additional rods. There were 7 males and 39 females with mean age of 69 years.

OUTCOME MEASURES: X-ray parameters (SVA, TK, LL and PT), Oswestry Disability Index (ODI), reoperation rates, rod fracture rates, junctional kyphosis(over 20 degrees kyphosis between upper instrumented vertebra and two above vertebra) and new vertebral fracture rates.

METHODS: We investigated age, operation time, intraoperative blood loss, junctional kyphosis(over 20 degrees), new vertebral fracture, rod fracture and reoperation until 2 years after surgery. Furthermore we checked X-ray parameters as follows TK (T5-12), LL (L1-S1), SVA, SS(sacral slope), PT and Plat preoperatively, first standing, 1year and 2years after surgery with whole spine standing X-ray films. ODI was checked at preoperatively, 6months, 1year and 2years after surgery. We compared the each parameter between local group and pelvic group. Statistical analysis was performed by t-test, ANOVA and chi-square test.

RESULTS: Average ages were 67.4 vs 70.2(local vs pelvic). Among the preoperative X-ray parameters, TK was significantly bigger in local group (51.5 vs 31.4, p<0.001), LL (36.6 vs 27.0, P<0.01) and SVA (70.7 vs 138, P<0.01) were poorer in pelvic group. There were no significant different in another parameters and ODI (48 vs 45.6) preoperatively. Average fusion number were 8.5 and 11.3 (p<0.05). Average operation time were 328 minutes and 441 minutes (P<0.0001) and average blood loss were 1004ml and 2166ml (P<0.0001). Postoperatively ODI changed 42.5 vs 28.6 (P<0.01) at 6M, 42.2 vs 26.7 (p<0.01) at 1Y and 45.3 vs 33.0 (p<0.05) at 2Y. In first standing X-ray parameters, there were significantly differences of LL (25.4 vs 40.3, P<0.05), SS (23 vs 34, P<0.001) and PT (30.3 vs 21.0, P<0.01). No significantly difference was in SVA. At 2 years after operation, there was significantly difference of LL (25.4 vs 40.3, p<0.05). No significantly differences were in another parameters. Proximal junctional kyphosis occurred 11/24 case in local group and 13/22 in pelvic group (p=0.37). Proximal junctional kyphosis occurred 10/24 case in local group and 1/22 in pelvic group (p=0.003). Rod fracture occurred 0/24 case in local group and 10/22 in pelvic group (p=0.0002). Reoperation rates were 7/24 in local group and 11/22 in pelvic group (p=0.15). The cases who were set additional rod were eight, in these cases, rod fracture occurred in only one.

CONCLUSIONS: This study showed that local correction and fixation for the patients with rigid kyphosis due to osteoporotic vertebral fracture who underwent 3-column osteotomy could not obtain good global alignment and ODI. Pelvic fixation could obtain good global alignment but occurred frequent rod fracture. Therefore they need to fix to pelvis with the additional rods.

P32. Utility of Oblique Sagittal Reformatted and Three-Dimensional Surface Reconstruction Computed Tomography in Foraminal Stenosis Decompression

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BACKGROUND CONTEXT: Determining the responsible level of cervical radiculopathy can be difficult. Radicular pain does not always follow commonly used dermatomal maps. Therefore, a combination of symptoms and physical and radiographic findings are necessary to identify the symptomatic level. Thus, accurate assessment of foraminal stenosis is important in formulating a treatment plan for cervical radiculopathy.

PURPOSE: To determine whether using oblique sagittal reformatteed computed tomography (oblique sagittal CT) and three-dimensional surface reconstruction CT (3DCT) affects surgical plans for patients with cervical foraminal stenosis and whether they are helpful in diagnosing foraminal stenosis.

STUDY DESIGN/SETTING: A retrospective imaging and surgical procedure analysis and cohort study.

PATIENT SAMPLE: We retrospectively analyzed 18 adult patients (11 males, 7 females) who were planning to undergo surgical treatment for cervical spondylotic radiculopathy or myeloradiculopathy.

OUTCOME MEASURES: We analyzed the foraminal levels that were decompressed using anterior cervical discectomy and fusion, artificial disc replacement, posterior lateral fusion, or laminoplasty, the mean percent change in the surgical plan, and the inter-observer variation in the decompressed foramem site.
Kappa-Fleiss coefficients were calculated to compare reviewers’ surgical decisions.

**METHODS:** Four reviewers were shown CT and magnetic resonance (MR) images of 18 patients planning to undergo surgical treatment for cervical spondylotic radiculopathy or myeloradiculopathy, along with their office notes. After reviewing the MR imaging (MRI) and sagittal, coronal, and axial CT images, the reviewers recorded the type of surgery they would perform and which foramen should be decompressed. They then examined oblique sagittal CT and 3DCT images of the same patients and were asked to note any differences from their surgical plans. We subsequently analyzed these differences.

**RESULTS:** The mean percent change in the surgical plan was 18.1%. Inter-rater reliability was “slight” when axial, sagittal, and coronal CT images and axial and sagittal MRI were reviewed ($\kappa = 0.194$) and “fair” when these along with oblique sagittal CT and 3DCT images were reviewed ($\kappa = 0.240$). Thus, the addition of oblique sagittal CT and 3DCT images can change surgical plans as well as improve inter-rater reliability.

**CONCLUSIONS:** Because adding oblique sagittal CT and 3DCT images is simple, involves no additional radiation, and is helpful in evaluating the foramen, we recommend their routine use when planning surgical intervention for patients with cervical radiculopathy.

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**P33. Radiological Fusion Criteria of Postoperative Anterior Cervical Discectomy and Fusion: Systematic Review**

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**BACKGROUND CONTEXT:** Numerous methods have been used to diagnose pseudarthrosis after anterior cervical fusion; however, diagnosis remains difficult and criteria for assessing fusion remains unclear. The diagnosis often depends on the surgeon’s subjective assessment because universally accepted radiographic criteria do not exist.

**PURPOSE:** This study aimed to investigate and review criteria for assessing fusion after anterior cervical surgery.

**STUDY DESIGN/SETTING:** This study is based on a systematic review.

**PATIENT SAMPLE:** We extracted data from 59 articles, including the timing of follow up, graft construction, radiographic modality, fusion rate, patient number, study design, and radiographic criteria for assessing fusion.

**OUTCOME MEASURES:** We calculated the mean fusion rate of 8 articles at 1 year and 23 articles at 2 years. The independence of fusion rate of 8 articles at 1 year and 23 articles at 2 years were analyzed. Chi-square test was used to analyze the independence of fusion rate. The differences of the fusion rate at 2 years which consist of combination criterion were analyzed. Single-factor ANOVA was used to analyze the difference between fusion rates of 19 articles.

**METHODS:** We conducted MEDLINE and SCOPUS database searches for articles on anterior cervical fusion describing assessment for fusion. We extracted data from 59 articles and categorized every described method for assessing anterior cervical fusion. From 59 articles, we categorized every described method for assessing anterior cervical fusion and we could collect the fusion rate at 1 year from 8 articles and the fusion rate at 2 years from 23 articles. We took the statistics of fusion rates at 1 year and 2 years and analyzed which criteria was reliable.

**RESULTS:** Ten types of fusion criterion were mentioned. The four most common were presence of bridging trabecular bone between the endplates, absence of a radiolucent gap between the graft and endplate, absence of or minimal motion between vertebral bodies on flexion-extension radiographs, and absence of or minimal motion between the spinous processes on flexion-extension radiographs. The mean fusion rate at 1 year was 90.2%. The mean fusion rate at 2 years was 94.7%. The fusion rate at 2 years had significant independence ($P=0.048$).

**CONCLUSIONS:** The one reason of scattering fusion rate is that the fusion rate are affected radiographic interpretation as well as number of fusion levels, implant, patient background and surgical technique. The most common fusion criterion for determining fusion was bridging trabecular bone between the endplates. However, because the first and second criteria are subjective, they may be affected by the surgeon’s hope of fusion. We recommend using less than 1 mm of interspinous motion between spinous processes on extension and flexion to confirm fusion.

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**P34. Does It Need to be Inserted in all the Lamina in the Plate Type Open-Door Laminoplasty? Evaluation Focusing on Bone Healing of Hinge Part and Recluse of Spinal Canal**

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**BACKGROUND CONTEXT:** Recently there have been many reports about the usefulness of the plate for the cervical expansive laminoplasty (ELAP), but there is little report on whether or not to use plate at all lamina levels requiring decompression. Reduction in the number of plates to be used leads to shortening of operation time and reduction of health care cost.

**PURPOSE:** The present study was undertaken in order to compare the plated and non-plated lamina of ELAP performed in our institution about bone healing of hinge part and the change of the diameter of spinal canal up to 6 months after surgical operation.

**STUDY DESIGN/SETTING:** Retrospective study

**PATIENT SAMPLE:** The participants comprised 40 consecutive patients (28 males and 12 females) who underwent ELAP in our institution between December 2014 to April 2017. The total number of lamina was 152, among which plated was 83, and non-plated was 69. Cases that was underwent cervical spinal surgery in the past, additional interbody fusion surgery, and in which clinical diagnosis is traumatic, infectious or neoplastic diseases were excluded.

**OUTCOME MEASURES:** Patient information was examined for sex, preoperative age, bone mineral density, presence or absence of diabetes mellitus, BMI, clinical diagnosis (which was limited to CSM, OPLL in this study), and whether or not bone grafting was performed on surgery. Regarding to the lamina evaluation, spinal cord diameter at each level was measured...
with Computer Tomography before operation, immediately, and 6 months after surgery. And, bone healing rate of hinge part immediately and 6 months after surgery was classified and evaluated according to the method Rhee JM et al. reported to Spine in 2010.

**METHODS:** JMP® 13.0 (SAS Institute Inc., Cary, NC, USA) was used for statistical data analysis.

**RESULTS:** Change of spinal cord diameter before and after surgery is [pre-operation: 11.51 mm / immediately after operation: 15.76 mm / 6 months after operation: 15.38 mm] in the plated lamina, [pre-operation: 11.28 mm / immediately after the operation: 15.85 mm / 6 months after surgery: 14.95 mm] in the non-plated lamina, and no significant difference was observed between each measurement point. With respect to the reduction of the spinal cord diameter from immediately after the operation to the 6 months after the operation, the plated was –2.2 ± 0.86 mm and non-plated was –5.5 ± 0.94 mm, which was significantly decreased in non-plated lamina (P = 0.011). The bone healing rate at the 6 months after the operation was plated: 59/83 = 71.1%, and non-plated: 46/69 = 66.7% respectively, there was no significant difference was found. In addition, there was no significant difference in the presence or absence of acquisition of bone healing in Hinge part and change in spinal diameter, and any patient background.

**CONCLUSIONS:** In ELAP using Plate, it was inferred that there was no obvious difference in the plated and non-plated lamina with respect to the viewpoint of bone healing and reclose of the spinal cord. It can be applied to shortening of operation time and reduction of health care cost.

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**P35. Clinical Outcomes of 15 Cases of Cervical Pyogenic Spondylodiscitis**

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**BACKGROUND CONTEXT:** Cervical pyogenic spondylodiscitis is quite rare compared to other vertebral segments. Therefore, the literature about cervical pyogenic spondylodiscitis is scarce. But, it can be associated to worse clinical outcomes.

**PURPOSE:** The aim of this study is to investigate the patients of cervical pyogenic spondylodiscitis, and evaluate their clinical outcomes.

**STUDY DESIGN/SETTING:** A retrospective clinical study.

**PATIENT SAMPLE:** We retrospectively reviewed 148 patients who were hospitalized and had treatment for pyogenic spondylodiscitis in our institution between January 2000 and December 2016. Patients with infection at the site of previous spinal instrumentation, spinal metastasis, tuberculous and epidural abscess without vertebral and discal change in MRI were excluded.

**METHODS:** Data were analyzed regarding prevalence, affected level, form of onset, causative organisms, epidural abscess, neurological deficit (Frankel’s classification), surgical approach and clinical outcome.

**RESULTS:** Fifteen (10.1%) patients had cervical involvement with a mean age of 62.7 years. C5/6 is the most affected level followed by C4/5. We found acute type in 10 cases (67%), subacute type in 4 cases (27%), and chronic type in 1 case. Pathogenic microorganisms were identified in 11 cases (73.3%). Epidural abscess were detected in 12 cases (80%). Twelve patients (80%) presented with varying degrees of neurological impairment. All patients underwent surgery, 6 cases in Group A (anterior decompression and fusion), 1 case in Group P (anterior abscess drainage and posterior decompression and fusion), and 8 cases in Group AP (anteroposterior decompression and fusion). Healing of infection was achieved in all cases. Interval to negative CRP (days) was 29.2 in Group A, 31 in Group P and 25.6 in Group AP. In Group A, three cases (50%) required additional posterior fusion due to nonunion, neurological impairments remained in 2 cases (33%). A case of Group P also showed postoperative kyphotic deformity and C5 palsy. In Group AP, there was no case requiring additional operation, and neurological impairments remained in only one case. Kyphotic deformity at affected level was corrected in good alignment.

