O01
SURGICAL VERSUS NON-OPERATIVE TREATMENT FOR LUMBAR DISC HERNIATION: EIGHT-YEAR RESULTS FOR THE SPINE PATIENT OUTCOMES RESEARCH TRIAL (SPORT)
Jon D. Lurie; Tor D. Tosteson; Anna N.A. Tosteson; Wenyan Zhao; Tamara S. Morgan; William A. Abdu; Harry Herkowitz; James N. Weinstein; Geisel School of Medicine at Dartmouth, Hanover, NH and Dartmouth-Hitchcock Medical Center, Lebanon, NH (Abdu); William Beaumont Hospital, Royal Oak, MI (Herkowitz)

INTRODUCTION: Eight year outcomes of surgery vs. non-operative care for lumbar intervertebral disc herniation (IDH). Though randomized trials have demonstrated small short-term differences in favor of surgery, long-term outcomes comparing surgical to non-operative treatment remain controversial.

METHODS: Eligible surgical candidates with imaging-confirmed IDH enrolled into prospective randomized (n=501) and observational cohorts (n=743) at 13 spine clinics in 11 US states. Interventions were standard open discectomy versus usual non-operative care. Primary outcomes were changes from baseline in the SF-36 Bodily Pain (BP) and Physical Function (PF) scales and the modified Oswestry Disability Index (ODI) assessed at 6 weeks, 3 and 6 months, and annually thereafter.

RESULTS: Advantages were seen for surgery in intent-to-treat (ITT) analyses for the randomized cohort for all primary and secondary outcomes other than work status; however, with extensive non-adherence to treatment assignment (49% patients assigned to non-operative therapy received surgery versus 60% of patients assigned to surgery) these observed effects were relatively small and not statistically significant for BP, PF or ODI. An as-treated analysis showed significant surgical treatment effects for primary outcomes (mean change Surgery vs. Non-operative; treatment effect; 95% CI): BP (45.3 vs. 34.4; 10.9; 7.7 to 14); PF (42.2 vs. 31.5; 10.6; 7.7 to 13.5) and ODI (-36.2 vs. -24.8; -11.2; -13.6 to -9.1). Importantly, the overall comparison of secondary outcomes was significantly greater with surgery in the ITT analysis (sciatica bothersomeness [p < 0.005], satisfaction with symptoms [p > 0.013], and self-rated improvement [p > 0.013]) in long-term follow-up.

DISCUSSION: Carefully selected patients who underwent surgery for IDH achieved greater improvement than non-operatively treated patients; there was little to no degradation of outcomes in either group (operative vs non-operative) from 4 to 8 years.

O02
BODY MASS INDEX AND ITS ASSOCIATION WITH LUMBAR DISC HERNIATION AND SCIATICA: A LARGE-SCALE, POPULATION-BASED STUDY
Dino Samartzis, (+)Jaro Karppinen, Keith DK Luk, Kenneth MC Cheung; Department of Orthopaedics and Traumatology, University of Hong Kong, Pokfulam, Hong Kong, SAR, China and the (+) Institute of Clinical Medicine, University of Oulu, Oulu, Finland

INTRODUCTION: Elevated body mass index (BMI) or overweight and obesity are pandemics. Lumbar disc herniation and sciatica occur in every population and present severe socioeconomic consequences. However, little is known regarding the role of BMI with lumbar disc herniation and sciatica. As such, the following large-scale study addressed the association of BMI, in particular overweight and obesity, with disc herniation, its global lumbar involvement and its implications with the development of sciatica.

METHODS: A cross-sectional study of 2,596 Southern Chinese (mean age: 42 years; 60% females) was conducted assessing T2-
weighted MRI, environmental and lifestyle factors, as well as clinical profiles of sciatica. On imaging, the presence of disc bulge/extrusion (DBE) and other spinal phenotypes from L1-S1 were assessed. A total DBE (TDBE) Score of L1-S1 was calculated. Asian-modified BMI values and categories were obtained of each subject. Results: DBE was noted in 46.3% of the subjects, mainly occurring at L4-S1. The mean TDBE score was 0.7. Historical prevalence of sciatica was 44.6%, with 17.9% reporting sciatica at the time of assessment. The mean BMI was 22.9 kg/m2 (7.2% underweight, 47.9% normal-weight, 36.1% overweight, 8.9% obese). TDBE Score significantly increased with elevated BMI categories (p<0.001). Multivariate analyses noted that elevated BMI was significantly associated with DBE [normal-weight (Ref); underweight OR: 0.71(0.49-1.03); overweight OR: 1.26(1.04-1.52); obese OR: 1.78(1.30-2.44)]. TDBE score (OR: 1.36; 1.15-1.60) and obesity (OR: 1.68;1.25-2.24) were significantly related with sciatica. Worse functional and disability scores were associated with sciatica (p<0.05).

**DISCUSSION:** Based on the largest population-based study to assess the role of BMI and its association with disc herniation, overweight and obesity significantly increased the likelihood of having lumbar DBE, its global severity and the risk of developing sciatica.

**O03**

**DEFINING DISC HERNIATION: IS CLINICAL DIAGNOSIS ENOUGH?**

M.C. Battie, L. Gibbons, M. Bruno-Brayda, J. Fairbank, C. Heywood, A. Lazary, I. McCall, S. Roberts, P.P. Varga; University of Alberta, Canada; University of Helsinki, Finland; Oxford University, Keele University, & East Midlands Spine Limited, UK; National Center for Spinal Disorders, Hungary; IRCCS Istituto Ortopedico Galeazzi, Italy; University of Washington, USA

**INTRODUCTION:** Whether comparing patient outcomes between clinics, conducting multi-center trials, or pooling subjects for gene association studies, clearly defined phenotypes are needed. The simplest approach to defining a clinical phenotype for disc herniation (DH) is to rely on the treating or consulting physician’s diagnosis, but is clinical diagnosis enough?

**METHODS:** Patients in the Genodisc research consortium project were recruited from spine surgeons’ clinics in 3 European countries. There were 1134 patients diagnosed with lumbar DH who also had an independent assessment of their lumbar MRI by a radiologist blinded to diagnosis. We compared data from the standard diagnostic sheet completed by the spine surgeon, the MRI assessments, and patient self-report between 5 clinical sites, using ANOVA or Fisher’s exact test.

**RESULTS:** Spine surgeons noted radicular pain in a dermatomal pattern in 89.0-95.9% of patients (p=0.139), and associated nerve root compression was identified on imaging in 76.2-86.3% (p=0.032). Substantial differences were reported by the spine surgeons for the portion of subjects with extruded or sequestered discs (64.6-95.8%; p<.001), but these differences were not supported by the independent MRI assessments (56.5-69.9%; p=0.342). There were notable differences across sites for spinal comorbidity (spondylolisthesis (4.1-16.0%; p<0.001) and spinal stenosis (16.4-33.0%; p< 0.001)), duration of leg pain (4.5-22.0 months; p<0.001), and interference with work (43.5-79.8%; p<0.001).

**DISCUSSION:** Is the clinical diagnosis of DH enough to achieve a homogeneous phenotype? The answer is mixed. While some findings for the clinical phenotype of diagnosed DH were similar, there were also variations by site for severity, chronicity, and complexity of cases that could affect
patient outcomes and comparisons. If related data are not gathered and differences addressed, mixed phenotypes, misinterpretation, and failure to replicate findings could result.

**O04**

**HOW HEALTHY DISCS HERNIATE: A BIO-MECHANICAL AND MICROSTRUCTURAL STUDY INVESTIGATING THE COMBINED EFFECTS OF COMPRESSION RATE AND FLEXION**

Kelly R. Wade, Peter A. Robertson, Ashvin Thambyah, Neil D. Broom; Experimental Tissue Mechanics Laboratory, Department of Chemical and Materials Engineering, University of Auckland, New Zealand. Department of Orthopaedic Surgery, Auckland City Hospital, New Zealand

**INTRODUCTION:** At the level of the motion segment failure of the disc in compression has been extensively studied. However, at the microstructural level the exact mechanisms of disc failure are still poorly understood, especially in relation to loading posture and rate. The purpose of this study was to provide a microstructural analysis of the mechanisms of annular wall failure in healthy discs subjected to flexion and an elevated rate of compression.

**METHODS:** 72 healthy mature ovine lumbar motion segments were compressed to failure in either a neutral posture or in high physiological flexion (10°) at a displacement rate of either 2mm/min (low) or 40mm/min (high). Testing at the high rate was terminated at stages ranging from initial wall tearing through to facet fracture so as to capture the evolution of failure up to full herniation. The damaged discs were then analysed microstructurally.

**RESULTS:** ~50% of the motion segments compressed in flexion at the high rate suffered annulus or annulus-endplate junction failure, the remainder failed via endplate fracture with no detectable wall damage. The average load to induce disc failure in flexion was 18% lower (p < 0.05) than that required to induce endplate fracture. Microstructural analysis indicated that wall rupture occurred first in the posterior mid-then-outer annulus.

**DISCUSSION:** Disc wall failure in healthy motion segments requires both flexion and an elevated rate of compression. Damage is initiated in the mid-then-outer annular fibres, this a likely consequence of the higher strain burden in these same fibres arising from endplate curvature. Given the similarity in geometry between ovine and human endplates it is proposed that comparable mechanisms of damage initiation and herniation occur in human lumbar discs.

**O05**

**THE SIGNIFICANCE OF CARTILAGE ENDPLATE WITHIN A LUMBAR DISC HERNIATION**

P Lama, U Zehra, C Balkovec, U Harding*, P Dolan, MA Adams; Centre for Comparative and Clinical Anatomy, University of Bristol, Bristol, U.K *Department of Orthopaedics, Southmead Hospital, Bristol, UK

**INTRODUCTION:** Herniated disc tissue removed at surgery contains varying proportions of nucleus pulposus, annulus fibrosus, hyaline cartilage and bone. The origins and significance of hyaline cartilage within a herniation are largely unknown.

**METHODS** Lumbar herniated (extruded) disc tissue was removed surgically from 21 patients aged 35-74 yrs. Frozen sections, 5-μm thick, were examined histologically, and antibodies were used to label cells for the pro-inflammatory mediator TNF-α, and the matrix-degrading enzyme MMP1. Proportions of each tissue type were quantified using image analysis software. Cartilage-bone junctions were examined in 5-μm frozen sections from 17 cadaveric spines, aged 61-98 yrs. Strength of the disc-cartilage and cartilage-bone interfaces of the endplate...
were compared by stretching to failure 5 mm-thick cadaveric bone-disc-bone specimens.

**RESULTS:** Fragments of hyaline cartilage were found in 10/21 herniations. On average they were 5.0 mm long, and occupied 26% of the area of the herniated mass. Two had a small quantity of bone attached. Hyaline cartilage was present in a higher proportion of herniations from patients with sciatica (7/10) compared to those from patients whose main symptom was back pain (3/11) (P<0.05). Cartilage appeared to have been peeled off the bony endplate along the ‘tide mark’, and this was the mode of failure in the mechanical experiments. Hyaline cartilage showed little swelling, proteoglycan loss or inflammatory cell invasion, although cartilage chondrocytes often formed small clusters which expressed TNFα and MMP1.

**DISCUSSION:** Disc herniations often include hyaline cartilage pulled from the vertebral endplate. The collagen network of cartilage fragments minimises swelling, proteoglycan loss and resorption, so they are likely to cause persisting sciatica. Loss of cartilage endplate will increase endplate permeability, increasing the risk of inflammatory ‘Modic’ changes, and of disc infection.

**O06**

**SPONTANEOUS RESORPTION OF LUMBAR DISC HERNIATION IS LESS LIKELY WHEN MODIC CHANGES ARE PRESENT**

Zhi Shan M.D, Shunwu Fan M.D, Qingbo Xie M.D, Letu Syou M.D, Junhui Liu M.D, Chongyan Wang M.D, Fengdong Zhao M.D.; Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University

**INTRODUCTION:** Spontaneous resorption of lumbar disc herniation (LDH) has been demonstrated, while the mechanisms are unclear. Modic changes (MCs) are closely associated with disc degeneration, but research focusing on their association with spontaneous resorption of LDH have not been specifically investigated.

**METHODS:** Eighty-five consecutive LDH patients (52 men, 33 women, aged 20-66yrs) were included. Patient diagnosis was based on clinical presentation, MRI and CT. Patients were divided into surgical and conservative groups, and further divided into MC and non-MC subgroups. Spontaneous resorption and clinical success in the conservative group were assessed by reduction in the herniated volume AND Oswestry disability index (ODI). Disc tissues collected from the surgical group were examined histologically, and immunohistochemistry was used to identify endothelial cells and macrophages.

**RESULTS:** In total, 35/85 patients showed MC, mostly Type II. Herniated tissue in MC group contained relatively more hyaline cartilage endplate than non-MC group (on average, 50% vs 8%, P<0.05) but less nucleus pulposus (18% vs 55%, P<0.05). Conservative treatment reduced ODI scores in non-MC group from 29.4 to 23.5 on average (P <0.05), but reductions in MC group (30.1 to 29.0) were non-significant. Herniated volumes reduced following conservative treatment in non-MC group (0.44 to 0.21 cm³, P<0.05) but not in MC group (0.52 to 0.45 cm³, P>0.05). More neovascularization and macrophage infiltration was observed in herniated tissue from non-MC group than MC group (P<0.001).

**CONCLUSIONS:** Modic changes in LDH patients are associated with cartilaginous herniations which resorb poorly, so that patients respond less well to conservative treatments. Loss of cartilaginous endplate may explain the origins of MCs, and their association with disc infection.
ORAL PRESENTATIONS

O07
ACCELERATED DDD IN YOUNG ADULTS IS ASSOCIATED WITH POLYMORPHISMS IN MMP 7, CALM 1 AND COX 2 GENES. ANALYSIS OF 58 SINGLE NUCLEOTIDE POLYMORPHISMS IN 580 INDIVIDUALS BASED ON TOTAL DEGENERATIVE DISC SCORE

1.Prof.S.Rajasekaran,Ph.D, 2.Dr.Rishi M Kanna, 3.Prof.Kenneth Cheung, 4.Prof.Danny Chan, 5.Dr.Patrick Kao, 6.Dr.Anita Yee, 7.Dr.Raveendran M, 8.Dr.Senthil N; 1,2 Dept. of Spine Surgery, Ganga Hospital, Coimbatore, India 3,4,5,6 - University of Hong Kong, Pokfulam, Hong Kong. 7,8 Tamil Nadu Agricultural University, Coimbatore, India.

INTRODUCTION: Significant genetic influence for degenerative disc disease (DDD) has been established, but however studies focusing specifically on young adults with DDD are not present.

METHODS: Patients < 40 years with lumbar DDD were evaluated with MRI imaging and Genetic association studies for 58 SNPs of 35 candidate genes. Subjects were stratified into three groups based on a Total Degenerative Disc Score (TDDS), which was developed by adding the individual scores of Pfirrmann grading of all five lumbar discs. The severity of DDD was classified as mild (TDDS <10), moderate (TDDS of 10 to 15) and severe (TDDS > 15). 58 potential SNPs based on previous genetic studies on DDD and located in candidate genes encoding for vital disc components (collagen, proteoglycan, degradative enzymes); in bone remodeling (Vitamin D receptor, bone morphogenic protein) and those involved in important intracellular signaling mechanisms were considered.

RESULTS: In 580 subjects (308 patients - mild TDDS, 211 - moderate TDDS and 61 - severe TDDS), there was no significant difference in the gender and the mean age. Association analysis of SNPs was performed between mild and severe TDDS groups. 3 of the 35 candidate genes showed significant association with severe TDDS. SNPs viz., rs1940044 of MMP (Matrix Metalloproteinase 7), rs2300496 SNP and rs3213718 SNPs of CALM1 (Calmodulin) and rs5277 of COX 2 (Cyclooxygenase) were found to be significantly associated with severe TDDS.

CONCLUSION: Our study is the first to report SNP analysis specific to DDD in the young adults. The study has identified specific SNP associations of three genes (MMP 7, CALM 1 and COX2) in young adults with severe DDD. Involvement of Matrix genes MMP 7 and CALM 1 and inflammatory gene COX2 shows that DDD is a complex process with an interplay of multiple genetic polymorphisms.

O08
CHARACTERIZATION OF ANNULUS LAYER DEFORMATIONS IN AN INTACT INTERVERTEBRAL DISC UNDER MECHANICAL COMPRESSION

Han Sang Kuy,1 Tang Qinggong,1 Kim Hyunchul, 1, Chen Yu,1 Hsieh H. Adam 1,2; 1 Fischell Department of Bioengineering, University of Maryland, College Park, MD, United States; 2 Department of Orthopaedics, University of Maryland, Baltimore, MD, United States

INTRODUCTION: Annulus fibrosus (AF) in the intervertebral disc (IVD) plays a key role for bearing external loads on the IVD. AF in mechanical compression has been extensively studied, but the deformations of an individual annulus lamellar layer in a fully intact IVD are not well understood. In this study, we utilized optical coherence tomography (OCT), which is a non-invasive imaging technique for visualizing AF mesostructural features, to characterize AF lamellar layer deformations of fully intact IVDs in mechanical compression.

METHODS: Fresh-frozen ovine lumbar motion segments were subjected to different compressive loads (300, 500 and 1000 N). A
swept-source OCT system was paired with a materials testing system to visualize a 2.1 x 2.1 x 3.6 mm³ volume in AF layers from the anterior region in mechanical compression. Outer annular layer deformations including trans-lamellar cross bridge were characterized.

**RESULTS:** OCT image is able to characterize the most outer AF layers in an intact IVD (Fig. 1a). In mechanical compression of the IVD, AF lamellar layers were compressed in the radial direction and extended in the axial and circumferential direction (Fig. 1b and c). Furthermore, the deformations of trans-lamellar cross bridge structures indicated that shear loads were occurred within an individual lamellar layer (Fig. 1c).

**DISCUSSION:** To our knowledge, this is the first study to characterize the deformations of an individual annular layer of fully intact IVDs in mesoscale level. Based on our results, individual annuls layer mechanics is more complicated under mechanical compression because of multiple strains, i.e., compression, tensile and shear, within the annulus layer. Further study will aim to investigate annular layer mechanics of degenerated IVDs, and the onset and progress of lamellar herniation using an OCT elastography.

![Figure 1](image.png)

*Figure 1. (a) OCT images of AF lamellar layers in a fully intact IVD (2.1 x 2.1 x 3.6 mm³). (b) and (c) Annular layer deformations.*

**O09**

**EARLY PATTERN AND LONGITUDINAL EVOLUTION OF DEGENERATIVE CHANGES IN INDIVIDUAL COMPONENTS OF INTERVERTEBRAL DISCS IN STRESSED AND NON-STRESSED SEGMENTS OF LUMBAR SPINE: AN IN-VIVO MR IMAGING STUDY.**
anular tears, radial tears, herniations, and nuclear degeneration. Degeneration in stressed discs starts early, often in the form of radial tears prior to any recognizable signs of nuclear degeneration. Discs in the stressed segments also demonstrate a more accelerated degeneration on follow-up imaging.

Data were combined for the RCT and observational cohorts. Surgeries were classified as occurring from 0-3 months, 3-6 months, or greater than 6 months from enrollment. Variables were selected for adjustment based on Cox models for time of surgery. Patients were classified as non-operative until time of surgery. At that point, the classification switched, and survey times were assigned in terms of time from surgery. Effects were estimated with longitudinal regression models.

RESULTS: For IDH, approximately 50 of 675 surgeries were performed more than 6 months from enrollment, with approximately 45 during the 3-6 month period. For SpS, these numbers with 60 and 40 out of 358, and for DS, 85 and 59 out of 322. For PF in the IDH trial, the strongest mean improvements at one year from surgery were for the 3-6 month group (mean (se)=48.4(4.1)) and the 3 months group (45.2(4.1)). The after 6 months group showed considerably smaller gains at one year (33.2(3.3)), less than 6 points above the nonoperative group (27.3(1.2)). These general results persisted over the 8 years, with only a weak advantage for the > 6 months surgical group over non-operative. The DS nonoperative and >6 months groups converged (see figure). The PF results for SPS were more variable. Sciatica and stenosis bothersomeness show the same trends.

O10

COMPARISONS OF THE EFFECTS OF TIME TO SURGERY IN THE SPINE PATIENT OUTCOMES RESEARCH TRIALS FOR LUMBAR DISC HERNIATION (IDH), SPINAL STENOSIS (SPS), AND DEGENERATIVE SPONDYLOLISIATHESIS (DS)

1Tor D. Tosteson; 1Jon D. Lurie; 1Wenyan Zhao; 2Emily Blood, 1Kevin Spratt, 1Anna N.A. Tosteson, 1James N. Weinstein; 1Geisel School of Medicine at Dartmouth, Hanover, NH and Dartmouth-Hitchcock Medical Center, Lebanon, NH; 2Harvard Medical School, Boston, MA.

INTRODUCTION: The SPORT IDH, SpS and DS trials feature surgery times beyond 3 months of enrollment. Analytic methods were used to estimate treatment effects at specified times from surgery. These effects were compared according to when the surgery was performed relative to enrollment.

METHODS: The trial outcomes examined were SF-36 Physical Functioning (PF) and sciatica or stenosis bothersomeness, at 6 weeks, 3 months, 6 months, and yearly.
DISCUSSION: Surgeries occurring more than 6 months from enrollment showed diminished gains for surgery. Surgeries occurring between 3-6 months appeared to be at least as effective as surgery within the first 3 months.

**O11**

IMPROVEMENT OF GLOBAL SAGITTAL ALIGNMENT AFTER LUMBAR DECOMPRESSION WITHOUT FUSION – ANALYSIS OF 88 CASES.

*Japanese Red Cross Medical Center, Department of Spine and Orthopedic surgery **Tokyo Metropolitan Cancer and Infectious Diseases Center Komagome Hospital, Department of Musculoskeletal Oncology

INTRODUCTION: In surgical treatment for lumbar canal stenosis with degenerative spondylolisthesis, we consider of correction of deformity if there exists global sagittal imbalance. However, little is known about the autonomic alignment change after lumbar decompression. The objective of this study is to evaluate the short-term radiological change after lumbar decompression without fusion.

METHODS: Retrospective analysis of 88 patients (53 males and 36 females, with an average age of 69.6 years) who underwent lumbar decompression without fusion at a single institution between October 2011 and May 2013, minimum 5-months follow up. Standing radiographs of preop and final follow up were accessed. Radiological parameters included Sagittal Vertical Axis (SVA), Lumbar Lordosis (LL), and pelvic parameters.

RESULTS: Mean follow up period was 12.8 months and mean decompression level was 2.2 levels. LL (38.4°vs 45.0°, p<0.001) increased and SVA (49mm vs 32mm, p<0.001) decreased significantly. There was no significant correlation between the levels of decompression and LL increment (p=0.47). Furthermore, preop PI-LL correlated significantly with LL increment (r=0.63), and SVA decrement (r=0.45). Preop LL also negatively correlated significantly with LL increment (r=0.74), and SVA decrement (r=0.51). Interestingly, over 40% of the cases with preoperative sagittal imbalance showed normalization of imbalance postoperatively without corrective procedure. Of 51 cases with preop excessive PI-LL (>=10°), 21cases (47%) showed improvement to <10°. Also, of 49 cases with preop excessive SVA (>=40mm), 20 cases (41%) showed improvement to <40mm.

**DISCUSSION:** This study suggests that lumbar decompression can induce autonomic improvement of lumbar and global sagittal alignment, even if there exists sagittal imbalance (PI-LL>10°, and SVA>40mm) in some cases. This finding provides new insight into proper indication for corrective procedure in lumbar canal stenosis.

**O12**

TOEI STUDY - SAGITTAL SPINAL ALIGNMENT VERSUS HEALTH-RELATED QUALITY OF LIFE IN HIGH AGE VOLUNTEERS

Togawa D, Yamato Y, Yasuda T, Watanabe Y, Ide K, Yamada T, Kobayashi S, Arima H, Banno T, Hasegawa T, Hoshino H, Matsuyama Y.; Department of Orthopaedic Surgery, Hamamatsu University School of Med-
INTRODUCTION: In adult spinal deformity, sagittal mal-alignment has been demonstrated to correlate with health related quality of life (HRQOL), but the frequency of this pathology was still unknown. The purpose of this study was to investigate the relationship between sagittal spinal / pelvic alignment and quality of life in high age volunteers.

METHODS: From June to December 2012, 746 people (413 Male, 333 Female) with age over 50 (average 73) underwent musculoskeletal (physical) and radiographic examination in Toei town of Aichi prefecture in Japan. Total spinal and pelvic X-rays in standing position were taken. Radiographic parameters (Sacral Slope (SS), Pelvic Tilt (PT), Pelvic Incidence (PI), Lumbar Lordosis (LL), Thoracic Kyphosis (TK), and Sagittal Vertical Axis (SVA)) were measured by image analysis software. HRQOL scores were investigated by EuroQOL and Oswestry Disability Index (ODI). The correlation among these radiographic parameters and HRQOL was investigated.

RESULTS: Poor quality X-rays and questionnaires in 56 cases were excluded. Radiographic and HRQOL data valuable for analysis was available in 694 people. According to the sagittal modifiers of Schwab SRS classification, PI - LL less than 10 degrees were seen in 400 (57.6%), 10 to 20 degrees in 161 (23.2%), more than 20 degrees in 133 (19.2%). SVA less than 40mm was seen in 330 (47.6%), 40 to 95mm in 265(38.2%), and more than 95mm in 99 (14.2%). PT less than 20 degrees was seen in 404(58.2%), 20 to 30 degrees in 182(26.2%), more than 30 degrees in 108(15.6%). EuroQOL value was significantly decreased (p<0.0001) in worse sagittal modifier levels in all PI-LL, SVA, and PT categories. ODI was also significantly increased in worse sagittal modifier levels in all categories (p<0.0001).

DISCUSSION: Even in volunteers, relatively frequent sagittal spinal mal-alignment was seen in high age population (average 73). Worse sagittal mal-alignment decreased their HRQOL.

O13
PREDICTABLE FACTORS OF DEEP VEIN THROMBOSIS IN PATIENTS UNDERGOING SPINE SURGERY
Ikeda T MD, Miyamoto H, Hashimoto K, Akagi M; Dept. of Orthopaedic Surg., Kinki University Faculty of Medicine

INTRODUCTION: Postoperative incidence of Deep Venous Thrombosis (DVT) can cause catastrophic complications such as pulmonary embolism, therefore careful examinations and treatments have been carried out for the cases who undergo orthopaedic surgeries, especially in the lower extremities. However, little is known about the incidence of DVT in spine surgery. If the predictable factors of the incidence can be detected, it must be a big advantage for preventing complications. The purpose of the present study, therefore, was to elucidate the possible predictable factors of the postoperative DVT after spine surgery.

METHODS: One hundred ninety-five patients who underwent spine surgeries (male 104, female 91, mean age of 65.5 years old, cervical surgeries 58 case, lumbar surgeries 137 case,) were enrolled. The incidence of postoperative DVT was examined using ultrasonography (US). Preoperative amounts of D-dimer, age, gender, BMI, operation time, amount of bleeding, preoperative ambulatory status, and usage of instrumentation were compared between DVT(+) and DVT(-) groups for detecting the predictable factors of postoperative DVT.

RESULTS: Fifty-nine cases (59 cases, male 20, female 39) of postoperative DVT were detected by the US after spine surgery. Significant difference was found in respect of preoperative higher amounts of D-dimer,
older age (>75 years old), female, non-ambulatory, usage of instrumentation between DVT(+) and DVT(-) groups, therefore these factors should be recognized as predictable factors of the incidence. Cut-off amount of preoperative D-dimer was found to be 1.4µg/ml (ROC analysis, AUC=0.88).

DISCUSSIONS: The present study has shown several predictable factors of the incidence of DVT after spine surgery. When we intend to perform spine surgery on the patients with such clinical factors, US should be applied postoperatively, and preventive treatment such as administration of anticoagulant therapy and early take-off from the bed should be considered.

O14
POST-SURGICAL REHABILITATION PATIENTS HAVE SIMILAR FEAR AVOIDANCE BEHAVIOUR LEVELS AS THOSE IN NON-OPERATIVE CARE
Chris Gregg MHealSc, Greg McIntosh MSc, Hamilton Hall MD, Chris Hoffman MD, Tom Carter BSc PT; The Back Institute, Wellington, New Zealand; CBI Health Group Research Department, Toronto, Canada

INTRODUCTION: The effect of spine surgery on baseline Tampa Scale for Kinesiophobia (TSK) levels is uncertain and limits the development of appropriate postoperative care. The purpose of this study was to measure baseline and change in fear avoidance levels for those with previous spine surgery commencing active rehabilitation compared to non-surgical LBP patients.

METHODS: This was a prospective study of LBP cases (n=305) treated at four spine care rehabilitation clinics in New Zealand between January 2008 and October 2012. In addition to baseline data on pain, function, and sociodemographics, all patients completed the TSK at assessment and discharge from treatment. All patients had mechanical LBP with no abnormal neurology, as determined by the Saskatchewan Spine Pathway triage methodology.

RESULTS: Of the 305 cases, 129 (42.2%) stated they had previously had spine surgery and 176 (57.8%) had been managed non-operatively. There were no baseline statistically significant differences between groups for: medication use, gender, pain classification, SLR testing, numeric pain rating, perceived function or work status. The median symptom duration for the surgical group was 367 days (7% acute, 93% chronic) and non-surgical was 118 days (39% acute, 61% chronic). The surgery group had significantly better (less fear) baseline TSK scores (39.9 vs 42.0, p<0.008). At the conclusion of rehabilitation, there was no statistically significant difference in the reduction of TSK scores between groups.

CONCLUSION: Post-surgical patients had less fear avoidance than those treated non-operatively, at baseline. Surgery did not have a negative consequence on fear avoidance changes following rehabilitation. Post-surgical patients do not require additional rehabilitation input to address kinesiophobia than that provided to non-operative patients.

O15
THE RE-OPERATION RATE IN A SINGLE DATASET VARIES SIGNIFICANTLY DEPENDING ON THE DEFINITIONS APPLIED
Donna D. Ohnmeiss, Dr.Med., Ray Baker, M.D., Richard D. Guyer, M.D., Scott L. Blumenthal, M.D., Jack E. Zigler, M.D.; Texas Back Institute Research Foundation, Plano, TX; Washington Interventional Spine Assoc., Kirkland, WA; and Texas Back Institute, Plano, TX

INTRODUCTION: Re-operation is an important factor for safety of spine surgery. Various criteria have been applied in different studies when defining re-operation. This creates challenges in meta-analyses or
comparing results. The purpose of this study was to determine the impact of varying definitions for determining re-operation when applied to a single large dataset.

**METHODS:** The study population was 1,279 consecutive patients undergoing lumbar total disc replacement or serving as fusion control group in randomized trials comparing artificial disc to fusion. Various definitions of re-operation, nested such that each progressive definition included the previous, were applied to determine the rates produced by each.

**RESULTS:** There were statistically significant differences in re-operation rates based on definitions applied to one dataset (p<0.05), ranging from 1.9% (implant removal or revision), 3.7% (implant revision, removal, or addition of supplemental fixation), 4.5% (any structural surgery at index level - previous criteria with addition of decompression or similar procedure; does not include surgery for infection, hematoma, etc.), 7.2% (any structural surgery at index or any other lumbar level (previous criteria with addition of surgery at non-index level)), and 10.9% (previous criteria with addition of treatment of infection, hematoma, spinal cord stimulator, etc.)).

**DISCUSSION:** Re-operation rates varied significantly in the same study population based solely on definitions applied. It is hoped that this study increases awareness of the importance of clearly describing criteria used to determine re-operation in publications as well as exercising caution when combining or comparing re-operation rates in different studies. These results also highlight the importance of developing and rigorously applying standardized re-operation definition for use with registries to produce valid results when performing benchmarking comparison across multiple providers.

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**O16**

**PREVALENCE OF NEUROPATHIC PAIN AND ITS SURGICAL OUTCOME IN SURGERALLY INDICATED DEGENERATIVE LUMBAR SPINAL DISEASE: MULTI-CENTER PROSPECTIVE SURVEY**

Yong Eun Cho***, Chang-Joo Whang**, Kyung-Soo Suk*, Jee-Hye Kim*, Moon-Soo Park*, Jae-Ho Yang*, Sun-Young Kim*, Hwan-Mo Lee*, Seong-Hwan Moon*; Department of Orthopaedic Surgery, Yonsei University College of Medicine **Ulsan University College of Medicine ***Department of Neurosurgery, Yonsei University, Seoul, Korea

**INTRODUCTION:** Leg pain caused by lumbar disc herniation or spinal stenosis possibly has nociceptive pain and/or neuropathic pain (NP). However there is no epidemiologic study regarding prevalence of NP in degenerative lumbar spinal disease (DLSD) with lower back pain and leg pain. Hence current multi-center prospective survey was performed to examine the prevalence and characteristics of NP and its surgical outcome in surgically indicated DLSD.