**CONCLUSIONS:** Occurrence of infection in the cervical spine is quite rare (5–20%). But, in contrast with other locations of spinal infections, cervical pyogenic spondylodiscitis can be a much more dramatic and rapidly deteriorating process, leading to early neurologic deficit. In this study, cervical involvement was only 10.1% in all patients with pyogenic spondylodiscitis. However, most of them (80%) showed epidural abscess and neurological impairment. All patients who had cervical involvements needed surgical treatment. In Group A, 3 cases in 6 (50%) required additional surgery due to nonunion. On the other hand, no additional surgery was needed in Group AP. Clinical outcome of Group AP was good compared to Group A and P in bone fusion, improvement of kyphotic deformity and neurological impairments.

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**P36. The Postoperative Cervical Kyphosis after Cervical Laminoplasty in Patients with Ossification of Posterior Longitudinal Ligament**

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**BACKGROUND CONTEXT:** Preoperative cervicothoracic kyphosis and cervical regional positive imbalance are the risk factors for postoperative cervical kyphosis after expansive laminoplasty (ELAP). Recent study showed the preoperative global positive sagittal imbalance is also risk factor for postoperative cervical kyphosis after ELAP in cervical spondylotic myelopathy (CSM). However, the risk factors for postoperative cervical kyphosis in patients with cervical ossification of the posterior longitudinal ligament (OPLL) has been little known and the difference of CSM without OPLL are unclear.

**PURPOSE:** The purpose of this study was to investigate the relationship between the onset of postoperative cervical
kyphosis after ELAP and the preoperative global spinal sagittal alignment in patients with OPLL with normal spinal sagittal alignment and compare to those of the CSM without OPLL.

**STUDY DESIGN/SETTING:** Retrospective case series.

**PATIENT SAMPLE:** This is a retrospective radiographic study of a consecutive case series of OPLL and cervical spondylotic myelopathy (CSM) without OPLL patients. Among a total of 174 consecutive patients who received ELAP for cervical OPLL and CSM in our hospital from January 2011 to December 2015, patients with a history of previous cervical spine surgery, patients who underwent anterior or posterior fixation with ELAP and who could not stand up without assistance were excluded. Finally, 69 patients were enrolled with the following criteria: underwent global sagittal alignment radiography prior to and one year after surgery, without cervical kyphosis (C2-C7 angle was 0 or greater than 0), without imbalance according to a cervical spine deformity (CSD) classification, and without adult spinal deformity (C2-C7 SVA is 80 mm or less than 80 mm, C7 SVA is 95 mm or less than 95 mm).

**OUTCOME MEASURES:** The subjects were divided into a postoperative cervical lordosis group (LG) or a kyphosis group (KG) at one year postoperatively. The preoperative global sagittal spinal alignment between LG and KG in CSM and OPLL was compared.

**METHODS:** 69 consecutive patients without preoperative cervical kyphosis who underwent ELAP for OPLL and CSM were enrolled. The global sagittal alignment radiography preoperatively and one year postoperatively were examined.

**RESULTS:** The occurrence of cervical kyphosis after ELAP was 7 of 27 cases (25.9%) in OPLL and 13 of 42 cases (31.0%) in CSM. In patients with CSM in the KG group, C7 sagittal vertical axis (SVA) was smaller than that in the LG group. In patients with cervical OPLL in the KG group, C2-C7 angle, C2-C7 SVA, and thoracic kyphosis (TK) were smaller than those in the LG group. In OPLL, the age of the KG group was younger than that of LG; however, this difference was not significant in CSM. Safety factors of the postoperative cervical kyphosis were the cervical lordosis type in the cervical shape classification, the continuous type of OPLL, and more than three level contentious ossification of OPLL.

**CONCLUSIONS:** In patients with cervical OPLL without preoperative global spinal sagittal imbalance, the typical characteristics of postoperative cervical kyphotic deformity after ELAP was different to those in CSM. In CSM, the preoperative global sagittal alignment effects the postoperative cervical kyphosis, which were the small SVA with lumbar hyperlordosis. In OPLL patients, younger age, the less effects of the global alignment, and the preoperative small angle in C2-C7, C2-C7 SVA, and TK were the risk factors of postoperative cervical kyphosis while the cervical lordosis type in the cervical shape classification, the continuous type of OPLL, and more than three level contentious ossification of OPLL were considered to have less the risk.

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**P37. Anterior Decompression and Fusion versus Laminoplasty for Cervical Myelopathy Caused by Soft Disc Herniation: A Long-Term Prospective Multicenter Study**

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**BACKGROUND CONTEXT:** Anterior decompression and fusion (ADF) has conventionally been used for cervical myelopathy caused by soft disc herniation with stable outcomes. However, complications related to bone grafting and recurrence of myelopathy due to adjacent segment degeneration are its drawbacks. The efficacy of laminoplasty as an alternative has been sporadically reported, but no prospective study has been conducted to verify it.

**PURPOSE:** The purpose of this study was to compare the long-term surgical outcomes of ADF and laminoplasty for cervical myelopathy caused by soft disc herniation and to determine whether or not laminoplasty is comparable for this condition.

**STUDY DESIGN/SETTING:** A long-term prospective multicenter study on the outcomes of ADF versus laminoplasty was conducted at Tohoku University Hospital, Sendai Nishitaga Hospital, and Tohoku Rosai Hospital, all belonging to the Tohoku University Spine Society.

**PATIENT SAMPLE:** Patients with cervical myelopathy caused by soft disc herniation, whose preoperative disease period was less than one year, were studied. The first 30 patients and the next 30 patients were treated with ADF and laminoplasty, respectively. All patients were given the same postoperative management.

**METHODS:** Twenty-two patients from the ADF group and 20 patients from the laminoplasty group (follow-up rate: 70%) who completed a follow-up examination 10 years after surgery were analyzed.

**RESULTS:** The two groups were found statistically matched regarding age at surgery, gender, disc level of herniation, anteroposterior diameter of the spinal canal, preoperative severity of myelopathy assessed by a scoring system proposed by Japanese Orthopaedic Association (JOA score), cervical lordosis angle, and cervical range of motion (ROM). There was no statistically significant difference in the postoperative JOA score or recovery rate of myelopathy (discribed by Hirabayashi) between the two groups. Although operative time was not significantly different, the amount of blood loss during surgery was significantly less in the laminoplasty group. Cervical lordosis angle and ROM were diminished postoperatively without a significant difference between the two groups. Donor site pain was minimal in all patients in the ADF group. Neck pain was significantly more frequent in the laminoplasty group than in the ADF group. Bone fusion was attained in all patients in the ADF group. All patients in the laminoplasty group, herniation...
was evidently reduced in postoperative MRI 10 years after the surgery. New disc herniation was observed in 5 patients, but none of the patients showed neurological deterioration. One patient from the ADF group underwent laminoplasty for secondary myelopathy due to adjacent segment degeneration 2 years after the surgery.

**CONCLUSIONS:** There was no critical difference between the ADF and the laminoplasty groups with regard to neurological recovery and other surgical-related factors 10 years after surgery. Laminoplasty can be employed for cervical myelopathy caused by soft disc herniation in particular combined with multilevel spinal canal stenosis to avoid secondary myelopathy.

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**P38. The Effect of Posterior Shift of the Spinal Cord after Laminoplasty with Prophylactic Foraminotomy for Postoperative C5 Paralysis**

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**BACKGROUND CONTEXT:** We reported that prophylactic foraminotomy was performed less than 2.5mm in foraminal diameter of C4/5 for preventing C5 paralysis after laminoplasty. But C5 paralysis could not be prevented completely, the possibility of another factors were considered.

**PURPOSE:** The purpose of this study is to investigate the effect of posterior shift of the spinal cord after laminoplasty with prophylactic foraminotomy for postoperative C5 paralysis.

**STUDY DESIGN/SETTING:** This study included 385 consecutive surgically treated patients with laminoplasty from Jan, 2012 to Mar, 2016. Laminoplasty with prophylactic foraminotomy (PF) was performed for 188 cases (129 men and 59 women, avg 66.7 y.o, avg 29.6M) and classified non-paralysis group (NP group) and paralysis group (P group). C5 paralysis was defined that weakness of deltoid muscle less than 3 level in MMT.

**METHODS:** Anterior distance was measured from posterior wall of vertebra to anterior aspect of spinal cord in C4/5 level with MRI axial view. Posterior shift distance was the difference between the postoperation and the preoperation of anterior distance. Investigation factors were incidence of C5 paralysis, preoperative and postoperative anterior distance, shift distance, angle of C2-7, angle of C4/5, C4 slipping and T2 high intensity in MRI. Each factor was compared P group and NP group.

**RESULTS:** NP group was 178 cases (120 men and 58 women, avg 66.9 y.o) and P group was 10 cases (9 men and 1 women, avg 59.1 y.o). The incidence of C5 palsy in all cases was 2.6% and in PF cases was 5.3%. The mean anterior distance of preoperation was 0.73mm, postoperation was 1.66mm and the mean posterior shift was 0.92mm in NP group. In P group, the mean anterior distance of preoperation was 0.57mm, postoperation was 2.28mm and the mean posterior shift was 1.72mm. The angle of C2-7 was 12.1/10.7 (NP group/P group), the angle of C4/5 was 3.3/6.5, the presence of C4 slipping was 15 cases (8.4%)/0 case and the presence of T2 high intensity in MRI was 8 cases (80%)/79 cases (44.4%). The significant difference was seen in posterior shift distance of spinal cord between two group (p<0.01). No significant difference was seen in preoperative and postoperative anterior distance of spinal cord, angle of C2-7, local angle of C4/5, C4 slipping and T2 high intensity in MRI.

**CONCLUSIONS:** The factors of posterior shift as angle of C2-7, angle of C4/5 and C4 slipping and of disorder of spinal cord as T2 high intensity in MRI have no influence for C5 paralysis. PF prevented postoperative foraminal stenosis and the impingement of C5 nerve root at the medial facet joint. Posterior shift of spinal cord caused posterior shift and tethering of C5 nerve root. Posterior shift of spinal cord became longer, the power of tethering of C5 root became stronger. As posterior shift distance was significantly longer in P group, tethering of C5 nerve root might have relation to C5 paralysis. PF could not prevent tethering of C5 nerve root. Posterior shift of spinal cord caused tethering of C5 root and might have relation to C5 paralysis.

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**P39. The Influence of Multi-Factor on Spinal Cord of Patients with C-OPLL Using Extension-Flexion CT**

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**BACKGROUND CONTEXT:** Single factor which influences outcome of laminoplasty for patients with cervical ossification of posterior longitudinal ligament(C-OPLL) were reported in several literatures. However, spinal cord of patients with C-OPLL are complicated by multi-factor such as size of ossification, alignment, range of motion (ROM), spinal cord tethering and so on. Dynamic multidetector row computer tomography during flexion and extension after myelography (ExFx CT) would be useful to evaluate multi-factor of C-OPLL patients.

**PURPOSE:** The objective of this study was to evaluate the influence of multi-factor on spinal cord of patients with C-OPLL using ExFx CT.

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

**PATIENT SAMPLE:** Consecutive 107 patients with C-OPLL who had myelopathy and underwent posterior laminoplasty were prospectively enrolled.

**OUTCOME MEASURES:** The severity of myelopathy was evaluated by Japanese Orthopedic Association’s scoring system (JOA score). The recovery rate of the JOA score after laminoplasty was calculated as (postoperative - preoperative JOA score)/17 - preoperative JOA score*100%.

**METHODS:** ExFx CT were taken in all patients and spinal cord cross-sectional area at the most stenotic cervical level was measured. The dynamic change, which is the gap between extension and flexion of spinal cord cross-sectional area (gapExFx), was also measured. Furthermore, C2-7 range of motion (ROM), local ROM, age, occupying ratio of ossification, and C2-7 alignment was measured.

**RESULTS:** The most stenotic level was located at C2/3 in 4 cases, C3/4 in 36 cases, C4/5 in 29 cases, C5/6 in 24 cases, and C6/7 in 14 cases. All patients with C-OPLL had myelopathy and their mean JOA score was 10.7, recovery rate was 51.6%, C2-7 ROM was 28.6 degrees, local ROM was 5.3 degrees, occupying ratio of ossification was 41.0%, and C2-7 alignment was 6.5 degrees lordosis. The average spinal cord cross-sectional area of each stenotic level was less during extension than during flexion at all levels. Multiple regression analysis indicated gapExFx correlated with the JOA score and the recovery rate. In contrast, occupying ratio, C2-7 ROM, and local ROM were not associated with the JOA score.

**CONCLUSIONS:** Only the gap between extension and flexion of spinal cord cross-sectional area correlated with the JOA score and
also the recovery rate after laminoplasty. This is because, gapExFx includes multi-factor such as size of ossification, alignment, ROM, spinal cord tethering. Dynamic multidetector row computer tomography during flexion and extension after myelography was useful to evaluate C-OPPL patients who are complicated by multi-factor. GapExFx would be a predictor for severity and recovery of patients with C-OPPL who undergo laminoplasty.

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

**P40. Preoperative Factors for Fair Surgical Outcome after Surgical Treatment for Patients with Proximal CSA Using Electrophysiological Exam and Neurological Findings**

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**BACKGROUND CONTEXT:** It is difficult to determine whether surgery of the cervical spine should be recommended for patients with proximal CSA because some patients had fair and/or poor outcomes. The preoperative factors for a fair outcome are not well known.

**PURPOSE:** The aim is to investigate preoperative factors for a fair outcome after surgical treatment for patients with proximal cervical spondylotic amyotrophy (CSA) using electrophysiological exam and neurological findings.

**STUDY DESIGN/SETTING:** Retrospective study.

**PATIENT SAMPLE:** 56 patients with proximal CSA who underwent surgical treatment of the cervical spine were enrolled.

**OUTCOME MEASURES:** Manual muscle testing of deltoid and biceps brachii muscle.

**METHODS:** Erb-point stimulated (compound muscle action potentials) CMAPs were recorded in the deltoid and biceps in all patients. The average percentages of CMAPs amplitude on the affected side compared to the normal side in the deltoid and biceps brachii muscles (AP), the percentages of CMAPs amplitude on the affected side compared to the normal side in the deltoid (PD) and in the biceps brachii muscles (PB) were calculated. Preoperative and postoperative strength of most atrophic muscles was evaluated using manual muscle testing. Improvements in strength were classified as excellent, good, fair, or poor.

**RESULTS:** The surgical outcomes were excellent in 25 patients (44.6%), good in 16 (28.6%), fair in 16 (28.6%), and poor in 10 (17.9%). AP was the only significant factor (p = 0.0134) with an odds ratio of 0.29 (95% confidence interval, 0.11-0.77; for a change of 25%) There were 10 patients (17.9%) with poor outcomes. The incidence of C5 palsy was 14.3% (8 patients). Two patients were diagnosed with ALS at 12 and 13 months postoperatively.

**CONCLUSIONS:** We found that AP can be used as a factor related to becoming achieving a fair outcome. Even if the symptom was gradually getting better postoperatively, we must pay attention to patients with CSA until at least 12 months postoperatively.

**FDA DEVICE/DRUG STATUS:** This abstract does not discuss or include any applicable devices or drugs.
P42. An Evaluation of Finger Posture and a Disorder Level for Finger Drop Due to Cervical Radiculopathy

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BACKGROUND CONTEXT: Cervical radiculopathy could cause finger drop and deteriorate quality of life. Besides, finger drop could result from radial nerve paralysis, posterior interosseous nerve paralysis, ulnar nerve paralysis, and so on. It is difficult and important to diagnose the cause of finger drop correctly. Moreover, even if it is diagnosed as cervical radiculopathy, it is difficult to specify the disorder level.

PURPOSE: The purpose of this study was to evaluate whether it is possible to predict a disorder level from imaging findings and surgical outcome from the preoperative finger posture of finger drop in cervical radiculopathy cases.

STUDY DESIGN/SETTING: A retrospective study.

PATIENT SAMPLE: We defined a case that extension of any fingers MMT was 2/5 or less as finger drop. Twenty patients who had finger drop and underwent cervical foraminotomy from 2005 to 2013 (17 male, 3 female, mean age 60.2 years, mean follow-up 14.8 months) were included in this study.

OUTCOME MEASURES: The accuracy rate of a disorder level between diagnosed by imaging findings and intraoperative findings. The correlation between finger posture and a disorder level. The surgical outcomes in each finger posture.

METHODS: We evaluated the accuracy rate of a disorder level between diagnosed by imaging findings and intraoperative findings. We also classified finger drop cases into 3 types according to dropped finger posture and evaluated the correlation between 3 types and a disorder level. Type 1: middle and ring finger extension deficit is severe and index and little finger deficit is mild. Type 2: finger extension deficit is the severest in little finger and gradually got mild toward index finger, but thumb is intact. Type 3: finger extension deficit is the severest in little finger and gradually got mild toward index finger, and thumb abduction is weak or absent (MMT is less than 2/5). In addition, surgical outcomes were compared for each type of finger posture.

RESULTS: In the cases of cervical disc herniation diagnosed by imaging findings, the predicted disorder level and intraoperative findings coincided with high probability, but a probability were as low as 42% in the other cases. One of the causes of differences between imaging findings and intraoperative findings was due to an adhesion of nerve roots with fibrous capsule. C7 nerve root was impaired at 80% in the type 1, and C8 nerve root at 90 % in the type 2. In the type 3, all patients had C8 nerve root deficit and atrophy of dorsal interosseous muscle. Finally, good surgical outcomes were obtained in all the types in spite of different preoperative paralysis.

CONCLUSIONS: It is difficult to diagnose a disorder level of cervical radiculopathy with finger drop only by imaging findings. However, the type of finger posture could be helpful in diagnosis of a disorder level.

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

P43. Anterior Cervical Discectomy and Fusion in Professional Athletes: Allograft versus Autograft

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BACKGROUND CONTEXT: Anterior Cervical Discectomy and Fusion (ACDF) and the techniques used in the surgery continues to be a controversial topic amongst spine surgeons involved in the care of the professional athlete. The choice of ICA versus allograft continues to be a point of contention. This represents the largest series of professional athletes, to our knowledge, from a single surgeon with largely unchanged techniques for the duration of the series. Indications for the surgery were cervical disc herniation with radiculopathy, fracture, or traumatic neuropaxia.

PURPOSE: To characterize the fusion rate and outcomes for anterior cervical discectomy and fusion in professional athletes comparing allograft and autograft interbody graft choices.

STUDY DESIGN/SETTING: Retrospective analysis of the senior author’s case series of treating professional athletes with single level ACDF. The same technique used in all cases, with the exception being the choice of allograft versus ICA.

PATIENT SAMPLE: A retrospective database of professional athlete patients treated with ACDF for cervical disc herniation, cervical fracture, or traumatic neuropraxia by the senior author (A.B.D.). This was a total of 53 patients.

OUTCOME MEASURES: Outcome measures included graft choice, fusion status, clearance for return to activities, and return to play status.

METHODS: A retrospective database of professional athlete patients treated with ACDF for cervical disc herniation, cervical fracture, or traumatic neuropraxia by the senior author (A.B.D.). We analyzed the database with regards to graft choice, fusion or pseudarthrosis, clearance for return to athletic activity, and return to play. The graft choice was documented from the operative note. The fusion was evaluated with either Computed Tomography (CT) Scan or Flexion/Extension radiographs at 3-6 months post-op, with interval imaging as needed until fusion documented. Postoperative clinical notes were reviewed for clearance for return to activities and return to play status. We also analyzed whether the athletes were “self-employed” or “league-contracted.”

RESULTS: Our analysis identified 53 professional athlete patients who had an ACDF for cervical disc herniation, traumatic neuropaxia, or fracture. Of these patients, 38 were grafted with a structural iliac crest autograft and 15 with an allograft. We excluded 4 patients from final analysis secondary to prior surgery or other injuries. The range of follow-up was from 13-271 months. This provided a total of 49 patients, 34 autograft and 15 allograft. 47/49 players were “collision-sport” athletes (football, hockey, rodeo, bull riding, baseball). All 34 autograft patients had a confirmed bony fusion, whereas 13/15 allograft patients had a confirmed bony fusion based on CT scan or Flexion/Extension radiographs at 3-6 months post op. One allograft had a delayed union that went on to bony fusion at 1 year. The one player with a pseudarthrosis did return to play. In total 42/49 players (85.7%) returned to play, 24/26 (92.3%) “self-employed” and 18/23 (78.2%) “league-contracted.” 47/49 players were “cleared to return to athletic activities” by the treating surgeon.
CONCLUSIONS: Surgical treatment of cervical disc herniations, cervical fractures, or traumatic neuropraxia in the professional athlete with iliac crest autograft results in very high union rates and return to play rates. We recommend iliac crest autograft when preforming ACDF on athletes in collision sports. 2/15 (13%) of players who had allograft missed an additional season secondary to delayed union or pseudarthrosis.

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

P44. Improvement versus Deterioration of the Neck Disability Index after Surgery for Degenerative Cervical Myelopathy: An Analysis of a Global Cohort of Patients

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PURPOSE: Several studies have shown the benefits of surgical intervention for degenerative cervical myelopathy (DCM). Nevertheless, surgical outcomes vary, and there is a subset of patients that experience increased neck disability after surgery. The purpose of this study is to compare patients with improvement versus deterioration of the neck disability index (NDI) after surgery for DCM.

METHODS: This is a retrospective review of two prospective multicenter studies (the AOSpine CSM-North America and CSM-International studies) conducted between 2005 and 2011. Adult patients with DCM who underwent surgical intervention were included. Characteristics were compared between those with improvement versus deterioration based on their NDI. The difference between NDI at last follow-up, up to 2 years postoperatively and baseline for patients who underwent surgical treatment for DCM were computed. We removed patients with scores which approximated no clinically significant differences (+/-5). Patients with changes greater than +/-5 NDI were categorized into 2 separate groups and compared using univariate and multivariate logistic regression analyses.

RESULTS: A total of 367 patients with complete NDI data pre-operatively and follow-up to 24 months were available. Out of these 367 patients, 319 had improvement of their NDI by greater than 5 points and 48 patients deteriorated by greater than 5 points. On univariate analysis, smoking (p<0.038), psychiatric comorbidities (p=0.046), MRI evidence of spondylolisthesis (p=0.043), higher initial baseline NDI score (p<0.001), and a lower K-line (p=0.001). In terms of surgical factors, laminectomy and fusion was statistically different (p=0.023) and longer operative time tended to be different between the groups. On multivariate analysis, patients with deterioration were more likely smokers (p=0.016), to have psychiatric comorbidities (p=0.018), higher initial baseline NDI score (p<0.001), and a lower K-line (p<0.001). The area under the receiver operating characteristic curve was 0.767.

CONCLUSIONS: Improvement in the Postoperative NDI is significantly associated with primarily non-modifiable factors, such as the K-line and spondylolisthesis, but also factors that can be managed including smoking and psychiatric comorbidities.

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

P45. Best versus Worst Neurological Outcome after Surgery for Degenerative Cervical Myelopathy: An Analysis of a Global AOSpine Cohort of Patients

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BACKGROUND CONTEXT: Multiple studies have proven the benefits of surgical intervention for degenerative cervical myelopathy (DCM). Nevertheless, surgical outcomes vary, and there is a subset of patients that experience limited benefit from surgery.

PURPOSE: The purpose of this study is to compare patients with best versus worst neurological outcome after surgery for DCM.

STUDY DESIGN/SETTING: Retrospective analysis of a prospective database.

PATIENT SAMPLE: 171 patients with complete preoperative MRI and 2-year mJOA scores.

OUTCOME MEASURES: mJOA score at 2-years of follow-up.

METHODS: This is a retrospective review of two prospective multicenter studies (the AOSpine CSM-North America and CSM-International studies) conducted between 2005 and 2011. For patients with complete preoperative MRI and 2-year follow-up, characteristics were compared between those with best versus worst outcomes based on the modified Japanese Orthopedic Association (mJOA) scale. Only patients with baseline mJOA ≤14 were included to minimize ceiling effects. Based on the top and bottom 20% scores, best and worst outcomes were defined as final mJOA scores of 18 and ≤13, respectively.

RESULTS: Based on “best” and “worst” definitions for outcome at 2 years, 98 and 73 patients with complete preoperative MRI and 2-year follow-up were identified, respectively. On multiple logistic regression analysis, gait impairment (p=0.050), duration of symptoms (p=0.016), spondylolisthesis (p=0.032), T1W-hypointensity (p=0.003), and severe baseline myelopathy (p=0.013) were all independent significant predictors of outcome, with an area under the curve of 0.82 for the model.

CONCLUSIONS: In this study, several baseline patient factors were found to significantly differ between those who experienced the best versus worst neurological outcome after surgery for DCM. These findings may provide useful for patient counseling, perioperative expectations, and surgical decision-making.

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P46. Spinopelvic Sagittal Alignment after Minimally Invasive Decompression Surgery without Fusion in Patients with Lumbar Degenerative Spondylolisthesis

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BACKGROUND CONTEXT: Spinopelvic sagittal balance is important in managing lumbar diseases and low back pain (LBP). Anterior translation of the C7 plumb line, high pelvic incidence (PI), and pelvic retroversion were reportedly marked in degenerative spondylolisthesis (DS) patients compared with a normal population.

PURPOSE: The purpose of this study was to evaluate the change in spinal sagittal alignment after decompression alone in patients with low-grade DS.

STUDY DESIGN/SETTING: This study was a retrospective review of prospectively collected surgical data.