**METHODS:** Forty-four spinal centers with ortho (22) and neurospinal surgeons (22) were included. Total of 1109 patients (M:F 459:650) were enrolled for prospective survey. Visual analog pain scale (VAS), Leeds assessment of neuropathic symptoms and signs (LANSS) scale, EuroQol (EQ)-5D, SF-36 were measured preoperatively, 1-2 weeks, and 3 months postoperatively. LANSS scale 12< was defined as having NP.

**RESULTS:** Among 1109 patients, NP was identified in 404 (36%) patients. During postoperative follow up at 1-2 weeks, and 3 months, NP was found in 95 (8.5%) and 44 (3.9%) patients respectively. In preoperative analysis, patients with NP (Vs. nociceptive pain) showed more pain (VAS 7.5, 7.2) worst EQ-5D (0.49, 0.55) and all items of SF 36 except general health. (p<0.05) However patients with NP gained more quality of life...
than those without NP, as measured by EQ-5D (quality of life gain 0.37 with NP, 0.31 without NP) and also in all items of SF 36 except general health. (p<0.05)

**DISCUSSION:** This is first report regarding prevalence of NP (36%) in surgically indicated DLSD. Patients with NP complaint more pain, poor quality of life preoperatively, however those with NP underwent significant reduction of NP (36.0% to 3.9%) and higher quality of life gain. In conclusion, although NP was prevalent in DLSD causing poor quality of life, NP was efficiently and rapidly subsided with surgery gaining more quality of life.

**O17**

**PROXIMAL JUNCTIONAL FAILURE IN ADULT DEFORMITY PATIENTS RESULTS IN HIGHER RATE OF REVISION BUT LIMITED IMPACT ON CLINICAL OUTCOME**

Hart, Robert A.1; Hiratzka, Jayme R.1; Hamilton, D. Kojo1; Bess, Shay 2; Schwab, Frank J.3; Shaffrey, Christopher I.4; Ames, Christopher P.5; Lafage, Virginie3; Smith, Justin S.4; Mummaneni, Praveen V.5; Klineberg, Eric7; McCarthy, Ian8; Burton, Douglas C; 1. Orthopaedic Surgery, Oregon Health and Science University, Portland, OR, United States. 2. Orthopaedic Surgery, Rocky Mountain Hospital for Children, Denver, CO, United States. 3. Orthopaedic Surgery, NYU Hospital for Joint Diseases, New York, NY, United States. 4. Neurosurgery, University of Virginia Medical Center, Charlottesville, VA, United States. 5. Neurosurgery, University of California, San Francisco Medical Center, San Francisco, CA, United States. 6. Orthopaedic Surgery, University of California, San Francisco Medical Center, San Francisco, CA, United States. 7. Orthopaedic Surgery, University of California, Davis, Sacramento, CA, United States. 8. Institute for Health Care Research and Improvement, Baylor Health Care System, Plano, TX, United States. 9. Orthopaedic Surgery, University of Kansas Medical Center, Kansas City, KS, United States. 10. Orthopaedic Surgery, Baylor Spinal Cord Injury Center, Plano, TX, United States. 11. ISSGF, Littleton, CO, United States.

**INTRODUCTION:** Proximal Junctional Failure (PJF), a more severe form of Proximal Junctional Kyphosis (PJK) that includes evidence of mechanical failure, has been recognized as an important concern in adult deformity patients. Prospective evaluation of incidence and clinical impact of PJF has not been reported. We performed a prospective evaluation of PJF in patients undergoing adult deformity surgery.

**METHODS:** 172 patients from 10 centers were followed prospectively with minimum 2 year follow-up. PJF was defined as increased proximal kyphosis of > 10 degrees plus fracture of the upper instrumented vertebrae (UIV) or UIV+1 or instrumentation failure. PJK was defined as increased kyphosis of > 10 degrees without evidence of mechanical failure. Patients were grouped as PJF, PJK, or neither. One and two year HRQoL scores, rate of revision surgery, and development of neurological deficit were compared among the 3 groups.

**RESULTS:** There were 23 PJF patients, 36 PJK patients, and 113 with neither (NoPJF), for a PJF incidence of 13.3% and a PJK incidence of 20.5%. There was no worsening among PJF or PJK patients in 1-year, 2-year, or change from baseline scores for ODI, SF-36 PCS, or SRS-22 scores compared to NoPJF patients. There was a significant increase in rate of proximal extension of fusion among PJF versus PJK patients (14.6% vs. 1.9%; p=0.018). No PJF or PFK patients experienced neurological motor deficits due to their junctional compromise in this patient cohort.

**DISCUSSION:** PJF represents a more substantial complication than PJK, as shown by the increased rate of fusion extension among patients with PJF. However, negative impact on HRQoL measures were not found at 1 or 2 year follow up between patients
with PJF or PJK compared to NoPJF patients. There were no neurological deficits due to PJF in this cohort. The reported incidence of 13.3% represents the highest level of medical evidence to date for occurrence of PJF among adult deformity surgical patients.

O18

TLIF SURGERY RESULTS IN SLIGHTLY HIGHER RISK OF NEUROGENIC LEG PAIN 2 YEARS AFTER SURGERY COMPARED TO STANDARD INSTRUMENTED POSTEROLATERAL FUSION. RESULTS FROM A RANDOMIZED CLINICAL TRIAL.
Kristian Høy, Blazej Grycel, Thomas Andersen, Bent Niederman, Peter Helmig, Ebbe Stender Hansen, Haisheng Li, Cody Bünger; Spine Section, Department of Orthopedics E, Aarhus University Hospital, Denmark

INTRODUCTION: TLIF has gained increasing popularity as an easy way of obtaining circumferential fusion using a posterior only procedure. Due to cage insertion close to the exiting nerve root concerns has been raised as to whether the procedure carries an increased risk of subsequent neurogenic pain due to damage to the dorsal nerve root ganglion.

METHODS: Pain drawings from 100 patients (40 male, 58 female) included in a RCT comparing TLIF to posterolateral instrumented fusion (PLF) was analyzed. 51 patients had TLIF, 47 PLF. Mean age was 49(TLIF)/45(PLF). Pain drawings were completed preoperatively and at 1 and 2 year follow-up. The pain drawing consisted of a front and back outline of a person as well as the area under the feet. Six different symbols could be used for marking pain: dull/aching, burning, numbness, pins and needles, stabbing/cutting and muscular cramps. Pain drawing analyses were done assessing presence and type of pain marks in both legs.

RESULTS: A slightly higher number of patients in the TLIF group reported any leg pain a two year follow-up: No leg pain 47% (PLF) 37% (TLIF), Unilateral leg pain 31% (PLF) 25% (TLIF), Bilateral leg pain 22% (PLF) 37% (TLIF), p=0.270. Likewise looking at pain radiating below the knee: No leg pain 55% (PLF) 45% (TLIF), Unilateral leg pain 29% (PLF) 25% (TLIF), Bilateral leg pain 16% (PLF) 29% (TLIF), p=0.294. Numbness and pins & needles on the anterior aspect of the lower leg were marked by 10% and 12% of TLIF patients compared to 6% and 4% in PLF patients (p=0.498/0.197). Looking at the posterior aspect of the lower leg numbness and pins & needles were marked by 10% and 10% of TLIF patients compared to 16% and 8% in PLF patients (p=0.332/0.774).

DISCUSSION: TLIF patients were more likely to have bilateral leg pain two years after surgery and also used pain symbols commonly associated with neurogenic pain to a slightly higher extent than patients who underwent PLF.

O19

LUMBAR FUSION SURGERY FOR DEGENERATIVE DISC DISEASE IS ASSOCIATED WITH SIGNIFICANTLY HIGHER RATES OF FAILED BACK SURGERY SYNDROME DEVELOPMENT WHEN COMPARED TO FUSION FOR SPONDYLOLISTHESIS IN WORKER’S COMPENSATION SUBJECTS
Joshua T. Anderson, BS (1,2), Ryan J. Duff (3), Uri M. Ahn, MD (4), Nicholas U. Ahn, MD (1); 1 University Hospitals Case Medical Center Department of Orthopaedic Surgery 2 Case Western Reserve University School of Medicine 3 University of Minnesota Twin Cities 4 New Hampshire Spine Institute

INTRODUCTION: Failed back surgery syndrome (FBSS) is a feared complication of back surgery that leaves the patient with decreased functional capacity, morale, and productivity. FBSS is also associated with psychosocial problems and addiction to pain medication. Few studies have evaluated predictors of poor lumbar fusion outcomes
in the worker’s compensation (WC) population.

METHODS: We used ICD-9 diagnosis and CPT procedural codes to identify 2321 subjects receiving medical benefits from the Ohio Bureau of Worker’s Compensation that underwent lumbar fusion surgery after injury for the indication of spondylolisthesis or degenerative disc disease (DDD), each with 5 years of follow-up minimum. We determined which subjects developed FBSS within 5 years of fusion. Subjects with a positive smoking history and pre-fusion FBSS were not included. We used a logistic regression.

RESULTS: Subjects undergoing fusion for spondylolisthesis had significantly lower rates of FBSS development (p=0.01; OR 0.68, CI 0.49-0.93) than subjects undergoing fusion for DDD. The number of levels fused at index fusion did not significantly impact FBSS rates. 60 of 700 (8.6%) subjects undergoing fusion for spondylolisthesis developed FBSS. 217 of 1404 (15.5%) subjects undergoing fusion for DDD developed FBSS. The number of fusion surgeries within 5 years of index fusion significantly impacted FBSS rates (p=0.05; OR 1.34, CI 1.00-1.79), but this follows logically. Lower income significantly affected FBSS rates (p=0.03). The odds ratio (1.00) suggests that this impact was not considerable. Age, gender, and obesity did not significantly impact FBSS rates.

DISCUSSION: We demonstrated that performing lumbar fusion, irrespective of levels fused for the indication of degenerative disc disease in worker’s compensation subjects is associated with significantly higher rates of failed back surgery syndrome within 5 years of surgery compared to subjects undergoing fusion for spondylolisthesis.

O20

LONG-TERM COST EFFECTIVENESS OF LUMBAR SPINE SURGERY IN THE SPINE PATIENT OUTCOMES RESEARCH TRIAL (SPORT)

1Anna N.A. Tosteson, 1Tor D. Tosteson; 1Jon D. Lurie; 1Wenyan Zhao; 2Emily Blood, 1Margaret R. Grove, 1William A. Abdu, 1James N. Weinstein; 1Geisel School of Medicine at Dartmouth, Hanover, NH and Dartmouth-Hitchcock Medical Center, Lebanon, NH.

INTRODUCTION: Surgery appeared to be cost-effective over 4 years for SPORT participants with intervertebral disc herniation (IDH), stenosis alone (SPS) or with degenerative spondylolisthesis (DS). However, surgery’s long-term value based on patient-reported health utility is unknown.

METHODS: Mean cost per quality-adjusted life year (QALY) gained was estimated for surgery vs. non-operative treatment by disease group using pooled data from the SPORT randomized and observational cohorts. Costs using Medicare standardized payments were estimated based on medical resource use and impact on usual activities/work status at 6 weeks, 3, 6, 12, 24, 36, 48, 60, 72, and 84 months. Time-weighted sums of health utilities obtained with EQ-5D (US scoring) were used to estimate QALYs. Longitudinal regression analyses according to treatment received controlling for baseline covariates were used to estimate cost/QALY gained with bootstrapped 95% confidence intervals (CI). We examined the impact of higher fee schedules, SF-6D, and other factors in sensitivity analyses.

RESULTS: Among 1,195 IDH participants, 803 (67%) underwent surgery, among 634 SPS participants, 422 (67%) underwent surgery with most involving decompression alone 329/422 (78%). Surgery improved health with QALY differences observed through 8 years (IDH QALY gain 0.42, 95%CI:0.30, 0.55; SPS QALY gain 0.32,
O21
TRANSFORAMINAL LUMBAR INTERBODY FUSION VS. POSTEROLATERAL INSTRUMENTED FUSION - COST-UTILITY EVALUATION ALONGSIDE AN RCT WITH 2-YEARS OF FOLLOW-UP
K. Høy2, A Christensen1, T Andersen2, C. Bünger2, P. Helming2, E. S. Hansen2, & R. Søgaard3,4; 1. Centre for Applied Health Services Research, University of Southern Denmark, Odense C, Denmark 2. SpineSection, Departments of Orthopedics E, Aarhus University Hospital, Aarhus C, Denmark 3. Public Health and Quality Improvement, Central Denmark Region, Aarhus N, Denmark 4. Institute of Public Health, Aarhus University, Denmark

INTRODUCTION: Long-lasting low back pain is an increasing problem and for some patients surgery is the final option for improvement. Several techniques for spinal fusion are available and the optimal technique remains uncertain. The objective of this study was to assess the cost-effectiveness and cost-utility of transforaminal lumbar interbody fusion (TLIF) compared to posterolateral fusion (PLF) from the societal perspective.

METHODS: 100 patients were randomized to TLIF or PLF (51/49) and followed for 2 years. Cost data was acquired from national registers and the Oswestry Disability Index and health utility index scores were collected using questionnaires. A conventional cost-effectiveness methodology was employed to estimate net benefit and to illustrate cost-effectiveness acceptability curves. The statistical analysis is based on means and bootstrapped confidence intervals. All monetary estimates are in 2012–€.

RESULTS: Results showed no statistically significant difference in either cost or effects although a tendency for the TLIF regimen being more costly on bed days (€2,554) and a higher production loss (€1,915) was observed. The probability that TLIF would be cost effective did not exceed 30% for any threshold of willingness to pay per quality-adjusted life year (QALY). Sensitivity analysis was conducted and supported the statistical model for handling of missing data.

DISCUSSION: TLIF does not seem to be a relevant alternative to PLF from a socio-economic, societal point of view.

Keywords: RCT, economics, cost-effectiveness, cost-utility, transforaminal lumbar interbody fusion, posterolateral fusion

O22
TRENDS IN THE USE OF BONE MORPHOGENETIC PROTEIN AMONG PATIENTS UNDERGOING FUSION FOR DEGENERATIVE DIAGNOSES IN THE UNITED STATES, 2002-2011.
Brook I. Martin, PhD MPH [1]; Jon D. Lurie, MD MS [1]; Richard A. Deyo, MD MPH [2]; Anna N.A. Tosteson, ScD [1]; Farrokh Farrokhi, MD [3]; Sohail K. Mirza, MD MPH [1]; [1] Geisel School of Medicine at Dartmouth, The Dartmouth Institute for Health Policy and Clinical Practice, and Dartmouth-Hitchcock Medical Center [2] Oregon Health & Science University [3] Virginia Mason Medical Center
INTRODUCTION: Independent reviews of pivotal trials and a US Senate Finance Committee investigation have supported concerns regarding the safety, effectiveness, and financial conflicts associated with Recombinant Human Bone Morphogenetic Protein-2 (BMP) as an adjunct to spinal fusion. We determined whether clinical practice has changed as concerns emerged.

METHODS: We examined spinal fusion admissions in the 2002-2011 Nationwide Inpatient Sample, a nationally representative discharge registry in the United States. We used the International Classification of Diseases, 9th revision, Clinical Modification to identify the proportion of fusion operations involving BMP for degenerative diagnoses. A time-series regression tested the significance of a change in the proportion of BMP use following a 2008 FDA Safety Notification.

RESULTS: The age and sex-adjusted rate of fusion operations for degenerative diagnoses in the U.S. was 133.1 per 100,000 in 2011 (95%CI 132.6, 133.6). Following its FDA approval, BMP use increased rapidly until 2008, involving up to 44.4% of lumbar and 13.4% of cervical fusions. Its use decreased following a 2008 FDA Safety Notification. The coefficient for the monthly difference in the proportion of BMP use following the notification was -0.012 (p<0.001) for lumbar and -0.003 (p=0.117) for cervical fusion, compared to their pre-notification rate of 0.006 and 0.001, respectively. The decrease in BMP use continued through 2011, when additional concerns about risks, efficacy, and inadequate scientific reporting arose. By the end of 2011, BMP was used in 26.1% of lumbar and 4.9% of cervical fusion cases.

DISCUSSION: The use of BMP in fusion appeared to decline subsequent to published safety concerns and amid revelations of financial conflicts of interest among investigators involved in pivotal trials. Developing ongoing, systematic, population-based methods to monitor the use and safety of emerging technologies may improve patient care.

O23
COST-EFFECTIVENESS OF SPECIALTY CARE VS SPINE STRENGTHENING FOR CHRONIC SPINAL PAIN
Paul D. Kim, MD* Ramin Raiszadeh, MD* Conor W. O'Neill, MD** Choll W. Kim, MD, PhD* Eden Keh, MPH*** Paul Durr, CPA*** Robert Jamison, M.T.M*** Glenn Perelson, MD*** John Jenrette, MD*** Kamshad Raiszadeh, MD*; * Spine Institute of San Diego, San Diego, CA, USA **University of California, San Francisco, San Francisco, CA, USA***Sharp Community Medical Group. San Diego, CA, USA

INTRODUCTION: Patients with spinal pain who fail primary care are often referred to surgeons or other specialists and ultimately receive expensive treatments such as surgery. The evidence suggests that intensive multi-disciplinary rehabilitation, supervised by physical therapists and psychologists and lasting several hours/day for several weeks, is as effective for chronic low back pain as surgery. Due to a lack of perceived value, insurance plans rarely cover these programs, so an alternative is needed. This study compared the costs and effectiveness of usual specialty care with a moderate-intensity, low-cost rehabilitation program that focuses on spinal strengthening.

METHODS: The study population was all patients in a managed care group in San Diego, California diagnosed with new onset low back or neck pain between June 2007 and June 2008 who were referred by their primary care physician (PCP) because of persistent symptoms. Patients were allocated into 2 groups- those referred for specialty care and those referred to a spine strengthening program, which uses progressive resistance exercises with pelvic stabilization, consists of two sessions/week over
ten weeks, and is supervised by exercise physiologists. All medical costs were determined for the 2 years following PCP referral. Effectiveness was measured by narcotic consumption.

RESULTS: Cost per patient in the specialty care group (n=2373) was $3,091 and in the exercise group(n=340) $2,139, for a cost savings of $954/patient. Surgery costs were 3.5x higher in the specialty care group. Narcotic consumption was 57% less in the strengthening group.

DISCUSSION: A spine strengthening program was less costly and more effective than usual specialty care for chronic spinal pain. Prospective studies comparing spinal strengthening with intensive multi-disciplinary programs and surgery are needed to define the appropriate patient population for each of these treatments.

O24
DEFINING CLINICALLY-RELEVANT VALUES FOR DEVELOPMENTAL SPINAL STENOSIS: A LARGE SCALE MRI STUDY
Jason Pui Yin Cheung(1), Dino Samartzis (1), Hideki Shigematsu (2), Kenneth Man-Chee Cheung (1); (1)Department of Orthopaedics and Traumatology, Queen Mary Hospital, University of Hong Kong, Pokfulam, Hong Kong SAR, China (2)Department of Orthopaedics Surgery, Nara Medical University, Kahiara, Nara, Japan

INTRODUCTION: Developmental spinal stenosis is a precipitating factor in patients presenting with lumbar canal stenosis. Yet due to a lack of agreement on definitions and methods of assessment, as well as ethnic-specific normative values, its prevalence and significance is not known. The aim of this study was to define lumbar spinal stenosis in a cohort of 100 surgical cases and 100 asymptomatic controls.

METHODS: This was a case-control study comparing 100 age and sex-matched asymptomatic, volunteers to that of 100 patients who underwent surgery for spinal stenosis. All patients were of Chinese ethnicity and their details were blinded to two observers. Spinal stenosis parameters were measured based on axial (pedicle level) and sagittal (mid-sagittal) MRI scans.

RESULTS: Anteroposterior (AP) spinal canal diameters changes with levels. At each level, patients were found to have significantly narrower AP canal diameters compared with controls. By use of receiver operating characteristic (ROC) curve, we defined developmental spinal stenosis if the AP canal diameter at L1<20mm, L2<19mm, L3<19mm, L4<17mm, L5<16mm and at S1<16mm based on a value including 50% of controls and demonstrated best sensitivity and specificity. Furthermore, for L4, L5 and S1, critical stenosis values could be defined, below which almost all subjects needed surgery, these were 14mm for L4, 14mm for L5 and 12mm for S1.

DISCUSSION: This is the largest MRI-based study with standardized measurements and comparable groups to determine clinically-relevant radiographic criteria for lumbar spinal stenosis. The findings strongly suggest that developmental stenosis plays an important role in the pathogenesis of symptomatic spinal stenosis. Critical values of stenosis below which symptoms were highly likely were defined. These will need to be validated by longitudinal studies in future. However, they may possess clinical utility in determining the appropriate levels requiring canal-widening surgery.

O25
PATIENT-RATED OUTCOME OF SPINAL FUSION IN GERIATRIC PATIENTS (> 80 YEARS OF AGE) WITH LUMBAR DEGENERATIVE SPONDYLOLISTHESIS: DOES AGE MATTER?
Marbacher S, Mannion AF, Burkhardt JK, Schär R, Porchet F, Kleinstück FS, Jeszenszky D, Fekete TF, Haschtmann D; Spine Center, Schulthess Clinic, Zurich, Switzerland
INTRODUCTION: Current demographic changes are characterized by population aging and surgical treatment of degenerative spine conditions in the elderly is gaining increasing relevance. However, there is a general reluctance of considering spinal fusion procedures in this patient age group due to anticipated potential complications. The aim of this study was to assess complications of fusion surgery and patient-rated outcome of lumbar fusion procedures in three different age groups.

METHODS: Data from consecutive patients, who underwent one to three level instrumented fusion for degenerative spondylolisthesis of the lumbar spine between 2004 – 2011 in a single center were obtained from the International Spine Tango Register. Patients completed the multidimensional Core Outcome Measures Index (COMI), the Global Treatment Outcome (GTO) and satisfaction with care before surgery, at 3month and 12 month. Patients were divided into three groups according to their ages: younger (YG, =50y <65y); older (OG =65y <80y), and geriatric group (GG, = 80y).

RESULTS: 707 consecutive patients were included. The comorbidity status were significantly different (p<0.0001) with the highest scores in GG (n=40). General complications were lowest in YG (n=317) compared to OG (n= 350; p=0.006). Duration of hospital stay was longer in GG compared to YG (p=0.007). There was no significant difference among the groups in any of the COMI domains (pain, function, symptom specific well-being, general QOL, and social/work disability), GTO and patient-rated satisfaction.

DISCUSSION: With increasing life expectancy spinal fusion procedures in older and geriatric patients is gaining increasing relevance. Frequent comorbidities increase the risk for general intra- and perioperative complications. However, the results among the age groups are comparable. This suggests that geriatric age per se is not a con-

ORAL PRESENTATIONS

O26

THE CORRELATION OF OSTEOPOROTIC VERTEBRAL FRACTURE WITH SPINOPELVIC SAGITTAL ALIGNMENT

Yongsoo Choi, Daehee Kim, Minwook Kim; Department of Orthopaedic Surgery, Kwangju Christian Hospital, Gwangju, Korea

INTRODUCTION: The spinopelvic sagittal imbalance causes abnormal axial force transmission to vertebra and causes fatigue of back extensor muscle, which can provoke the insufficiency fracture of vertebra body. We were to examine the correlation of osteoporotic vertebral fracture with spinopelvic sagittal alignment.

METHODS: Thirty-eight patients with osteoporotic vertebral fracture and thirty-four non-fracture patients were enrolled in this study. The spinopelvic sagittal parameters (PI; pelvic incidence, PT; pelvic tilt, SS; sacral slope, L4 slope, L5 slope, thoracic kyphosis, lumbar lordosis), age, lumbar bone mineral density and amount of back muscle around lumbar spine were analyzed.

RESULTS: Several spinopelvic parameters, such as PI, PT, and L5 slope, in the osteoporotic vertebral fracture group were significantly greater than those in the non-fracture group. The mean PI was 51.02 degrees in fracture group and 43.35 degrees in non-fracture group, respectively (p=0.007). The mean PT was 22.13 degrees in fracture group and 13.70 degrees in non-fracture group (p=0.002), which meant that the pelvis of the fracture group was more retroverted than the non-fracture group. The mean L5 slope was 17.89 degrees in fracture group and 14.20 degrees in non-fracture group (p=0.044). The mean amount of lower back extensor muscle in the fracture group was 2,170mm², which was lower than non-fracture group, 3,040mm² (p=0.001).
**DISCUSSION**: High PI has more potential to get gradual increasing of pelvic retroversion with age and this serial change can result in stretching of back extensor muscle. The spinopelvic sagittal imbalance and weakness of back extensor muscle can be a risk factor of vertebral fracture in the osteoporosis patients. The strengthening exercise of extensor back muscle is recommended in these patients.

**O27**

DECREASING DISC HEIGHT AFFECTS LUMBAR SEGMENTAL LORDOSIS IN THE AGING LUMBAR SPINE

Hidetoshi Nojiri, MD, PhD; Alejandro A. Espinoza Orias, PhD; Louis Fogg, PhD; Gunnar B.J. Andersson, MD, PhD; Howard S. An, MD; Nozomu Inoue, MD, PhD; Rush University Medical Center, Chicago, IL 60612

**INTRODUCTION**: The influence of aging on segmental lumbar lordosis (SLL) to aging is important to assess natural history and low-back-pain symptoms, however, precise SLL changes are not well understood. This study investigated correlations of disc height (DH) to SLL in vivo and in 3D.

**METHODS**: IRB-approved study with twenty-seven volunteers, (mean age 49.8±16.4, range: 24.3- 86.0 years old), were classified into three decade-based age groups: young (20s/30s: n=10), middle-aged (40s/50s: n=13) and an older adult group (60s and older: n=10). Discs were graded using Pfirrmann’s MRI classification. 3D lumbar vertebral surface models were created from CT images. This data was used to determine the vertebral posterior wall eigenvectors from all lumbar levels (L1 to S1), and subsequently calculate the SLL, described by the angle subtended between axially oriented eigenvectors in two adjacent vertebrae. Cluster analysis was used to study relationships between DH and alignment. A cutoff value was sought to show at what point changes in SLL occurred with decreasing disc height.

**RESULTS**: Disc grade increased with each older group (p<0.001). There was significant DH decrease in the older age group (p<0.001). Disc grade and DH were inversely proportional (r =-0.58, p<0.001). SLL in the older age group was significantly smaller than the other groups (p<0.01), and this decrease was level-dependent. Particularly at the L5/S1 level, the mean SLL value was significantly smaller than in the other age groups (p<0.05). The disc height cutoff values were found to be 5mm for L1/2-L2/3 and 6mm for L3/4 and below.

**DISCUSSION**: This study demonstrates that with advancing age, the lumbar spine straightens up with a maximum decrease in lordosis at L5S1. SLL showed an accelerated kyphotic transition when DH was less than 5mm in upper segments and less than 6mm in lower levels. These changes in the L5-S1 SLL can affect biomechanics and kinematics of the upper lumbar motion segments.

**O28**

CAN PRO-INFLAMMATORY CYTOKINE GENE EXPRESSION EXPLAIN MULTIFIDUS MUSCLE FIBER CHANGES AFTER AN INTERVERTEBRAL DISC LESION?

1Paul W. Hodges PhD, 1Gregory James PhD, 1Linda Blomster PhD, 1Leanne Hall PhD, 1Annina Schmid PhD, 2Cindy Shu PhD, 2Chris Little PhD, 2James Melrose PhD; 1The University of Queensland, Centre of Clinical Research Excellence in Spinal Pain, Injury and Health, School of Health and Rehabilitation Sciences, Brisbane QLD 4072, Australia

1University of Sydney, Raymond Purves Bone and Joint Research Laboratories, Kolling Institute of Medical Research, The Royal North Shore Hospital, St. Leonards, NSW 2065, Australia

**INTRODUCTION**: Structure and behavior of the multifidus muscle change in acute and
chronic back pain, but the mechanisms are surprisingly poorly understood and the link between structure and behavior is tenuous. Although changes in muscle fiber types have the potential to unify the observations, the effect of injury on muscle fiber distribution has not been adequately tested and understanding of possible mechanisms is limited. This study aimed to investigate the effect of an intervertebral disc (IVD) lesion on the proportion of slow, fast and intermediate muscle fiber types in the multifidus muscle in sheep, and whether muscle fiber changes were paralleled by local gene expression of the pro-inflammatory cytokine Tumor Necrosis Factor-alpha (TNF-a).

**METHODS.** The L1-2, L3-4 and L5-6 IVDs of 11 male whether sheep received anterolateral lesions. Six control sheep underwent no surgical procedures. Multifidus muscle tissue was harvested at L4 for muscle fiber analysis using immunohistochemistry, and L2 for cytokine analysis with Polymerase Chain Reaction (PCR) for local gene expression of TNF-a.

**RESULTS.** The proportion of slow muscle fibers in multifidus was significantly less in the lesioned animals both ipsilateral and contralateral to the IVD lesion. The greatest reduction in slow fibers was in the deep medial muscle region. A greater prevalence of intermediate fibers on the uninjured side implies a delayed fiber type transformation on that side. TNF-a gene expression in multifidus was greater on the side of the lesion than the muscle of control animals.

**DISCUSSION.** These data provide definitive evidence of muscle fiber changes following induction of an IVD lesion and a parallel increase in TNF-a expression. Pro-inflammatory cytokine changes provide a novel mechanism to explain behavioral and structural changes in multifidus.

**ORAL PRESENTATIONS**

**O29**

**LEPTIN AND THE INTERVERTEBRAL DISC: A PRO-INFLAMMATORY ENVIRONMENT MAY POTENTIATE THE BIOCHEMICAL EFFECTS OF OBESITY**

Anand Segar BHB MBChB (1,2), Keir Edwards (1); Jeremy Fairbanks MD FRCS (2); Jill Urban PhD(2); 1 Department of Physiology, Anatomy and Genetics, University of Oxford, Oxford, United Kingdom 2 Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford, Oxford, United Kingdom

**INTRODUCTION:** Obesity is a significant risk factor for development of low back pain and intervertebral disc (IVD) degeneration. The mechanism underlying this link is unclear but is commonly thought to arise from altered loading. However, adipokines such as leptin, produced by adipose tissue, are now known to be involved in inflammation. Hence there may be a biochemical link between obesity, back pain and disc degeneration. The aim of the study was to identify responses of nucleus pulposus (NP) and outer annulus fibrosus (OA) cells to leptin and to determine if synergistic effects exist in the presence of other pro-inflammatory cytokines.

**METHODS:** Bovine intervertebral discs were used as a model system. Freshly isolated NP and OA cells embedded in 3D alginate beads, were cultured under varying concentrations of leptin alone or together with the pro-inflammatory cytokines TNF-a and IL-1β. Lactate was used to assess energy metabolism. Active and proMMP-2 and -9 in the culture medium were measured using gelatin zymography. Western blotting was used to assess levels of MMP-1, -3 and -13 and quantitative real-time PCR was used to assess expression levels of anabolic and catabolic genes.

**RESULTS:** Leptin alone significantly increased energy metabolism and production of some proteases at the gene and protein
level for both NP and OA cells. Addition of leptin to medium containing the pro-inflammatory cytokines, demonstrated a marked synergistic effect with energy metabolism and some proteases, especially MMP-2.

**DISCUSSION: OUR** results show that leptin can upregulate proteases involved in degenerative processes in the IVD, and that this effect is potentiated in the presence of pro-inflammatory cytokines such as TNF-a and IL-1β. Leptin levels are increase markedly in obese patients and hence a biochemical mechanism may be involved in the association between obesity, disc degeneration and back pain particularly in an inflammatory environment.

**O30**

**EVALUATION OF CARTilage ENDPLATE BIOCHEMICAL COMPOSITION WITH ULTRASHORT ECHO TIME (UTE) MRI**

Aaron J. Fields, Misung Han, Roland Krug, Jeffrey C. Lotz; Department of Orthopaedic Surgery, University of California San Francisco

**INTRODUCTION:** Proper cartilage endplate function is important for maintaining intervertebral disc health, yet endplate function is not assessed in the clinic. Since endplate function is governed by its biochemical composition, non-invasive assessment of endplate composition may be a powerful clinical tool. We determined the sensitivity of ultrashort echo time (UTE) MRI to depletion-induced changes in endplate biochemical composition.

**METHODS:** Twenty-three endplate samples (8 x 10 x 10 mm) comprising of cartilage and subchondral bone were harvested from three cadaveric lumbar spines. Following baseline UTE MR imaging on a 3T GE scanner (0.22 x 0.22 x 0.9 mm3 resolution, TR = 30 ms, TE = 0.075, 2, 5, 12.5, 19, 25 ms), endplate samples were digested in solutions of collagenase P enzyme (1, 2, or 4 mg/ml) for 5 hr at 37°C. Control samples were maintained in PBS under equivalent conditions. After digestion, all samples were re-imaged. Changes in endplate T2* relaxation time at site-matched locations (1.8 mm3) in the baseline and post-digestion images were correlated with changes in endplate GAG, collagen, and water content.