PATIENT SAMPLE: The study subjects were 87 patients (48 men, 39 women; mean age 69.2 ± 9.3 years) who underwent microendoscopic laminotomy. All patients had presented with lower-extremity pain and/or numbness. Thirty-five included patients had degenerative spondylolisthesis (DS group), and 52 did not (non-DS group).

OUTCOME MEASURES: Primary outcome was a change in spinopelvic alignment between the baseline and latest follow-up values (DS group versus non-DS group). Secondary outcomes were the relations between the improved global sagittal alignment and the preoperative spinopelvic parameters.

METHODS: Surgical outcomes were evaluated using the Japanese Orthopaedic Association (JOA) score and spine-pelvic parameters by comparing the three groups. As for radiological assessment, we measured coronal Cobb angle, lumbar lordosis (LL), anterolisthesis, lateral listhesis, C7 plumb line, sagittal vertical axis (SVA), sacral slope (SS), pelvic tilt (PT), and PI. Radiologic factors and clinical outcomes were statistically compared between the two groups using Student’s t test or the Mann-Whitney U-test. Correlations between the improvement of the SVA and spinopelvic parameters were calculated using Pearson’s correlation coefficient. P value < 0.05 was considered statistically significant.

RESULTS: Both groups showed significantly alleviated LBP, leg pain, and leg numbness. There were no significant intergroup differences in the JOA score or VAS at the latest follow-up. Preoperative SVA and PI were significantly higher in the DS group than in the non-DS group (p < 0.05). SVA significantly decreased and LL significantly increased in the DS group (p < 0.05), whereas those parameters did not differ significantly from before to after surgery in the non-DS group. No significant differences existed between the groups for SS, PT, or PI (= minus) LL. In both groups, the SVA improvement correlated significantly with the preoperative SVA (DS: r = 0.702, non-DS: r = 0.397). There was also a significant intergroup difference in the correlation coefficient (z = 1.98 r = 0.048).

CONCLUSIONS: SVA and LL significantly improved after microsurgical laminotomy in patients with low-grade DS and neurologic symptoms. SVA improvement in the DS group was correlated with preoperative spinopelvic sagittal imbalance. It should be noted that the strength of those correlations was greater than for those in the non-DS group.

P47. Low Back Pain after Single Level Posterior Lumbar Interbody Fusion for Lumbar Spinal Stenosis with Adult Spinal Deformity

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PURPOSE: The surgical strategy of lumbar spinal stenosis (LSS) with adult spinal deformity (ASD) is still controversial. The purpose of this study was to investigate surgical outcomes and limitations of single level posterior lumbar interbody fusion (PLIF) for LSS with ASD.

STUDY DESIGN/SETTING: A retrospective single center cohort study.

PATIENT SAMPLE: Three hundred and eighty consecutive patients having undergone single level PLIF were divided into three groups by coronal Cobb angles. Thirty-one patients (8.2%) had 20 degrees and more, 57 patients (15.0%) had between 10 degrees and 19 degrees and 292 patients had (76.8%) had between 0 and 9 degrees. Coronal Cobb angles of Group 1 and Group 2 were between 0 and 9 degrees and between 10 and 19 degrees, respectively. Group 1 and Group 2 each comprised of 20 patients matched with the Scoliosis Group in age, gender, surgical levels, disease, and follow up period. The Scoliosis Group comprised of 19 patients with coronal Cobb angles of 20 degrees or more.

METHODS: The enrolled patients were followed up for at least 4 years. Only a local level that caused their leg pain due to local instability was treated by single level PLIF. We evaluated clinical and radiological outcomes including visual analog scale, Japanese Orthopaedic Association (JOA) score and spinopelvic parameters by comparing the three groups. As for radiological assessment, we measured coronal Cobb angle, lumbar lordosis (LL), anterolisthesis, lateral listhesis, C7 plumb line, sagittal vertical axis (SVA), sacral slope (SS), pelvic tilt (PT), pelvic incidence (PI), and PI minus LL. The average age at operation was 69.4 years. The average period of follow up was for 5.4 years.

RESULTS: The clinical outcomes of the Scoliosis Group was significantly worse than the other two groups, especially in total JOA score (p<0.05) and in low-back pain (p<0.01). The Scoliosis Group’s low-back pain did not improve compared with the other two control groups and was worse at final follow up. There was no significant difference regarding leg pain. The Postoperative coronal Cobb angle was corrected significantly (p<0.01) but had worsened at final follow up (p<0.01) just in the Scoliosis Group. The progression of scoliosis was correlated with the pre-operative coronal Cobb angle (r=-0.598, p<0.001). The deterioration of clinical outcomes was correlated with the progression of scoliosis after surgery (r=-0.556, p<0.001).

CONCLUSIONS: The greater pre-operative coronal Cobb angle caused the greater progression of coronal Cobb angle and the worsened clinical outcomes after the single level PLIF for LSS with ASD. We do not recommend long-corrective spinal fusion, because corrective surgery is a major invasive surgery and has a high complication rate. On the other hand, there are problems with short spinal fusion also. One reason is remain of spinal deformity due to insufficient correction, and another reason is difficulty of corrective revision surgery after short spinal fusion. Therefore, even if single level spinal fusion is performed, good local alignment at the primary surgery stage is recommended.

FDA DEVICE/DRUG STATUS: This abstract does not discuss or include any applicable devices or drugs.
P48. Surgical Outcomes for Degenerative Lumbar Spondylolisthesis: AOSpine Asia Pacific Prospective, Comparative, Multicenter Trial

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BACKGROUND CONTEXT: There was no high evidence if spine fusion is effective in clinical outcomes for degenerative lumbar spondylolisthesis (DLS). In addition, it is unclear whether spinal fusion is the most effective procedure for improving clinical outcomes in DLS.

PURPOSE: To compare clinical and radiological outcomes in patients with DLS treated using different surgical procedures.

STUDY DESIGN/SETTING: A prospective observational multicenter cohort study.

PATIENT SAMPLE: A total of 165 patients with single level DLS

OUTCOME MEASURES: Patient-reported outcomes (PROs) including a visual analogue scale (VAS) for low back pain, leg pain, and numbness, Zurich Claudication Questionnaire (ZCQ) and EuroQol 5 Dimension (EQ-5D), operative time, estimated blood loss (EBL) and complications, radiological assessments including slippage, lumbar lordosis, lumbar axis sacral distance, range of motion at each disc level, bony fusion, and disc degeneration according to the Schneiderman classification.

METHODS: The inclusion criteria were the presence of neurogenic claudication, single-level DLS. The exclusion criteria were previous spine operation, multi-level lumbar spinal stenosis, osteoporosis, degenerative scoliosis, concomitant conditions that could compromise outcome assessment, or psychological disorders. Surgical indication and methods were decided based on each institute’s standard practice. A total of 165 cases were registered from 10/2013 to 3/2016. Demographic data including age, gender, body mass index, smoking, bone mineral density, comorbidity, and duration of symptoms before surgery were recorded. The patient-reported outcomes (PROs) and radiological items were measured at pre, 3, 6 12 months postoperatively (PO). Twelve patients were excluded. Sixteen patients underwent posterior decompression only (D group), and 137 underwent decompression and fusion (DF group). In the DF group, 41, 78, and 18 patients had posterolateral fusion (PLF), lumbar interbody fusion (IF), and another procedure, respectively. We used propensity score matching to avoid bias related to confounding preoperative variables and compared clinical and radiological outcomes between the D and DF groups and between the PLF and IF groups. A p-value < 0.05 was considered to be significant.

RESULTS: The 14 patients in the D and DF groups were matched. Operative time and EBL were significantly lower in the D group than those in the DF group (95.1 vs. 185.6 min, 67.3 vs. 308.6ml, P<0.05). At 3 months PO, only VAS for leg numbness and ZCQ Physical function scale had improved significantly in the DF group, compared with the D group (11.8 vs. 34.5 mm, 6.9 vs. 9.6, p<0.05). At 6 and 12 months, PROs did not differ between the groups. The 28 patients in the PLF and IF groups were matched using the propensity score. The operative time, EBL, complications and PROs at 3 months did not differ between the PLF and IF groups. The VAS for low back pain, EQ-5D score, and ZCQ patient satisfaction with treatment at 6 and 12 months were better in the IF group than in the PLF group (p<0.05). Radiological outcomes didn’t differ between the PLF and IF groups up to 12 months.

CONCLUSIONS: Although the number of patients in each group was small after matching, the results of this prospective multicenter trial suggest that, compared with decompression only, decompression and fusion might improve clinical outcomes such as leg numbness and physical function at 3 months and that IF might result in better clinical outcomes up to 12 months postoperatively than PLF.

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

P49. Total En Boc Spondylectomy for Primary Tumors of the Lumbar Spine

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BACKGROUND CONTEXT: Lumbar spine total en bloc spondylectomy (TES) is challenging due to the anatomic relationship between the vertebrae and abdominal structures. Unlike thoracic spine TES performed with transaction of nerve roots, lumbar spine TES usually necessitates extensive nerve root dissection with frequent retraction to preserve lower extremity motor function. Thus, TES in the lumbar spine typically requires an anterior-posterior combined procedure, while thoracic spine TES can often be performed using a solely posterior approach. For these reasons, the majority of published accounts describing lumbar spine TES performed for primary tumors are case reports or small case series.

PURPOSE: The purpose of this study was to assess our experience of TES against primary tumors in the lumbar spine and investigate its clinical outcomes.

STUDY DESIGN/SETTING: Retrospective study.

METHODS: We performed a retrospective chart review of all cases of surgically treated primary malignant or locally aggressive benign spinal tumor at our institution between 1993 and 2015. Patients who underwent TES for treatment of a tumor primarily located in the lumbar spine (L1–L5) were included. Primary outcome measures were the rates of perioperative complications and reoperation for instrumentation failure. Secondary outcome measures included local recurrence and disease-free survival. A simple logistic regression analysis was performed to investigate the relationship between specific patient and operative parameters and instrumentation failure occurrence. A probability value (p-value) of less than 0.05 was considered statistically significant.

RESULTS: We enrolled 30 patients (13 men). The median
age and follow-up period were 38 years and 87 months, respectively. Previous radiotherapy, intraluminal resection, and chemotherapy were found in three, seven, and five cases, respectively. The most common tumor was giant cell tumor (14 cases) followed by osteosarcoma (4 cases) and plasmacytoma (3 cases). Twenty-two cases (73.3%) required a combined anterior-posterior approach. The median estimated blood loss was 1450 mL and median operative time was 11 hours. Twenty-six patients (86.7%) developed at least one perioperative complication, with the most common being postoperative muscle weakness (24 patients, 80.0%) followed by surgical site infection and postoperative cerebrospinal fluid leakage (7 patients, respectively; 23.3% each). Revision surgery for instrumentation failure was required in six patients (20.0%) at a median of 33 months after the index TES. Logistic regression analysis showed no significant factors associated with instrumentation failure. Local tumor recurrence occurred in four patients (13.3%), and all had undergone previous intraluminal resection. Their 10-year disease-free rate was 75.0%.

**CONCLUSIONS:** TES is a feasible and effective procedure for the treatment of primary tumors of the lumbar spine, but the risks of perioperative complications and late instrumentation failure should be acknowledged. Although postoperative transient lower extremity muscle weakness is an almost inevitable feature of lumbar spine TES, oncologic outcomes were good, especially in patients who underwent TES as their first surgical treatment. Therefore, it is important to be familiar with the indications for TES and the surgical technique.

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

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**P50. Over 10 Year Outcomes Following Lumbar Microendoscopic Decompression**

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**PURPOSE:** The purpose of this study was to assess the long-term outcomes following lumbar microendoscopic decompression (MED).

**METHODS:** Between June 2005 and September 2007, 151 consecutive patients, diagnosed with single or double levels of disc herniation (DH) or spinal stenosis (SS), met the criteria for inclusion into the study. Patients with previous spine surgery or with other lesions such as cerebrovascular disease at the most recent follow-up evaluation (MRFE) were ineligible. Seventy-five patients were excluded from the study: 40 patients were lost to follow-up within 10 years after their initial operations, 23 patients were interviewed by telephone but did not attend our clinic to confirm the other lesions at MRFE, 12 patients had lost the records of preoperative evaluation. Seventy-six patients were classified into three groups: DH group (33 DH patients underwent MED and discectomy); S group (23 SS without degenerative spondylolysis/thesis (DS) patients underwent MED); and DS group (20 SS and DS [7-26% slipping] patients underwent MED). All 76 operations were performed by the same surgeon. All patients were prospectively followed, and clinical outcomes were evaluated by using the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire. The mean duration of follow-up was 126 (120–143) months. Seven patients in the DH group and 4 patients in the S and DS groups required reoperations within 10 years after their initial operations, and their clinical outcome evaluations were done just before the reoperations. The effectiveness rate in each group and the degree of improvement (DOI) were calculated. The results were statistically compared using Scheffe’s F test for differences among the DH, S, and DS groups. DOIs at the first follow-up evaluation (mean, 12 months after their initial operations) and DOIs at MRFE (mean, 126 months) of the DH group were statistically compared by paired t-test. DOIs at MRFE of the S group (mean, 126 months) and DS group (mean, 125 months) were statistically compared by unpaired t-test.

**RESULTS:** The effectiveness rates of low back pain in the DH, S, and DS groups were 71, 77, 71%, respectively. Those of lumbar function were 61, 57, 60%, those of walking ability were 77, 74, 85%, those of social life function were 79, 70, 70%, and those of mental health were 45, 35, 45%, respectively. The ages at surgery were significantly younger in the DH group (mean, 42 years) than in the S group (mean, 59 years) and in the DS group (mean, 63 years) (P<0.05). However, the follow-up durations showed no significant differences among the DH, S, and DS groups. No significant differences were observed between the first follow-up evaluation and at MRFE concerning the DOIs of the DH group, and between the S and DS groups concerning the DOIs at MRFE.

**CONCLUSIONS:** The effectiveness rates of low back pain, lumbar function, walking ability, and social life function were good in the DH, S, and DS groups. Clinical 1-year outcomes of the DH group were thought to be maintained for over 10 years. The same surgeon has been using MED for all patients with SS associated with DS. Fusion was not performed. From the results of this study, there was no impact of DS on clinical long-term outcomes for SS. We think this is because, with MED, we could perform sufficient decompression while preserving the posterior structures of the spine.

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**P51. Total Spondylectomy for Enneking Stage III Giant Cell Tumor of the Mobile Spine**

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**BACKGROUND CONTEXT:** En bloc excision is strongly recommended for Enneking stage III spinal giant cell tumor (GCT) because of its high local recurrence rate after intraluminal tumor excision. We perform total en bloc spondylectomy (TES) with transpedicular ostetomy using T-saw; however, transpedicular ostetomy often involves an intraluminal procedure and the procedure level associated with recurrence is still unclear.

**PURPOSE:** We aimed to report surgical outcomes of TES with intraluminal T-saw transpedicular ostetomy in patients with Enneking stage III spinal GCT, comparing those of total piecemeal spondylectomy.

**METHODS:** We examined data for 25 spinal GCT patients who...
were treated surgically at our hospital between May 1994 and April 2015, with more than 2 years of follow-up. Data including physical and image examinations, medical records, and pathological studies were retrospectively reviewed to study clinical results.

RESULTS: Eight men and 17 women with a mean age of 34.2 years (range, 16–51 years) at the time of surgery were included. Six patients had previous tumor excision at another hospital and one patient had a history of denosumab treatment. The GCTs were at the cervical level in 3 patients, thoracic level in 9, and lumbar level in 13. TES was performed in 13 patients; 12 of them required intraligosomal pediclecotomy. The remaining patients underwent total piecemeal spondylectomy with further intraligosomal tumor resection. During a mean of 99.2 months of follow-up (range, 24–216 months), 2 patients who underwent total piecemeal spondylectomy had local tumor recurrence, but no patients who underwent TES with intraligosomal pediclecotomy had recurrence. The 2- and 10-year recurrence-free survival rates for patients treated by total piecemeal spondylectomy were 91.7% and 78.6% while those for patients treated by TES were 100%. Total piecemeal spondylectomy was associated with a longer operative duration, greater intraoperative blood loss, and a higher surgical morbidity rate.

CONCLUSIONS: TES with intraligosomal pediclecotomy had great survival outcomes in patients with Enneking stage III spinal GCT, suggesting that minimal intraligosomal procedures could achieve radical cure of spinal GCT. Conversely, curative tumor excision would be challenging in patients needing further intraligosomal tumor resection, and adjuvant therapy should be considered to avoid local tumor recurrence.

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P52. Complications and Outcomes of Posterior Thoracic Corpectomies for Metastatic Disease: Analysis of 90 Patients

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BACKGROUND CONTEXT: Posterior corpectomies for metastatic thoracic spine tumors (MTT) achieve multiple surgical goals in one operation. Posterior corpectomies reduce thoracotomy morbidity, provide immediate decompression and stability, and do not require a co-surgeon.

PURPOSE: Introduction: Posterior corpectomies for metastatic thoracic spine tumors (MTT) achieve multiple surgical goals in one operation. Posterior corpectomies reduce thoracotomy morbidity, provide immediate decompression and stability, and do not require a co-surgeon. We wish to report on our experience with outcomes and complications of this procedure.

STUDY DESIGN/SETTING: retrospective research

PATIENT SAMPLE: Ninety patients with MTT who underwent one-stage posterior corpectomies were retrospectively analyzed.

OUTCOME MEASURES: Methods: Ninety patients with MTT who underwent one-stage posterior corpectomies were retrospectively analyzed. Characteristics evaluated included number of MTT tumors per year, tumor location, involved vertebrae numbers, sex, histology, pre- and postoperative ASIA classification, VAS pain scores, operation time, blood loss and length of hospital stay.

METHODS: Methods: Ninety patients with MTT who underwent one-stage posterior corpectomies were retrospectively analyzed. Characteristics evaluated included number of MTT tumors per year, tumor location, involved vertebrae numbers, sex, histology, pre- and postoperative ASIA classification, VAS pain scores, operation time, blood loss and length of hospital stay.

RESULTS: The average follow-up time was 20.8±27.9 (0.5–139.4) months. 76.67% patients had a single metastasis and 23.33% had multiple metastases to the spine. 37.9% of tumors were from T9 to T12. On histology, 16.67% was breast, 15.56% was lung, 12.22% was prostate and 12.22% was renal cell carcinoma. 74% (37/50 patients) of paraplegic and paraparetic patients improved. One patient improved from ASIA score A to D, three from B to C, eight from C to D or E, and 25 from D to E. Three (6%) patients with ASIA A and one (2%) patient with ASIA B had no improvement. One patient with ASIA C and B (16%) patients with D had no improvement. After surgery, VAS pain scores decreased from 8.45±1.57 to 1.21±1.81. In terms of complications, 2 patients (2.22%) had DVTs, and one had a PE (1.11%). Other complications included wound infection (4.44%), CSF leak (4.44%), pleural effusion (3.33%), wound dehiscence (2.22%), cellulitis (1.11%), epidural hematoma (1.11%), and pneumothorax (1.11%). 2.22% of patients had implant failure and pseudoarthrosis, with one patient needing revision surgery. One patient (1.11%) had tumor recurrence during the follow up period.

CONCLUSIONS: Conclusions: Our results suggest that posterior thoracic corpectomies for MTT have a reasonable complication rate with favorable outcomes.

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P53. The Influence of Ossification Occupancy and the Analysis of Postoperative Outcomes for the Patients with Thoracic Ossification of Posterior Longitudinal Ligament

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BACKGROUND CONTEXT: Thoracic ossification of the posterior longitudinal ligament (T-OPLL) often causes severe myelopathy. Conservative therapy is ineffective for T-OPLL to most cases, and the most patients are performed surgical treatment. However, the optimal method is still unclear because of the high rates of postoperative complications. In addition, there are no reported the influence of occupation rate of ossification (ORO) to postoperative outcome.

PURPOSE: The purpose of this study was to evaluate the influence of ORO and relationships between ORO and postoperative outcomes for the patients with T-OPLL.

STUDY DESIGN/SETTING: This study is retrospective clinical study in single hospital.

PATIENT SAMPLE: This study included 33 patients (16 male and 17 female, the mean age 58 years old) who underwent surgical treatment at one institution during 10 years period from 2006 to 2017.

OUTCOME MEASURES: Not applicable

METHODS: The authors evaluated clinical data (BMI, length of hospital stay, follow-up period, surgical methods, operation time, intraoperative bleeding, ORO, surgical outcomes) from medical and operative records retrospectively. The surgical outcomes were evaluated using modified Japanese Orthopaedic Association (JOA) scale score (maximum point; 11) and

113
improvement recovery rate. The JOA scale score were collected at preoperative, postoperative, and final follow-up point. The anteroposterior diameters of thoracic spinal canal and T-OPPL were investigated from CT axial view in the narrowest level. The ORO was defined as below: (The anteroposterior diameter of T-OPPL / The anteroposterior diameter of thoracic spinal canal) ×100 (%) The relationships between ORO and JOA improvement recovery rate were also examined.

**RESULTS:** The mean BMI was 26 and the mean length of stay was 26 days. The mean follow-up period was 68 months. Surgical methods consisted of posterior decompression (n=3), anterior decompression and posterior instrumented fusion (n=2), and posterior decompression and instrumented fusion (n=28). The mean operation time was 225 minutes and the mean intraoperative bleeding was 435ml. The mean ORO was 49%. The mean improvement recovery rate was 49%. A correlation coefficient between improvement recovery rate and ORO was r=-0.15, which was very weak negative relationship. When the patients were divided into two groups; less than 64 years old (Y group, n=21) and more than 65 years old (O group, n=12), the correlation coefficient between improvement recovery rate and ORO was r=-0.19 (Y group) and r=-0.07 (O group), respectively. In addition, the patients were divided into two groups; ORO less than 49% (S group, n=15) and ORO more than 50% (L group, n=18). The improvement recovery rate by ORO was 54% for S group and 46% for L group, respectively. There was no significant difference in two groups.

**CONCLUSIONS:** The postoperative outcomes for T-OPPL were favorable. The correlation of JOA improvement recovery rate and ORO was very weak. In older patients, almost no correlation was identified between JOA improvement recovery rate and ORO. This study shows that ORO does not influence JOA recovery rate.

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**P54. Surgical Results of Microsurgical Bilateral Decompression via a Unilateral Approach for L4/5 Lumbar Spinal Canal Stenosis with Wedging More than Five Degree**

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**BACKGROUND CONTEXT:** Surgical treatment for lumbar canal stenosis (LCS) is controversial whether a combination of fusion surgery. From the past, we have undergone Microscopic Bilateral Decompression via a Unilateral approach (MBDU) that can preserve the posterior element against severe degenerative spondylolisthesis and wedging.

**PURPOSE:** This study was made to consider surgical result of MBDU for LCS at L4/5 with wedging 5 degrees or more. We defined 20 cases with wedging 5 degrees or more as Wedging group (W group) and age adjusted 46 cases without coronal malalignment as control group (C group).

**METHODS:** We defined 20 cases with wedging 5 degrees or more as Wedging group (W group) and age adjusted 46 cases without coronal malalignment as control group (C group).

**RESULTS:** The mean age at surgery of W group/C group was 74.3/72.7 years and the mean follow up period was 28.5/30.9 months, respectively, and there was no significant difference. JOA score at preoperation and final follow-up was 13.1/15.7 and 21.2/24.8 (W group/C group). JOA score of W group at preoperation and final was lower than that of C group, significantly. The recovery rate of JOA score was 50.8/67.2% (W group/C group). The recovery rate tended to be low in the W group, but no significant difference was observed. The L4/5 ROM at preoperation and final follow-up was 3.7/7.4 degrees, and 4.0/7.4 degrees (W group/C group), the disc height at preoperation and final was 0.53/0.66 and 0.43/0.59 (W group/C group), respectively. There was significant difference between both groups in the L4/5 ROM and the disc height at preoperative and final. Two of the three patients who performed revision surgery after MBDU were W group, and the preoperative L4/5 ROM was 9 degrees and 10 degrees, which was much larger than the average value of W group.

**CONCLUSIONS:** The surgical result of MBDU for LCS at L4/5 with wedging 5 degrees or more was lower than control group in JOA score at preoperation and final follow-up. In cases with Wedging 5 degrees or more, there is a possibility of reoperation if the preoperative ROM is large.

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the spine, number of the level, operation time, intraoperative bleeding and complication were studied.

**METHODS:** A ward nurse measures the patient’s neck circumference of the same location of the neck which is marked with a magic pen before the surgery. It is measured once before and four times after the surgery: just after the surgery, three hours, six hours and one day after the surgery.

**RESULTS:** Total 61 patients (43 males and 18 females) were included and the mean age was 52.7 (34 to 82) years old. The mean figure of BMI was 24.6. There were three patients who used anticoagulant. The operation level were; C3/4: 7, C4/5: 12, C5/6: 32, C6/7: 9, C7/1: 1 case. There was one two level operation case and the others were one level operations. The mean operation time was 66.6 minutes and the mean interoperation bleeding was 42.1 g. The mean neck circumference before surgery was 37.6 cm and it was changed to as follows; at just after: 40.0 cm, at 3 hours: 39.8 cm, at 6 hours: 39.7 cm, on the next day: 39.3 cm. One patient needed a hematoma removal and the circumference in the case was extended by 5 cm at one and half hours after the surgery compared with the one of just after surgery. The degree of extension of the case was extremely high compared with the other patients. There was no other important complication.

**CONCLUSIONS:** The neck circumference is a very simple method of simply measuring the neck circumference but is very useful and practical to predict postoperative retropharyngeal hematoma. If the figure of the neck circumference is extended by 3 or more cm compared with the one of just after surgery, the surgeon should decide to give the patient a reoperation of removal of the hematoma.