**RESULTS:** Enzymatic digestion significantly depleted endplate GAG content by 14.4 ± 25.8% (p < 0.01, paired t-test) and collagen content by 12.3 ± 15.7% (p < 0.001 paired t-test). These changes induced variations in water content (Panel A), which correlated significantly with UTE T2* (Panel B, negative values indicate decrease relative to baseline). UTE T2* decreased with depth (Panel C, * p < 0.005 paired t-test) and did not associate with changes in GAG or collagen content (p > 0.40).

**DISCUSSION:** We found that UTE MRI is sensitive to changes in cartilage endplate water content. Prior work showed that loss of endplate water content reduces solute transport and associates with disc degeneration. Taken together, these findings suggest that T2* mapping may be a useful tool for longitudinal assessment of cartilage endplate transport function.

**O31**

**A PHASE III, MULTICENTER, DOUBLE-BLIND, RANDOMIZED, PLACEBO-CONTROLLED, STUDY OF CONDOLIASE FOR THE TREATMENT OF PATIENTS WITH LUMBAR DISC HERNIATION**

Kazuhiro Chiba, MD, PhD1, Yukihiro Matsu-yama, MD, PhD2, Yoshiaki Toyama, MD, PhD3, the Japanese SI-6603 Study Group; 1. Department of Orthopaedic Surgery, Kitasato University Kitasato Institute Hospital 2.
ORAL PRESENTATIONS

Department of Orthopaedic Surgery, Hamamatsu University, School of Medicine 3. Department of Orthopaedic Surgery, Keio University, School of Medicine

INTRODUCTION: Chemonucleolysis is a method to dissolve a herniated nucleus pulposus by injecting an enzyme into the intervertebral disc. In 1980s, chemonucleolysis using chymopapain, a proteolytic enzyme, was widely used and favorable clinical outcomes were reported. However, its use was discontinued due to occurrence of serious adverse events including anaphylaxis and paraplegia. We have conducted a multicenter, double-blind, randomized, placebo-controlled trial to evaluate the efficacy and safety of condoliase, an enzyme that specifically degrades glycosaminoglycans, main constituents of the nucleus pulposus, in the treatment of patients with lumbar disc herniation.

METHODS: The subjects were patients 20 to 70 years of age, with a contained disc herniation at L4-L5 or L5-S1 and positive in the straight leg raising test, who showed no improvement of their symptoms after at least 6 weeks of conservative treatment. The subjects were equally randomized into two groups, condoliase and placebo group. One milliliter of solution containing either condoliase or placebo was administered into the intervertebral disc. The primary endpoint was the changes of mean VAS score of the worst leg pain over the past 24 hours at week 13 from the baseline. Oswestry Disability Index (ODI) and physical component of SF-36 were evaluated as secondary endpoints. The efficacy and safety data were collected up to week 52.

RESULTS: A total 163 subjects received condoliase (n=82) or placebo injection (n=81). The VAS for leg pain, ODI and SF-36 improved significantly greater in the condoliase group than in the placebo group. Adverse events including back pain, disc height decrease and Modic changes occurred, but without serious consequences and good tolerability of condoliase by the subjects was demonstrated.

DISCUSSION: These results suggest that condoliase is a novel and potent chemo-nucleolytic drug for patients with lumbar disc herniation unresponsive to conservative treatment.

O32

PHYSICAL LIMITATIONS TO TISSUE ENGINEERING OF INTERVERTEBRAL DISC CELLS USING GROWTH FACTORS. EFFECT OF BONE MORPHOGENETIC PROTEIN (BMP)-7 AND FIBROBLAST GROWTH FACTOR (FGF)-2 ON GLY COSAMINOGLYCAN PRODUCTION AND CELL METABOLISM

Kobayashi S, Takeno K; Department of Orthopaedics and Rehabilitation Medicine, Faculty of Medical Sciences, The University of Fukui

INTRODUCTION: Proteoglycan loss is one of the first signs of disc degeneration; there is increasing interest in developing biological methods for its replacement both by in vivo repair and through tissue engineered constructs. Regeneration of disk tissue with sufficient mechanical strength particularly requires the production of glycosaminoglycan (GAG), which accounts for 7-10% of healthy disk tissue. In this study, we examine how growth factors influence the rate at which proteoglycans can be accumulated in a three dimensional cell culture system.

METHODS: Cells were isolated from the nucleus pulposus of adult bovine coccygeal discs by enzyme digeston. They were cultured for 5 days in alginate beads in DMEM containing 6% FBS at densities of 4 million cells/ml under 5% oxygen and a normal osmotic condition (400 mOsm) like that of healthy discs. The medium was changed every day and Bone morphogenetic protein-7 (BMP-7[OP-1]; 100 ng/ml ) or fibroblast growth factor 2 (FGF-2; 50 µl/ml) was added to both groups every day. GAG accumu-
oration (as a measure of proteoglycan) was measured using a DMB assay.

RESULT and DISCUSSION: At cell densities found in vivo (standard conditions) in the disc nucleus viz. 4.106 cells/ml and at 5% oxygen the concentration of GAG in the bead reached 0.077 ± 0.005 mg/ml/day. Calculated times to produce a concentration equal to the in vivo concentrations of 7% GAG per wet weight (viz. 70 mgs/ml) assuming initial rates were maintained and there was no loss of GAG, were > 900 days. This concentration could be increased to 0.190 ± 0.005 and 0.159 ± 0.011 mg/ml/day by BMP-7 and FGF-2, respectively. Growth factors support could increase rates of GAG production by up to 2-3 fold. However the theoretical time necessary to produce a construct with the same concentration as the disc matrix even under ideal conditions would still be >>1 year. Such long culture times are consistent with results seen in articular cartilage tissue engineering.

O33
DIFFUSION PROPERTIES OF HUMAN AN- NULUS FIBROSUS. - A SERIAL POST-CON- TRAST MRI STUDY DOCUMENTING THE “DUAL SOURCE” OF NUTRITION.
Naresh-Babu J (Presenting author) ReshmaBegum SK, Neelima G, Adinarayana Rao M, SivaLeela Voleti; Mallika Spine Centre, Guntur, Hyderabad, India

INTRODUCTION: Intervertebral disc being avascular, depends on nutrition either from endplate or annulus fibrosus (AF). Role of endplate on disc diffusion had been extensively studied. However diffusion of human AF remains poorly understood due to lack of reliable techniques to study AF in-vivo & non-invasively. Present study for the first time evaluates the 24-hr diffusion characteristics of AF in radial, axial & circumferential directions.

METHODS: 25 discs from 5 healthy volunteers (age < 20 yrs) were studied. Diffusion over 24-hours following i.v gadodiamide injection (0.3mmol/kg) was studied at 10min, 2, 4, 6, 12 and 24 hrs. Axial images at cranial, middle and caudal zones of disc were obtained. 39 ROIs (24 in AF, 15 in Nucleus-pulposus) at each disc were analysed. Peak enhancement percentage (EPmax) and time to attain EPmax (Tmax) were calculated. Radial (outer vs inner AF), axial (cranial vs caudal vs middle zone) and circumferential diffusion was analysed.

RESULTS: AF showed a biphasic pattern of diffusion with a characteristic “double peak”. Early peak was seen at 10mins (coinciding with Tmax of VB) and delayed peak at 6 hrs (coinciding with Tmax of nucleus pulposus) and characteristically noted after Tmax of endplate (2hrs). Inner AF showed significant regional differences both at the early and delayed peaks but outer AF had no regional differences in the early peak. In axial direction, both outer and inner AF showed maximum EP at middle zone followed by caudal and least at cranial zone.

CONCLUSION: Annulus fibrosus characteristically showed a “double peak” pattern of diffusion. Both the peaks had different characteristics confirming two different sources of nutrition. Initial peak was contributed by periannular vascularity and delayed one via endplate from vertebral body. The fact that even AF depends on endplate for nutrition, help us to better understand the complex nutritional pathways of inter vertebral discs.

O34
THE EFFECT OF CAPACITIVELY COUPLED (CC) ELECTRICAL STIMULATION ON HUMAN INTERVERTEBRAL DISC CELLS AND THE RELATIONSHIP BETWEEN CC AND BMP
Zili Wang, William C Hutton, and S. Tim Yoon; Atlanta VA Medical Center; Emory Spine Center, Emory University School of Medicine, Atlanta, GA, USA
ORAL PRESENTATIONS

INTRODUCTION: Capacitively coupled (CC) electrical stimulation is a non-invasive adjunctive treatment (FDA approved) for spine fusion. However any effect that CC stimulation may have on intervertebral disc cells has not been established. We carried out experiments to determine: 1) if CC can stimulate the synthesis of the disc matrix macromolecules; 2) if CC stimulation can be enhanced by BMP-7 or negated by the absence of BMPs.

METHODS: Human nucleus pulposus (NP) cells were cultured in alginate beads and were stimulated with CC or not (control). The effect of BMP on CC stimulation was evaluated by applying a BMP blocker (noggin) or by applying additional BMP-7 to the culture. The mRNA levels of aggrecan, collagen II and BMPs were measured by real-time PCR. The protein levels were determined by ELISAs and Western blots. sGAG was assayed by the DMMB method. The data presented are the mean ± S.D. of three independent experiments. A 2-tailed T-test was used to compare between the results of two groups. p<0.01 was considered significant.

RESULTS: 1) CC stimulation upregulates the production of the disc matrix macromolecules: sGAG (50%), aggrecan (120%), and collagen II (100%) (p<0.01); 2) CC stimulation induces the expression of endogenous BMP-4 (130%) and BMP-7 (90%) (p<0.01); 3) Inhibition of BMP activity reduces CC-mediated upregulation of aggrecan and collagen II (p<0.01); 4) CC plus BMP-7 applied together (acting in synergy) upregulates aggrecan and collagen II to greater effect than BMP-7 applied alone plus CC applied alone (see Figure using aggrecan mRNA as an example) (p<0.01).

CONCLUSION: CC stimulation upregulates the production of the intervertebral disc matrix macromolecules by a mechanism involving BMPs. CC stimulation acts in synergy with BMP-7 to amplify the upregulation of the disc matrix macromolecules. CC stimulation is a noninvasive strategy that could be useful in the biological treatment of disc degeneration and disc disease.

O35
LUMBAR DISC DEGENERATION PROGRESSION IN YOUNG ADULTS IN THEIR 20’S
Hirotó Makino, Yoshiharu Kawaguchi, Masato Nakano, Taketoshi Yasuda, Shoji Seki, Tomoatsu Kimura; Toyama University, Japan

INTRODUCTION: Lumbar disc diseases (LDDs) are the main cause of low back disorders. LDDs sometimes contribute to the development of low back pain. These diseases are based in part on the aging process, however LDDs also occur in the young population. The purpose of this study was to clarify the process of lumbar disc degeneration in young adults and to evaluate the relationship between progression of disc degeneration and low back pain.

PATIENTS AND METHODS: Prospective study was carried out in 86 university students in nursing department. All of them were in their 20’s. MRI of the lumbar spine was taken twice: first when they were a university student and second at 6-12 years (average: 9.8±3.5 years) after the first MRI. The grade of disc degeneration was determined according to Schneiderman’s four-grade classification. The progression of disc degeneration was evaluated by the change of DDD score (the summation of degener-
ORAL PRESENTATIONS

O36
HEALING OF THE BONE-BONE INTERFACE IN LUMBAR INTERVERTEBRAL DISC ALLOGRAFT TRANSPLANTATION IN A GOAT MODEL
Yong-Can Huang1, Jun Xiao2, William W. Lu1, Victor Y.L. Leung1, Keith D.K. Luk1; 1Department of Orthopaedics and Traumatology, The University of Hong Kong, Pokfulam, Hong Kong SAR, China 2Department of Joint Surgery, Nanfang Hospital, Southern Medical University, Guangzhou, China

INTRODUCTION: A previous human study suggested that intervertebral disc allograft transplantation in the cervical spine can relieve neurological symptoms and restore segmental kinematics. We have demonstrated that lumbar intervertebral disc transplantation could restore the global and segmental mobility after 12m using a goat model. However, the healing process of the bone interface and the subsequent remodeling of the bony endplate of the disc allograft are still unknown. This study examines this issue.

METHODS: 20 male goats were used in this study, with 5 goats as disc allograft donors and the remaining 15 goats as allograft recipients. Disc allograft transplantation without internal fixation was performed at lumbar L4/L5. Radiological healing was assessed with lateral radiographs of the lumbar spine at 1, 3, 6, 9 and 12m post-op. 5 goats were sacrificed at 1.5, 6, and 12m postoperatively respectively. The transplanted segments together with the adjacent levels were then harvested en bloc and fixed for Micro-CT scanning and 3D reconstructions. Sequentially, the sample was mid-sagittally cut. One half was decalcified for Masson’s trichrome staining to morphologically observe new bone formation and bone remodeling; the other without decalcification was used for SEM and line-scan EDX analysis for assessing distribution profile of calcium(Ca) and phosphate (P) as well as the ratio of Ca/P at the newly formed bone of healing sites.

RESULTS: Radiographically, bony union was seen after 3 months. Micro-CT and EDX results demonstrated that healing and remodeling of the host-graft bony interface was basically completed at 6 months post-op. Histologically, the bony structure of the disc allograft was replaced by newly formed trabecular bone through creeping substitution.

DISCUSSION: Healing of the bone interface and the subsequent remodeling of the bony endplate of the allograft were determined. A further study on the blood vessels ingrowths of disc allograft is underway.
O37
HUMAN CARTILAGE ENDPLATE COMPRESSION AND PERMEABILITY PROPERTIES ARE ALTERED BY DEGENERATION AND DISC LOCATION
John F. DeLucca, Daniel H. Cortes, Nathan T. Jacobs, Randall L. Duncan, Dawn M. Elliott; University of Delaware Department of Biomedical Engineering University of Delaware Department of Biological Sciences University of Pennsylvania Department of Mechanical Engineering

INTRODUCTION: Degenerative changes of the nucleus pulposus (NP) and the annulus fibrosus (AF) have been well documented, but the effects of degeneration on human cartilage endplate (CEP) mechanics and permeability are unknown. The objective of this study was to measure the human CEP compressive and permeability properties, their changes with degeneration and location within the disc (superior vs inferior).

METHODS: Human lumbar discs were acquired, imaged with MRI, and graded for degeneration. CEPs were removed via sharp dissection and a 4 mm diameter cylindrical sample was prepared from the central region. Samples were tested in confined compression using established protocol (Cortes et al, J Ortho Res, 2013). A tare load of 0.1N was applied, the sample swelled to equilibrium in 0.15M PBS bath, and then was compressed at a quasi-static rate to 5%, 10%, and 15% strain, and held until equilibrium after each strain increment. The equilibrium compressive modulus was calculated and the load curves were curvefit to determine permeability. The effect of degeneration and disc location on compressive modulus and permeability was analyzed using a two-way ANOVA with Bonferonni post-hoc comparisons.

RESULTS: The equilibrium compressive modulus in degenerate discs was twice that of healthy discs for inferior endplates (p<0.05), while degeneration did not alter the modulus of superior endplates (p>0.05) (Figure 1A). Superior endplate modulus was greater than inferior modulus (p<0.005). Permeability significantly degreased with degeneration (p<0.05) and tended to be greater in superior endplates (p=0.09) (Figure 1B).

DISCUSSION: Healthy and degenerate human CEP compressive and permeability properties were measured for the first time. Disc degeneration was accompanied by increased inferior modulus and decreased CEP permeability. Future finite element modeling studies will address the impact of altered CEP properties on overall disc mechanics.

O38
VERTEBRAL ENDPLATE POROSITY REFLECTS MECHANICAL LOADING IN OLD AND DEGENERATED DISCS
Uruj Zehra, Kate Robson-Brown*, Michael A Adams, Patricia Dolan; Centre for Comparative and Clinical Anatomy, University of Bristol, Bristol, UK *School of Archaeology and Anthropology, University of Bristol, Bristol, UK

INTRODUCTION: Decreased endplate porosity has been proposed as a risk factor for intervertebral disc degeneration, because it interferes with disc metabolite transport. However, endplate porosity has recently been shown to increase with age and disc degeneration. We hypothesise that this increase reflects adaptive remodelling in response to altered mechanical loading from adjacent discs.

METHODS: Nineteen cadaver motion segments (61-98 yrs) were compressed at 1kN
while a pressure-transducer was pulled across the mid-sagittal diameter of the disc. “Stress profiles” indicated nucleus pressure (IDP) and maximum stress in the anterior and posterior annulus. Subsequently, micro-CT was used to evaluate endplate porosity along the antero-posterior diameter of the adjacent endplates. Disc degeneration was graded from 1 to 4 based on histological examination. Data were analysed using ANOVA and linear regression.

**RESULTS:** Endplate porosity (mean±SD) was 67±16% centrally (where IDP averaged 0.85±0.52MPa) and decreased steadily to 52±16% and 55±18% in the anterior and posterior periphery (where maximum stresses were 1.37±0.60MPa and 1.33±0.53MPa, respectively). At each location, porosity was inversely related to IDP (or max. stress) with R²=0.43 centrally (Fig 1), 0.38 anteriorly, and 0.35 posteriorly (P<0.01 in each case). Porosity was 3% higher in the inferior compared to superior endplate of the disc (P=0.07). Average porosity for both endplates increased significantly with grade of disc degeneration (P=0.01).

**DISCUSSION:** In old spines, strong inverse relationships between endplate porosity and intradiscal stresses (at each location) indicate mechanically-adaptive remodelling. Differences in endplate porosity (across the antero-posterior diameter) probably reflect varying nutritional demands of nucleus and annulus, as well as adaptations to loading from an adjacent decompressed disc. In younger age-groups, high loading may reduce endplate porosity, promoting disc degeneration.

**O39**

**DO MACROSCOPIC AND MICROSCOPIC ASSESSMENTS OF INTERVERTEBRAL DISC DEGENERATION REFLECT CHANGES IN DISC FUNCTION?**

Uruj Zehra, Natasha Noel-Barker, John Marshall, Michael A Adams, Patricia Dolan; Centre for Comparative and Clinical Anatomy, University of Bristol, Bristol, UK

**INTRODUCTION:** Disc degeneration can be assessed using macroscopic or microscopic grading systems. But do the degenerative “grades” adequately reflect functional changes in degenerated discs?

**METHODS:** Disc function was assessed in 20 cadaver motion segments (61-98 yrs) by pulling a pressure transducer across the mid-sagittal diameter of the disc while a 1kN compressive load was applied. Resulting “stress profiles” indicated intradiscal pressure (IDP) and maximum stress in the anterior (MaxStress_Ant) and posterior (MaxStress_Post) annulus. Discs were then sectioned in the mid-sagittal plane, and each region was assessed macroscopically to yield an overall score from 1 to 48, and a degeneration “grade” from 1 to 4. Histological sections from anterior annulus, nucleus pulposus and posterior annulus were then scored collectively from 1 to 108, yielding a microscopic grade of degeneration, also from 1 to 4. ANOVA was used to compare the effects of degeneration grade on the functional measures, and regression was used to establish dependence on degeneration scores.

**RESULTS:** IDP decreased with increasing grade of degeneration, assessed both macroscopically (P = 0.01) and microscopically (P = 0.01). MaxStress_Ant, however, decreased significantly only in relation to the microscopic grading (P<0.01, Figure 1). Comparison of the functional measures with
overall scores of degeneration showed that both IDP and MaxStress_Ant fell linearly with increasing macroscopic score (RSq = 0.46, P<0.01 and RSq = 0.25, P = 0.02 respectively). Furthermore, IDP, MaxStress_Ant and MaxStress_Post all decreased with microscopic score (RSq = 0.47, P<0.01; RSq = 0.20, P = 0.02; RSq = 0.38, P = 0.01, respectively).

**DISCUSSION:** Macroscopic and microscopic “grades” of disc degeneration both reflect changes in disc function. However, altered function was better predicted by detailed “scores” of degeneration, especially when those scores were based on microscopic observations.

**O40**

**LUMBAR DISC AND FACET JOINT DEGENERATION: A LONGITUDINAL IN VIVO STUDY**

Hidetoshi Nojiri, MD, PhD; Alejandro A. Espinoza Orías, PhD; Louis Fogg, PhD; Gunnar B.J. Andersson, MD, PhD; Howard S. An, MD; Nozomu Inoue, MD, PhD; Rush University Medical Center, Chicago, IL 60612

**INTRODUCTION:** Lumbar spine degeneration is a leading source of physical disability. In spite of general consensus that aging results in disc height (DH) and facet joint space width (FJSW) alterations, their progression and correlations are not well understood.

**METHODS:** Twenty-three subjects (mean age 40.6±8.7, range 24.3-54.8 years old) underwent MR for disc grading and CT for facet joint grading and morphologic measurements twice over a mean follow-up period of 5.96 years. DH and FJSW were measured from high-resolution, subject-specific 3D models and multivariate statistics analysis was used to probe the data for interactions and level-effects.

**RESULTS** A total of 110 discs from the L1/2 to L5/S1 levels were evaluated. Of these, 12.8% exhibited disc grade deterioration, and a mean DH loss of 0.51 mm (7.3% of the initial height) when assessed at follow-up. DH decreases began in Grade 2 discs. DH reduction in middle-aged adults was larger than in younger subjects. 17.8% exhibited deterioration of the joint status in CT grading and FJSW decreased at an average of 0.10 mm (6.8% of the initial width) in 214 facet joints. Facet narrowing was found to be non-uniform across the facet surface, as shown by local zone topographic analyses. Facet joints with low initial grades showed significantly larger decreases in facet gap than those with worse initial scores (p=0.01). Of note, younger subjects experienced significant reductions in FJSW (p = 0.0001), whereas middle-aged adults did not (p=0.49). There was a weak inverse correlation between changes in the DH and FJSW (r=-0.339). Multivariate statistics analyses confirmed the multifactorial nature of spine degeneration.

**DISCUSSION** Both DH and FJSW narrowing begin at an early age, but the degenerative processes follow different paths when low back pain symptoms are considered.

**O41**

**EFFECT OF ANTI-BFGF NEUTRALIZING ANTIBODY ON NEUROPATHIC PAIN INDUCED BY SPINAL NERVE LIGATION IN RATS**

Hisako Fujimaki, Gen Inoue, Kentaro Uchida, Hiroyuki Sekiguchi, Masaki Ueno, Wataru Saito, Naonobu Takahira, Masashi Takaso;
INTRODUCTION: Basic fibroblast growth factor (bFGF) is a potent trophic factor for neurons and astrocytes that has recently been reported to be a pain transmitter. We evaluated the expression of bFGF and glial activation in the rat spinal nerve ligation model and investigated the potential of anti-bFGF neutralizing antibodies as a treatment for neuropathic pain.

METHODS: Sprague-Dawley rats (5 weeks old) underwent L5 spinal nerve ligation. To evaluate the contribution of bFGF in neuropathic pain, we injected neutralizing antibodies against bFGF (40 ul) intrathecally twice a week (experimental group). Additional rats were injected with PBS (control group). Two weeks after surgery, ligated left L5 spinal nerves, bilateral L5 dorsal root ganglia (DRG), and spinal cords were processed for immunohistochemistry, western blotting, and RT-qPCR for bFGF, glial fibrillary acidic protein (GFAP, an astrocytic marker), and Iba1 (a marker of microglia or macrophages). Additionally, von Frey tests were conducted post-surgery.

RESULTS: Following injection of the neutralizing antibody, bFGF expression was significantly suppressed in the experimental group at both the mRNA and protein levels. GFAP and Iba1 expression was also suppressed. In immunohistochemical analyses, bFGF expression in astrocytes in the dorsal horn and in neuronal cells in the left DRG was suppressed. Significantly fewer astrocytes and microglia were present in the dorsal horn of the experimental group. Finally, post-injury allodynia was alleviated in the experimental group.

DISCUSSION: Neutralizing antibodies suppressed both peripheral and central expression of bFGF, reduced glial activation, and alleviated allodynia. These results suggest that bFGF may play an essential role in neuropathic pain, and that anti-bFGF treatment may facilitate recovery of neurological function and peripheral axon regeneration. bFGF could represent a novel therapeutic target for the treatment of chronic neuropathic pain.

WHERE DO SMOKERS HURT? A COMPREHENSIVE BODY-WIDE ANALYSIS OF PAIN REVEALS SMOKING IS MOST ASSOCIATED WITH BACK PAIN.

Matthew Smuck, MD; Christy Thomkins-Lane, PhD; Ming-Chih Kao, PhD, MD; Stanford School of Medicine, Departments of Orthopaedic Surgery and Anesthesiology; Mount Royal University, Department of Physical Education and Recreation

INTRODUCTION: Smoking has been shown to increase the odds of back pain by a factor of two to three fold. To elucidate its association with back pain relative to other musculoskeletal body pain, we perform a body-wide analysis of pain in a large population-based cohort. In addition, we study the mitigating effects of physical activity, a protective factor of back and musculoskeletal pain.

METHODS: Data on 6,781 subjects from the National Health and Nutrition Examination Survey was obtained from the CDC: comprehensive pain reports, smoking history, demographics, anthropometrics, medical history, and 7-day physical activity measurements. With custom SAS macros (Cary, NC) and Python 2.7, we performed weighted multivariate logistic regression analyses.

RESULTS: After adjusting for demographic, anthropometric, and medical variables, significant associations of smoking were observed in all body regions except chest and foot pain. When clustered as axial (neck, upper and low back), appendageal, truncal, and head pain, this association is strongest with axial pain (OR 2.89, 95% CI 2.21-3.77),
compared to appendageal (OR 1.99), truncal (OR 2.17) and head (OR 2.47). Mitigating effects were seen for sustained light physical activity (7-day average light activity bout) with each SD increase association with 22.2% reduction of the risk from smoking on truncal pain (p= 0.070), and 14.6% reduction for appendageal pain (p=0.038). This effect was not seen for head or axial pain.

CONCLUSION: This population-based study examined the association of smoking with musculoskeletal and regional body pain, finding statistical associations between smoking and pain and nearly all body regions. The association between smoking and pain was particularly strong for axial pain. In addition, sustained light physical activity can mitigate substantial portions of this risk for truncal and appendageal pain, but it has no effect on smoking’s link to axial pain.

O43 WORKAHOLISM AS A RISK FACTOR FOR DEPRESSION AND DISABLING BACK PAIN AMONG JAPANESE WORKERS
Ko Matsudaira(1), Takayuki Sawada(2), Norimasa Kikuchi(2), Emiko Sato(2), Mari Suzuki(2); (1) Clinical Research Center for Occupational Musculoskeletal Disorders, Kanto Rosai Hospital, 1-1 Kizukisumiyoshicho, Nakahara-ku, Kawasaki, Kanagawa 211-8510, Japan (2) CLINICAL STUDY SUPPORT, INC., Nagoya Life Science Incubator, 2-22-8, Chikusa, Chikusa-ku, Nagoya, Aichi 464-0858, Japan

INTRODUCTION: Although it is well-known that work-related factors, including job demands, job control, and workplace support, are associated with workers’ health and well-being including low back pain (LBP), the role played by personal characteristics, especially workaholism (WH), has not been fully examined. This study investigated WH’s associations with depression and LBP with disability among Japanese workers.

METHODS: A cross-sectional Internet survey was conducted using self-administered questionnaires. Data from 3,899 Japanese workers were analyzed. WH was measured using the Dutch Workaholism Scale. Scores were divided into tertiles, where respondents were classified into three groups (high, middle, and low). Depression was assessed using the SF-36 mental health subscale. Disabling back pain was defined as LBP that had occurred within one year and caused disruption to a worker’s job. Multiple logistic regression analyses were conducted to examine the association between workaholism and depression, low back pain with disability, adjusting for demographic characteristics, job demand, job control, and workplace support.

RESULTS: Compared to the low WH group, the middle and high WH groups had significantly higher odds for depression (Odds ratio (OR) = 1.93 and 3.59 for the middle and high groups, respectively), disabling back pain (ORs = 1.38 and 1.90 for the middle and high groups, respectively).

DISCUSSION: WH is significantly associated with not only poor psychological health, but also disabling back pain. To our knowledge, this is the first study to find an association specifically between WH and LBP. The mechanism by which WH might lead to disabling LBP is unclear. However, since psychological factors are known to be associated with LBP, poor psychological health caused by WH may play a role. WH needs to be studied further as a risk factor for LBP, along with other psychosocial factors.

O44 LIMITS OF HIGH FIELD MRI FOR THE DETECTION OF INTERVERTEBRAL DISC LESIONS – A COMPARISON BETWEEN 11.7 T AND 3 T
Nikolaus Berger-Roscher (1), Fabio Galbusera (1,2), Volker Rasche (3,4), Hans-Joachim
INTRODUCTION: It is assumed that fissures in the intervertebral disc lead to instability, which is an indication for surgery. Until now, investigations by discography, aimed to detect fissures, are under criticism and not recommended. Therefore, alternative methods, such as MRI, have to be investigated. We want to evaluate the limits of clinically available systems and the capabilities of state of the art techniques to see how clinical systems may evolve in the near future.

METHODS: Three fresh frozen bovine tail discs (Cy2 – Cy3) were used for analysis. Six needles with different diameters (0.3 – 2.2 mm / 30 – 14G) were inserted 13 mm deep into the anulus with a custom made device in anteroposterior direction in the mid-transverse plane of the disc with a distance of 3 mm to each other. The needles were then removed and the discs were scanned in an 11.7 T MRI (Bruker, USA; Res.: 0.058 x 0.058 x 0.625 mm3, tscan: 31 min.) as well as in a 3 T MRI (Philips, Netherlands) with an enhanced clinical protocol (Res.: 0.44 x 0.44 x 0.50 mm3, tscan: 12 min.). The scanned images were analyzed for lesion volume and lesion length using specialized software.

RESULTS: Reconstructed lesions did not have an ideal cylindrical shape. The measured volumes of the lesions ranged from 1.24 to 11.5 mm3 (11.7 T) and 0.96 to 8.45 mm3 (3 T). The lengths ranged from 5.7 to 10.0 mm (11.7 T) and 1.2 to 5.1 mm (3 T), respectively (Figure).

Even lesions of 0.3 mm were clearly visible in 11.7 T, whereas in 3 T scans smaller lesions (= 0.5 mm) were not or almost not visible.

DISCUSSION: The reconstructed volumes correlated, but were smaller than the corresponding needle size. These differences may be attributed to the elastic collapse of the soft tissue. Results showed that diagnosis of degenerative disc disease may be improved with more modern MRI and enhanced protocols.

O45
LONG-TERM RESULTS OF TOTAL LUMBAR DISC REPLACEMENT: A PROSPECTIVE ANALYSIS WITH 5-10 YEAR FOLLOW-UP
Siepe Cl, Wiechert K, Heider F, Korge A, Mehren C, Mayer HM; Schön Clinic Munich Harlaching, Spine Center, Harlachinger Str. 51, D-81547 Munich, Germany

INTRODUCTION: The role of fusion of lumbar motion segments for the treatment of intractable LBP from DDD remains controversially debated. Total lumbar disc replacement (TDR) has been used as an alternative in a highly selected patient cohort. However, the amount of long-term FU data on TDR is limited.

MATERIALS AND METHODS: Outcome Parameters VAS, ODI and satisfaction rates were acquired within the framework of an ongoing prospective clinical trial. Professional activity / employment status, complications and reoperations were recorded.
RESULTS: 181 out of 201 patients were available for final FU (90.0% FU rate) after a mean FU of 7.4 years (range 5.0–10.8 yrs). VAS and ODI scores revealed a highly significant improvement (p<0.0001). VAS scores demonstrated a slight (VAS 2.6 to 3.3) but statistically significant deterioration from 48 months onward (p<0.05). Patient satisfaction rates remained stable throughout the postoperative course, with 63.6% reporting a ‘highly satisfactory’ or ‘satisfactory outcome’ (22.7%), whilst 13.7% were not satisfied. The overall complication rate was 14.4% (n=26/181). The incidence of revision surgeries for general and/or device related complications was 7.2% (n=13/181). Results for 2-level TDR were significantly inferior in comparison to 1-level cases and were associated with higher complication (11.9% vs. 27.6%; p=0.03) and inferior satisfaction rates (p<0.003).

CONCLUSION: Although the current data from one of the first European Centers to employ TDR comprises the early experiences and learning curve associated with a new surgical technique, the results demonstrate satisfactory mid to long-term outcome after a mean FU of 7.4 years. Patient safety was proven with acceptable complication and reoperation rates. Fear of excessive late complications or reoperations cannot be substantiated with the present data. In carefully selected cases, TDR can be considered a viable treatment alternative to lumbar fusion.

O46

SINGLE LEVEL LUMBAR FUSION IN WORKER’S COMPENSATION SUBJECTS FOR DEGENERATIVE DISC DISEASE IS ASSOCIATED WITH LOWER RETURN TO WORK RATES COMPARED TO FUSION FOR SPONDYLOLISTHESIS

Joshua T. Anderson, BS (1,2), Ryan J. Duff (3), Uri M. Ahn, MD (4), Nicholas U. Ahn, MD (1); 1 University Hospitals Case Medical Center Department of Orthopaedic Surgery

2 Case Western Reserve University School of Medicine 3 University of Minnesota Twin Cities 4 New Hampshire Spine Institute

INTRODUCTION: Clinical outcomes of lumbar fusion are difficult to predict, and worker’s compensation (WC) subjects undergoing this surgery consistently have worse outcomes when compared to non-WC subjects. Few studies have evaluated predictors of poor fusion outcomes in WC subjects.

METHODS: We used ICD-9 diagnosis codes and CPT procedural codes to identify 1851 subjects receiving medical benefits from the Ohio Bureau of Worker’s Compensation that underwent single level lumbar fusion surgery as their index fusion after injury for the primary indication of either spondylolisthesis or degenerative disc disease (DDD), each with 3 years of follow-up minimum. We determined which subjects were able to return to work within 2 years after fusion and maintain a returned to work status for 1 year minimum. Subjects with a positive smoking history and a pre-fusion diagnosis of failed back syndrome were not considered. We used a logistic regression analysis.

RESULTS: Return to work rates were significantly higher in patients with a pre-fusion diagnosis of spondylolisthesis when compared to those with a pre-fusion diagnosis of degenerative disc disease and discogenic low back pain without spinal deformity or instability (p < 0.001). The odds ratio was 1.42 (CI 1.16-1.74). Age significantly influenced return to work rates (p = 0.01). The odds ratio (0.99, CI 0.98-1.00) suggests that this impact was not considerable. Gender, obesity, and income were not significant. 375 of the 714 spondylolisthesis subjects (53%) and 494 of the 1137 DDD subjects (43%) returned to work.

DISCUSSION: We demonstrated that performing single level fusion surgery for the indication of degenerative disc disease and discogenic low back pain in worker’s compensation subjects is associated with lower
return to work rates when compared to WC subjects undergoing fusion for spondylolisthesis. Further studies of the WC population are needed to determine which patients are the best candidates for fusion surgery.

**RESULTS:** 42% of patients were injured in the work place. 88% were employed at the time of injury. 57% continued to work until surgery. 77% returned to work at an average of 8.7 months post surgery. Physical demands of the work were the same in 52%, less demanding in 38% and more demanding in 10%. Non-RTW was due to pain in 10, other medical problems in 2, unavailability of work in 2, retirement in 8, and unknown in 3. Literature meta analysis demonstrates a mean RTW rate in compensation patients that is dramatically inferior to the NZ rates for ACC patients. The RTW rate for NZ ACC patients is comparable with the RTW rates for non-compensation patients elsewhere.

**DISCUSSION:** This study suggests that RTW rates are dramatically improved in a universal no fault compensation environment, matching the RTW rates for non-compensation patients elsewhere. The generally accepted poor RTW rates for spine fusion in compensation patients relate to the type of compensation rather than the presence of compensation itself.

**O47**
**UNIVERSAL NO FAULT COMPENSATION IS ASSOCIATED WITH IMPROVED RETURN TO WORK RATES IN SPINE FUSION**
Manson JF, Montgomery AS, Cunningham JE, Landham PR, Don AS, Robertson PA.; Auckland Hospital Orthopaedic Department, Auckland, New Zealand

**INTRODUCTION:** Worker’s or injury compensation is an unfavorable prognostic factor for return to work (RTW) after spinal fusion. An adversarial environment, engagement of lawyers, and a need to display disability to achieve financial gain are likely factors. Universal no fault compensation improves outcomes in whiplash, and improves functional gains from spine fusion to the equivalent of non-compensation patients. This study examined RTW rates for spine fusion patients in New Zealand, where a no fault universal compensation system (Accident Compensation-ACC) exists.

**METHODS:** 108 lumbar spine fusion patients who received ACC coverage completed a phone interview. Work related parameters were assessed. A meta-analysis of RTW rates for compensation patients undergoing lumbar fusion surgery was performed.

**O48**
**THE ASSOCIATION BETWEEN MORPHOLOGICAL STENOSIS GRADE AND THE OUTCOME OF SURGERY FOR LUMBAR SPINAL STENOSIS.**
Mannion AF, Fekete T, Luca A, Schizas C; Spine Center, Schulthess Klinik, Zürich, Switzerland, Service de d’orthopédie et traumatologie CHUV, Lausanne, Switzerland

**INTRODUCTION:** A new measure of radiological lumbar spinal stenosis (LSS) was recently introduced, based on grading of the rootlet/cerebrospinal fluid ratio rather than the dural sac cross-sectional area. However, there has been no external validation of the measure or the rationale for its use as a surgical indication. We sought to validate the new grading system by relating patient outcomes to the stenosis grade.
METHODS: Blinded T2 axial magnetic resonance images were evaluated from 65 patients (72±8y) with LSS and 15 “controls” (54±15y) with e.g. disc degeneration. Classification was based on dural sac morphology: Grades A and B showed cerebrospinal fluid presence while grades C and D showed none. In examining the correlation between outcomes (Core Outcome Measures Index (COMI)) and stenosis grades, the worst grade of all vertebral levels was used.

RESULTS: In the control group, 15/15 (100%) patients were (at worst) grade A. In the LSS group, 14/65 (21.5%) were grade A, 8/65 (12.3%) grade B, 29/65 (44.7%) grade C, and 14/65 (21.5%) grade D. Increasing stenosis grade showed a tendency (n.s.) to correlate with higher preoperative pain (worst out of back or leg pain), but not with any other baseline outcome measures. Multiple regression analysis, accounting for number of affected levels, revealed significant (p<0.01) associations between stenosis grade and the change-score (reduction, preop to 12 mo) for pain and COMI score. In each case, a higher grade resulted in a better outcome. The difference between A and D grades in the change-scores for COMI (2.6 points) and worst pain (3.9 points) were clinically relevant.

DISCUSSION: This study suggests that the new grading system, which gives most consideration to the impairment of neural tissue, may represent an appropriate clinical tool and be of prognostic value. It should be evaluated in larger prospective studies.

O49
PREOPERATIVE PAIN PATTERN PREDICTS SURGICAL OUTCOME MORE THAN TYPE OF SURGERY IN PATIENTS WITH CENTRAL SPINAL STENOSIS WITHOUT CONCOMITANT SPONDYLOLISTHESIS
A REGISTER STUDY OF 9,051 PATIENTS
Sigmundsson FG, Jönsson B, Strömqvist B.; Department of Orthopedics, Clinical Sciences, Lund University, Skåne University Hospi-

tal, Malmö, Sweden

INTRODUCTION: Predominant back pain in lumbar stenosis (LSS) is associated with inferior outcome of surgical treatment. It is unknown if adding spinal fusion improves outcomes. The aim of our study was to evaluate outcome of surgery for LSS without concomitant degenerative spondylolisthesis in relation to predominance of pain and to analyze the if adding spinal fusion to the decompression improves outcome in patients with predominant leg or back pain.

METHODS: In a register study of 9,051 patients we studied outcome of surgery in terms of back and leg pain (VAS), function (ODI and self-estimated walking distance), health-related quality of life (SF-36 and EQ-5D), and satisfaction with outcome. Outcome was analyzed for 4 groups at 1 and 2 year follow up; preoperative back pain = leg pain and decompression, preoperative back pain = leg pain and decompression and fusion, preoperative back pain < leg pain and decompression, preop back pain < decompression and fusion.

RESULTS: Patients with concomitant fusion were younger and had higher level of back pain and ODI scores and lower preoperative EQ-5D. Predominant back pain was associated with inferior outcome in terms of pain, HRQoL and function. Patients most often satisfied (69%) were patients with back pain < leg pain treated with decompression and fusion and the least satisfied group was patients with back pain = leg pain treated with decompression (54%). Fusion was associated with higher EQ-5D at 1-year follow up for patients with predominant back pain up but was also associated with increased leg pain at 2-year follow up in patients with predominant leg pain. Patients with predominant back pain experienced small gains in the physical component summary by fusion. The benefits of fusion generally decreased when adjustments were made for confounders.
**DISCUSSION:** Predominance of back pain infers inferior outcome of LSS surgery. Adding spinal fusion improves outcome but the benefit is small and not clinically relevant.

**O50**

**USE OF LUMBAR DISCOGRAPHY IS ASSOCIATED WITH SIGNIFICANTLY LOWER RETURN TO WORK RATES AFTER LUMBAR FUSION IN WORKER’S COMPENSATION SUBJECTS**

Joshua T. Anderson, BS (1,2), Ryan J. Duff (3), Uri M. Ahn, MD (4), Nicholas U. Ahn, MD (1); 1 University Hospitals Case Medical Center Department of Orthopaedic Surgery 
2 Case Western Reserve University School of Medicine 
3 University of Minnesota Twin Cities 
4 New Hampshire Spine Institute

**INTRODUCTION:** Lumbar discography (LD) is an injection technique used to evaluate patients being considered for back surgery, typically lumbar fusion. Recent studies have questioned its use and thrown LD into significant controversy. Our study is the first to evaluate the efficacy of LD in worker’s compensation (WC) subjects.

**METHODS:** We used ICD-9 and CPT codes to identify 2887 subjects from the Ohio Bureau of Worker’s Compensation that underwent lumbar fusion following injury with 3 years of follow-up minimum. 1003 subjects underwent fusion for the indication of spondylolisthesis, 118 of which had LD performed on them before fusion. 1884 subjects underwent fusion for degenerative disc disease (DDD), 756 of which had LD performed on them before fusion. We determined which subjects returned to work within 2 years of fusion and maintain a returned to work status for 1 year minimum. Subjects with a smoking history and pre-fusion diagnosis of failed back syndrome were not considered. We analyzed the spondylolisthesis group and the DDD group separately with logistic regression.

**RESULTS:** Return to work (RTW) rates were significantly lower in subjects that underwent LD before fusion in both the spondylolisthesis group (p=0.05; OR=0.65) and the DDD group (p<0.00; OR=0.71). Among the spondylolisthesis group, 453 subjects (51.2%) that did not undergo LD before fusion returned to work. 47 LD subjects (39.8%) returned to work. Male gender was associated with higher RTW rates (p=0.05, OR=1.34). Among the DDD group, 515 subjects (45.7%) that did not undergo LD before fusion returned to work. 286 LD subjects (37.8%) returned to work. Older age was associated with lower RTW rates (p=0.01, OR=0.99). In both groups, obesity and levels fused at index fusion did not significantly impact RTW rates.

**DISCUSSION:** Use of lumbar discography as a patient selection tool before lumbar fusion in worker’s compensation subjects is associated with significantly worse return to work rates.

**O51**

**PROSPECTIVE ANALYSIS OF RISK FACTORS FOR PROXIMAL JUNCTIONAL FAILURE IN ADULT DEFORMITY PATIENTS**

Hart, Robert A.1; Hamilton, D. Koji1; Hiratzka, Jayme R.1; Bess, Shay S2; Schwab, Frank J.3; Shaffrey, Christopher I.4; Ames, Christopher P.5; Lafage, Virginie3; Mummaneni, Praveen V.; Smith, Justin S.4; Klineberg, Eric7; McCarthy, Ian8; Burton, Douglas C.; 1. Orthopaedic Surgery, Oregon Health and Science University, Portland, OR, United States. 2. Orthopaedic Surgery, Rocky Mountain Hospital for Children, Denver, CO, United States. 3. Orthopaedic Surgery, NYU Hospital for Joint Diseases, New York, NY, United States. 4. Neurosurgery, University of Virginia Medical Center, Charlottesville, VA, United States. 5. Neurosurgery, University of California, San Francisco Medical Center, San Francisco, CA, United States. 6. Orthopaedic Surgery, University of California, San Francisco Medical Center, San Francisco, CA,
INTRODUCTION: Proximal Junctional Failure (PJF), a severe form of Proximal Junctional Kyphosis (PJK) with evidence of mechanical failure, is an important concern in adult deformity patients. Post-operative sagittal imbalance and proximal and distal end points for the fusion are possible risk factors for PJF. Prospective evaluation of these factors has not been reported.

METHODS: 352 adult deformity surgical patients from 10 centers were followed prospectively with minimum 1 year follow-up. PJF was defined as increased proximal kyphosis of >10 degrees plus fracture of the upper instrumented vertebrae (UIV), UIV+1, or instrumentation failure. PJK was defined as increased kyphosis of >10 degrees without evidence of mechanical failure. Patients were grouped as PJF, PJK, or neither (NoPJF). Proximal fusion levels were Upper Thoracic (UT, T2-T5) or Thoracolumbar (TL, T9-T12). Age, Sacral Slope (SS), Pelvic Tilt (PT), Pelvic Incidence (PI), Sagittal Vertical Axis (SVA), Lumbar Lordosis (LL), and PI-LL were compared.

RESULTS: There were 41 (11.7%) PJF, 54 (15.3%) PJK, and 257 (73.0%) NoPJF patients found. There were significant differences in age (65.1 vs. 55.7; p = .001) and pre-op PT (26.8 vs. 22.0; p = .043) between PJF and NoPJF patients. There was a trend toward increased pre-op SVA and PI-LL, as well as operative change in SVA, LL, and PI-LL among PJF patients. Postop SVA and PI-LL were similar between PJF and No PJF patients. No patient experienced PJF without fusion to the pelvis. Among patients fused to the pelvis, there was no difference between UT vs. LT proximal endpoints for rate of PJF (13.4% vs. 16.8%; p > .05), although the rate of PJK was greater for UT patients (26.8% vs. 13.5%; p = .017).

DISCUSSION: Post-op sagittal alignment and proximal fusion end point did not differ between PJF and NoPJF patients. Older patients with worse pre-op sagittal imbalance, larger sagittal corrections and pelvic fixation were identified as those at greatest risk of PJF.

O52 DISCOGRAPHY AND AXIALLY LOADED MRI IN THE PROVOCATION OF DISCOGENIC PAIN - A COMPARATIVE PILOT STUDY.

Hanna Hebelka MD* and Tommy Hansson MD, Ph.D**; Departement of Radiology*, Sahlgrensk University Hospital, SU/M and Department of Orthopedics**, Sahlgrenska University Hospital, SU/S, University of Gothenburg, Gothenburg, Sweden.

INTRODUCTION: Recent findings of induced pressure increase in adjacent discs during discography strongly question the validity of discography. Alternative diagnostic tools seem necessary. The aim of this study was to investigate if axial loaded MRI (alMRI) can induce discogenic pain and if positive discograms display any specific morphological features under increased axial loading.

METHODS: 41 patients with clinically assessed discogenic pain were examined with MRI, alMRI and pressure controlled discography (PCD) (119 discs) at the same occasion. Provoked pain at discography and at alMRI was classified as concordant or discordant with the daily experienced pain as reference. PCD was performed until one of the following endpoints; 100psi (pressure), 3.5ml (contrast volume) and/or concordant pain. Concordant discogram demanded pain intensity =5/10 at =50psi and a negative control disc. Associations between pain at
discography and at aLMRI were evaluated as were relations between pain and morphological disc measures (degeneration, height, bulge, angle, area, and circumference) at MRI/alMRI/difference between MRI and alMRI.

RESULTS: At discography 98% of the patients experienced concordant pain and 78% at alMRI with a significant correlation between the two (p=0.01). The PPV of a concordant discogram when concordant pain was evoked at alMRI was 97%. None of the morphological MRI features predicted painful discs in a clinically relevant way.

DISCUSSION: Pain provoked at alMRI was highly predictive of corresponding pain at discography. No morphological MRI features or dynamic properties predicting painful discs were found but alMRI may be a valuable tool in future research trying to establish such features. Provoking pain at a similar frequency as discography, being non-invasive and without risk for injection induced degeneration, makes alMRI a realistic alternative in the diagnosis of painful disc(s) at least when single level discogenic pain is suspected clinically.

O53
ANALYSIS OF VASCULAR PATTERNS FOR THE POSTERIOR ELEMENTS OF THE LOWER LUMBAR SPINE
Fumitake Tezuka, Toshinori Sakai, Toshihiko Nishisho, Yoichiro Takata, Yuichiro Goda, Kosaku Higashino, Shoichiro Takao, Masashi Harada, Koichi Sairyo; Department of Orthopaedic Surgery, Tokushima University Department of Rehabilitation, Tokushima University Hospital Department of Radiology, Tokushima University

INTRODUCTION: The Lower lumbar spine around L5 is the most susceptible to spondylosis or degenerative disorders such as disc herniation, spinal canal stenosis, spondylolisthesis. In this study, to clarify the anatomical differences affecting their pathomechanism around L5 compared with the other lumbar spinal levels, we evaluated the vascular patterns in detail, particularly focused on them surrounding the posterior elements.

METHODS: We evaluated 300 abdominal contrast-enhanced multidetector 3D-CT scans that were taken for surgical plans of colon cancer patients in our hospital. Extraosseous vascular patterns surrounding the lumbar spine were evaluated by two orthopaedic surgeons independently. Three hundreds patients included 187 male and 113 female, whose age ranged from 15 to 89 years (mean: 66.6).

RESULTS AND DISCUSSION: Segmental arteries. On the L1-L4 levels, each segmental artery was observed from the vertebra through the lamina in more than 90% patients. However, on the L5 level, it was observed in less than 10% patients (Rt: 5.0%, Lt: 8.3%). Extraosseous vascular supply for the posterior element of the L5 Extraosseous vascular supply for the L5 lamina was basically composed of two vessels on each side. One vessel was mostly derived from the L4 segmental artery (Rt: 92.0%, Lt: 91.7%) that was distributed around the superior articular process, the other one was derived from iliolumbar artery (Rt: 63.0%, Lt: 57.3%) that was distributed around the inferior articular process through the lamina. There were some variations one those two vessels. Our results showed there were various vascular patterns around lower lumbar spine. Focusing on the posterior elements of the L5, there were only approximately 60% subjects with regular vascular patterns that had been written in the old textbook. Although there are some limitations of this study as the intraosseous vascular was not evaluated, it is true that L5 has more various vascular patterns than the other l
O54 (ISSLS PRIZE PAPER)
LONG-TERM FOLLOW UP SUGGESTS SPINAL FUSION IS ASSOCIATED WITH INCREASED ADJACENT SEGMENT DISC DEGENERATION BUT WITHOUT INFLUENCE ON CLINICAL OUTCOME. RESULTS OF A COMBINED FOLLOW-UP FROM 4 RCTS
Anne F Mannion, Gunnar Leivseth, Jens-Ivar Brox, Peter Fritzell, Olle Hägg, Jeremy CT Fairbank; Spine Center, Schulthess Klinik, Lengghalle 2, 8008 Zürich, Switzerland Department Of Clinical Medicine, Neuromuscular Diseases Research Group, University of Tromsø, Norway Department of Orthopedics, Oslo University Hospital, Oslo, Norway Neuroortopediskt Centrum, Lånsjukhuset Ryhov, 551 85 Jönköping, Sweden Spine Center Göteborg, Gruvghan 8, SE 421 30, V:a Frölunda, Sweden Nuffield Orthopaedic Centre, Oxford University Hospitals, Oxford, OX3 7HE, UK

INTRODUCTION: There is ongoing debate as to whether adjacent segment disc degeneration results from the increased mechanical stress of fusion. We analysed long term follow-up (LTFU) data from four randomized controlled trials of operative versus non-operative treatment for chronic low back pain to examine the influence of spinal fusion on adjacent segment disc space height as an indicator of disc degeneration at LTFU.

METHODS: Plain standing lateral radiographs were taken at 13±4 years follow-up in 229/464 (49%) patients randomized to surgery and 140/303 (46%) to non-operative care. Disc space height and posteroanterior displacement were measured for each lumbar segment using a validated computer-assisted distortion compensated roentgen analysis (DCRA) technique. Values were reported in units of standard deviations (SDs) above or below age and gender-adjusted normal values. Patient-rated outcomes included the Oswestry Disability Index and pain scales.

RESULTS: Radiographs were usable in 355/369 (96%) patients (259 fusion and 96 non-operative treatment). Both treatment groups showed significantly lower values for disc space height of the adjacent segment compared with norms. There was a significant difference between treatment groups for the disc space height of the cranial adjacent segment (in both as-treated and intention-to-treat analyses). The mean treatment effect of fusion on adjacent segment disc space height was -0.44 SDs (95% CI, -0.77 to -0.11; p=0.01; as-treated analysis); there was no group difference for posteroanterior displacement (0.18 SDs (95% CI, -0.28 to 0.64, p=0.45)). Adjacent level disc space height and posteroanterior displacement were not correlated with Oswestry or pain scores at LTFU (r=0.010-0.05; p>0.33).

DISCUSSION: Fusion was associated with lower disc space height at the adjacent segment after an average of 13 years follow-up. However, the reduced disc space height had no influence on patient self-rated outcomes (pain or disability).

O55 (ISSLS PRIZE PAPER)
MECHANICAL INFLUENCES IN PROGRESSIVE INTERVERTEBRAL DISC DEGENERATION
Manos Stefanakis PhD*, Jin Luo PhD**, Phillip Pollintine PhD Patricia Dolan PhD, Michael A. Adams PhD; Centre for Comparative and Clinical Anatomy, University of Bristol, Bristol, U.K.* School of Science and Engineering, University of Nicosia, Cyprus ** University of Roehampton, London, U.K.

INTRODUCTION: Although mechanical loading can initiate disc degeneration, it may be unimportant in disease progression because degenerative changes cause human lumbar discs to be increasingly “stress-shielded” by the neural arch. However, the most typical feature of advanced disc degeneration (de-lamination and collapse of the annulus) may not depend on absolute values of compressive stress, but on gradients of compressive
stress which act to shear annulus lamellae. We hypothesise that, as grade of disc degeneration increases, stress gradients also increase, even though nucleus pressure and annulus compressive stresses decrease.

**METHODS:** 191 motion segments (T8-9 to L5-S1) were dissected from 42 cadavers aged 19-92 yrs. Each was subjected to approximately 1 kN compression, while intradiscal stresses were measured by pulling a pressure transducer along the disc’s mid-sagittal diameter. “Stress gradients” in the inner annulus were quantified as the maximum rate of increase in compressive stress (MPa/mm) between the nucleus and the region of maximum stress in the anterior or posterior annulus. Measurements were repeated before and after creep loading, and in simulated flexed and erect postures. Disc degeneration was assessed macroscopically on a scale of 1 to 4.

**RESULTS:** As grade of disc degeneration increased from 2 to 4, nucleus pressure decreased by an average 68%, and maximum compressive stress in the annulus decreased by 48-64%, depending on location and posture. In contrast, stress gradients in the annulus increased by an average 75% in the anterior annulus (in flexed posture), and by 108% in the posterior annulus (in erect posture). Spearman rank correlation showed that these increases were statistically significant (P<0.05).

**DISCUSSION:** Despite stress-shielding by the neural arch, gradients of compressive stress increase as disc degeneration progresses. Stress gradients act to shear adjacent lamellae, and can explain progressive annulus delamination and collapse.

**O56 (ISSLS PRIZE PAPER)**
**INCREASED INNERVATION AND SENSORY NERVOUS SYSTEM PLASTICITY IN A MOUSE MODEL OF LOW BACK PAIN DUE TO INTERVERTEBRAL DISC DEGENERATION.**
Masayuki Miyagi, MD, PhD1-3,7 Magali Millecamps, PhD1-3, Alexander T Danco, MSc1-3,6, Seiji Ohtori, MD, PhD7, Kazuhisa Takahashi, MD, PhD7, Laura S. Stone, PhD1-6.; 1 Faculty of Dentistry, McGill University; 2Alan Edwards Centre for Research on Pain, 3McGill Scoliosis & Spine Research Group, McGill University; Departments of 4Anesthesiology, 5Pharmacology & Therapeutics, and 6Neurology & Neurosurgery, Faculty of Medicine, McGill University, Montreal, Canada 7Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Japan

**INTRODUCTION:** Intervertebral disc (IVD) pathology is thought to be a significant contributor to chronic low back pain (LBP). In humans and rodents, decreased expression of SPARC (Secreted Protein, Acidic, Rich in Cysteine) is associated with IVD degeneration. We previously reported that SPARC-null mice exhibit age-dependent behavioral signs of chronic axial LBP and radiating leg pain. The aim of the current study was to determine if behavioral signs of LBP and radiating pain in SPARC-null mice are accompanied by sensory nervous system plasticity.

**METHODS:** SPARC-null and age-matched Wild-Type control mice in three age cohorts (young, 1.5 months old: SPARC n=21, WT n=18; middle aged, 6 months old: SPARC n=18, WT n=16; and old, 24 months old: SPARC n=25, WT n=23) were evaluated. Cutaneous sensitivity to cold, heat, and mechanical stimuli were used as measures of radiating pain. Grip force and tail suspension tests were performed to evaluate axial LBP. Motor impairment was assessed using an accelerating rotarod. Innervation of IVDs was determined by immunohistochemistry targeting the nerve fiber marker PGP 9.5 and the sensory nerve neuropeptide calcitonin gene-related peptide (CGRP). To assess sensory neuron and spinal cord plasticity, CGRP- and neuropeptide-Y-immuno-reactivity (-ir) were measured in dorsal root ganglia (DRG) neurons and GFAP-
and CGRP-ir were measured in the spinal cord.

RESULTS: SPARC-null mice developed (1) hypersensitivity to cold, (2) axial discomfort, (3) age-dependent motor impairment, (4) age-dependent increases in sensory nerve fibers in and around the IVDs, (5) age-dependent upregulation of CGRP and neuropeptide-Y in DRGs, and (6) age-dependent upregulation of CGRP, microglia and astrocytes in the spinal cord dorsal horn. DISCUSSION: The increased innervation of degenerating IVDs by sensory nerve fibers and the neuroplasticity in sensory neurons and spinal cord could contribute to the underlying pathobiology of chronic discogenic LBP.

O57
CORRELATION BETWEEN BIOMECHANICAL PROPERTIES OF ANNULUS FIBROSUS AND MAGNETIC RESONANCE FINDINGS
Zhi Shan M.D, Fengdong Zhao M.D, Chongyan Wang M.D, Junhui Liu M.D, Letu Suyou M.D, Shunwu Fan M.D; Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University.

INTRODUCTION: Annulus fibrosus, located in the exterior region of intervertebral disc, is primarily a tensile component providing structural stability against multidirectional loads and deformations, but limited understanding associating its tensile properties with MRI findings has been reported in human.

METHODS: 27 human cadaveric lumber spines were harvested (16 male, 11 female, mean age 44.3 years, range 31-57). All spines underwent MRI examination. Then all intervertebral discs were removed from between adjacent motion segments, divided into parts as nucleus pulposus, anterior AF, anterolateral AF, lateral AF and posterolateral AF, and further divided into three subgroups averagely: inner, middle and outer for tensile test. RESULTS: 1738 specimens from 158 discs, 27 cadavers were tested. All degeneration and MCs visible by MRI are seen in L4-L5 and L5-S1. The mean tensile module of all tested specimens is 4.80±1.96MPa, 8.25±2.73MPa and 13.20±3.19MPa, for inner, middle and outer AF, respectively. The overall UTS are 1.13±0.54MPa, 1.73±0.87MPa and 3.37±1.30MPa, respectively. No significant age- or gender-related change can be found. Tensile module and UTS all increased from the inner to outer annulus, with elongation decreased. Tensile module and UTS all decreased with the severity of degeneration increases, except the UTS of middle annulus. The outer annulus presents the highest UTS decreasing of 40% in severely degenerated disc, and in the middle and inner annulus the decrease was 18% and 28% respectively. When MCs presents, inner annulus showed significantly lower module with MCs, while this difference did not appear in middle and outer annulus. The UTS presented decreased significantly in all inner to outer region when MCs appears.

CONCLUSION: The tensile properties decreases with higher Pfirrmann grade of MRI. When MCs presents, AF showed lower tensile module, especially the inner region.

O58
BIOMECHANICAL EVALUATION OF THE TRANSPEDICULAR NUCLEOTOMY WITH INTACT ANULUS FIBROSUS
Fabrizio Russo1, Gianluca Vadala1, Robert Allen Hartman2, Kevin M. Bell2, Gwendolyn A. Sowa2, Nam Vo2, James D. Kang2, Vincenzo Denaro, MD1; 1 Department of Orthopedic and Traumatology, University Campus Bio-Medico of Rome, Rome - Italy 2 Ferguson Lab for Orthopedic and Spine Research, University of Pittsburgh, Pittsburgh, PA - USA

INTRODUCTION: Mechanical loading represents a crucial part of intervertebral disc (IVD) homeostasis. However, traditional
regenerative strategies require violation of the annulus fibrosus (AF) that results in significant alteration of joint mechanics. The transpedicular nucleotomy represents a suitable method to create a cavity into the nucleus pulposus (NP), as a model to study IVD regeneration with intact AF (Vadala et al. 2013). The aim is to study how the transpedicular approach (TA) and the novel mechanical nucleotomy (MN) affect the biomechanics of the NP.

**METHODS:** 60 ovine lumbar FSUs (L1-L6) randomly assigned to 5 groups: control, TA, TA + polymethylmethacrylate (PMMA), TA + MN, TA + MN + PMMA. TA and MN were performed. The robotic spine testing system consists of a robotic manipulator (Staubli RX90) and a six-axis load cell (JR3 Inc.). We evaluated flex-extension, lateral bending and axial rotation under adaptive displacement control. Axial compression was applied for 15 cycles of preconditioning followed by 1 h constant compression. Creep properties were determined.

**RESULTS:** TA has minimal effects on IVD biomechanics. MN increases ROM and NZ displacement width while decreasing NZ stiffness. TA + PMMA has small effects in terms of ROM. TA + MN + PMMA brings ROM back to the control, increases NZ stiffness and decreases NZ displacement width. TA and MN primarily altered early creep response. The use of PMMA reduced viscosity (S2) and increased stiffness (.2) in late creep.

**DISCUSSION:** Biomechanical properties of NP are crucial for IVD repair. TA does not affect segmental stability. Mechanical changes that occur with nucleotomy are similar to those characteristics of early degeneration. In particular, the NP play a crucial role for spine stability and early creep response, while the late creep response may be determined more by the AF and endplate. These results could be crucial for understanding the mechanism of spine instability caused by IVD degeneration.

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**OS9**

**DOES DAILY TERIPARATIDE ENHANCE THE HEALING PROCESS OF OSTEOPOROTIC VERTEBRAL FRACTURE? EVALUATION USING MRI AND BIOCHEMICAL MARKERS OF BONE TURNOVER**

Akira Iwata, MD 1; Masahiro Kanayama MD 1; Keiichi Shigenobu, MD 1; Fumihiro Oha, MD 1; Shingo Onda, MD 1; Masaru Tanaka, MD 1; Tomoyuki Hashimoto, MD 1; Norimasa Iwasaki, MD 2; 1 Spine Center, Hakodate Central General Hospital, Hakodate, Japan 2 Dept. of Orthopedic surgery, Hokkaido University, Sapporo, Japan

**INTRODUCTION:** Teriparatide (recombinant human PTH 1-34) is increasingly used for osteoporosis treatment, which stimulates bone formation and might have a potential advantage to enhance fracture healing. The current randomized controlled trial aims to evaluate the effect of teriparatide (TPD) versus bisphosphonate (BP) on the healing process of vertebral fracture using MRI examination and biochemical markers of bone turnover.

**METHODS:** Twenty-two osteoporosis patients who underwent non-operative treatment for a single-level fresh thoracolumbar vertebral fracture were enrolled in this trial. They were randomly assigned to (1) TPD group (daily subcutaneous injection of 20 micrograms of TPD) or (2) BP group (weekly oral administration of 35mg alendronate). The fracture healing process was assessed by temporal changes in MRI T2 signal intensity of fractured vertebra with reference to the pre-treatment baseline. BAP (bone formation marker) and TRACP5b (bone resorption marker) were measured periodically for biochemical evaluation of the fracture healing.

**RESULTS:** With reference to the pretreatment baseline, MRI T2 signal intensity of fractured vertebra was decreased by 46% at 3 months and 60% at 6 months in the TPD group; BP group showed 10% increase at 3
months and 20% decrease at 6 months. Regarding bone formation marker, BAP at 1, 2, 3 and 6 months after treatment was 44%, 73%, 132% and 103% in the TPD group, and 25%, 8%, 6%, 10% in the BP group, respectively. TRACP5b as a bone resorption marker was 84%, 78%, 65% and 64% in the TPD group, and 23%, 24%, 8% and 31% in the BP group, respectively.