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**P56. Evaluation of the Surgical Stress in the Lumbar Interbody Fusion Using E-PASS Scoring System**

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**BACKGROUND CONTEXT:** Predictive surgical risk scores have been developed for general surgery. Among several risk scores, the usefulness of Estimation Physiologic Ability and Surgical Stress (E-PASS) score in orthopaedic field has been reported.

**PURPOSE:** The purpose of this study was to investigate the surgical risk of posterior lumbar interbody fusion (PLIF) and Lateral lumbar interbody fusion (LLIF) for the patients with lumbar spinal canal stenosis using preoperative risk score (PRS) and surgical stress score (SSS) in E-PASS.

**STUDY DESIGN/SETTING:** A multicenter reliability study was conducted.

**PATIENT SAMPLE:** Clinical data were collected on 169 (102 were female and 67 were male) consecutive patients who underwent lumbar interbody fusion for lumbar spinal canal stenosis with degenerative spondylolisthesis or disc degeneration.

**OUTCOME MEASURES:** PRS = -0.0686 + 0.00345X1 + 0.323X2 + 0.205X3 + 0.153X4 + 0.148X5 + 0.0666X6; where X1 is the age, X2 is the presence of severe heart disease, X3 is the presence of severe pulmonary disease, X4 is the presence of diabetes mellitus, X5 is the performance status index, and X6 is the American Society of Anesthesiologists physiological status classification. SSS = -0.342 + 0.0139X1 + 0.0392X2 + 0.352X3; where X1 is the blood loss/ body weight (g/kg), X2 is the operation time (h), and X3 is the extent of skin incision.

**METHODS:** The surgical procedure included 51 patients treated with single level PLIF (group P1), 20 patients treated with 2 levels PLIF (group P2), 63 patients treated with single level LLIF with percutaneous pedicle screw; PPS (group L1) and 35 patients treated with 2 levels LLIF with PPS (group L2). We calculated PRS and SSS in E-PASS and compared in each group.

**RESULTS:** A mean age at the surgery was 67.1 years. A mean PRS was 0.498±0.123 in the group P1, 0.520±0.137 in the group P2, 0.523±0.144 in the group L1, and 0.533±0.122 in the group L2. There is no statistically significant deference in each group. A mean SSS were -0.176±0.044 in the group P1, -0.063±0.082 in the group P2, -0.251±0.026 in the group L1, and -0.208±0.04 in the group L2. SSS in each group showed a significantly high value in order of the group O1, O2, P1, P2.

**CONCLUSIONS:** Both PLIF and LLIF have been performed for degenerative spondylolisthesis with good result, but no study has directly compared these surgical stresses so far. Although PRS wasat the same level between PLIF and OLIF group, SSS was significantly lower in the LLIF group than in the PLIF group even if it was compared 2 level LLIF group with single level PLIF group. Procedure with lower surgical stresses may result in considerably less patient morbidity. Furthermore, minimally invasive spinal surgery such as the LLIF with PPS may serve a particularly useful role in the management of elderly patients with several illnesses.

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**P57. Retrospective Review of Short to Mid Term Outcome in Oblique Lateral Lumbosacral Fusion (OLIF51) Surgery**

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**BACKGROUND CONTEXT:** Oblique lateral interbody fusion (OLIF) restores disc height and enables indirect decompression of narrowed spinal canals in patients with the lumbar disease such as spondylolisthesis causing decreased disc height and foraminal narrowing via oblique lateral corridor in front of the psoas muscle. Recently the concept of the technique is applied to the lumbosacral junction, which is based on the concept of traditional anterior lumbar interbody fusion (ALIF) using specially-designed retractors to achieve effective indirect foraminal decompression and lumbosacral lordosis as well as a better clinical outcome.

**PURPOSE:** To evaluate the short to mid-term clinical and radiological outcomes of this OLIF51 surgery.

**STUDY DESIGN/SETTING:** Retrospective cohort study

**PATIENT SAMPLE:** We retrospectively enrolled 15 patients with lower back pain and radicular leg pain due to L5-S1 foraminal stenosis who underwent OLIF51 surgery (ave. 64.2 yo, 7 males,
8 females). The control subjects were those who were case-matched cases who underwent traditional posterior L5-S1 TLIF surgery. The OLIF51 surgery was performed via a 7-cm length incision in the left anterolateral abdominal wall in the complete decubitus position, and 6° lordotic titanium cage was inserted and fused through the bifurcation of great vessels followed by posterior percutaneous pedicle screw fixation with indirect decompression in the prone position.

**OUTCOME MEASURES:** Perioperative data, the Japanese Orthopaedic Association (JOA) score, imaging analysis using the computed tomography (CT) scan

**METHODS:** Perioperative data such as operative time and blood loss were investigated. Postoperative outcomes were also evaluated by using the Japanese Orthopaedic Association (JOA) score at baseline, just after, 3, 6, and 12 months. Radiological evaluation using the computed tomography (CT) scan was performed to measure and evaluate the section area of the L5-S1 foramen at the sagittal plane as well as L5-S1 lordotic angle in OLIF51 group subjects. A P value < 0.05 was considered as statistically significant.

**RESULTS:** OLIF51 patients showed significantly shorter operative time in practical operative duration (excluding the preparation time of position change from decubitus to prone) compared with the traditional TLIF patients (162 min vs. 198 min), and significantly less intraoperative blood loss (65g vs. 257g). The height of Intervertebral cage used for the lumbosacral junction was 10.8mm in average. Acquired lumbosacral lordosis was 4.2° just after the surgery, with correction loss of 1.2° at final observation. Recovery of the foraminal area was increased by 41.1% just after the surgery, with a significant gradual decrease of 37.2%/6 months, then 35.1% at the final observation. JOA score showed significant improvement just after the surgery and the improvement remained until the final observation. Compared with the TLIF group the improvement was significantly better after the surgery. One of the OLIF51 cases showed increased postoperative leg pain due to severe L5 spondylolytic spondylodiscitis. There were no operation-related complications.

**CONCLUSIONS:** OLIF51 surgery provided considerable outcome as traditional TLIF surgery with significantly improved outcomes. Acquired recovery of foraminal stenosis showed clinical improvement, while lumbosacral lordotic angle showed slight correction loss. The mini-open OLIF51 surgery can efficiently and less invasively expose the lumbosacral IVD to achieve efficient L5-S1 ALIF.

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**P58. Early Onset Adjacent Vertebral Fracture Following Kyphoplasty for the Osteoporotic Vertebral Fracture in Thoracolumbar Lesion**

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**BACKGROUND CONTEXT:** BKP used on osteoporotic vertebral fracture is known to offer instant pain relief and sound restoration of vertebral body after fracture. On the other hand, there are reports of fracture in the area adjacent to vertebral body treated with BKP (adjacent vertebral fracture) within 8 weeks of the treatment. While there are some previous studies on fractures in adjacent areas related to BKP, differences in patient backgrounds and observation periods left the AVF risk factors widely varied.

**PURPOSE:** Aiming to investigate the risk factors of postoperative AVF unique to BKP.

**STUDY DESIGN/SETTING:** Retrospective study

**PATIENT SAMPLE:** Among 148 vertebral bodies (VB) treated with BKP between April 2012 and January 2016, we examined 108 vertebral bodies after excluding cases with tumor-related bone fractures, previous spinal operation history, articular rheumatism, and fracture in the adjacent areas before the operation. At last, 93 VBs in thoracolumbar lesion were included in this study.

**OUTCOME MEASURES:** The study examined patients and backgrounds (age, BMI, comorbidities, vertical location of affected vertebral body, use of perioperative osteoporosis drugs), surgery-related factors (balloon volume, cement volume, cement leakage outside vertebral body), and imaging findings (vertebral body angle, corrected vertebral body angle, and local kyphotic angle)

**METHODS:** For factors manifesting differences through univariate analysis, correlation analysis was conducted for each parameter to examine confounders between factors before they were examined through multivariate analysis. We used SPSS for statistical processing.

**RESULTS:** AVF incident rate was 28% (26/93) vertebral bodies in thoracolumbar lesion (T10-L2) for 28% (26/93) vertebral bodies. Between patients with AVF and without AVF, significant differences (P<0.05) manifested in their ages (76/80 years), preoperative vertebral body angles (17.8/23 degrees), and corrected vertebral body angles (7.5/13.5 degrees). Other factors were not identified with significant differences. There were significant correlation between preoperative vertebral angle and corrected vertebral body angle (r=0.718, P<0.05). Odds ratio in preoperative vertebral angle and age were 1.072/1.130 respectively (95% CI 1.017-1.131/1.032-1.236).

**CONCLUSIONS:** Preoperative angle and Age were identified as independent predictable risk factors before operation in thoracolumbar lesion.

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

**P59. Influence of Skeletal Muscle Mass and Spinal Alignment on Surgical Outcomes for Lumbar Spinal Stenosis**

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**BACKGROUND CONTEXT:** Although it seems likely that reductions in skeletal muscle mass would affect surgical outcomes, the relationship between skeletal muscle mass and surgical outcomes in LSS has not been elucidated.

**PURPOSE:** We consider the relationship between spinal alignment and skeletal muscle mass with clinical outcomes following surgery for lumbar spinal stenosis.

**STUDY DESIGN/SETTING:** Our target population included 34 women who underwent surgery for lumbar spinal stenosis (LSS) (mean age 74.5 years). Before surgery and 6 months following surgery, systemic bone mineral density and lean soft tissue mass
were measured using DXA. Skeletal muscle mass index (SMI) was calculated as the sum of arm and leg lean mass in kilograms divided by height in meters squared. Spinal alignment was measured. Clinical outcomes included JOA score, leg pain and low back pain VAS, and Roland-Morris Disability Questionnaire (RDQ). Along with these clinical outcomes, we examined bone mineral density, skeletal muscle mass, and spinal alignment before and after surgery. We used the Spearman correlation coefficient to examine the associations between clinical outcomes and preoperative muscle mass and spinal alignment.

PATIENT SAMPLE: Our target population included 34 women who underwent surgery for LSS (mean age 74.4 years).

OUTCOME MEASURES: Before surgery and 6 months following surgery, systemic bone mineral density and lean soft tissue mass were measured using DXA. Skeletal muscle mass index (SMI) was calculated as the sum of arm and leg lean mass in kilograms divided by height in meters squared. Spinal alignment was measured. Clinical outcomes included JOA score, leg pain and low back pain VAS, and Roland-Morris Disability Questionnaire (RDQ). Along with these clinical outcomes, we examined bone mineral density, skeletal muscle mass, and spinal alignment before and after surgery.

METHODS: We used the Spearman correlation coefficient to examine the associations between clinical outcomes and preoperative muscle mass and spinal alignment.

RESULTS: Sarcopenia (SMI<5.46) was observed in 9 of 34 subjects (26.5%). Compared with normal subjects (SMI>6.12), RDQ was significantly higher in subjects with sarcopenia (p=0.04). RDQ had a significant negative correlation with SMI (r=-0.42, p<0.05). There was a significant positive correlation between postoperative RDQ and PT (r=0.41, p<0.05). SMI and PT had a significant negative correlation (r=-0.39, p<0.05).

CONCLUSIONS: Good postoperative outcomes were negatively correlated with low preoperative appendicular muscle mass, suggesting that postoperative outcomes were inferior in cases of decreased appendicular muscle mass (sarcopenia). Posterior pelvic tilt due to decreased limb muscle mass may contribute to postoperative back pain, showing that preoperative reduced limb muscle mass and posterior pelvic tilt are predictive factors in the persistence of low back pain postoperatively.

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P60. Clinical Assessment and Prevalence of Patients with Ossification of Posterior Longitudinal Ligament (OPLL) in Lumbar Spine
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BACKGROUND CONTEXT: Only a few reports regarding postoperative patients with ossification of posterior longitudinal ligament (OPLL) in lumbar spine can be seen, and its clinical characteristics have not yet been well established because the number of patients who require surgical treatment is quite low. Those patients with OPLL in lumbar spine who required a surgical treatment were included in this study and clinical and radiological assessments were performed.

PURPOSE: To assess clinical outcome, radiographical characteristics and prevalence of patients with OPLL in lumbar spine.

STUDY DESIGN/SETTING: Retrospective study

PATIENT SAMPLE: From Aug 2008 to July 2017, 3014 spine surgeries were performed and 2020 patients with degenerative lumbar disease were treated surgically in our institution. Only six patients with OPLL in lumbar spine were found in the record.

OUTCOME MEASURES: Clinical assessment was performed with Japan Orthopaedic Association score and prevalence of lumbar OPLL was examined in our institution.

METHODS: Clinical and radiological assessments were performed in those patients. Japan Orthopaedic Association Score and recovery rate were assessed. Radiographical characteristics of OPLL and complication rate were examined.