**DISCUSSION:** The current study demonstrated that MRI signal intensity of fractured vertebra was returning to normal in the early phase in the TPD group. Bone formation and resorption markers were elevated at any phase of healing process in the TPD group. TPD enhances the healing and remodeling processes in fresh vertebral compression fractures related to osteoporosis.

**O60**

**USEFULNESS OF “ONE STRETCH”, A SIMPLE, DAILY, STANDING BACK EXTENSION EXERCISE, FOR THE PREVENTION OF ONSET OR AGGRAVATION OF LOW BACK PAIN IN CARE WORKERS**

Mari Suzuki (1), Ko Matsudaira (2), Takayuki Sawada (1), Emiko Sato (1), Tatsuya Isomura (1, 3); (1) CLINICAL STUDY SUPPORT, INC., Nagoya Life Science Incubator, 2-22-8, Chikusa, Chikusa-ku, Nagoya, Aichi 464-0858, Japan (2) Department of Medical Research and Management for Musculoskeletal Pain, 22nd Century Medical and Research Center, Faculty of Medicine, The University of Tokyo, Japan (3) Institute of Medical Science, Tokyo Medical University, 6-1-1 Shinjuku, Shinjuku-ku, Tokyo 160-8402, Japan

**INTRODUCTION:** Low back pain (LBP) is a worldwide health problem. Recently, extension of the back has been recognized as an effective exercise to prevent back problems. We suggested “One Stretch”, a simple, daily, standing back extension exercise, and examined its efficacy to improve or prevent LBP in Japanese care workers.

**METHODS:** This study was performed at a single health care facility in Japan. We provided 166 care workers with an exercise manual, where we described how to do the exercise “One Stretch” based on the McKenzie method, and assigned them to the intervention or control groups according to their working floors. Participants in the intervention group took a 30-min seminar on LBP, and were encouraged to exercise on working hours. We mainly evaluated the change of severity of LBP and compliance with the exercise by using self-administrated questionnaires at baseline and one year later.

**RESULTS:** A total of 136 care workers completed the study (64 in the intervention group and 72 in the control group). 30 care workers were excluded from analysis due to lack of information. Baseline characteristics, including age, sex, mental health score of SF-36, and severity of LBP, had no statistically significances between the groups. One year later, a rate of care workers who improved LBP were 42.9% in the intervention group and 15.0% in the control group, and some care workers without LBP at baseline remained healthy condition. About compliance with the exercise, the intervention group indicated higher proportion of care workers who frequently exercised than the control group (82.8% vs. 8.8%, p <0.01; chi-square test). No care workers in the intervention group had a first medical consultation or work disability in the year.

**DISCUSSION:** The exercise “One Stretch” could improve or prevent LBP in Japanese care workers. For better compliance with the exercise, support from co-workers would play an important role.
O61
PERSISTENT RACIAL AND ECONOMIC DISPARITIES IN PHYSICAL THERAPY REFERRAL FOR LOW BACK PAIN PATIENTS IN PRIMARY CARE
Matthew Smuck, MD; Patricia Zheng, MD; Nicholas Karayannis, PhD; Ming-Chih Kao, PhD, MD; Stanford School of Medicine, Departments of Orthopaedic Surgery and Anesthesiology

INTRODUCTION: Evidence suggests that physiotherapist-led exercise programs can decrease disability, but the rate of physical therapy referral in clinical practice has been dismal, averaging, about 7% for a primary diagnosis for low back pain (LBP). On the contrary, the rate of opioid prescription has steadily increased. This study examines the low referral rate with respect to socioeconomic factors.

METHODS: Nationally representative surveys National Ambulatory and National Hospital Ambulatory Medical Care Surveys (NHAMCS, NAMCS) from the Center for Disease Control and Prevention (CDC) were investigated for PCP visits between the years 1997 and 2009. Diagnoses, prescription medications, insurance source, and demographics were determined. Weighted logistic regression modeling with SAS estimated covariate effects.

RESULTS: Referrals have remained stable among PCPs from 1997 to 2006, in sharp contrast to our previous finding of increasing rates of opioid prescription for LBP during this time period. Among Medicaid and Medicare insured population and African Americans, referrals have decreased. The data supports evidence that there is a growing U.S. trend of providing cheaper forms of treatment for chronic LBP (i.e., opioid prescription) which are less effective. Low referral rates for African-American patients is also concerning. While the reasons for this disparity is unknown, it has been conjectured that such differences result from complex patient, health care provider and health care system factors.

CONCLUSIONS: With more evidence now that PT is an effective method of treating LBP, there needs to be a push for greater insurance coverage of physiotherapy commensurate with its low-risk and high efficacy profile. In addition, disparities in subpopulations must be further elucidated and addressed. As the Affordable Care Act is being implemented, we must work to assure that PT access is improved, especially for those patients suffering from LBP.

O62
ASSESSMENT OF NEUROFORAMINAL AREA OF THE LUMBAR SPINE DURING FLEXION-EXTENSION MOTION
Havey R, Muriuki M, Carandang G, Voronov L, Patwardhan A; Edward Hines, Jr. VA Hospital, Hines, IL, USA Loyola University Medical Center, Maywood, IL, USA

INTRODUCTION: Degenerative changes of the lumbar spine affect the area available for the nerve roots. The area is greatly affected by the spine posture. This study assessed foraminal area of lumbar spines undergoing flexion-extension (FE) range of motion (ROM) testing.

METHODS: Six human cadaveric spines (L1-Sacrum, 40.2±6.9 years) were studied. Each specimen was instrumented with five 3.2mm spherical radiopaque markers per body. A 3-dimensional (3D) specimen-specific anatomical model was reconstructed using fine-slice (0.63mm) CT scans. 3D vertebral motions were measured using optoelectronic motion measurement system in FE (8-6Nm). During testing a digital link was made between the radiopaque spheres in the CT reconstruction and the motion measurement system. The 3D vertebral motion data was used to drive the CT anatomical model, resulting in the ability to evaluate motion of any anatomical landmark moving in response to loads applied
during testing. The L4-5 and L2-3 neural foramen isthmus were traced on the reconstruction and tracked throughout the arc of motion of the spine. Change in area was expressed as percent of area in the neutral posture.

**RESULTS:** The 3D CT model was used to quantify percent change of foraminal area relative to the neutral posture throughout the ROM. Foraminal area increased in flexion and decreased in extension (Fig. 1).

Regression analysis showed a significant correlation between percent change in foraminal area and angular motion (R2 =0.9, p<0.05). Foraminal area changed by 2.4% for every degree of motion in flexion-extension at L4-5, and by 3.2% per degree at L2-3.

**DISCUSSION:** This is the first work to dynamically assess foraminal area of the spine throughout the arc of motion of lumbar motion segments. Increased foraminal area in flexion, demonstrated in this study is consistent with treatment modalities used to relieve radicular symptoms associated with foraminal stenosis.

**O63**

**HRQOL SCORES AND RADIOGRAPHIC PARAMETERS DO NOT DRIVE PATIENT SATISFACTION AFTER ADULT SPINAL DEFORMITY SURGERY**

D. Kajo Hamilton M.D., Jayme HiratzkaM.D., Shay Bess M.D., Frank Schwab M.D. Ph.D, Christopher I Shaffrey M.D., Chris AmesM.D., Gregory Mundis M.D., Virginie Lafarge Ph.D, Vedat DevirenM.D., Justin Smith M.D., Ph.D, Eric KlinebergM.D, OheneBa Boachi; Oregon Health and Science University, International Spine Study Group

**INTRODUCTION:** Drivers of patient satisfaction with fusion surgery for adult spinal deformity are incompletely understood. To date, there is no large prospective evaluations of HRQoL measures and impacts of radiographic parameters on patient satisfaction. This study assessed correlations of HRQoL measures and radiographic parameters with patient satisfaction.

**METHODS:** A prospective multicenter cohort of 157 adult patients undergoing fusion for adult thoracolumbar spinal deformity with minimum 2year follow-up. Analyses were performed between SRS-22 satisfaction scores and final and change from baseline for Visual Analogue Scale (VAS) back/leg, Oswestry Disability Index (ODI), SRS-22, and Short Form-36 Mental Component Score (MCS) and Physical Component Score (PCS). Satisfaction scores were also correlated to radiographic changes in sagittal vertical axis (SVA), coronal C7 plumbline, lumbar lordosis, pelvic tilt (PT) and the difference between pelvic tilt and lumbar lordosis (LL). We also compared three patient groups: Highly Satisfied (HS; N=123, SRS-22 > 4.0) and Less Satisfied (LS; N=34, SRS-22 < 4.0) and Not Satisfied (NS; N=9, SRS<2.5)-a subset of LS.

**RESULTS:** Overall SRS-22 satisfaction scores were high (Mean 4.29, range 1-5). There was a moderate correlation between satisfaction and final SRS-22 score (r2= 0.40),
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and a weak correlation, with change in SRS-22 score from baseline (r²=0.32). All other HRQoL data and radiographic parameters showed weaker correlations to SRS satisfaction scores (r² range 0.00001-0.27). There were significant differences between HS and NS patients in all HRQols (p<.0001-.0089). There were no differences in final and change in radiographic parameters between HS, LS and NS patients.

CONCLUSIONS: Radiographic parameters have weak correlations to patient satisfaction. HRQoL scores are also weakly correlated. Factors driving patient satisfaction appear to differ from surgical goals and current HRQoL measures.

O64
SURGICAL INDICATION IN DEGENERATIVE LUMBAR SPINAL DISEASE BASED ON HEALTH RELATED QUALITY OF LIFE: MULTI-CENTER PROSPECTIVE OUTCOME BASED ANALYSIS

INTRODUCTION: Surgical indications for degenerative lumbar spinal disease (DLSD) were largely ambiguous. Most surgical indications reside on patients’ subjective presentation. Hence, in this study, we are to validate success predictive value of quantitatively described surgical indication in multicenter prospective surgical outcome based analysis.

METHODS: Quality of life was evaluated, using the EuroQol (EQ)-5D in 393 patients (M:F 153:240, mean age of 67 years) from 17 tertiary hospitals after spinal fusion for DLSD, preoperatively and postoperatively at 3 months. Five items of EQ-5D: mobility(M), self-care(S), usual activities(A), pain/discomfort(P), and anxiety/depression(D) were checked as level 1, 2, 3 and 3 as worst. Minimal significant change in calculated EQ-5D (cEQ-5D) was set as 0.05. Logistic regression analysis was performed to predict highest successful outcome (calculated EQ-5D change after operation >0.05) with given sets of 5 items of EQ-5D. Significant level was <0.05.

RESULTS: In calculated EQ-5D analysis, patients with formula score as S+A+2*P+D <=8, 50/68 (73%) patients showed reduction or no significant change in cEQ-5D postoperatively. However formula score >9 248/287 (86%) patients demonstrated significant improvement in cEQ-5D postoperatively. (p<0.05) In general health score (0-100, 100 as best) analysis, preoperative M and A positively, but D negatively correlated with improvement in general health score. (p<0.05) Other factors including age (<70 years), multiple perioperative pain management, and preemptive pain control render significant improvement in calculated EQ-5D. (p<0.05)

DISCUSSION: Preoperative poor health related quality of life in terms of S, A, P, D positively predict successful surgical outcome as expressed as improvement in cEQ-5D. Also worst M and A, and with less D predict improvement in general health score. In conclusion, S+A+2*P+D =>9 in EQ-5D dimensions can be quantitatively described surgical indication for DLSD.

O65
ULTRASONIC WAVES REMOVE A BACTERIAL BIOFILM ON IMPLANT SURFACE AND PREVENT THE IMPLANT-ASSOCIATED INFECTION
1Yoshioka Kenji, 1lshii Ken, 2Nagai Shigenori, 4Kakinuma Yusuke, 3Sasaki Aya, 4Aizawa Mamoru, 3Okada Yasunori, 2Koyasu Shigeo, 1Toyama Yoshiaki, 1Matsumoto Morio; 1Department of Orthopedic Surgery, School of Medicine, Keio University, Shinjuku, To-
INTRODUCTION: The purpose of this study was to evaluate the antibacterial effect of irradiation of ultrasonic wave (UW) against the biofilm and implant-associated infection (IAI) both in vitro and in vivo.

METHODS: To prepare for bacterial biofilm, metal plates were incubated in medium containing bioluminescent strain of Staphylococcus aureus. Twelve treatments (no treatment, dry, washing with natural saline (NS), jet irrigation, washing with purified water, washing with NS containing cefazolin sodium, washing with povidone iodine, washing with hydrogen peroxide water, and UW irradiation (800kHz, 1-3w/cm2, 3 and 10 min)) were applied to the bacterial biofilm in vitro. The biofilm configuration after each treatment was observed by fluorescent microscope and electric microscope (EM). To evaluate whether UW treatment prevents the incidence of IAI in vivo, the UW treated or no treated plates were buried into the paraspinal muscle of BALB/c adult mice. After the surgery, the bacterial signals were sequentially measured by bioluminescence imaging.

RESULTS: The thickness of biofilm treated with dry and jet irrigation was significantly reduced compared with that of no treatment group in vitro. The thickness and the density of biofilm in four UW treatments were markedly reduced. Only a few bacteria were observed in UW treatments groups in EM. In vivo study, the mean signal in control increased and reached a peak at day 3 and gradually decreased and stabilized for over 2 weeks. Surprisingly, the signals in UW treatments were significantly weaker than those in the control at the early stage and disappeared on day 3. Histologically, muscle structure was maintained in only UW treated groups.

DISCUSSION: The assessment of biofilm removal by UW irradiation showed that only UW treatments markedly removed biofilm in vitro. In addition, no developments of IAI were observed in the UW irradiation group in vivo. Intraoperative UW irradiation may be useful to avoid the IAI.

A LARGE-SCALE STUDY OF MODIC CHANGES IN THE LUMBAR SPINE: MORPHOLOGY AND ASSOCIATION WITH MRI PHENOTYPES

Juhani Määttä1, Kenneth MC Cheung2, Jaro Karppinen1,3, Dino Samartzis2; 1Institute of Clinical Medicine, Department of Physical and Rehabilitation Medicine, University of Oulu, and Medical Research Center Oulu, Oulu, Finland 2Department of Orthopaedics and Traumatology, University of Hong Kong, Hong Kong, China 3Finnish Institute of Occupational Health, Health and Work Ability, and Disability Prevention Center, Oulu, Finland

INTRODUCTION: Modic changes (MC) are associated with low back pain. They represent vertebral endplate (EP) and adjacent vertebral marrow changes on MRI, traditionally classified into three types (M1, M2, M3). Due to methodological biases in previous studies, the morphology, involvement of MC and their association with other spinal phenotypes remains speculative. As such, the aim of this study was to evaluate the relationship of MC with spinal MRI phenotypes in a large-scale population-based study.

METHODS: Based on the Hong Kong Disc Degeneration (DD) Cohort of Southern Chinese, we assessed the T1- and T2-weighted MRIs of 1,604 subjects (62.4% females; mean age 49 years) from L1 to S1. The MC assessment included: the presence, type,
vertical height and axial area. Additional imaging findings were assessed (herniations/bulges, Schmorl’s nodes). A global degenerative disc disease (DDD) score was tabulated.

RESULTS: The prevalence of MC was 24.7% (M1: 6.3%, M2: 15.5%). Of all MC, 77% were at L4-S1. Subjects with MC were older (mean age: 53 vs. 48 years, p<0.001) and had higher DDD scores (p<0.001). M1 were more common at lower levels (p=0.021), were less likely located in the anterior region only (p=0.017), and were associated with disc herniations (p<0.001) in comparison to M2. MC of the lower levels (L4-S1) were not commonly noted in the anterior region only, involved the left or right EP, had a higher prevalence of disc herniation and DD in comparison to upper levels (L1-L4) (p<0.001). Large MC (≥2/3 of the axial area) were more likely located at lower levels (83% vs. 73%, p=0.001), higher prevalence of disc herniation (83% vs. 72%, p=0.001) and Schmorl’s node at the affected level (52% vs. 39%, p<0.001) compared to smaller MC.

DISCUSSION: Based on one of the largest population-based studies, MC were clearly associated with disc and endplate changes. However, MC type- and level-related findings in relation to MRI phenotypes were identified.

O67
PREDICTION OF FUTURE FIRST-TIME LOW BACK PAIN BASED ON BASELINE MRI FINDINGS
Dino Samartzis, (+)Jaro Karpinnen, Keith DK Luk, Kenneth MC Cheung; Department of Orthopaedics and Traumatology, University of Hong Kong, Pokfulam, Hong Kong, SAR, China (+) Institute of Clinical Medicine, University of Oulu, Oulu, Finland

INTRODUCTION: Previously, it has been noted that there is no predictive value of MRI findings of degenerative changes of the lumbar spine in asymptomatic individuals in the development of first time episodes of low back pain (LBP). In a population-based cohort, this study addressed if radiographic findings on MRI in asymptomatic individuals are predictive in the development of first-time episodes of LBP and pain severity.

METHODS: A prospective, radiographic and clinical study was performed of 248 asymptomatic (93 males, 155 females, mean age: 42.9 years) Southern Chinese with no previous history of LBP. Utilizing MRI, disc degeneration, DDD score (i.e. disc degeneration severity) and other radiographic findings were assessed. At 2 years minimum follow-up (mean: 4.3 years, range: 2.2-10.0 years), clinical assessment was performed to identify the development of LBP and functional outcome status.

RESULTS: Overall presence of disc degeneration, disc space narrowing, and disc bulge/extrusion was noted in 60.5%, 19.0%, and 34.3% of individuals, respectively. The mean DDD score was 2.2. Schmorl’s nodes and Modic changes were noted in 10.5% and 1.2%, respectively. The incidence rate of first-time LBP episodes was 34.7% (mean age: 44.8 years). Regression modeling noted that the presence of disc bulge/extrusion (OR: 2.37; 95% CI:1.30-4.32) and increasing DDD score (>7 score OR: 6.90; 95% CI: 1.86-25.52) demonstrated significant predictive utility for developing first-time LBP episode as well as greater functional disability and increased frequency of future LBP episodes (p<0.05).

DISCUSSION: This is the largest prospective study to address the development of future, first-time LBP episodes based on baseline MRI. This study substantiates the belief that spinal changes are found in asymptomatic subjects on MRI; however, the "global severity" or patterns of disc degeneration on initial MRI may be predictive in the development of first-time LBP episodes.
INTRODUCTION: We have already reported that the cross-sectional area (CSA) of the paraspinal muscles tends to decrease with age and that our new index, referred to as the T-back value (used to quantify the depth of the groove between the paraspinal muscles; equal to the length of the bulge of the muscle to the attachment of the spinous process) was strongly correlated with the CSA of the paraspinal muscles (K. Takayama et al. ISSLS 2012). Additionally, we reported that the CSA of the paraspinal muscles and psoas muscles showed a similar decreasing tendency with age, but the fat infiltration rate of the paraspinal muscles was markedly higher compared to that of the psoas muscles in the elderly (T. Kita et al. ISSLS 2013). Therefore, we consider that the paraspinal muscles are more prone to atrophy with age compared with the psoas muscles. The aim of this study was to investigate the CSA and fat infiltration of the psoas muscles in patients with paraspinal muscle atrophy by MRI and to compare the findings with those in patients with less degenerative spine.

METHODS: We considered patients with T-back values =0 as those with atrophied paraspinal muscles. Of 704 patients who underwent MRI of the lumbar spine at our hospital during 2010, 45 male (13%) and 80 female (22%) patients with T-back values =0 were included in this study and were compared with previously reported patients with less degenerative spine. Sagittal T2-weighted MRI was used to measure lumbar lordosis (L1–S1 angle). Axial T2-weighted MRI was used to measure the CSA and fat infiltration rate of the psoas muscles at the intervertebral disc levels from L1/2 to L4/5.

RESULTS: The mean lumbar lordosis was 19.5°, which was lower than that of patients with less degenerative spine (36.7°). However, the CSA and fat infiltration rate of the psoas muscles was similar to those in patients with less degenerative spine. Thus, the psoas muscles are not significantly affected in patients with paraspinal muscle atrophy.
na 4. Institute of Clinical Medicine, University of Oulu, Oulu, Finland

INTRODUCTION: Numerous genetic association studies addressing lumbar disc degeneration (LDD) have been performed, but few of them can be replicated. The possible reasons could be the phenotype definition of LDD was highly variable between studies and level-specific variations were not addressed. As such, this study addressed the relationship between MRI features of the discs at different lumbar levels to explore the etiology of LDD; thereby, providing new insights and measurements for genetic studies.

METHODS: Sagittal T2-weighted MRI of the lumbar spine was assessed in a population sample of 2,952 Southern Chinese (mean age, 41.1 years; range, 15.0 to 65.4 years; 40.7% males; 59.3% females). Loss of disc signal intensity, disc bulges/extrusions, Schmorl’s nodes, high-intensity zones, and bone marrow changes were assessed on imaging. Subject demographics, environmental and lifestyle factors were also evaluated. Polychoric correlations, heritability estimations and local regression statistical analyses were performed.

RESULTS: Analyses suggested distinct genetic etiologies for the upper (L1-L2) versus lower regions (L3-S1). Age-related condition was restricted to lower regions while the upper region suggests congenital. By combining highly-correlated MRI-phenotypes in the upper and lower regions separately, two composite scores were generated: a degenerative score (DgS) (represents age-related disc changes) and a developmental score (DvS) (represents congenital variations).

DISCUSSION: Based on one of the largest population-based studies of LDD, comprehensive analyses of MRI-phenotypes provided new insights into its etiology. Our study proposes a novel phenotype scoring system. This scoring system can be used as the basis to promote a standardization of phenotype delineation, maximizing the potential of replication and meta-analysis studies of genetic risk factors for LDD.

O70
SURGICAL INTERSPINOUS IMPLANT VERSUS CONVENTIONAL DECOMPRESSION FOR LUMBAR SPINAL STENOSIS - A RANDOMIZED CONTROLLED TRIAL

Wouter A Moojen, Mark P Arts, Wilco CH Jacobs, Erik W van Zwet, M Elske van den Akker-van Marle, Bart W Koes, Carmen LAM Vleggeert-Lankamp, Wilco C Peul; Leiden University Medical Center, Leiden, The Netherlands (author 1, 3, 4, 5, 7 and 9) department of Neurosurgery (author 1, 3, 7 and 9), Medical Statistics, and Medical Decision Making (author 5) Erasmus Medical Center, Rotterdam, The Netherlands, department of General Medicine (author 6), Medical Center Haaglanden, The Hague, The Netherlands, department of Neurosurgery (authors 1 and 2)

INTRODUCTION: Interspinous process devices (IPD) are implanted to treat patients with intermittent neurogenic claudication based on lumbar spinal stenosis. Although widely implemented by the surgical community, efficacy has not been compared with standard bony decompression. It is hypothesized that implanting an interspinous process device results in faster post-operative recovery, and a higher success rate according to the Zurich Claudication Questionnaire at eight weeks compared to conventional bony decompression.

DESIGN: A randomized design with variable block sizes was used, with allocations stratified according to center. Patients and research nurses were blind throughout the follow-up.

METHODS: 211 participants were referred to the Leiden-The Hague Spine Prognostic Study Group. 159 participants with intermittent neurogenic claudication based on lumbar spinal stenosis at one or two levels with
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an indication for surgery were blindly randomized into two groups. 80 participants received an IPD and 79 participants underwent spinal bony decompression. The primary outcome at short-term (eight weeks) and long-term (one year) follow-up was the score for the Zurich Claudication Questionnaire. Repeated-measurement analyses were applied to compare outcomes over time.

RESULTS: At eight weeks, the success rate according to the Zurich Claudication Questionnaire for the IPD group (63 % CI 51 to 73) was not superior to that for standard bony decompression (72 % CI 60 to 81). No differences in disability (2CQ p 0.44) or other outcomes were observed between groups during the first year. The repeat surgery rate in the interspinous implant group was substantially higher, 29 %, in the early post-surgical period compared to the conventional group, 6% (p-value <0.001).

DISCUSSION: This double blinded study could not confirm the hypothesized short-term advantage of IPD over conventional “simple” decompression, and even showed a fairly high re-operation rate after IPD use.

O71

SURGICAL VERSUS NON-OPERATIVE TREATMENT FOR LUMBAR SPINAL STENOsis EIGHT-YEAR RESULTS OF THE SPINE PATIENT OUTCOMES RESEARCH TRIAL (SPORT)

Jon D. Lurie, MD, MS; Tor D. Tosteson, ScD; Anna N.A. Tosteson, ScD; Wenyuan Zhao, PhD; Tamara S. Morgan, MA; William A. Abdu, MD, MS; Harry Herkowitz, MD; James N. Weinstein, DO, MS; Geisel School of Medicine at Dartmouth, Hanover, NH and Dartmouth-Hitchcock Medical Center, Lebanon, NH; William Beaumont Hospital, Royal Oak, MI

INTRODUCTION: Surgery for lumbar spinal stenosis (SpS) has been shown to be more effective compared to non-operative treatment over four years in as-treated analyses. In this study we compare 8-year SpS outcomes from SPORT.

METHODS: Surgical candidates from 13 centers in 11 U.S. states with at least 12 weeks of symptoms and confirmatory imaging were enrolled in a randomized cohort (RCT) or observational cohort (OBS). Protocol treatments were decompressive laminectomy or standard non-operative care. Primary outcomes were SF-36 bodily pain (BP) and physical function (PF) scales and the modified Oswestry Disability index (ODI) assessed at 6 weeks, 3 months, 6 months and yearly thereafter.

RESULTS: 55% of RCT and 52% of OBS participants provided data at the 8-year follow-up. Intent-to-treat analyses showed no differences between randomized cohorts, however 70% of those randomized to surgery and 52% of those randomized to non-op had undergone surgery by 8 years. As-treated analyses in the RCT showed an early benefit to surgery out to 4 years (as previously reported) however the two groups converged over time with no significant treatment effect of surgery seen in years 6-8 for any of the primary outcomes. Analysis of the OBS group showed a stable advantage for the surgical groups in all outcomes between years 5-8. Re-operation rate for the combined cohorts was 18% through 8 years. Patients who were lost to follow-up were older, less well-educated, sicker, and had worse outcomes over the first 2 years in both surgery and non-operative arms.

DISCUSSION: Patients with symptomatic spinal stenosis show diminishing benefits of surgery in as-treated analyses of the RCT between 4-8 years while outcomes in the OBS group remained stable. Loss to follow-up of patients with worse early outcomes in both treatment groups suggest that the reported outcomes are likely to be overly-optimistic but the treatment effect estimates are unlikely to be biased.
O72
WHAT LEADS TO SURGICAL DECISION IN DEGENERATIVE LUMBAR STENOSIS IN THE PREFERENCE-BASED, SHARED DECISION?
Ho-Joong Kim, Jae-Young Park, Kyoung-Tak Kang, Bong-Soon Chang, Choon-Ki Le, Jin S. Yeom; Spine Center and Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital

INTRODUCTION: Several subjective and/or objective factors may influence the final surgical decision for degenerative LSS, including back/leg pain, symptom duration, neurologic deficit, radiologic severity of stenosis, and amount of disability in the preference-based, shared decision making. Nonetheless, the understanding about the significance of each influencing factor on surgical decision making remains primitive. Therefore, the purpose of this study was to clarify the significance of each influencing factor on the surgical decision for the treatment of LSS in a preference-based shared decision-making setting.

METHODS: A total of 555 patients, aged 45–80 years, who were given conservative or surgical treatment for chronic leg and/or back pain caused by LSS from April to December 2012 in the preference-based shared decision-making system were included in this study. Univariate and multivariable-adjusted logistic regression analyses were used to assess the association of surgical decision-making with age, sex, body mass index, symptom duration, radiologic stenotic grade, Oswestry Disability Index (ODI), Visual Analog Scale (VAS) for back/leg pain, Short Form (SF)-36 subscales, and motor weakness.

RESULTS: In univariate analysis, male sex, VAS for leg pain, ODI, morphological stenotic grades B, C, and D, motor weakness, and physical function, role of physical, bodily pain, social function, and role of emotion SF-36 subscales were associated with higher odds of a surgical decision for LSS. Multivariate analysis revealed that male sex, ODI, grade C and D stenosis, and motor weakness were significantly associated with higher possibility of a surgical decision (Figure 1).

DISCUSSION: This study suggests that male sex, morphological stenotic grade and the amount of disability are critical factors leading to surgical decision in the preference-based shared decision-making process.

O73
CLINICAL DEPRESSION: A PREDICTOR OF POOR RETURN TO WORK RATES AMONG WORKER’S COMPENSATION SUBJECTS FOLLOWING LUMBAR FUSION
Joshua T. Anderson, BS (1,2), Ryan J. Duff (3), Uri M. Ahn, MD (4), Nicholas U. Ahn, MD (1); 1 University Hospitals Case Medical Center Department of Orthopaedic Surgery 2 Case Western Reserve University School of Medicine 3 University of Minnesota Twin Cities 4 New Hampshire Spine Institute

INTRODUCTION: Worker’s compensation (WC) subjects undergoing lumbar fusion consistently have worse outcomes than the general population. Few studies have evaluated specific predictors of poor fusion outcomes in WC subjects.
METHODS: We used ICD-9 and CPT codes to identify subjects. We identified 4107 subjects from the Ohio Bureau of Worker’s Compensation that underwent single level lumbar fusion as their index fusion after injury. 720 subjects had fusion for the indication of spondylolisthesis, 37 of which were had depression before fusion. 1166 subjects underwent fusion for degenerative disc disease, 78 of which had depression before fusion. All subjects had 3 years of follow-up minimum. We determined who was able to return to work within 2 years of fusion and maintained a returned to work status for 1 year minimum. Subjects with a smoking history and pre-fusion diagnosis of failed back syndrome were not considered. We analyzed the spondylolisthesis group and the DDD group separately with logistic regression.

RESULTS: Return to work rates were significantly lower in patients with depression in the spondylolisthesis group (p<0.00; OR=0.18, CI=0.07-0.47) and the DDD group (p<0.00; OR=0.42, CI=0.23-0.75). Among the spondylolisthesis group, 368 of 683 subjects (53.9%) without depression returned to work. Only 9 of 37 subjects (24.3%) with depression and spondylolisthesis returned to work. Among the DDD group, 483 of 1088 subjects (44.3%) without depression returned to work. 19 of 78 subjects (23.1%) with depression and DDD returned to work. For the DDD group, age significantly influenced return to work rates (p=0.03). The odds ratio (0.98) suggests that this impact was not considerable. For both populations, influences of gender, obesity, and income were not significant.

DISCUSSION: Single level fusion surgery in WC subjects with clinical depression for the indication of either spondylolisthesis or degenerative disc disease is associated with poor return to work rates.

O74
THE ASSESSMENT OF PATIENT-RATED OUTCOME IN SPINAL STENOSIS: COULD LESS BE MORE?
Mannion AF, Fekete T, Kleinstück F, Jeszenszky D, Wertli M*, Porchet F in collaboration with the Lumbar Stenosis Outcome Study (LSOS) group; Spine Center, Schulthess Klinik, Zürich, Switzerland; *Horten Centre, Zürich University Hospital, Switzerland

INTRODUCTION: The Core Outcome Measures Index (COMI) is a short, validated questionnaire for assessing the key outcomes of importance to back patients. With just one question per domain, it enables the efficient assessment of large groups, with minimal respondent burden. However, for a given pathology, intuitively it may be expected to be less responsive than a disease specific instrument. In patients with lumbar spinal stenosis (LSS), we compared the performance of COMI and the widely accepted Swiss Spinal Stenosis Measure (SSM).

METHODS: The following questionnaires were completed before surgery by 91 LSS patients (73±8y; 50 m, 45 f) and after surgery by 47 patients who had reached 12mo post-op: SSM, COMI, Roland Morris disability (RM), EuroQol-VAS (EQ-VAS), complaints “feeling thermometer” (FT), pain numeric rating scale (pain NRS). At 12 mo post-op, SSM “satisfaction with treatment result” and the Global Treatment Outcome (rated 1-5) were assessed.

RESULTS: The COMI correlated with the SSM and the comparator questionnaires to the expected (r=0.4=0.8) extent, indicating good construct validity. The external criterion of Global Treatment Outcome correlated better with the change score (baseline to 12 mo FU) for COMI (r=0.62) than for SSM symptoms (r=0.43) or SSM function (r=0.42) (each p <0.05). Similarly, “SSM satisfaction” correlated better with the change score for COMI (r=0.63) than for SSM.
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symptoms (r=-0.59) or SSM function (r=-0.45).

DISCUSSION: COMI correlated to the expected extent with the SSM and its subscales, and with pain, disability and QoL, suggesting construct validity. With either “SSM-satisfaction with treatment results” or Global Treatment Outcome serving as the external criterion, COMI was more responsive than the SSM subscales. The COMI is well able to detect important change in LSS and has the added benefits of facilitating outcome comparisons with other spinal pathologies and reducing the response burden for the patient.