RESULTS: There were 127 cases concerned with OPLL or ossification of yellow ligament (OYL). 93 cases underwent surgery due to OPLL in cervical spine, 7 due to OPLL in thoracic spine, and 6 due to lumbar spine. Twenty were patients with ossification of yellow ligament in thoracic spine and one in lumbar spine. Quite a small rate (6/127: 4.7%) of OPLL in lumbar spine was treated surgically. Four of the 6 cases underwent posterior decompression and 2 underwent posterior spinal fusion. The recovery rate of JOA score at the latest follow up was 14.2% in average. Four of them had diabetes mellitus and four had hyper tension and the average BMI was 29.1% in the 6 cases. Total spine was examined by CT scan. All 6 cases had OPLL in cervical and thoracic spine and OYL in thoracic and lumbar spine. Three cases underwent laminoplasty in cervical spine and 3 underwent posterior decompression in thoracic spine before the lumbar surgery. Five of the six patients underwent multilevel lumbar surgery. In terms of type of ossification, four were segmental type, one was continuous and one was mixed type.

CONCLUSIONS: The rate of OPLL in lumbar spine was pretty low but their clinical recovery rate of JOA score was also poor. Our result revealed that OPLL in lumbar spine was serious disease due to multiple OPLL in their spine. Especially careful follow-up should be taken for those patients.

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P61. Two Years Outcome and Risk Factors for the Poor Results of the Microendoscopic Foraminotomy for the Extraforaminal Stenosis at the Lumbosacral Junction
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BACKGROUND CONTEXT: Microendoscopic spine surgery is thought to be an ideal procedure for the treatment of extraforaminal stenosis at the lumbosacral junction, because it can reach to a deep layer and provide a bright and magnified visual surgical field with minimal invasion of surrounding structures. However, there were few reports of the large case series in this procedure.

PURPOSE: The purpose of this study was to evaluate the 2 years surgical outcome and to clarify the risk factors of poor results in patients surgically treated with the microendoscopic foraminotomy.

STUDY DESIGN/SETTING: A retrospective cohort study of the surgically treated patient at a single spine center

PATIENT SAMPLE: A total of 109 patients (60 men, 49 women, average age 67.8 years), who received this procedure and
OUTCOME MEASURES: Clinical outcomes were evaluated according to the Japanese Orthopaedic Association score for low-back pain (JOA score: 0-29 points), the visual analog scale (VAS: 0-100mm) for low-back pain, leg pain, and leg numbness, and Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ). Disease pathology was classified as spondylosis, degenerative scoliosis, and spondyloysis etc. Radiological features were evaluated by presence of interbody vacuum, endplate degeneration, height between vertebral bodies and vertebral body tilt angle on coronal plane.

METHODS: 1) Postoperative change of evaluated items were observed. Minimal clinically important difference (MICD) of VAS was defined as 20mm. 2) Based on the JOA score recovery rate (RR), RR of 50%≤ and RR of <50% was defined as good results and poor results, respectively. To clarify the risk factors for poor results, a multiple logistic regression analysis was conducted using univariate analysis as a factor whose P value was less than 0.2 as an explanatory variable. As sub-analysis, male and female were divided, and univariate analysis was performed on predictability of poor performance in each. Significance level was set at p <0.05.

RESULTS: The mean JOA score was significantly improved from 14.2 points to 20.5 points, and the average improvement rate was 42.4%. The mean VAS scores for low-back pain, leg pain, and leg numbness were also improved from 53.8, 72.1, and 57.7 to 30.0, 28.6, and 28.3, respectively. The patients' rates improved more than MICD were 50.5%, 75.0%, and 59.0% in low-back pain, leg pain, and leg numbness, respectively. From the logistic regression analysis, female (odds ratio 4.18) and low score of preoperative JOABPEQ psychological disability (unit odds ratio 1.04) were statistically significant risk factors of a poor outcome. As a result of sub-analysis, low score of preoperative JOABPEQ psychological disability (p = 0.0103), coexistence of endplate degeneration (p = 0.0452) in men, coexistence of degenerative scoliosis (p = 0.0255) in women is a related factor of a poor outcome.

CONCLUSIONS: The JOA recovery rate in this case series was 42.4%, which is significantly less than our experience in the microendoscopic decompression surgery for the patients with central type LSS. Female and psychological disorder were found to be risk factors for poor surgical results. In addition, preoperative risk factors for a poor outcome differ between male and female. The risk factors were the poor psychological status, the presence of endplate degeneration in men, and the presence of degenerative scoliosis in women.

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

P62. Cost Effectiveness of Vancomycin Powder in Lumbar Laminectomy

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BACKGROUND CONTEXT: Intra-wound application of vancomycin powder has demonstrated dramatic reductions of infection rate following lumbar laminectomy and fusion. The economic benefit of this prophylactic protocol has been previously validated for laminectomy and fusion, but the cost effectiveness is less clear for lumbar laminectomy alone.

PURPOSE: The goal of this study is to demonstrate that application of vancomycin powder is a cost effective method for preventing infection following lumbar laminectomy.

STUDY DESIGN/SETTING: Break-even cost analysis.

PATIENT SAMPLE: Not Applicable.

OUTCOME MEASURES: This study determined the magnitude by which the rate of infection following lumbar laminectomy alone and lumbar laminectomy and fusion would need to be reduced by in order to make application of vancomycin powder cost effective.

METHODS: The product cost of vancomycin powder was obtained from our institution’s purchasing records. Total charges for lumbar laminectomy and lumbar laminectomy and fusion, rates of infection, and cost of revision were obtained from the literature. A break-even analysis (Break-even Infection Rate = (Initial Infection Rate - Cost of Protocol) / Cost of Treatment) was then performed to determine the absolute risk reduction (ARR) in infection rate to make prophylactic application of vancomycin powder cost effective.

RESULTS: Costing $3.06 per gram at our institution, vancomycin powder was determined to be cost effective in lumbar laminectomy if the infection rate of 4.2% decreased by an ARR of 0.015%. Laminectomy and fusion was also determined to be cost effective at the same cost of vancomycin powder if the infection rate of 8.5% decreased by an ARR of 0.0034%. At the current highest cost reported in the literature, $44.00 per gram of vancomycin powder remained cost effective with respective ARRs of 0.21% and 0.048% for laminectomy and laminectomy and fusion. Varying the baseline infection rate did not influence the ARR for either procedure when the analysis was performed using the product cost of vancomycin at our institution.

CONCLUSIONS: This break-even analysis demonstrates that prophylactic intra-wound application of vancomycin powder can be highly cost effective not only for lumbar laminectomy and fusion, but also for laminectomy alone. At our institution’s price point, use of vancomycin powder is economically justified if it prevents at least one infection out of 6,700 lumbar laminectomy surgeries.

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P63. Balloon Kyphoplasty for Osteoporotic Vertebral Fractures with Posterior Wall Injury

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BACKGROUND CONTEXT: According to the current guidelines, balloon kyphoplasty (BKP) for treatment of osteoporotic vertebral fractures (OVF) with posterior wall injury is a relative contraindication because of a potential risk for cement leakage into the spinal canal.

PURPOSE: The aim of this study is to compare clinical outcomes, radiologic outcomes and complications of BKP for OVF with or without posterior wall injury.

STUDY DESIGN/SETTING: A retrospective study.

PATIENT SAMPLE: Thirty-five patients (9 males and 26 females) underwent BKP from September 2012 to January 2017. Their mean age was 77.9 ± 6.4 years ranged from 65 to 91 years.
These patients were divided into two groups: group A (with posterior wall injury) and group B (without posterior injury). Group A consisted of 22 patients (6 males and 16 females) with the mean age 79.0 ± 6.0 years ranged from 65 to 91 years, and group B consisted of 13 patients (3 males and 10 females with the mean age 76.1 ± 6.9 years ranged from 65 to 88 years.

**OUTCOME MEASURES:** The study compared clinical outcomes (two factors [low back pain, lumbar function]) of the JOA Back Pain Questionnaire (JOA BPEQ), the improvement rate of the JOA BPEQ, Visual Analog Scale (VAS), radiologic outcomes (vertebral kyphotic angle, anterior vertebral body height restoration, cement leakage) and complication.

**METHODS:** Indication for BKP included OVF particularly when conservative treatment has failed. The operations were performed by the same senior surgeon. The reduction of the fractures was supported by positioning of the patients prone on the operating table under general anesthesia. Two small balloons were inserted through bilateral pedicle, inflated to create a cavity in the vertebral body, deflated and removed. Once the vertebra was in the correct position, the created cavity was filled with bone cement. Postoperatively all patients who underwent BKP were received thoraco-lumbosacral orthosis and teriparatide injections for prevention of secondary OVF.

**RESULTS:** Both groups demonstrated a significant improvement in the factors about low back pain (preoperatively group A: 21.4 ± 20.6 and group B: 35.0 ± 27.0, postoperatively group A: 87.0 ± 22.8 and group B: 94.5 ± 15.9, respectively), lumbar function (preoperatively group A: 10.2 ± 16.0 and group B: 13.5 ± 17.8, postoperatively group A: 79.8 ± 23.6 and group B: 78.1 ± 26.8, respectively) of the JOA BPEQ, VAS (preoperatively group A: 8.54 ± 1.2 and group B: 7.84 ± 1.5, postoperatively group A: 1.04 ± 2.03 and group B: 0.84 ± 1.46, respectively) and vertebral kyphotic angle (preoperatively group A: 14.3 ± 7.0 and group B: 16.4 ± 6.3, postoperatively group A: 10.6 ± 6.3 and group B: 10.9 ± 5.9, respectively). The improvement rate of the JOA BPEQ (low back pain: group A: 86.2 ± 5.2 % and group B: 90.4 ± 7.8 %, respectively, P = 0.655, lumbar function: group A: 78.0 ± 5.2 % and group B: 82.9 ± 5.4 %, respectively, P = 0.520) and the rate of cement leakage (30.8 % and 45.5 %, respectively, P = 0.391) is no significantly different in the two groups. All patients with cement leakage were clinically unremarkable. Three patients suffered adjacent OVF after BKP in group A.

**CONCLUSIONS:** BKP for treatment of OVF with or without posterior wall injury showed no significant differences with regard to clinical and radiographic outcome. Even for the patients with OVF with the posterior wall injury, BKP is an effective procedure with few complications.

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**P64. Hemoglobin A1c as a Predictor of Surgical Site Infection Following Single Level Lumbar/Lumbosacral Posterior Fusion in Patients with Diabetes**

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**BACKGROUND CONTEXT:** Diabetes mellitus (DM) is a prevalent disease of glucose dysregulation that has been demonstrated to increase multiple postoperative complications. Surgical site infection (SSI) is one of the most common complications after spinal surgery which increases the morbidity, mortality, length of hospital day, readmission, and health care costs.

**PURPOSE:** Goals of the present study were: (1) to evaluate the association of preoperative glycemic control as demonstrated by HbA1c in DM patients with the incidence of surgical site infection following single level lumbar/lumbosacral posterior fusion. (2) to calculate a threshold level of HbA1c above which the risk of postoperative infection after spinal fusion increases significantly in patients with diabetes.

**STUDY DESIGN/SETTING:** retrospective case report

**PATIENT SAMPLE:** 251 patients who underwent lumbar and/ or lumbosacral posterior fusion with recorded preoperative HbA1c from 1 January 2009 until 31 December 2015. The inclusion criteria were (1) single level lumbar/lumbosacral posterior fusion, (2) patients with established diabetes, and (3) arthrodesis performed by conventional open techniques. Ninety-two patients met the inclusion and exclusion criteria.

**OUTCOME MEASURES:** HbA1c assessment. The diagnosis of infection was determined using the CDC definition of SSI. Laboratory studies - C-reactive protein value

**METHODS:** From January 2009 to December 2015, total 92 patients who underwent single level lumbar/lumbosacral posterior fusion with diabetes and had preoperative HbA1c recorded within 4 weeks of surgery were included in the study. Patients were divided into two groups according to whether they had surgical site infection (SSI) and their demographic/clinical data were compared. A receiver operating characteristic (ROC) analysis was conducted to define the cut-off value of HbA1c above which the risk of SSI was significantly increased. Including this value, potential variables were verified by multiple logistic regression analysis.

**RESULTS:** Twenty four patients were treated for SSI and 68 patients maintained noninfectious condition within 1 year. Three of the 24 (12.5%) patients developed SSI in the deep layer requiring operative irrigation and debridement. The preoperative HbA1c value was significantly higher in patients with SSI (6.8%) than in those without SSI (6.0%; p=0.008). The results of ROC analysis determined that HbA1c ≥ 6.9% could serve as a threshold for significantly increased risk of SSI (p=0.003, AUC=0.708, sensitivity=62.5%, specificity=70.6%). After adjusting for confounding factors, there was a significant association between preoperative HbA1c and occurrence of SSI (p=0.008, OR=4.500, 95% CI=1.486-13.624).

**CONCLUSIONS:** In patients with diabetes, the preoperative glycemic control as indicated by HbA1c is an independent risk factor for SSI following single level lumbar/lumbosacral posterior fusion. Particularly when preoperative HbA1c exceeded 6.9%, the risk of SSI significantly increased.