O75
SURGICAL OUTCOME OF LUMBAR SPINAL STENOSIS: 10 YEARS PROSPECTIVE FOLLOW-UP.
Tuomainen I1, Aalto T1,2, Vanhanen S1, Pakarinen M1, Sinikallio S1Leinonen V3, Herno A1, Kröger H4, Turunen V4, Savolainen S3, Miettinen H, Airaksinen O1; 1Department of Physical and Rehabilitation Medicine, Kuopio University Hospital, P.O.Box 1777, FIN-70211 Kuopio, Finland 2Kyyhkylä Rehabilitation Hospital, Mikkeli, Finland 3Department of Neurosurgery, Kuopio University Hospital, Kuopio, Finland 4Department of Orthopaedics and Traumatology Kuopio University Hospital, Kuopio, Finland

INTRODUCTION: Previous prospective clinical studies on lumbar spinal stenosis (LSS) have reported clinical outcomes with follow-up times from one to five years in. Our aim was to evaluate the surgical outcome in LSS up to 10 years with insufficient outcome. Exclusion criteria were 1) emergency or urgent spinal operation; 2) cognitive impairment prohibiting completing the questionnaire or other failure in co-operation. At 10 years follow-up there were 72 LSS patients (mean age 69 years, 45 women, 27 men) in the study. 18 patients were died and 12 patients were not available for the evaluation (various reasons). Main outcome measures were Oswestry Disability Index (ODI), Visual Analogue Scale (VAS) and Patients Global Assessment and Satisfaction to Surgery (PGASS), prior to the intervention at 2 years and the last evaluation at least 10 years postoperatively.

RESULTS: The mean ODI before surgery was 43.9 (SD 15.2); at two years follow-up 26.6 (SD 19.2) (p<0.001) and 29.4 (SD 20.9) (p<0.05), respectively. The mean baseline VAS was 33.0 (SD 23.6); at two years 11.6 (SD 16.9) (p<0.001); and at 10 years 32.8 (SD 28.2) (p<0.001). The PGASS for good or excellent outcome was 61% at two years follow-up and 68% at 10 years follow-up, respectively (p<0.05). 3 patients had moved from good outcome to totally cured group during the follow-up.

DISCUSSION: In general VAS (pain) and ODI values deteriorated during the 10 years follow-up. However patients Global Assessment and Satisfaction for the Surgery Outcome improved. Patients comorbidities may explain the conflicting results. Furthermore the experience of disability and pain may change during aging.

O76
RELATIONSHIP BETWEEN LUMBAR SPINAL STENOSIS AND PSYCHOSOCIAL FACTORS - A MULTICENTER CROSS-SECTIONAL STUDY (DISTO-PROJECT) -
Miho Sekiguchi 1), Koji Yonemoto 2), Tatsuyuki Kakuma 2), Takuya Nikaido 1), Kazuyuki Watanabe 1), Kinshi Kato 1), Koji Otani 1), Shoji Yabuki 1), Shin-ichi Kikuchi 1), Shin-ichi Konno 1); 1) Department of Orthopaedic
INTRODUCTION: Lumbar spinal stenosis (LSS) is a lumbar spinal disorder and causes leg symptoms and intermittent claudication. It is reported that the risk factors for low back pain are age, family history, smoking, obesity, work-related physical load, exercise, stress, depression and etc. In contract, few large-scale surveys in Japan have been performed to investigate risk factors of LSS. The aim of this study was to investigate the prevalence of LSS with age, and the relationship between LSS and the psychosocial factors and job satisfaction. METHODS: This study enrolled subjects who were 50 and over from the survey of lumbar spinal stenosis diagnosis support tool (DISTO)-project in 2,177 hospital and general practices nationwide and 18,642 participants were analyzed. LSS was diagnosed using the diagnostic support tool (LSS-DST). The clinical characteristics between LSS and non-LSS groups were compared using x2 test and multivariate logistic regression analysis were performed to examine the associated factors of LSS.

RESULTS: A total 18,642 patients (8,338 male and 10, 267 female) were analyzed and the rate of LSS was 38.3%. The rate of subjects who do regular exercise in the LSS group was lower than that in the non-LSS group (p<0.001). The odds ratios for having LSS were higher than in subjects with having perceived stress and strenuous use of low back or legs (p<0.001). The satisfaction in all items job related in the LSS group were less than in the non-LSS group (p<0.001). There was an increase the odds of heart diseases, hypertension, while a decrease the odds of diabetes mellitus, respectively (p<0001).

CONCLUSION: This study was investigated the associated factors with LSS. Perceived stress, strenuous use of low back or legs might be associated with LSS, and job satisfaction was lower with LSS.

O77
AGE ASSOCIATED RELATIVE RISK INCREASE FOR IN-HOSPITAL MORTALITY AND COMPLICATIONS FOLLOWING LUMBAR SPINE SURGERY
Hamid Hassanzadeh MD, Sreeharsha V. Nandyala BA, Alejandro Marquez-Lara MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: Lumbar arthrodesis is commonly utilized to treat degenerative conditions of the spine. Despite its widespread utilization, few studies have characterized the age associated relative risk increase for inpatient complications and mortality following a lumbar fusion (LF) procedure.

METHODS: Data from the Nationwide Inpatient Sample was queried from 2002-2011. Patients who underwent an index lumbar fusion were identified and stratified into age groups as follows: 18-39, 40-49, 50-59, 60-69, 70-79, and 80+. Postoperative inpatient complications and mortality were assessed. The relative risks in each decade were calculated in reference to the previous respective age group. SPSS v.20 was utilized for statistical analysis with a 95% confidence interval for relative risk.

RESULTS: A total of 315,597 LF procedures were recorded from 2002-2011. The relative risk for inpatient mortality, pulmonary embolism (PE), cardiac events, and renal failure was significant beginning at the 5th decade and compounded for the subsequent age groups. The risk increase for mortality was most dramatic for patients >80 years when compared to the 7th decade. The initial significant relative risk increase for deep vein thrombosis (DVT) was demonstrated at the 4th decade and was consistently significant for the subsequent age groups. There was no relative risk increase in each decade in
regards to inpatient wound infection or ileus following LF.

**DISCUSSION:** In this analysis of the NIS database, the 4th decade demonstrated an increased relative risk for DVT whereas the 5th decade demonstrated the initial risk increase for in-hospital mortality, PE, cardiac events, and renal failure after LF. These results suggest that the risk increase for in-hospital mortality and catastrophic complications develops early, in the 4th and 5th decades. Further studies are warranted to investigate the etiologies for this early risk increase for complications following lumbar arthrodesis.

**O78**

**LUMBAR DEGENERATIVE SPONDYLOLISTHESIS IS NOT ALWAYS UNSTABLE ~ A CLINICO-BIOMECHANICAL EVIDENCE ~**

Kazuhiro Hasegawa, Ko Kitahara, Haruka Shimoda, Keiji Ishii, Takao Homma; Niigata Spine Surgery Center, Niigata, Japan

**INTRODUCTION:** Is a segment with lumbar degenerative spondylolisthesis (LDS) always unstable? Although radiographic evaluation of the lesion is extensively performed, the diagnosis of segmental instability remains controversial. The purpose of this study is to clarify clinico-biomechanical characteristics of the segment with LDS using an original intraoperative measurement system (IOM).

**METHODS:** IOM is the first clinically available system which performs a cyclic flexion-extension displacement of the segment with all ligamentous structures intact and can determine stiffness (N/mm), absorption energy, and neutral zone (NZ, [mm/N]). Forty-eight patients with LDS (M/F=19/29, 68.5 years) (Group L) were compared with 48 lumbar spinal stenosis patients without LDS (M/F=33/15, 64.8 years, Group N) in terms of symptoms, radiological, and biomechanical results. Instability was defined as a segment with NZ>2mm (IBJS2011). Symptoms (SF-36), radiographic findings (X-rays, MRI, CT), stiffness, NZ, and frequency of Instability were also compared. Risk factors of instability were analyzed by multivariate logistic regression with a forward stepwise procedure.

**RESULTS:** There was neither significant difference in all categories in physical function of SF-36 and low back pain (VAS) between the groups, nor is in radiological findings. Although NZ in Group L (1.97) was significantly greater than that in Group N (1.73) (p<0.05), there was no difference in frequency of Instability. Facet opening (Odd’s 10.4, p<0.01) and sagittally oriented facets (Odd’s 4.4, p<0.05) were risk factors of Instability.

**DISCUSSION:** There was no significant difference in symptoms and the frequency of Instability between the groups. The indicative radiological finding of Instability was not LDS, but facet opening and sagittally oriented facets. Thus, LDS is neither always unstable nor symptomatic, suggesting that the instability of LDS can be stabilized spontaneously in the natural course.

**O79**

**SURGICAL VERSUS NON-OPERATIVE TREATMENT FOR LUMBAR DEGENERATIVE SPONDYLOLISTHESIS: EIGHT-YEAR RESULTS OF THE SPINE PATIENT OUTCOMES RESEARCH TRIAL (SPORT)**

1Jon D. Lurie, MD, MS; 1Tor D. Tosteson, ScD; 1Anna N.A. Tosteson, ScD; Wenyan Zhao, PhD; 1Tamara S. Morgan, MA; 1William A. Abdu, MD, MS; 2Harry Herkowitz, MD; 1James N. Weinstein, DO, MS; 1Geisel School of Medicine at Dartmouth, Hanover, NH and Dartmouth-Hitchcock Medical Center, Lebanon, NH; 2William Beaumont Hospital, Royal Oak, MI

**INTRODUCTION:** Surgery for lumbar spinal stenosis with associated degenerative spondylolisthesis (DS) has been shown to be more effective compared to non-operative treatment over four years in as-treated
analyses from SPORT. In this study, we compare 8-year DS treatment outcomes from SPORT.

**METHODS:** Surgical candidates from 13 centers in 11 U.S. states with at least 12 weeks of symptoms and confirmatory imaging were enrolled in a randomized cohort (RCT) or observational cohort (OBS). Protocol treatments were decompressive laminectomy with (93%) or without (7%) fusion compared to standard non-operative care. Primary outcomes were SF-36 bodily pain and physical function scales and the modified Oswestry Disability index assessed at 6 weeks, 3 months, 6 months and yearly thereafter.

**RESULTS:** 69% of RCT and 57% of OBS participants provided data at the 8-year follow-up; 72% of those randomized to surgery and 55% of those randomized to non-operative treatment had undergone surgery by 8 years. Intent-to-treat analyses showed no differences between randomized cohorts at early time points, however they favored the non-operative groups at later time points with differences that were statistically significant in years 6, 7, 8 and averaged over all time points. As-treated analyses in the RCT adjusted for selection bias showed a stable advantage for surgery out to 8 years with similar findings in the OBS group. Re-operation rate for the combined cohorts was 22% through 8 years. Patients who were lost to follow-up were older, less well-educated, sicker, and had worse surgical outcomes but similar non-operative outcomes over the first 2 years.

**DISCUSSION:** SPORT DS patients randomized to surgery had somewhat worse long-term outcomes; however, high rates of cross-over and long-term loss to follow-up complicate the interpretation of these findings. Factors differentially affecting loss to follow-up between comparison groups could affect treatment effects estimates.

**O80**

**LINKING PARITY, HISTORY OF ABDOMINAL SURGERY, AND TRUNK MUSCLE FUNCTION TO DEGENERATIVE SPONDYLOLISTHESIS IN OLDER WOMEN**


**INTRODUCTION:** Degenerative spondylolisthesis (DS) is a major cause of disabling low back pain among the older population, often requiring surgery to alleviate symptoms. But the question remains as to why women suffer from DS at a rate 3-9 times higher than men. One study found a relationship between the number of pregnancies and DS [1] and suggested that impaired abdominal muscle function causing poor spine mechanics could eventually lead to degenerative spine disease. Therefore, this study examined the association of parity, abdominal surgery, and trunk muscle function to DS.

**METHODS:** A questionnaire containing information about parity and past abdominal surgeries was completed by 324 women between ages of 40 and 80 (153 with DS and 171 controls without DS determined radiologically). A sub-set of 32 women with DS and 63 controls volunteered for a clinical assessment of their trunk muscles (blinded abdominal muscle function and hip extension tests).

**RESULTS:** Pearson’s Chi-squared tests revealed a significantly higher presence of past abdominal surgeries (p=0.001) and pregnancies (p=0.012) among women with DS. Logistic regression analysis identified age, body-mass index, hysterectomy, and
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the number of full-term pregnancies as specific factors predictive of DS (p<0.001, concordance 73%). Moreover, women with DS were more likely to exhibit abdominal muscle weakness (p=0.041), whereas the hip extension tests revealed no significant differences.

DISCUSSION: These results support our hypothesis that DS is associated with a history of abdominal surgeries, especially hysterectomies (nearly twice greater risk), and the number of full-term pregnancies. DS is likely mediated by impaired abdominal muscle function (Fig. 1). Specific interventions could be designed to target these muscles postpartum and following hysterectomies.


O81

CLINICAL OUTCOME OF DECOMPRESSIVE SURGERY FOR LUMBAR EPIDURAL LIPOMATOSIS

Haschtmann D, Ferlic P, Kleinstück FS, Porchet F, Mannion A, Jeszenszky D, Fekete TF; Spine Center, Schulthess Clinic, Zurich, Switzerland

INTRODUCTION: The treatment of spinal epidural lipomatosis (SEL) is controversial. The limited evidence for the success of surgical decompression is mostly derived from case reports. Moreover, no patient-reported outcome studies are available. The objective of this study was to evaluate patient-reported outcome after lumbar decompressive surgery for SEL in the largest series of patients examined to date.

METHODS: Consecutive patients with symptomatic SEL documented on MRI undergoing surgical treatment in a single centre (2004 – 2012) were analysed. Data were obtained from the International Spine Tan-go Register. Patients with spinal stenosis caused by other pathologies were excluded. Outcome was evaluated using Core Outcome Measure Index (COMI; scored 0 – 10) including the pain scale for leg and back. Three months was defined as the minimal follow-up time; for most patients a two-year follow-up period was available (mean 20.2 months).

RESULTS: In 170 patients undergoing lumbar decompressive surgery SEL was documented. 141 pts. were excluded due to accompanying discogenic or arthropgenic stenosis. In 6 pts. MRI scans was unavailable and 1 pt. did not complete the forms. Finally, 22 patients (19 male, 3 female, mean age: 68.2, 50.4 – 88.7 years) were included. At 3 months the outcome scores showed a significant improvement: COMI from 7.5 ± 1.7 (mean ± SD) to 4.9 ± 2.5 (p<0.0001), leg pain from 5.9 ± 2.6 to 3.5 ± 2.8 (p=0.0042) and back pain from 5.4 ± 3.2 to 4 ± 2.8 (p=0.004). The effect was retained for 2 years (COMI: 5.1 ± 3.1, p=0.003 vs. preoperative).

CONCLUSION: Based on patient-reported outcome, we could demonstrate a beneficial effect of decompressive surgery for spinal stenosis due to epidural lipomatosis. As expected, the improvement of leg pain was more pronounced than the effect on back pain and lasted for at least 2 years.
SP01
REOPERATION RATE AFTER MICRODISCECTOMY FOR THE TREATMENT OF LUMBAR DISC HERNIATION: LONG-TERM FOLLOW-UP AFTER AN AVERAGE OF 10.8 YEARS
Alexander Aichmair, MD*; Jerry Y. Du, BSc†; Jennifer Shue, MS*; Gisberto, Evangelisti, MD§; Andrew A. Sama, MD*; Alexander P. Hughes, MD*; Darren R. Lebl, MD*; Frank P. Cammisa, MD*; Federico P. Girardi, MD*
*Department of Orthopaedic Surgery, Spine and Scoliosis Service, Hospital for Special Surgery, Weill Cornell Medical College, New York, NY †Weill Cornell Medical College, New York, NY #1st Orthopaedic Clinic, Cisanello Hospital, University of Pisa, Italy

INTRODUCTION: The aim of the present study was to assess the reoperation rate after microdiscectomy for the treatment of lumbar disc herniation (LDH) in patients with a minimum five-years follow-up and identify demographic, perioperative, and outcome-related differences between patients with and without a re-operation.

METHODS: The medical records, operative reports, and office notes of patients who had undergone microdiscectomy at a single institution between 03/1994 and 12/2007 were reviewed, and long-term follow-up assessed via a telephone questionnaire.

RESULTS: Forty patients (M:24, F:16) with an average age at surgery of 39.9±12.5 years (range: 18-80) underwent microdiscectomy at the levels L5-S1 (n=28, 70%), L4-L5 (n=9, 22.5%), L3-L4 (n=2, 5.0%), and L1-L2 (n=1, 2.5%). After an average of 40.4±40.1 months (range: 1-128), 25% of patients (10/40) required further spine surgery related to the initial microdiscectomy. At an average post-operative follow-up of 10.8±4.0 years (range: 5-19), additional symptoms apart from back and leg pain were reported more frequently by patients who underwent a re-operation (p=0.005). Patient satisfaction was significantly higher in patients who did not undergo a re-operation (p=0.041). For the ODI, pain intensity (p=0.036) and pain-related sleep disturbances (p=0.006) were reported to be more severe in the re-operation group.

DISCUSSION: Microdiscectomy for the treatment of LDH results in favorable long-term outcomes in the majority of cases. The re-operation rate was higher in our series than reported in previous investigations with shorter follow-up. Although there were no pre- or perioperative differences between patients with and without re-operation, our findings suggest a difference in self-reported long-term outcome measures.

SP02
ANALYSIS OF INTERNET INFORMATION ON THE CONTROVERSIAL X-STOP DEVICE
Joshua T. Anderson, BS (1,2), T. Barrett Sullivan (1,2), Uri M. Ahn, MD (3), Nicholas U. Ahn, MD (1); 1 University Hospitals Case Medical Center Department of Orthopaedic Surgery 2 Case Western Reserve University School of Medicine 3 New Hampshire Spine Institute

INTRODUCTION: Patients frequently use the internet to aid in medical decision-making, and this information actively influences patient choices. The X-Stop is a controversial interspinous spacer device for the treatment of intermittent neurogenic claudication secondary to lumbar spinal stenosis. Our study is the first to examine internet information on the controversial X-Stop.

METHODS: Search engines Google, Yahoo!, and Bing and search terms X-Stop, interspinous distraction device, and interspinous spacer decompression were used to identify and characterize 105 sites providing information on X-Stop.

RESULTS: 43% of websites were authored by private medical groups, 4% by academic medical groups, 16% by insurance companies, 9% by biomedical industry, 10% by news sources, and 19% by websites not
fitting into those categories. 31% of webpages cited peer-reviewed literature. 56% of all sites provided at least one appropriate patient inclusion criterion (in addition to lumbar spinal stenosis). 33% of sites reported at least one patient exclusion criteria. 91% of sites reported at least one purported benefit of X-Stop. One or more complications were reported in 23% of sites. One of the most commonly seen complications with all interspinous spacers, spinous process fractures, was discussed in 19% of sites. Specific non-surgical treatment alternatives were discussed in no higher than 28% of sites. 33% of sites mentioned the existence of conservative therapy without including specifics. 51% of sites included laminectomy and 22% fusion as surgical treatment options.

**DISCUSSION:** Publicly accessible information on the X-Stop was of poor quality, often incomplete, and potentially misleading. The high reporting rates of benefits (91%) contrasted with the abysmally low reporting rates of complications (23%) raises the concern that this information lends itself more toward patient recruitment than to education.

**SP03**

A PROSPECTIVE COMPARATIVE STUDY OF TWO DIFFERENT MINIMALLY-INVASIVE PROCEDURES FOR LUMBAR SPINAL CANAL STENOSIS - UNILATERAL LAMINOTOMY FOR BILATERAL DECOMPRESSION (ULBD) VERSUS MUSCLE-PRESERVING INTERLAMINAR DECOMPRESSION (MILD)

Yoshiyasu Arai, Takashi Hirai, Toshitaka Yoshii, Kenichi Shinomiya, Makoto Takahashi, Shigenori Kawabata, Mitsuhiro Enomoto, Tsuyoshi Kato, Shoji Tomizawa, Kenichirou Sakai, Atsushi Okawa; Department of Orthopedic Surgery, Graduate School, Tokyo Medical and Dental University 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8519, JAPAN

**INTRODUCTION:** Unilateral laminotomy for bilateral decompression (ULBD) and muscle-preserving interlaminar decompression (MILD), which were two different types of minimally invasive surgery for lumbar canal stenosis, were compared prospectively to reveal whether there are any differences in clinical and radiological outcomes.

**METHODS:** From 2005 to 2009, we prospectively enrolled 50 LSCS patients for the treatment with ULBD, and 50 patients for MILD. The patients’ symptoms were evaluated using Japanese Orthopedic Association (JOA) score, JOA Back Pain Evaluation Questionnaire (JOABPEQ), and visual analog scale (VAS) before and 2-year after operation. For radiological evaluation, changes in disc height, sagittal translation, and lateral wedging at the decompressed segment, as well as lumbar lordosis were investigated using plain X-rays.

**RESULTS:** Ninety-nine of 100 patients were followed for a minimum of 2 years. No significant differences were found in the recovery rate of JOA score, improvement of JOABPEQ, and changes of the VAS between the two groups. Radiologically, no significant differences were present in the postoperative degenerative changes in disc height, sagittal translation, and lateral wedging. In multi-level surgeries; however, clinical scores in low back pain and lumbar function were significantly greater in the ULBD group than those in the MILD group. The lateral wedging change at L2/3 and L3/4 more frequently occurred in the ULBD group than in the MILD group. On the contrary, the number of patients who demonstrated the postoperative sagittal translation at L4/5 was significantly greater in the MILD group than in the ULBD group.

**DISCUSSION:** Both MILD and ULBD were efficacious procedures for improving neurological symptoms in LSCS patients. In multi-level decompression surgeries, ULBD was superior to MILD in terms of improvement.
of low back pain and lumbar function at 2-year time-point.

**SP04**

**EPIDEMIOLOGICAL STUDY OF LUMBAR SPINAL STENOSIS: SIX-YEAR FOLLOW-UP IN THE COMMUNITY**

Koji Otani, Shinichi Kikuchi, Shoji Yabuki, Takuya Nikaido, Kazuyuki Watanabe, Kinshi Kato, Shinichi Konno; Dept. of Orthopaedic Surgery, Fukushima Medical University School of Medicine, Fukushima, Japan

**INTRODUCTION:** It is well known that Lumbar Spinal Stenosis (LSS) is one of the most serious problems in the elderly because of its high prevalence and negative impact on quality of life (QoL). Natural history of LSS is still not clear. The purpose of this study was to clarify natural history and the associated factors of LSS in the community.

**PARTICIPANTS AND METHODS:** 1578 people (age ranged from 40 to 79 yo) agreed to participate and were interviewed about LSS and comorbidities including osteoarthritis of the hip and the knee (hip OA, knee OA) by Altman’s criteria (Altman 1996, 2001) in 2004. The presence of LSS was assessed by a specially designed questionnaire (Konno 2007). In 2010, follow-up study was performed using mail. 790 people were traced. Follow up rate was 50%.

**RESULTS:** 1. 161 (20.4%) in 2004 and 155 (19.6%) in 2010 of 790 were judged as LSS-positive. At least for 6-year, total prevalence of LSS did not increase.
2. 69 of 161(42.9%) showed that LSS existed in both 2004 and 2010. On the other hand, in the rest of 92 (57.1%), they were judged as LSS-negative at the follow-up. In 2004, 629 were judged as LSS-negative and 86 of 629 (13.7%) were judged as LSS-positive in 2010.
3. From a multiple logistic regression analysis, male and the presence of LSS and knee OA in the initial analysis might be risk factors for 6-year follow-up. Depressive symp-

tom, hypertension, cardiovascular disease, cerebrovascular disease, respiratory disease, diabetes mellitus and hip OA did not affect the presence of LSS for 6 years at least.

**DISCUSSION:** To maintain and improve QoL through the prevention and treatment of musculoskeletal diseases in the elderly, it is believed that LSS is one of the most serious health problems that should be targeted because of its high prevalence and strong negative influence on QoL. Therefore associated and/or risk factors for LSS revealed may provide preventability of LSS and possible application in the promotion of health in the community.

**SP05**

**NIGHT LEG CRAMP AND LUMBAR SPINAL STENOSIS - AN ANALYSIS OF 304 PEOPLE IN THE COMMUNITY**

Junichi Handa, Koji Otani, Takuya Nikaido, Shin-ichi Kikuchi, Shin-ichi Konno; Department of Orthopaedic Surgery, Fukushima Medical University School of Medicine, Fukushima, Japan

**INTRODUCTION:** Night leg cramp is thought as one of the characteristic symptoms of the lumbar spinal stenosis (LSS). However, details of night leg cramps with LSS are still unknown. The purpose of this study was to determine the characteristic of night leg cramp with LSS in the community.

**METHODS:** 304 voluntary participants (men 93, women 211, most frequently age group; 60s) were enrolled in this study. The presence of LSS was assessed by a validated and self-administrated diagnostic support tool (Konno et al: Eur Spine J. 2007). The presence of night leg cramp and physical examination such as sensory disturbance and motor weakness of the lower extremities were evaluated by one experienced spine surgeon. Furthermore, Roland-Morris Disability Questionnaire (RDQ) was also assessed. All participants received lumbar MRI and cross-
sectional area of dural tube at from L1/2 to L5/S1 was calculated by Hamanishi’s method (Hamanishi et al: J Spinal Disorders. 1994).

RESULTS: 1.) 77 participants (25.3%) were judged as LSS positive. In LSS positive group, 41 of 77 participants (53.2%) showed night leg cramp. On the other hand, in LSS negative group, 65 of 227 participants (28.6%) showed night leg cramp. There was statistically significant difference of prevalence of leg cramp between two groups (p<0.0001). 2.) Cross-sectional area of dural tube did not show any influence on the presence of night leg cramp. 3.) Sensory disturbance, motor weakness and lower RDQ score showed statistically significant difference of the presence of night leg cramp (p<0.05).

DISCUSSION: From the results of this study, the severity of mechanical compression such as the area of dural tube did not affect the presence of night leg cramp. The severity of symptom such as sensory disturbance, motor weakness and lower low-back-pain related QoL evaluated by RDQ were associated with the presence of night leg cramp. These results mean that night leg cramp with LSS might show the severity of symptom caused by LSS.

SP06
EVOLUTION OF SPINAL CANAL DIMENSIONS IN SWITZERLAND. A NARROWING EPIDEMIC?
Constantin Schizas MD FRCS, Aline Schmit, Alexis Schizas, Fabio Becce MD, Gerit Kulik PhD, Katarzyna Pierzhala PhD; University of Lausanne, Lausanne Switzerland and Spine Unit, Cecil Clinic, Lausanne Switzerland

INTRODUCTION: Development of symptomatic lumbar spinal stenosis (LSS) is among others related to the dimensions of the bony canal the latter reaching adult size early on in life. Several factors can influence its final dimensions such as protein intake.

We hypothesized that similar to what prevails in human stature, adult bony canal size has grown larger in recent generations given the improvement of socioeconomic conditions.

METHODS: Computer tomographies (CT) from 184 subjects performed for either trauma (n= 81) or abdominal pathologies (n=103) were included in this study. CTs performed on patients born either between 1940-49 (n=88) or 1970-79 (n=96) were selected. Bony canal was digitally measured at pedicle level (i.e. at a level not influenced by degenerative changes) for each lumbar vertebra. Intra and inter-observer reliability was assessed.

RESULTS: Intra and inter-observer measurement reliability was excellent (ICC =0.87) and good (ICC= 0.61) respectively. Contrary to our hypothesis we observed that the younger generation of patients had highly statistically significant differences at all levels compared to the older subjects, the latter having larger lumbar canals (p< 0.001). This difference was particularly pronounced in the trauma subgroup.

DISCUSSION: Given that human stature evolution has stabilized and that adult height is determined by the first two years of long bone growth, it is possible that antenatal factors are responsible for this surprising finding. Maternal smoking and age could be possible explanations. This finding could have significant implications with an increased number of patients developing LSS as degenerative changes develop putting at strain health resources. Further studies in different population groups and countries would be important in order to further confirm this trend.

SP07
THE ROLE OF BMI IN MATRIX DELAMINATION DURING INTERVERTEBRAL DISC DEGENERATION
Hans-Joerg Meisel1, Andrea Friedmann2,3, Stefan Schwan2,3, Andreas Heilmann3, Felix
INTRODUCTION: Intervertebral disc (ID) degeneration is a natural process during aging, contributed by mechanical-, genetic and biochemical parameters. Interactions between these parameters cause an instance of matrix degeneration in ID tissue on the macroscopic and microscopic scale. The process of disc degeneration by means of matrix destruction should be promoted by an increased body mass index (BMI) representing increased mechanical loadings. The objective is to determine and correlate tissue changes of ID degeneration in different states under consideration of patients’ BMI value.

METHODS: As part of a clinical study, human ID tissue samples from 60 patients removed during standard sequestrectomy as neurosurgical treatment after disc herniations are investigated regarding their microstructure using scanning electron microscopy. Investigations are focused on the delamination of the tissue matrix as well as cellular changes. With digital image analyzing software, degeneration characteristics are evaluated and correlated with clinical relevant parameters.

RESULTS: Matrix delamination is identified by digital image analysis as microstructural destruction in disc degeneration closely related to patients’ BMI in the one hand but on the other hand not related to patients’ age or gender. Cellular variations are proved as decrease in cell density and increase in cell size while creeping reduction of the thickness of the extracellular matrix.

DISCUSSION: Due to the future development of regenerative therapies for intervertebral disc degeneration it is essential to understand the mechanism of degenerative processes in disc tissue. This study demonstrates that structural variations in the micro-scale are characteristically for disc degeneration and may be the link or trigger for prolapse of degenerated disc tissue.

SP08
CEREBRAL VASCULAR ACCIDENTS FOLLOWING LUMBAR SPINE FUSION SURGERY
Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: Although rare, postoperative cerebral vascular accidents (CVA) can be catastrophic. However, the impact of a postoperative CVA on perioperative outcomes in lumbar spinal fusion has not been well characterized.

METHODS: The Nationwide Inpatient Sample (NIS) was queried from 2002-2011. Patients undergoing elective anterior (ALF), posterior (PLF), or circumferential (APLF) lumbar fusions were selected. Patients with a documented postoperative CVA were identified. Patient demographics, comorbidity burden (CCI), length of stay (LOS), costs, and mortality were assessed. Regression analysis was utilized to identify significant risk factors of a CVA with a 95% confidence interval. SPSS v.20 was utilized for statistical analysis and a p-value of <0.001 denoted statistical significance.

RESULTS: A total of 264,891 LFs were identified between 2002-2011 of which 340 (1.3 per 1,000) developed a postoperative CVA. The CVA cohort was significantly older and demonstrated a greater CCI than unaffected patients. In addition, affected patients more often underwent 3+ level fusions and deformity corrections. Furthermore, regression analysis demonstrated that age >65 years, and a history of neurologic disorders, paralysis, liver disease, congestive heart failure (CHF), or electrolyte imbalance were significant risk factors for a postoperative
CVA. Lastly, the CVA cohort was associated with a significantly greater LOS, costs, and mortality than unaffected patients.

**DISCUSSION:** A postoperative CVA following a LF procedure is associated with worsened patient outcomes and greater hospital resource utilization. Older patients with a history of CHF, neurologic disorders, or electrolyte imbalance were at a significantly increased risk for developing a CVA. The risk of mortality from a CVA following lumbar fusion surgery is exponential. Further studies are warranted to characterize and identify pre-operative risks in order to mitigate these catastrophic events from occurring.

**SP09**

**DE NOVO POST-OPERATIVE NEUROPATHIC PAIN IN LUMBAR SPINAL SURGERY**


**INTRODUCTION:** Neuropathic pain (NP) is caused by damage or disease that affects the somatosensory system, associated with abnormal sensations called dysesthesia and allodynia. Prevalence of NP in failed back surgery syndrome has been reported to be 6-16%. However there is no report regarding postoperative de novo NP in spinal surgery. Hence prospective multicenter survey was performed to identify iatrogenic NP postoperatively, which was not found preoperatively.

**METHODS:** Forty-four spinal centers with ortho (22) and neurospinal surgeons (22) were included. Total of 1109 patients (M:F 459:650) were enrolled for prospective survey. Visual analog pain scale (VAS), Leeds assessment of neuropathic symptoms and signs (LANSS) scale, EuroQol (EQ)-5D, SF-36 were measured preoperatively, 1-2 weeks, and 3 months postoperatively. Demographic characteristics, other surgery and clinically related data were collected. LANSS scale 12< was defined as having NP.

**RESULTS:** Among 1109 patients, NP was identified in 404 (36%) patients while remaining 705 (64%) patients represented as having nociceptive pain. In patients group without NP (n=705) preoperatively, during postoperative follow up at 1-2 weeks, and 3 months, NP was found in 22 (3.1%) and 16 (2.2%) patients respectively. Patients with de novo postoperative NP showed more pain, poor quality of life as measured by EQ-5D and SF 36. (p<0.05) In logistic regression analysis, gender, diagnosis, surgical procedures, symptom duration, level of surgery, preoperative pain scale, and quality of life did not provide significant impact on postoperative NP.

**DISCUSSION:** Surgical procedure including nerve root retraction and posterior lumbar interbody procedure might cause de novo NP postoperatively. The current study showed incidence of de novo postoperative NP in spinal surgery was 3.1% at 2 weeks and 2.2% at 3 months. Surgical procedure
related postoperative NP should be explained to surgical candidates preoperatively.

**SP10**

**INDIRECT EFFECTS OF DECOMPRESSION SURGERY ON GLYCEMIC HOMEOSTASIS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS AND LUMBAR SPINAL STENOSIS: PRELIMINARY RESULTS**

Ho-Joong Kim, Hyeon-Guk Cho, Je-Min Yi, Ki-Woong Lee, Bong-Soon Chang, Choon-Ki Lee, Jin S. Yeom; Spine Center and Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital

**INTRODUCTION:** Decompression surgery, which can help patients to perform regular physical activity, has indirect positive effects on the control of blood glucose in LSS patients with DM. Therefore, the purpose of this study was to evaluate the indirect effects of decompression surgery on hemoglobin A1c (HbA1c) in the patient with type 2 DM and lumbar spinal stenosis.

**METHODS:** Prospectively planned routine medical records of 27 patients were reviewed. Data including the walking duration in a single trial, Oswestry Disability Index (ODI), and Visual Analog Scale (VAS) for back pain and leg pain were recorded for all patients before surgery. Three and 6 months after surgery, these data were reassessed in all patients. Height, body mass index (BMI), fasting total cholesterol (TC), fasting blood glucose (FBG), and HbA1c were also measured in all patients prior to surgery as well as 3 and 6 months after it.

**RESULTS:** Compared to the VAS for back/leg pain and ODI before surgery, there was significant reduction in the VAS for back/leg pain and ODI both 3 and 6 months after spine surgery. A single trial walking duration in a single trial walk was significantly increased 3 and 6 months after the surgery, compared to the preoperative values. The average of preoperative HbA1c levels was 7.19%, and 3 months and 6 months after decompression surgery, the mean HbA1c levels significantly decreased to 6.71% and 6.82%, respectively. There was a significant positive correlation between changes of ODI and changes of HbA1c 3 months after operation, compared to preoperative state (Figure 1). TC levels were significantly reduced 6 months after surgery as compared to the levels before surgery.

**DISCUSSION:** Decompression surgery with or without fusion in patients with DM and LSS has an indirect effect on the reduction in HbA1c level by increasing participation in physical activity.

**SP11**

**CLASSIFICATION OF CHRONIC BACK MUSCLE DEGENERATION AFTER SPINAL SURGERY AND ITS RELATIONSHIP TO LOW BACK PAIN**


**PURPOSE:** Back muscle injury and degeneration often occurs after posterior lumbar surgery, and back muscle degeneration may be a cause of back pain after surgery. However, the relationship between back muscle degeneration and back pain remains controversial. In the current study, we aimed to
classify back muscle degeneration using MRI and investigate its relationship with back pain after surgery.

**METHOD:** A total of 84 patients (average age: 65.1 years, 38 men, 46 women) with lumbar spinal stenosis underwent only posterior decompression surgery. MRI (1.5 tesla) was evaluated before and more than a year after surgery in all patients. Muscle on MRI was classified into 3 categories: low intensity in T1 weighted image, high in T2 weighted image (type 1), high in both T1 and T2 weighted images (type 2), and low in both T1 and T2 weighted images (type 3). The proportion of types and their relationship with back pain (visual analog scale: VAS) was evaluated.

**RESULTS:** MRI revealed muscle degeneration in all patients after surgery (type 1: 6%, type 2: 82%, and type 3: 12%). Type 2 was significantly frequent compared with type 1 and 3 (P < 0.01). Low back pain before surgery (average: VAS 7.5) significantly improved after surgery (average: VAS 2.0) (P < 0.01). Low back pain was not associated with any muscle degeneration MRI types after surgery (P > 0.05).

**DISCUSSION:** The current study showed the pathology of back muscle degeneration was various after posterior lumbar surgery. Type 2 (fatty change) was most frequent, and some patients were classified into type 3 (scar change), and type 1 (inflammation or water-like change). Modic classification is used for bone marrow change, and type 1 is associated with inflammation and back pain. However, no type of back muscle degeneration was correlated with back pain after surgery.

**SP12**

**THE TYPE OF METAL, LOCAL ANTIBIOTICS OR PROPHYLACTIC IV ANTIBIOTICS, WHAT INFLUENCES POSTOPERATIVE SPIKE INFECTIONS WITH MRSA THE MOST?**

_Sachin Gupta, Sukanta Maitra, Maria Graca, Pumibal Wetpiriyakul, Kavita Gupta, Blythe Durbin-Johnson, Munish Gupta; University of California at Davis, Sacramento, California, USA_

**INTRODUCTION:** The purpose of this study was to determine the efficacy of Vancomycin powder and IV prophylactic Vancomycin in treatment of spine infection with MRSA in presence of different metals.

**METHODS:** 42 rabbits underwent a posterior L5-L6 approach. A 4 cm wire was placed around the L5 and L6 spinous processes. The implant was inoculated with 100 µL MRSA containing 1000000 colonies. 40 mg of Powder Vancomycin was placed in the wound prior to closure. The dose of IV Vancomycin was 15mg/kg. Proportions of infected rabbits were compared between groups using chi-square tests, and compared between groups adjusting for confounding factors using Cochran-Mantel-Haenszel tests. CFU counts for the tissue and implant were compared between groups using Wilcoxon rank sum tests.

**RESULTS:** The proportions of rabbits with infection were significantly higher in rabbits who received no Vancomycin compared ones that received powdered Vancomycin (P < 0.001 for tissue-oxy, tissue-blood, implant-oxy, and implant-blood). CoCr had higher rates of residual infection despite the use of Vancomycin powder than Ti and SS (P = 0.040). In rabbits with SS, the proportions of infection differed significantly among Vancomycin types (non, powdered, or IV) (P = 0.015 for tissue-oxy, P = 0.020 for tissue-blood, P = 0.025 for implant-oxy, P = 0.023 for implant-blood), with a significantly lower proportion infected among those with powdered Vancomycin. Rabbits with SS implants treated with Vancomycin powder had a lower infection rate than those treated with IV Vancomycin, although this difference was not statistically significant(p=0.557)

**DISCUSSION:** The Vancomycin powder is very successful in eradicating infection.
CoCr had more residual infection in tissues when compared to SS and Ti. SS had a similar outcome than portrayed in the literature when compared to Ti. Local vancomycin powder appears better in eliminating infection than Prophylactic IV Vancomycin.

**SP13**

**DOSE DEPENDENT NERVE INFLAMMATION OF RH BMP-2 IN A RODENT SPINAL NERVE MODEL**

Liau Zi Qiong Glen, Raymond Wing Moon Lam, Tao Hu, Soo Yein Toh, Hee-Kit Wong; Department of Orthopaedic Surgery, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

Introduction: Recombinant human bone morphogenetic protein -2 (rhBMP-2) is frequently used in spinal surgery to augment spinal fusion. Clinical complications associated with rhBMP-2 have been reported, including radiculitis and seroma formation. Yet, the relationship of dose dependent rhBMP-2 on nerve inflammation has not been reported. The aim of this study is to develop a rodent spinal nerve model to study the effects of rhBMP-2 on nerve inflammation.

**METHODS:** Eighteen Sprague Dawley rats were studied. Lumbar 5(L5) nerve root was exposed via a paraspinal approach. Absorbable collagen sponges with saline/rhBMP-2 were wrapped around the L5 nerve root and secured. 3 groups were studied: 1) saline; 2) 1µg of rhBMP-2; 3) 10µg of rhBMP-2. The rats were sacrificed after 7 days. Their L3 and L5 nerve roots were harvested for RT-PCR (immune cell marker: MIP3-a, CD-68), immunohistochemistry (anti-CD 68, anti TNF-a) and histology (H&E stain) to measure the nerve inflammatory responses. Seroma volume was quantified as the secondary endpoint.

**RESULTS:** With RT-PCR, we found macrophage markers MIP3-a and CD-68 up-regulated by 14 and 20 folds respectively in the 10µg rhBMP-2 group. Immunohistochemistry showed that CD-68 labelled cells (macrophages) and the inflammatory cytokine TNF-a areas decreased in a dose dependent manner. In addition, more nucleated cells were found in the nerve root of 10µg rhBMP-2 than the other groups. Seroma formation rate and volume also increased with rhBMP-2 dose: 10µg rhBMP-2 group (85%, 0.7±0.5ml); 1µg rhBMP-2 group (60%, 0.1±0.1ml); and saline group (0%, 0ml).

**DISCUSSION:** The results of this study suggest that rhBMP-2 induce nerve inflammation in dose dependent manner. Our rodent model can be used to test materials that could ameliorate this reaction.

**SP14**

**NUTRIENT DEPRIVATION MODULATES CELL FATE—AUTOPHAGY, APOPTOSIS, AND SENESCENCE—AND EXTRACELLULAR MATRIX HOMEOSTASIS IN INTERVERTEBRAL DISC CELLS**

Takashi Yurube (1,2), William J. Buchser (3), Robert A. Hartman (4), Pedro P. I. Pohl (1), Michael T. Lotze (3), Nam Vo (1), Gwendolyn A. Sowa (1,4), James D. Kang (1); 1. Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA 2. Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan 3. Department of Surgery, University of Pittsburgh, Pittsburgh, PA 4. Department of Physical Medicine & Rehabilitation, University of Pittsburgh, Pittsburgh, PA

**INTRODUCTION:** Loss of nutrient supply is a likely contributor to disc degeneration.
RESULTS: With nutrient deprivation, cell proliferation and metabolic activity decreased. Then, autophagy markers, LC3 puncta number and LC3-II expression, increased time-dependently. Cytoplasmic HMGB1 intensity also increased following elevated total and nuclear expression. A negatively correlated marker, p62/SQSTM1 expression, decreased over time, all indicating enhanced autophagy. TUNEL, SA-β-gal, cleaved caspase-3, and p16/INK4A analysis indicated increased apoptosis and senescence. Quantitative PCR showed up-regulated MMPs and down-regulated ADAMTSs, TIMPs, aggrecan-1, and collagens under serum starvation. While newly synthesized proteoglycans and collagens decreased, aggrecan degradation increased, notably by MMPs.

DISCUSSION: Nutrient deprivation increases apoptosis and senescence along with autophagy in addition to shifting matrix homeostasis toward catabolism in disc cells—changes consistent with initial stages of disc degeneration. This study suggests a new treatment strategy for degenerative disc disease, autophagy regulation.

SP15
MOLECULAR EFFECTS OF BONE MORPHOGENETIC PROTEIN 13 ON INTERVERTEBRAL DISC CELLS
Twishi Gulati, Aiqun Wei, Sylvia Chung, Ashish D Diwan; Department of Orthopaedic Surgery, St George Hospital Clinical School, University of New South Wales, Sydney, Australia

INTRODUCTION: BMP-13 stimulates proteoglycan production in an ovine disc injury model, however its presence or absence in degenerate disc and its effect on degenerate human IVD cells has not been investigated.

METHODS: 22 IVDs were obtained from patients undergoing either scoliosis or degenerative surgery. Endogenous gene and protein expression of BMP-13 in human degenerate IVD was determined. The effect of rhBMP-13 on human derived nucleus pulposus (NP), annulus fibrosus (AF) and end plate (EP) cells cultured in alginate beads was evaluated by changes in cell viability (DNA content Hoechst dye) and proteoglycan accumulation (Alcian blue stain). The effect of BMP-13 on the expression of chondrogenic genes (Aggrecan, Col1, Col2, COMP, SOX9 using RT-PCR and REST) and proteins (Col1, Col2 ImmunoHistochemistry) by IVD cells was determined. The migratory potential (Boyden Chamber assay) of degenerate disc cells towards BMP-13 was examined.

RESULTS: The endogenous expression of BMP-13 in degenerate NP was not different to non-degenerate disc. While BMP-13 stimulation had a limited effect on the cellular viability of IVD cells, BMP-13 induced significant proteoglycan accumulation in NP, AF and EP cells cultured in alginate beads at a concentration of 400ng/ml after 7 days. REST results showed considerable
variation in the relative change of gene expression amongst four independent NP, AF and EP samples. In NP and EP cells 400ng/ml of BMP-13 increased collagen I and II protein expression. NP cells displayed chemotactic properties towards 800ng/ml of BMP-13 in the absence of fetal calf serum.

**DISCUSSION:** This is the first study to culture human end plate cells in three-dimensional culture and to investigate the effect of BMP-13 on human derived IVD cells. BMP-13 has the potential to enhance proteoglycan accumulation and induce cell migration in certain IVD cells. This data supports further exploration of BMP-13 as a probable therapeutic agent to ameliorate IVD degeneration.

**SP16**

**THE EFFECT OF NERVOUS SYSTEM ACTIVATION BY PAIN STIMULUS OF CAPCISIN INJECTION TO INTERVERTEBRAL DISC**

Hironobu Nishiori1), Kazuyo Yamauchi2), Yoshihiro Sakuma2), Yasuhiro Oikawa2), Kazuhide Inage2), Go Kubota2), Ken Saino2), Miyako Suzuki2), Yukio Nakata2), Jun Sato2), Sadao Arai2), Kazuhisa Takahashi2), Seiji Ohtori2), Sumihisa Orita2); 1) School of Medicine, Chiba University 2) Department of Orthopaedic Surgery, Chiba University

**BACKGROUND:** Previously, it was reported that pain perception is related to not only DRG but also to the reaction of the central nervous system; however, the reaction of the dominant nervous system to pain stimulus in the intervertebral discs is unknown. The purpose of this research was to verify the mechanism of reaction of the nervous system, which controls the intervertebral discs, using chemical pain stimulus.

**METHODS:** We used 6-week-old Sprague Dawley rats, and injected 20 µL capcisin solution, which contains 2% Fluoro- Gold (FG), into the L5/6 intervertebral disc. FG is an antidromic neuronal tracer. Seven days after injection, we prepared perfusion fixation of the rats and extracted DRGs from L1 to L6 along with the lumbar enlargement of spinal cord. At the DRG, we detected CGRP, which is a nociceptive pain-related protein, by immunostaining, and measured the distribution of the expression. At the lumbar enlargement of the spinal cord, we detected Iba1, which is a marker for pain stimulus-activated micro glia, and compared Iba1 expression in the capcisin group and vehicle group, in which we injected only 20 µL saline solution (each n = 5).

**RESULT:** The rate of distribution of CGRP positive cells in the FG positive rats was highest at the L2 DRG, and the rate was higher in the capcisin group (54.9%) than in vehicle group (27.1%), with a statistically significant difference (p < 0.05). The number of Iba1 positive micro glia cells per 1.4 × 10 mm2 was also larger in the capcisin group (31.7 cells) than in the vehicle group (14.8 cells), with a statically significant difference (p < 0.05)

**DISCUSSION:** The results of this experiment suggested that the chemical stimulus to the L5/6 intervertebral disc resulted in an elevated CGRP expression that caused pain around the L2 DRG area, and the mechanism of pain perception is strongly related to the activation of micro glia at the posterior horn of the spinal cord.

**SP17**

**UP-REGULATION OF NAV1.7 IN DORSAL ROOT GANGLIA AFTER INTERVERTEBRAL DISC INJURY IN RATS.**

Aya Sadamasu, MD, Yoshihiro Sakuma, MD, Miyako Suzuki, MD, PhD, Sumihisa Orita, MD, PhD, Kazuyo Yamauchi, MD, PhD, Gen Inoue, MD, PhD, Yasuchika Aoki, MD, PhD, Tetsuhiro Ishikawa, MD, PhD, Masayuki Miyagi, MD, PhD, Hiroto Kamoda, MD, PhD, Gou Kubota, MD; Department of Orthopaedic Surgery, Graduate School of Medi-
a derwent tracer

**OBJECTIVE:** To investigate pain-related expression of NaV1.7 in dorsal root ganglia (DRG) innervating intervertebral discs.

**SUMMARY OF BACKGROUND DATA:** Purpose. The pathophysiology of discogenic low back pain is not fully understood. Prostaglandins and cytokines produced by degenerated discs can cause pain, but nonsteroidal anti-inflammatory and steroid medications are often ineffective at pain reduction. Tetrodotoxin-sensitive voltage-gated sodium (NaV) channels are associated with sensory transmission in primary sensory nerves, and the NaV1.7 channel has emerged as an attractive analgesic target. The purpose of this study was to investigate pain-related expression of NaV1.7 in DRG innervating intervertebral discs.

**METHODS:** Using a rodent model of disc puncture, we labeled DRG neurons innervating L5/6 discs with FluoroGold neurotracer (n = 20). Half of the rats (n = 10) underwent intervertebral disc puncture using a 23-gauge needle (puncture group), and the other half underwent non-puncture sham surgery (non-puncture group). Seven and fourteen days after surgery, DRGs from the L1 to L6 levels were harvested, sectioned, and immunostained for NaV1.7, and the proportion of NaV1.7-immunoreactive DRG neurons was evaluated.

**RESULTS:** NaV1.7 was expressed in DRG neurons innervating intervertebral discs from L1 to L5. The ratio of NaV1.7-expressing DRG neurons to total FG-labeled neurons was 7.2% and 7.6% at 1 and 2 weeks after surgery, respectively, in the non-puncture group and 16.2% and 16.3% at 1 and 2 weeks, respectively, in the puncture group. The up-regulation of NaV1.7 after puncture was significant at both 1 and 2 weeks after surgery (P < 0.01).

Conclusions. We found that disc injury increases NaV1.7 expression in DRG neurons innervating injured discs. NaV1.7 may be a therapeutic target for pain control in patients with lumbar disc degeneration.

**SP18 ABNORMAL CELL METABOLISM IN DEGENERATED INTERVERTEBRAL DISCS: A RESPONSE TO FOCAL DAMAGE AND SWELLING?**

Lama P, H A Claireaux, L Flower, Le Maitre C, Dolan P, Tarlton J, Harding IJ, Adams MA; Centre for Comparative and Clinical Anatomy, University of Bristol, United Kingdom *Biomedical Research Centre, Sheffield Hallam University, United Kingdom ** Department of Orthopaedics, Southmead Hospital, United Kingdom

**INTRODUCTION:** Physical disruption of the extracellular matrix influences the mechanical and chemical environment of intervertebral disc cells. We hypothesise that this can explain degenerative changes such as focal proteoglycan loss, impaired cell-matrix binding, cell clustering, and increased activity of matrix-degrading enzymes.

**METHODS:** Disc tissue samples were removed surgically from 11 patients (aged 34-75 yrs) who had a painful but non-herniated disc. Each sample was divided into a pair of specimens (approximately 5mm3), which were cultured at 37°C under 5% CO2. One of each pair was allowed to swell, while the other was restrained by a perspex ring. Live-cell imaging was performed with a wide field microscope for 36 hrs. Specimens were then sectioned at 5 and 30 µm for histology and immunofluorescence using a confocal microscope. Antibodies were used to recognise free integrin receptor a5b1, matrix metalloprotease MMP-1, and denatured collagen types I-III. Proteoglycan content of the medium, analysed using the colorimetric DMMB assay, was used to assess tissue swelling and GAG loss. Constrained/unconstrained results were compared using matched-pair t-tests.
RESULTS: Time-lapse cinematography revealed small cell movements in un-constrained specimens, for up to 12 hrs. By 36 hrs, unconstrained (free swelling) samples showed greater: loss of GAG’s (p<0.003), loss of integrin binding (p<0.02), synthesis of MMP-1 (p<0.03), and collagen denaturation (p<0.009). Cell clustering was evident in all tissues after 36 hrs.

DISCUSSION: Swelling of disrupted disc tissue allows increased proteoglycan loss, disturbs cell-matrix binding, increases matrix degradation and thus could act as a stimulus for cell cluster formation. This sequence of events could follow disc injury or herniation in-vivo.

SP19
STIFFNESS AFTER FUSION FOR ADULT SPINAL DEFORMITY DOES NOT SIGNIFICANTLY IMPACT PATIENTS’ FUNCTIONAL STATUS OR SATISFACTION
Hiratzka, Jayme R.1; Hamilton, D. Kojo1; Bess, Shay 2; Schwab, Frank J.3; Shaffrey, Christopher I.4; Ames, Christopher P.5; Mundis, Gregory M.6; Lafage, Virginie3; Deviren, Vedat7; Smith, Justin S.4; Klineberg, Eric8; Boachie-Adjei, Oheneba9; Burton, Doug; 1. Orthopaedic Surgery, Oregon Health and Sciences University, Portland, OR, United States. 2. Orthopaedic Surgery, Rocky Mountain Hospital for Children, Denver, CO, United States. 3. Orthopaedic Surgery, NYU Hospital for Joint Diseases, New York, NY, United States. 4. Neurosurgery, University of Virginia Medical Center, Charlottesville, VA, United States. 5. Neurosurgery, University of California, San Francisco Medical Center, San Francisco, CA, United States. 6. San Diego Center for Spinal Disorders, La Jolla, CA, United States. 7. Orthopaedic Surgery, University of California, San Francisco Medical Center, San Francisco, CA, United States. 8. Orthopaedic Surgery, University of California, Davis, Sacramento, CA, United States. 9. Orthopaedic Surgery, Hospital for Special Surgery, New York, NY, United States. 10. Orthopaedic Surgery, University of Kansas Medical Center, Kansas City, KS, United States. 11. ISSGF, Littleton, CO, United States.

INTRODUCTION: The Lumbar Stiffness Disability Index (LSDI) is a validated measure of the effect of spinal stiffness on function following lumbar fusion surgery. No prospective analyses of stiffness impacts following adult spinal deformity surgery have been reported.

METHODS: The LSDI, SRS-22, SF-36 and ODI were administered prospectively at baseline and 2-year minimum followup to 50 adult patients undergoing thoracolumbar fusions to the pelvis for spinal deformity (excluding those with prior history of lumbar fusion). Patients were divided into 2 groups based on upper thoracic (UT, T2-5) or thoracolumbar (TL, T10-T11) proximal endpoints. Comparisons of pre-and post-operative HRQoL and LSDI scores and correlation of LSDI to SRS-22 satisfaction scores were performed.

RESULTS: Significant improvements were seen in both the UT group in ODI (36.4 to 21.8), SRS22 (3.1 to 3.8) and SF-36 PCS (32.1 to 45.0), and in the TL group in ODI (38.8 to 18.4), SRS22 (2.9 to 4.0), SF-36 PCS (30.5 to 44.1) (Table 1). In contrast, LSDI scores did not change from baseline in either group. There was a trend toward higher final LSDI scores among UT compared to TL patients which did not reach significance. No correlation was found between 2-year LSDI and overall SRS-22 satisfaction scores (R2=0.0193).

DISCUSSION: Adult deformity patients undergoing instrumented thoracolumbar fusion to the pelvis report no significant increased difficulty in performing of ADL’s as
a result of increased stiffness at 2 year follow up. While patients fused to the upper thoracic spine trended toward higher LSDI scores than patients with thoracolumbar stopping points, both groups experienced significant improvements in ODI, SRS22 and SF-36 PCS scores. In addition, stiffness as measured by LSDI did not correlate with overall patient satisfaction scores. These results suggest that adult deformity patients experience little increased disability due to stiffness, even after fusion of their entire lumbar spine.

SP20
RISK FACTORS FOR FLOATING SEGMENT DEGENERATION IN ADULTS AFTER LONG SEGMENT FUSION UNTO THE LUMBAR SPINE.

Woojin Cho, MD, PhD, Abhijit Pawar, MD, Andrew Lee, MD, Mike Faloon, MD, Matthew Cunningham, MD, PhD, Bernard Rawlins MD and Oheneba Boachie-Adjei, MD; Albert Einstein College of Medicine

INTRODUCTION: Risk factors for adjacent segment degeneration (ASD) of floating non-fused segments between the long thoracolumbar fusion construct and sacrum after correction of adult spine deformity have been rarely reported.

METHODS: In this retrospective study, medical records of 198 patients with adult spinal deformity who underwent long fusion of 6 segments or more in the thoracolumbar spine for the treatment of adult spine deformity with minimum 2-year follow-up were included. Patients who underwent primary long fusion down to the sacrum, and revision cases were excluded. Out of the 47 patients which matched the criteria, 8 Pts who underwent subsequent surgery extending the fusion to the sacrum were included in the Failed group (F) and 39 Pts were included in the non-failed group (NF). The radiological data at final follow up in NF group and final follow up before revision to sacrum in the F group was compared.

RESULTS: Patient demographics were similar in both groups. The average follow up was 2.9 years in NF and 4.8 years in F. The thoracic and lumbar curve correction was better in the NF as compared to failed group but the difference was not significant. The upper thoracic cobb was smaller in the NF at final f/u. The sagittal balance was significantly better in the NF; however, the coronal balance was similar in both groups at final follow up. The average lumbar lordosis and thoracic kyphosis was significantly better in NF. The average LIV (lowest instrument vertebra) tilt and disc angulation below LIV was smaller in NF. The LIV translation group and preoperative radiographic disc degeneration were higher in F but the difference was not significant. The pelvic tilt (PT) was larger in F while the pelvic incidence was similar.

DISCUSSION: Adequate restoration of Lumbar lordosis, Thoracic kyphosis, LIV tilt, LIV translation, disc angulation, sagittal balance, PT is important to prevent ASD after long fusions unto the lumbar spine.

<table>
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<th>NF</th>
<th>P-value</th>
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<td>2.5</td>
<td>0.01</td>
</tr>
<tr>
<td>LIV translation (cm)</td>
<td>1.7</td>
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<td>0.2</td>
</tr>
<tr>
<td>Pre-op radiographic disc degeneration*</td>
<td>0.62</td>
<td>0.48</td>
<td>0.2</td>
</tr>
<tr>
<td>PT</td>
<td>32.8</td>
<td>18.3</td>
<td>0.02</td>
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<tr>
<td>PI</td>
<td>58.2</td>
<td>53.2</td>
<td>0.2</td>
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</table>

*Disc Degeneration Scale: 0= No degeneration, 1=End plate changes, 2= Disc height change, 3= Sclerosis and significant narrowing of disc

SP21
SAGITTAL SPINAL ALIGNMENT OF DIFFUSE IDIOPATHIC SKELETAL HYPEROSTOSIS IN LUMBAR SPINAL STENOSIS

Yamada Kentaro, Toyoda Hiromitsu, Terai Hidetomi, Takahashi Shinji, Nakamura Hi-
INTRODUCTION: DISH has been considered a radiographic entity with less importance given to clinical signs. Some studies reported postural abnormality in DISH. However, there are no detailed reports regarding spinopelvic alignment in DISH. Sagittal spinal alignment is especially an important factor in the management of lumbar spinal stenosis (LSS). The purpose of this study was to evaluate the characteristics of DISH and its spinopelvic alignment in patients with LSS.

METHODS: A total of 132 patients over 40 years of age who required surgical procedures for LSS were investigated. DISH was defined by Resnick’s and Mata’s criteria on preoperative, standing radiographs of the whole spine. We investigated the prevalence and localization of DISH, and its relation to preoperative clinical symptoms. Sagittal spinal alignment was measured by sagittal C7 plumb line, lumbar lordosis, thoracic kyphosis, sacral slope, pelvic incidence, pelvic tilt, and overhang of S1. The association between DISH and spinopelvic alignment was analyzed using covariance adjusted with age, sex, spondylolisthesis, and degenerative lumbar scoliosis.

RESULTS: The prevalence of DISH was 39.4% (52/132), and increased with aging. Preoperative symptoms showed no differences, regardless of the presence of DISH. Lumber and thoracic alignment showed kyphotic change in DISH. DISH patients with lower fused vertebral ends in the lumbar level (46% of DISH) still showed significantly decreased lumbar lordosis (p=0.014) and horizontalization of the sacrum (p=0.001) after adjusting age, sex, spondylolisthesis, and degenerative lumbar scoliosis.

DISCUSSION: DISH prevalence increases with age, and spinopelvic alignment is affected by the presence of DISH in LSS patients, especially in patients with lower fused vertebral ends at the lumbar lesion. These results may therefore offer an explanation as to why elderly patients frequently show kyphotic changes in their spine.

SP22

RELATIONSHIP BETWEEN SPINAL LOADS AND PHYSIOLOGICAL VARIATIONS OF THE LUMBAR SAGITTAL ALIGNMENT: A NUMERICAL STUDY

Fabio Galbusera (1), Marco Brayda-Bruno (1) and Hans-Joachim Wilke (2); (1) IRCCS Istituto Ortopedico Galeazzi, Milan, Italy (2) Institute of Orthopedic Research and Biomechanics, Ulm University, Ulm, Germany

INTRODUCTION: This study presents a numerical approach to reproduce various patterns of spino-pelvic organization and is aimed to predict the spinal loads in two static conditions (standing and holding a weight in the hands) in the entire range of normal variability of the shape of the lumbar spine.

METHODS: First, a simplified finite element model of a healthy, normal thoracolumbar spine including relevant muscles has been developed, based on a published series of papers. The model was then modified to represent the physiological variation of the sagittal alignment. Following the classification system by Roussouly, 480 finite element models representing the entire range of normal variability were created. The models were based on three independent parameters, namely the sacral slope, the position of the apex and the inflection point. Two load-bearing conditions were simulated: the standing posture, by applying the body weight and optimizing the muscle forces in order to obtain equilibrium; a posture in which the subject is holding a weight of 50 N, by adding a load 40 cm in front of the center of T6.

RESULTS: The models predicted that, even in the case of a moderate external load, a...
well-balanced spine (e.g. type 3) was able to reduce the muscle activation in comparison with a straighter or a hyperlordotic spine. Such a sagittal configuration was however not correlated with a minimization of the loading state in the intervertebral discs, especially regarding anteroposterior shear loads. In the standing posture without any additional load, a less lordotic and more vertical spine (e.g. type 2) was sufficient to ensure a condition of minimal spinal loads.

**DISCUSSION:** Despite some limitations, inverse statics numerical models of the spine biomechanics including trunk muscles appear to be a promising tool to fill the knowledge gap between the clinical observations of the correlations between the spinopelvic organization and the consequent spinal disorders.

**SP23**

**PROGRESSIVE PATTERN OF VERTEBRAL DEFORMITY IN A POPULATION-BASED COHORT STUDY OF VERTEBRAL FRACTURE**

1,2Toshihiro Kato, 1Koji Akeda, 1Koichiro Murata, 1Norihiko Takegami, 1Akinobu Nishimura, 1, 2Ko Kato, 1Akihiro Sudo; 1Department of Orthopaedic Surgery, Mie University Graduate School of Medicine 2 Department of Orthopedic Surgery, Suzuka Kaisei Hospital

**INTRODUCTION:** Vertebral fractures (VFs) may cause spinal deformity and/or chronic back pain. Therefore, epidemiological studies of the natural history of VF are of great importance. Vertebral deformity may progress after VF; however, no detailed investigation of progression patterns has been reported. The purpose of this study was to examine the progression pattern of vertebral deformity in a population-based prospective cohort study.

**METHODS:** Over 10-years (1997-2009), 346 inhabitants (111 men, 235 women: mean age: 70.2 years) of a typical mountain village underwent medical examinations and were followed for more than 4 years. Of these, 196 who had prevalent VFs (450 vertebrae) at baseline (72 men, 124 women: mean age: 69.9 years) were subjects of this study. Lateral thoracic and lumbar spine radiographs of each subject were taken; the extent (G1: mild, G2: moderate, G3: severe) and type (wedge, biconcave, crush) of the prevalent fractures at baseline and final examination were evaluated using a semi-quantitative technique. The progression of deformity was divided into 3 groups by comparing the deformity at baseline and final examination: no change (NC), grade-progressed (GP) and type-changed (TC) groups.

**RESULTS:** Deformity extent at baseline (G1:80%, G2:16%, G3:4%) progressed compared to that at final examination (G1:60%, G2:29%, G3:11%). The percentage of G1 decreased, and G2 and G3 increased at final examination (P<0.05). There were no significant changes on type of deformity at baseline compared to that at final examination. However, biconcave type deformity (NC 59%, GP 29%, TC 12%) at baseline had a significant effect on both the extent and type of deformity at final examination compared to wedge type (NC:73%, GP:17%, TC:10%) and crush type (NC:86%, GP:7%, TC:7%).

**DISCUSSION:** This study showed that the extent of vertebral deformity in the elderly progressed with age. A biconcave type deformity at baseline may change the extent and type of deformity.