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P65. Spinal Metastasis Surgery in the Elderly: A Survival Analysis of 83 Cases
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BACKGROUND CONTEXT: Metastatic spine disease is a common complication to several types of cancer. As the incidence of cancer increases with age, spine surgeons need to assess older patients for surgical treatment.

PURPOSE: The aim of this study was to compare the survival after surgery for patients aged 75 or more with the survival of younger patients.

PATIENT SAMPLE: 83 patients aged 75 or more (60 men, 23 women, mean age 80 years) undergoing spinal surgery at Uppsala University Hospital, Sweden, due to metastatic spine disease 2006-2012.


METHODS: Data was collected prospectively for the Swedish Spine Register and retrospectively from the medical records. Survival data was compared to a cohort of 232 patients <75 years of age who underwent surgery due to spinal metastasis at the same hospital during the same period.

RESULTS: The mean estimated survival time after surgery for patients aged 75 or more was 14.7 months (CI 10-19) and median 5.2 months (CI 3-7). For patients aged >75, the mean estimated survival was 12.7 months (CI 10-15) and median 6 months (CI 3-7). Six months after surgery, 51% of the patients in the group aged 75 or more were alive compared to 57% in the group aged younger than 75. None of the differences reached statistical significance.

CONCLUSIONS: While there probably is a bias to select elderly patients in good general condition for surgery, our data suggests that age is a poor predictor for survival. As a group, elderly patients with metastatic spine disease have fairly good survival after surgery and should not be disqualified for surgery based solely on their age.

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PURPOSE: Introduction: Currently, there are three interbody fusion procedures for lumbar spinal canal stenosis (LSCS) with intervertebral instability; however, it is unclear which procedure should be chosen. The objective of the present study was to compare the short-term outcomes between conventional open-transforaminal lumbar interbody fusion (open-TLIF), minimally invasive surgical (MIS)-TLIF, and lateral lumbar interbody fusion (LLIF) for LSCS.

METHODS: Methods: From 2014 to 2016, 149 patients of LSCS with intervertebral instability underwent one-level lumbar interbody fusion and were followed for more than 1 year after surgery. Seventy-one patients underwent direct neural decompression and fusion by open-TLIF (OT group), 42 patients underwent direct neural decompression and fusion by MIS-TLIF using percutaneous pedicle screws (PPS) (MT group), and 36 patients underwent indirect neural decompression and fusion by LLIF using PPS (L group). Surgical invasiveness was evaluated by the surgical time, perioperative blood loss, and perioperative complications. For the clinical outcomes, the Japanese Orthopaedic Association (JOA) score, Visual Analogue Scale (VAS), and Oswestry Disability Index (ODI) were evaluated before surgery and at 1 year postoperatively. Changes in the fused intervertebral disc angle and bone union rate at 1 year postoperatively were investigated using X-ray and computed tomography.

RESULTS: The following numerical results are expressed as the OT group/MT group/L group. The surgical time (min) was 141/158/175 (P <0.05) and the perioperative blood loss (ml) was 704/414/91 (P <0.05). The representative perioperative complications included 6 cases (8%) of epidural hematoma and 5 cases (7%) of surgical site infection in the OT group, 1 case (2%) of cage retropulsion in the MT group, in addition to 12 cases (33%) of intraoperative endplate injury and 10 cases (28%) of transient thigh symptoms in the L group. The overall perioperative complication rate (%) was 28/12/61.

CONCLUSIONS: Conclusions: Although open-TLIF is an easy procedure for LSCS, problems regarding complications, clinical outcomes, bone union rate, etc. remain. MIS-TLIF is relatively less invasive, has a low complication rate, and a good clinical outcome. However, there is still room for improvement in the standardization of the procedure. Although there are specific complications such as thigh symptoms, LLIF is the most minimally invasive procedure and has an excellent bone union rate and clinical outcome. However, as it cannot be applied to all cases, the establishment of adaptation criteria is necessary. In addition, measures to reduce the radiation exposure dose for both LLIF and MIS-TLIF still need further research.

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P67. Minimally Invasive Lumbar Foraminotomy: Clinical Experience with a Novel Decompressive Tool and Meta-Analysis of the Literature
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BACKGROUND CONTEXT: Introduction: Spinal decompression is one of the most common spinal surgeries. Minimally-invasive spinal decompression offers even shorter hospitalization and recovery durations and reduced pain. However, due to the more difficult approach, adequate foraminal decompression without destabilization of the facet complexes continues to be a limiting factor in these procedures. The purpose of this study is to estimate patient outcome, as demonstrated in the improvement in VAS and ODI scores, as well as the operation length, in a
literature review and meta-analysis, focusing on foraminotomy procedures. In addition, the experience accumulated in two centers with minimally-invasive decompression foraminotomy with the addition of a novel facet sparing foraminal decompression tool (Dreal, Carevue Inc.) is presented.

**PURPOSE:** The purpose of this study is to estimate patient outcome, as demonstrated in the improvement in VAS and ODI scores, as well as the operation length, in a literature review and meta-analysis, focusing on foraminotomy procedures. In addition, the experience accumulated in two centers with minimally-invasive decompression foraminotomy with the addition of a novel facet sparing foraminal decompression tool (Dreal, Carevue Inc.) is presented.

**STUDY DESIGN/SETTING:** Google Scholar was searched for publications with "foraminotomy" and "minimally invasive" or "endoscopic" and without the word "cervical" in their title. Publications discussing lumbar foraminotomy were selected for further review. A prospective consecutive case control study was also performed with the addition of the foraminal decompression device with clinical parameters collected and compared to the authors historical published controls.

**PATIENT SAMPLE:** 49 patients with lumbar stenosis and foraminal compression were enrolled in two centers who underwent minimally invasive decompressions were enrolled.

**OUTCOME MEASURES:** The ODI and VAS scores were used in a random-effect meta-analysis model to estimate the overall postoperative average patient outcome.

**METHODS:** Data accumulated from 49 foraminotomies performed with standard minimally invasive techniques combined with a novel minimally invasive foraminal facet-sparing decompression tool, ages 37-84, performed in two centers was examined and analyzed to determine potential contributors to reducing the surgery length and improving patient outcome. Surgeon feedback, as reported in post-op questionnaires and general estimations and medical records was used for this analysis. MRI analysis of the postoperative foraminal and central decompression was also analyzed and compared to historical controls.

**RESULTS:** 25 publications were examined for this analysis. Out of these papers, 5 included some or all the requested parameters and their standard deviations. Using a maximum likelihood estimation model, parameter averages were calculated: The average Postoperative VAS and ODI scores were 2.7 and 22.7%, respectively. The average surgery length was 80 minutes. These figures are comparable with literature meta-analysis of classical fusion and spinal decompression results. Approximately 50% of the foraminotomies performed were minimally-invasive using a microscopic approach. Our experience with the addition of a novel foraminal decompression tool in 49 lumbar stenosis patients (Dreal) demonstrated similar patient outcomes in VAS back and ODI scores (p=.01) and OR time. However, VAS leg pain scores at 1,3,6 mos (p=.01) as well as MRI based foraminal volume analysis (p=.01) compared to historical controls within the authors MIS decompression series showed statistical improvement over conventional MIS techniques. Complication rates including durotomy, facet injury and progressive deformity were similar to historical controls (p=.01).

**CONCLUSIONS:** Minimal foraminotomy offers similar patient outcome to the open approach with improvements in surgical morbidity, cost, and length of stay. In these authors initial experience, the addition of specialized minimally invasive powered foraminal decompression tools (Dreal) appears to provide additional improvements in the thoroughness of foraminal decompression while sparing the functional facet complex.

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

**P68. Is Lateral Access Interbody Fusion Procedure Safe Even in the Cases with Prior Abdominal Surgery?**

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**BACKGROUND CONTEXT:** The number of Lateral Access anterior Lumbar Interbody fusion procedures (e.g., OLI, XLIF, XLIF corpectomy) has shown a rapid increase in the last several years, because of its nature of less invasiveness. However, the effect of scar tissue from the prior abdominal surgery is unknown.

**PURPOSE:** The purpose of this study is to determine whether a history of abdominal/pelvic surgery confirms an increased risk of retroperitoneal lateral approach related perioperative complications on undergoing lateral access anterior lumbar interbody fusion.

**STUDY DESIGN/SETTING:** The records of 209 patients who underwent lateral access retroperitoneal approach to the anterior aspect of lumbar spine for various etiology (e.g., degenerative, revision, osteoporotic vertebral fracture, trauma, infection, etc.), between April, 2013 and June, 2017 were retrospectively reviewed.

**OUTCOME MEASURES:** Patient demographics, Charlson's comorbidity index, preoperative diagnosis, surgical history, level of the anterior fusion, operative time, estimated blood loss and perioperative complications were collected.

**RESULTS:** One hundred comprised this study, with an average age of 71.5 years. All except 5 patients underwent lateral access anterior lumbar fusion combined with posterior fusion. Thirty-nine patients (18.6%) had single level anterior fusions. The other patients had multiple level involvement. The sixty-nine patients (33%) had the history of abdominal surgeries (e.g., total abdominal hysterectomy, appendectomy, open cholecystectomy, lysis of adhesion, Colectomy, oophorectomy, Cesarean section, appendectomy and inguinal herniation repair).

Average anterior operative time by one level was 62.6 minutes in patients with history of prior abdominal surgeries, and 65.2 minutes in patients without (P = 0.98). The average blood loss by one level in anterior procedure was 64.3ml in patients with history of prior abdominal surgeries and 64.3ml in those without (P = 0.99). The average age in patients with history of major abdominal surgery (except appendectomy and herniation repair) is statistically older than those without (75.2 vs. 70.5. P = 0.020). The average anterior operative time by one level was 69.1 minutes in patients with history of major abdominal surgery, and 62.6 minutes in patients without (P = 0.85). The average blood loss by one level in anterior procedure was 67.0ml in patients with history of prior abdominal surgeries and 64.4ml in those without (P = 0.87). No great vessel laceration, ureteral injury and limited or failed access to lumbar spine were documented.

**CONCLUSIONS:** Intraoperative difficulties related to prior abdominal surgeries are insignificant. By using the lateral access technique, prior abdominal surgery should not be regarded as an obstacle.

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

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BACKGROUND CONTEXT: Interspinous process devices (IPD) are utilized as an alternative to laminectomy for the treatment of lumbar spinal stenosis. Previous research has highlighted concerns that patients undergoing IPD implantation for the treatment of lumbar stenosis may have higher rates of reoperation in the immediate postsurgical period.

PURPOSE: This study aims to compare perioperative complication rates, length of stay (LOS), and inpatient hospital costs between patients undergoing laminectomy or interspinous process device (IPD) implantation.

STUDY DESIGN/SETTING: Retrospective Cohort Study.

PATIENT SAMPLE: A total of 624 patients undergoing treatment for lumbar spinal stenosis were analyzed. The average patient age in the laminectomy and IPD groups was 72.49 and 73.13 years, respectively (p=0.383). Patients with a diagnosis of fracture, traumatic spinal cord injury, spina bifida, neoplasia, or infection were excluded.

OUTCOME MEASURES: This study compared the laminectomy and IPD cohorts on high-end hospital charges, prolonged inpatient length of stay, and perioperative complications.

METHODS: This study screened over 35 million hospital discharges in the United States from 2010 to 2014 using the National Inpatient Sample and the Nationwide Inpatient Sample (NIS). The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes were used to identify 20,335 patients who underwent laminectomy without fusion (ICD 03.09) and 312 patients who had an IPD implanted (ICD 84.80). Perioperative complications were identified using ICD-9-CM diagnosis codes. The laminectomy and IPD groups were statistically matched based on age, year of procedure, sex, race, hospital type, and comorbidities. Mean hospital cost and length of stay (LOS) for each cohort were calculated and compared using the Kruskal Wallis H test. Univariate and multivariate logistic regressions were used to compare high-end cost and prolonged LOS between the cohorts, defined as patients with LOS and total hospital charges greater than the 75th percentile of the mean.

RESULTS: This study screened over 35 million hospital discharges in the United States from 2010 to 2014 using the National Inpatient Sample and the Nationwide Inpatient Sample (NIS). The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes were used to identify 20,335 patients who underwent laminectomy without fusion (ICD 03.09) and 312 patients who had an IPD implanted (ICD 84.80). Perioperative complications were identified using ICD-9-CM diagnosis codes. The laminectomy and IPD groups were statistically matched based on age, year of procedure, sex, race, hospital type, and comorbidities. Mean hospital cost and length of stay (LOS) for each cohort were calculated and compared using the Kruskal Wallis H test. Univariate and multivariate logistic regressions were used to compare high-end cost and prolonged LOS between the cohorts, defined as patients with LOS and total hospital charges greater than the 75th percentile of the mean.

CONCLUSIONS: In a statistically matched cohort, patients undergoing laminectomy for lumbar spinal stenosis had similar rates of perioperative complications compared to patients who underwent IPD implantation. Additionally, patients in the IPD cohort had significantly shorter LOS, but greater hospital costs.

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