**SP24**

**CLINICAL OUTCOME AFTER LUMBAR DECOMPRESSION SURGERY WAS NOT ASSOCIATED WITH PREOPERATIVE SAGITTAL ALIGNMENT.**

Tomohiro Hikata1, Kota Watanabe2, Nobuyuki Fujita1, Akio Iwanami1, Naobumi Hosogane1, Ken Ishii1, Masaya Nakamura1, Yoshiaki Toyama1 and Morio Matsumoto1; 1Department of Orthopaedic Surgery,
SPECIAL POSTERS

_**School of Medicine, Keio university., Tokyo, Japan. 2Advanced Therapy for Spine and Spinal Cord Disorders, Keio University., Tokyo, Japan.**_

**INTRODUCTION:** Sagittal spinal alignment is an important factor in the management of lumbar degenerative diseases. The purpose of this study was to investigate the correlation between preoperative sagittal spinopelvic alignment and improvement of clinical outcome after decompression surgery for lumbar canal stenosis (LCS).

**METHODS:** 132 patients who underwent elective lumbar spinous process-splitting laminectomy from 2009 to 2011 were retrospectively reviewed. There were 75 men and 57 women with a mean age of 71.2 years. The mean follow-up (f-u) period was 26.2 months (minimum 1Y f-u). The subject was divided into three groups according to the preoperative sagittal vertical axis (SVA) value: the patients with SVA less than 50 mm (Group A), those with SVA from 50 to 80 mm (Group B), and those with SVA more than 80 mm (Group C). Radiologic parameters including lumbar Cobb angle, coronal balance, SVA, lumbar lordosis, thoracic kyphosis, thoracolumbar kyphosis, Pelvic Incidence (PI), Pelvic Tilt (PT), Sacral Slope (SS)) were measured before surgery. The JOA score and JOA Back Pain Evaluation Questionnaire (JOABPEQ), VAS score, and RDQ score were used for clinical evaluation.

**RESULTS:** There were 83 patients in Group A, 34 patients in Group B, and 15 patients in Group C, respectively. The preoperative mean SVA was 21.2mm in Group A, 61.2mm in Group B, and 11.4 mm in Group C, respectively. Preoperative LL and SS were significantly smaller in Group C (LL;15.7°, SS;19.2°), than Group A (LL;39.9°, SS;26.9°) (p<0.01). Preoperative PT was significantly larger in Group C (27.8°), than Group A (20.2°) (p<0.05). There were no significant differences in the improvement of various questionnaires.

**DISCUSSION:** The loss of lumbar lordosis and pelvic retroversion were presented in the LCS patients with preoperative sagittal imbalance. Interestingly, preoperative sagittal alignment does not affect postoperative clinical outcomes after posterior decompression surgery for LCS.

**SP25**

**SHEAR MODULUS OF THE HUMAN NUCLEUS PULPOSUS MEASURED USING MR ELASTOGRAPHY CORRELATES WITH DIRECTLY MEASURED MECHANICAL PROPERTIES**

Daniel H. Cortes (1), John F. DeLucca (1), Jeremy F. Magland (2), Alexander A. Wright (2), Dawn M. Elliott (1); (1) Biomedical Engineering Program, University of Delaware, Newark DE 19716 (2) Department of Radiology, University of Pennsylvania, Philadelphia PA 19104

**INTRODUCTION:** Our group recently demonstrated that Magnetic Resonance Elastography (MRE) can serve as a non-invasive biomarker for disc degeneration, where the nucleus pulposus (NP) mechanical properties are significantly altered with degeneration (Cortes et al, Magn Res Med 2013). However, the MRE measurements were not directly compared to standard tissue mechanical tests. The objectives of this study were to validate MRE measurements by comparing the shear modulus to that of excised NP samples, and to quantify the contribution of the intradiscal pressure and glycosaminoglycan (GAG) content to the MRE shear modulus.

**METHODS:** The NP shear modulus was measured using MRE in 16 intact human bone-disc-bone segments from levels T12-L5 having degeneration grades from 1 to 4. NP samples were then dissected and tested in confined compression where the swelling pressure and the shear modulus were determined. The GAG content was measured using a DMBB assay.
RESULTS: There was a correlation between MRE shear modulus and confined compression shear modulus \( r = 0.57, p < 0.05 \) (Figure 1). There was also a correlation between MRE shear modulus and the isometric swelling pressure \( r = 0.51, p < 0.05 \). However, no correlation was observed between the MRE shear modulus and the GAG content.

DISCUSSION: This study validated the MRE measurements by comparing the NP shear modulus to those directly measured. The correlation between isometric swelling pressure and the MRE shear modulus suggests a contribution of the intradiscal pressure to the MRE shear modulus. This effect has been recently reported in experiments in articular cartilage where the shear modulus increased for higher osmotic pressures. The shear modulus measured using MRE is a potential biomarker for disc degeneration to directly evaluate the mechanical integrity of disc tissues.

SP26

BIOMECHANICAL ANALYSIS OF THE INFLUENCE OF INTERVERTEBRAL DISC DEGENERATION ON THE LUMBAR SPINE.

Won Man Park1, Dae Kyung Choi1, Kyungsoo Kim2, Yoon Hyuk Kim1; 1Department of Mechanical Engineering, Kyung Hee University, Korea 2Department of Applied Mathematics, Kyung Hee University, Korea

INTRODUCTION: Intervertebral disc (IVD) degeneration disease is one of the most common reasons of low back pain. In spite of a number of previous experimental and numerical studies, alteration of stiffness of motion segment by degeneration is still controversial. Furthermore, the effects of various degrees of degeneration on biomechanical behaviors at the degenerated and healthy levels are not clearly determined.

METHODS: Finite element models of the lumbar spine with various degrees of IVD degeneration at the L4-L5 motion segment unit (MSU) were developed and validated with comparing to experimental results. 20%, 50% and 80% loss of disc height were applied for mild, moderate and severe degeneration, respectively. Biomechanical behaviors at the degenerated and adjacent MSUs were investigated in hybrid loading condition.

RESULTS: The ranges of motions (ROMs) of flexion-extension and left-right lateral bending at the degenerated MSU decreased with progress of degeneration, while the ROMs in left-right axial rotation slightly changed by progress of degeneration. Intradiscal pressure (IDP) at the degenerated MSU decreased with progress of degeneration in flexion, lateral bending, and axial rotation, while the pressures at the adjacent MSUs increased in flexion and lateral bending. Facet joint force at the degenerated MSU decreased from 113N (healthy) to 41N (severe) in extension with progress of degeneration, while the force increased from 96N (healthy) to 137N (severe) in left axial rotation.

DISCUSSION: According to these findings, IVD degeneration could reduce the risk of age-related instability and discogenic pain at the degenerated MSU since the stiffness was increased and the IDP was decreased.
SP27
ESCAPE-AVOIDANCE COPING STRATEGY FOR PSYCHOSOCIAL STRESS IS ASSOCIATED WITH CHRONIC LOW BACK PAIN IN COLLEGE STUDENTS: A PROSPECTIVE COHORT STUDY
Kinshi Kato; Miho Sekiguchi; Takuya Nikido; Ken-ichi Otoshi; Yohei Matsuo; Shin-ichi Kikuchi; and Shin-ichi Konno; Department of Orthopaedic Surgery, Fukushima Medical University School of Medicine, Fukushima, Japan

INTRODUCTION: Psychosocial stress may affect the incidence and duration of low back pain (LBP); however, few longitudinal studies have examined whether specific stress coping strategies affect LBP. The purpose of this cohort study was to assess the association between specific coping strategies and the incidence and duration of LBP in college students.

METHODS: A longitudinal study was initiated among 135 students without LBP in July 2011. We reviewed LBP characteristics and assessed the psychosocial stress and coping strategies of students using the Stress Self-Rating Scale (SSRS). A follow-up survey was conducted in July 2013, analyzing all 135 students (follow-up rate, 100%). Coping strategies in students were categorized into the following three groups using SSRS scores: problem-focused (PF); emotion-focused (EF); and escape-avoidance (EA). Incidence and duration of new-onset LBP were evaluated in each coping strategy group. Wilcoxon and chi-square tests were used for statistical analyses.

RESULTS: Sixty-three (46.7%) students reported LBP during the 2-year follow-up. No significant differences were observed among the three groups in sex, body mass index, current smoking status, sleep time, past or family history of LBP, or physical activity. Furthermore, no significant differences were observed in the incidence rate (PF, 55.6%; EF, 46.3%; and EA, 45.3%) of LBP. However, the incidence of chronic LBP, defined as LBP duration >3 months, was significantly greater in the EA group than in the other groups (4.8% vs. 0%; p = 0.034).

DISCUSSION: Differences in stress coping strategies did not affect the incidence of new-onset LBP; however, the EA coping strategy increased the incidence of chronic low back pain in students compared with other coping strategies. The EA coping strategy for psychosocial stress may thus prolong the duration of LBP.

SP28
DOES THE CHANGE OF WEATHER CONDITION INFLUENCE PAIN LEVEL OF SYMPTOMS IN THE PATIENTS WITH LUMBAR SPINE DISEASES?
1,13Ishii Ken, 3,13Hosogane Naobumi, 1,13Hikata Tomohiro, 1,13Yoshioka Kenji, 2,13Shiono Yuta, 5,13Iida Tsuyoshi, 6,13Ozaki Masahiro, 1,13Ishihama Hiroko, 1,13Horiuchi Yosuke, 1,13Takahashi Yohei, 7,13Furukawa Mitsuru, 8,13Nagoshi Shigeito, 6,13Shingo I; 1 Department of Orthopedic Surgery, School of Medicine, Keio University, Shinjuku, Tokyo, JAPAN 2 Nerima General Hospital, Nerima, Tokyo, JAPAN 3 Department of Orthopedic Surgery, National Defense Medical College, Tokorozawa, Saitama, JAPAN 4 Keiyu Orthopedic Hospital, Tatebayashi, Gunma, JAPAN 5 Kawasaki Municipal Hospital, Kawasaki, Kanagawa, JAPAN 6 National Organization Saitama Hospital, Wako, Saitama, JAPAN 7 Keiyu Hospital, Yokohama, Kanagawa, JAPAN 8 National Organization Murayama Hospital, Musashimurayama, Tokyo, JAPAN 9 Saisei-
**INTRODUCTION:** Although it was previously reported that the weather conditions aggravate the symptoms in patients with musculoskeletal disorders such as rheumatoid arthritis, it is still unknown in lumbar diseases. The purpose of this study was to examine the correlation between the weather conditions and symptoms in lumbar diseases.

**METHODS:** 157 patients, who were treated for lumbar diseases with substantial low back pain and leg pain/numbness in participating hospitals in Tokyo area, were candidate for this study. There were 67 men and 90 women with a mean age of 71.2 years. The patients were asked to rate their daily symptoms with numeric rating scale (NRS) at evening every day, starting on November, 2012 for 30 days. Center for Epidemiologic Studies Depression (CESD) scale and clinical information were also obtained. The official local weather parameters such as temperature, barometric pressure, and relative humidity were collected from Japan Meteorological Agency database. We evaluated the correlation between average NRS scores obtained from each day and each weather parameter.

**RESULTS:** CESD scale was not correlated with all average NRS from low back pain, buttock and leg pain/numbness. Average NRS of low back pain tend to be negatively correlated with average and highest temperatures, but not with relative humidity (r=-.358, -.346, -.012). Average NRS of leg pain and buttock numbness were strongly correlated with temperatures (average: r=-.490, -.642; highest: -.553, -.552; lowest: -.374, -.600). Interestingly, only barometric pressure impacted NRS of low back and leg pain with positive significant correlation (r=.400, .403).

**DISCUSSION:** This is the first study to show the significant negative correlation between leg pain/buttock numbness and temperature in patients with lumbar diseases. The magnitude of the direct correlation between low back/leg pain and barometric pressure was large, reflecting time lag between barometric pressure and other weather parameter.

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**SP29**

**THE SIGNIFICANCE OF PAIN CATASTROPHIZING IN THE CLINICAL MANIFESTATIONS OF PATIENTS WITH LUMBAR SPINAL STENOSIS: MEDIATION ANALYSIS WITH BOOTSTRAPPING**

Ho-Joong Kim, Chan-Hee Cho, Kyoung-Tak Kang, Bong-Soon Chang, Choon-Ki Lee, Jin S. Yeom; Spine Center and Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital

**INTRODUCTION:** Pain intensity in various chronic pain disorders has been associated with catastrophizing. Considering the
pathomechanism and clinical symptoms of lumbar spinal stenosis (LSS), pain catastrophizing could be associated with pain intensity and disability in patients with LSS. The purpose of this study was to determine whether catastrophizing mediates increased pain intensity and disability in patients with degenerative LSS using mediation analysis with bootstrapping.

METHODS: Ninety-five patients with degenerative lumbar spinal stenosis who were scheduled to undergo spine surgery were included in this study. Data on detailed medical history, physical examination, and series of questionnaires were collected, including walking distance in a single trial without rest, Pain Catastrophizing Scale (PCS), Oswestry Disability Index (ODI), and Visual Analog Pain Scale (VAS) for back and leg pain. Radiologic analysis was performed using magnetic resonance imaging findings. Canal stenosis was graded using the method described by Schizas et al. Multivariate statistical analysis was performed with variables, including symptom severity, disability, and PCS.

RESULTS: Pain catastrophizing demonstrated a significant positive association with pain intensity and disability represented by VAS for back and leg pain and ODI scores. There was no significant association between the grade of canal stenosis and VAS for back or leg pain. The mediation analysis confirmed the mediating role of VAS for back pain in the relationship between PCS and ODI. Furthermore, multivariate regression analysis with bootstrapping demonstrated that the PCS significantly mediated the gender differences in VAS for back pain and ODI (Figure 1).

DISCUSSION: Pain catastrophizing was a mediator of gender differences for back pain and disability in patients with LSS. In addition, pain catastrophizing was associated with disability in LSS, which was partially mediated by increased back pain intensity.

SP30

CLINICAL EFFECTIVENESS OF TWO-LEVEL TRANSFORAMINAL EPIDURAL STEROID INJECTIONS: A SUB-GROUP ANALYSIS

George C Christolias, M.D. Jaspal R. Singh, M.D.; Weill Cornell Medical College - Division of Rehabilitation Medicine

INTRODUCTION: The purpose of this study was to assess the clinical effectiveness of two-level transforaminal epidural steroid injection (TFESI) in patients with radiculitis or radiculopathy. This study was a retrospective observational series at a single academic physiatry pain management practice. Two-level transforaminal epidural steroid injections may be more effective in a sub-group of patients with radicular pain.

METHODS: Subjects were assessed with a pain numerical rating scale (NRS 0-10) and Oswestry Disability Index (ODI) prior to TFESI and at 2 weeks and 2 months follow up. Successful pain relief (responders) were defined as greater than 50% reduction in NRS or greater than 40% reduction in ODI. Magnetic resonance imaging (MRI) was viewed on each subject and lumbar pathology was categorized as central, paracentral, foraminal, or other disc morphology.

RESULTS: 721 patients were included in this study having undergone a two-level transforaminal epidural steroid injection. As a group, there was a statistically significant (P<0.05) reduction in both NRS and ODI at all-time points. 62% of patients were responders in terms of NRS and 58% responded on ODI. In sub-group analysis, subjects with a paracentral disc herniation had an increased number of responders, 76% on NRS and 74% on ODI.
SPECIAL POSTERS

DISCUSSION: This retrospective observational study suggests that TFESIs are clinically effective in the treatment of lumbar radicular pain. More significantly, in patients with a paracentral disc herniation, two-level TFESIs may provide greater relief than a single level injection.

SP31
EVALUATION OF THE CORRELATION AMONG THE EXPRESSION OF INFLAMMATORY CYTOKINES, DEGENERATION OF THE INTERVERTEBRAL DISC, AND PROMINENT SYMPTOMS IN DEGENERATIVE HUMAN LUMBAR INTERVERTEBRAL DISCS

INTRODUCTION: Low back pain (LBP) disease is reportedly associated with inflammatory cytokines such as tumor necrosis factor (TNF-a) and interleukin-6 (IL-6), as well as with nerve growth factor (NGF) that is expressed in increased amounts within degenerative intervertebral discs (IVDs). In the present study, we aimed to assess the correlation between the local expression of TNF-a, IL-6, and NGF within degenerative human lumbar IVDS and the degree of degeneration, as well as the correlation between the expression of these mediators and the prominent symptoms.

METHODS: In total, 58 IVD samples of patients who underwent surgery for various lumbar disorders were examined. The expression level of these mediators in each sample was determined using enzyme-linked immunosorbent assay. The samples were grouped according to the degree of IVD degeneration using Pfirrmann grading on magnetic resonance imaging, and the grades were correlated with the individual expression levels. The chief complaints of the patients were then recorded and assigned to the LBP group and the leg pain group, and were compared with the individual expression levels.

RESULT: A gradual increase in TNF-a (R: 0.391) and IL-6 (R: 0.388) expression levels were observed with a progression in the degree of degeneration, but NGF (R: -0.164) exhibited a minimal decrease in the expression level. With regard to the chief complaints, the LBP group only exhibited a significant increase in the TNFa expression level.

DISCUSSION: We noted a trend of increasing expression levels of TNF-a and IL-6 with the progression of IVD degeneration, which indicates that these cytokines may have an important role in the degenerative process of IVD at any stage. Moreover, NGF may have an important effect during the early stage of the progression of degeneration. With regard to the symptoms, TNF-a expression was significantly greater in the LBP group. Thus, we propose that TNF-a may be significantly involved in LBP.

SP32
TISSUE ENGINEERED INTERVERTEBRAL DISC (IVD) WITH EITHER POLY E-CAPROLACTONE (PCL) OR POLY(E-CAPROLACTONE-CO-LACTIDE (PLCL) NANOFIBER
Yon Jin Chuah*1, Yuejun Kang*1, Hwan Tak Hee*1,2; *1 Nanyang Technological University, School of Chemical and Biomedical Engineering, Singapore *2 Nanyang Technological University, School of Physical and Mathematical Sciences, Singapore

INTRODUCTION: Low back pain due to intervertebral disc (IVD) degeneration is associated with significant health and economic burden to the society. Current surgical treatments such as spinal fusion or arthroplasty have their limitations in restoring normal function. Tissue engineering is potentially a more physiological approach to IVD regeneration. While many authors have
developed IVD constructs, they look different from the micro-architecture of the native IVD. Hence, the mechanical properties associated with the native IVD are still lacking in these constructs. In our study, we aim to develop an IVD construct with micro-architecture similar to the native disc.

**METHODS:** Mesenchymal stem cells (MSCs) were seeded onto electrospun PCL or PLCL nanofibrous sheet, and induced to form a layer of collagen type 1 cell sheet prior to forming a multiple annular lamellae construct. MSCs were encapsulated in hyaluronic acid hydrogel, and inserted into the centre of the annular lamellae, thus forming the nucleus pulposus. The engineered disc would then be subjected to chondrogenic differentiation. Cell viability, mechanical and biochemical composition were evaluated.

**RESULTS:** Cell proliferation was observed over 14 days on the nanofibrous sheet, with presence of collagen 1 production. After forming the disc construct, viable cells with minimal cell death were observed. Cell distribution displayed distinct cellular phenotypes similar to native IVD. The cells in the constructed nucleus pulposus were rounded while the annulus cells were elongated. Biochemical composition of the disc resembled closely to those found in native IVD. Mechanical strength of PLCL IVD constructs were higher as compared to PCL IVD constructs.

**DISCUSSION:** We have designed a composite IVD with micro-architecture and biological features similar to that of a native IVD. Given the appropriate culture conditions, other types of stem cells can be incorporated and differentiated to the respective tissues.

**SP33**

**HIGH GLUCOSE-INDUCED OXIDATIVE STRESS ACCELERATES THE PREMATURE STRESS-INDUCED SENECESSCE OF RAT NOTOCHORDAL CELLS THROUGH MITOCHONDRIAL DAMAGE**

Jong-Beom Park, MD and Eun-Young Park, PhD Eun-Young Park, PhD; Department of Orthopedic Surgery, Uijeongbu St. Mary's Hospital, The Catholic University of Korea, Korea

**INTRODUCTION:** A glucose-mediated increase of oxidative stress is a major causative factor for the development of diseases associated with DM through senescence. DM is also thought to be an important etiologic factor for intervertebral disc degeneration. The aim of this study was to investigate the effect of high glucose on mitochondria damage, oxidative stress, senescence of notochordal cells, and the intervertebral disc degeneration.

**METHODS:** Notochordal cells were isolated from 4-week-old young rats, cultured and placed in either 10% FBS or 10% FBS plus two high glucose concentrations (0.1M and 0.2M) for 1 day and 3 days. We identified and quantified the mitochondrial damage, oxidative stress (ROS), and antioxidants (MnSOD and catalase) for each condition. We also identified and quantified the occurrence of senescence and telomerase activity. Finally, the expressions of proteins were determined related to replicative senescence (p53-p21-pRB) and stress-induced senescence (p16-pRB).

**RESULTS:** Two high glucoses enhanced the disruption of mitochondrial damage and generation of ROS in notochordal cells with a dose- and time-dependent manner. The
expressions of MnSOD and catalase were enhanced in the notochordal cells treated with both high glucoses. The telomerase activity declined in a dose- and time-dependent manner. Two high glucoses increased the occurrence of senescence in a dose- and time-dependent manner. Both high glucoses increased the expressions of p16 and pRB proteins but decreased the expressions of p53 and p21 proteins.

**DISCUSSION:*** The current study demonstrated that despite the compensatory expression of antioxidants, a high glucose-induced oxidative stress accelerates premature stress-induced senescence in rat notochordal cells with a dose- and time-dependent manner. These results suggest that the strict blood glucose control is important to prevent or to delay premature intervertebral disc degeneration in younger patients with DM.

**SP34**

**TRANSCRIPTIONAL CHANGES IN NUCLEUS PULPOUS INTERVERTEBRAL DISC CELLS DUE TO HIGH OSMOLALITY, AS REVEALED BY CDNA MICROARRAY ANALYSIS**

Eleni Mavrogonatou 1, Vassilios Papadopoulos 2, Jill Urban 3 and Dimitris Kletsas 1; 1 Laboratory of Cell Proliferation & Ageing, Institute of Biosciences and Applications, NCSR “Demokritos”, 153 10 Athens, Greece 2 The Research Institute of the McGill University Health Centre, McGill University, Montreal, Canada 3 Department of Physiology, Anatomy and Genetics, University of Oxford, Oxford, UK

**INTRODUCTION:** Fluctuations in extracellular osmolality resulting from intervertebral disc’s specific physicochemical environment, daily activities or degeneration are an everyday experience for nucleus pulposus (NP) cells. Our aim was to investigate the effect of these changes on the transcriptional profile and physiological responses of NP cells.

**METHODS:** The Affymetrix Gene Chip Bovine Genome Array, specifically designed to monitor the expression of approximately 23,000 Bos taurus transcripts, was used in this study. Primary analysis was performed using the Affymetrix Expression Console and the PLIER algorithm and concurrent annotations in the gene lists were analyzed using GeneCodis. The differential expression of selected genes was verified by RT-qPCR, while functional analysis was performed in order to determine the physiological role of these molecules in NP cells’ osmo-regulatory responses.

**RESULTS AND DISCUSSION:** We have already shown that hyperosmotic stress hinders cellular proliferation by activating a p38 MAPK-mediated G2 growth arrest and by provoking DNA damage that leads to a p53-dependent block in the G1 phase of the cell cycle [DNA Repair (Amst). 2009 Aug 6;8(8):930-43]. These effects seem to stem from cell volume alterations rather than from elevated intracellular ionic concentration [J Cell Physiol. 2012 Mar;227(3):1179-87]. When NP cells were investigated at the transcriptome level using the genome array technology, hundreds of genes were found to be differentially expressed after a hyperosmotic treatment. Among these, seven genes encoding cell membrane ion transporters were up-regulated by high osmolality, while two were down-regulated. These results were validated by real-time PCR in cells cultured in 2D-cultures or in alginate beads. siRNA-mediated loss-of-expression of the up-regulated transporters revealed that the transporters’ expression is crucial for the response of NP cells to hyperosmotic stress.

**SP35**

**QUANTITATIVE DETECTION OF PROTEOGLYCAN IN INTERVERTEBRAL DISC BY ITIP GAGCEST**

1Wen Ling, 2Rob Hartman, 1,3Francesca Nicholls, 1Tao Jin, 2Nam Vo, 2Gwendolyn
Sowa, *1Michel Modo, *1Kyongtae Ty Bae, *2James Kang; 1Dept. of Radiology; 2Dept. of Orthopaedic Surgery; 3Dept. of Neuroscience, King’s College London

**INTRODUCTION:** Loss of proteoglycan (PG) in nucleus pulposus (NP) marks early disc degeneration. MRI methods used to assess NP changes are limited by lack of PG specificity and sensitivity. One method, gag CEST, has qualitatively detected discal PG content. A recent advance called iTIP gagCEST enables more sensitive PG quantification. The objective of this study is to apply this new method to discs by comparing iTIP gagCEST to gagCEST and conventional methods T1rho, T2 and T1 (using their reciprocal rates, R1rho, R2 and R1), by scanning a series of chondroitin sulfate (CS)-collagen-I phantoms and a lumbar disc.

**METHOD:** Five phantoms are constructed with 0%, 3%, 6%, 9%, and 12% (w/w) of a major PG constituent, CS, dissolved in 1% collagen I. A rabbit lumbar disc (n=1) was obtained within 3 hours of sacrifice. A 9.4T Varian scanner with Agilent VNMRJ software was used. Contrast of gagCEST is a function of magnetization when irradiated at chemical shift delta. In iTIP gagCEST, asymmetry of delta, R1rho,asym, provides contrast. For both methods, spin-lock power (w1 = 4.22uT) was applied (0.3s). R1rho was conducted with w1=93.9uT (50-500ms); R2 was acquired with multi-echo multi-slice technique, and R1 was measured by inversion-recovery.

**RESULTS:** Conventional gagCEST is not correlated with CS concentration (Fig.1b) while iTIP gagCEST (Fig.1a) demonstrates a linear correlation (R2=0.99) (Fig.1c). Unlike R1rho,asym, phantom results for R1rho, R2 and R1 (Fig.1d) exhibit significant offsets from 0, demonstrating collagen dependency. R1rho,asym is compared to R1rho in the rabbit disc (Fig.1e&1f), and R1rho maps are complicated by signal changes with both PG and collagen whereas R1rho,asym reflects PG content only.

**DISCUSSION:** iTIP gagCEST can quantitatively measure PG content with improvements over gagCEST. The correlation between the contrast of iTIP gagCEST and PG content, unlike R1rho and R2, which are commonly used to assess PG in NP, is not influenced by collagen.

**SP36**

HOW LONG SHOULD TERIPARATIDE BE USED TO ACCELERATE LUMBAR POSTEROLATERAL FUSION IN WOMEN WITH POSTMENOPAUSAL OSTEOPOROSIS?

PURPOSE: We have reported that daily subcutaneous injection of teriparatide (parathyroid hormone) significantly improved bone union after instrumented lumbar posterolateral fusion in women with postmenopausal osteoporosis compared with oral administration of bisphosphonate. However, the most effective duration of teriparatide use for spinal fusion has not yet been explored.

METHOD: Forty-five women with osteoporosis diagnosed with degenerative spondylolisthesis were divided into 3 teriparatide treatment groups: a short-duration treatment group (average 5.5 months: n = 15; daily subcutaneous injection of 20 microgram of teriparatide), a long-duration treatment group (average 13.0 months: n = 15; daily subcutaneous injection of 20 microgram of teriparatide), and a bisphosphonate treatment group (average 13.0 months: n = 15; weekly oral administration of 17.5 mg of risedronate). All patients underwent 1- or 2-level instrumented posterolateral fusion with a local bone graft. Fusion rate and duration of bone union were evaluated 2 years after surgery.

RESULTS: The rate of bone union and duration of bone union was 92% and 7.5 months for patients in the long-duration treatment group, 80% and 8.5 months in a short-duration treatment group, and 70% and 10.0 months in the bisphosphonate treatment group. The rate of bone union and average duration of bone union in patients in the teriparatide treatment groups were significantly superior to those in the bisphosphonate treatment group (P < 0.05). The rate of bone union and average duration of bone union in patients in the long-duration treatment group were significantly superior to those in the short-duration treatment group (P < 0.05).

DISCUSSION: Daily subcutaneous injection of teriparatide for bone union was more effective than oral administration of bisphosphonate. Furthermore, a longer peri

SP37

BIOMECHANICAL EFFECT OF THE PROGRESSION OF LOWER LUMBAR DISC DEGENERATION ON ADJACENT DISCS.

Natarajan RN, Andersson GB; Dept. of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL

INTRODUCTION: When lumbar disc degeneration occurs at one or at multiple levels, whether treated or not, degeneration frequently develops at mobile segments above or below the degenerated segments referred to adjacent segment disc disease (ASDD) causing pain and necessitate further surgical intervention. Aim of the current study is to understand how progressive degeneration at segments such as L4/5 or L5/S1 affects the biomechanics of the adjacent segments.

METHODS: Poro elastic finite element model of a lumbar spine with degenerated discs was validated using “specimen specific” models. Eight different models representing four different grades of disc degeneration (Thompsons Grades 2 to 5) either at L4/5 or at L5/S1 level were created. A hybrid approach was used for analyzing all the above models. The results provided understanding on how biomechanical motions at the segments adjacent to degenerated disc depend on (a) severity of disc degeneration, and (b) level at which degeneration occurred.

RESULTS: Larger increase in adjacent segment motion was seen when L4/L5 segment was degenerated (larger by 6% in flexion, 31% in extension, 0% in torsion and 21% in lateral bending) as compared to L5/S1 degeneration. With a degenerative grade V in either one of the two levels L4/L5 or L5/S1, the analysis also showed that the maximum percentage increase in segmental motions
occurred at a skipped segment (maximum at L2/L3 in flexion and L1/L2 under lateral bending).

**CONCLUSIONS**: Degeneration at L4/5 level and not L5/S1 level causes larger increase in adjacent segment motions leading to the conclusion that chances of developing ASDD is greater when L4/5 level degenerates. The study also showed that chances of ASDD is highest in the presence of grade V discs at L4/5 and/or L5/S1. Contrary to the belief, the study also showed that maximum increase in motions due to degeneration need not occur at discs adjacent to the degenerated disc.

**SP38**

**EFFICACY OF TRANSFORAMINAL EPIDURAL STEROID INJECTION ACCORDING TO NERVE ROOTS ENHANCEMENT**

Hyeong Jun Tak, M.D., Hee Kyung Cho, M.D., Yun Woo Cho, M.D., Sang Ho Ahn, M.D., PhD.; Departments of Physical Medicine and Rehabilitation, College of Medicine, Yeungnam University, Daegu 705-717, Korea

**INTRODUCTION**: The radicular pain is the result of nerve roots mechanical compression and chemical inflammations. In contrast magnetic resonance (MR) images, the enhanced nerve root is associated with chemical inflammatory reactions. To control the radicular pain, fluoroscopic-guided transforaminal epidural steroid injection (TFESI) is beneficial therapeutic method. However, there have been few studies about efficacy of TFESI for radicular pain according to nerve roots enhancement on contrast MR images. In current study, we evaluated the effectiveness of TFESI according to enhancement of nerve roots in managing the radicular pain due to herniated lumbar disc.

**METHOD**: From a 352 patients undertaken contrast enhanced MR and TFESI for radicular pain, 37 patients were selected by inclusion criteria. The patients were classified into two groups according to nerve roots enhancement; enhanced group and non-enhanced group. Then, the enhanced group was divided into two subgroups; pre-dorsal root ganglionic (DRG) only enhanced group and pre-DRG & post-DRG enhanced group, based on spreading pattern of enhancement. Clinical outcomes were evaluated by the Numeric rating scale (NRS) for leg pain and Oswestry disability index (ODI) at pre-treatment, 1, and 4 weeks after treatment.

**RESULTS**: At 1 week after treatment, significant improvement was observed in NRS and ODI compared with pretreatment, and maintained until 4 weeks after treatment (P<0.05). The improvement of NRS and ODI in enhanced group was significantly greater than those of non-enhanced group, at 1, 4 weeks after TFESI respectively (P<0.05). However there was no significant difference in improvement of NRS and ODI between pre-DRG only enhanced group and pre-DRG & post-DRG enhanced group at 1, 4 weeks after TFESI.

**CONCLUSION**: The improvement of NRS and ODI in enhanced group was significantly greater than those of non-enhanced group after TFESI.

**SP39**

**INFLUENCE OF EDUCATIONAL ATTAINMENT AND CATASTROPHIZING ON PAIN INTENSITY AND DISABILITY IN PATIENTS WITH LUMBAR SPINAL STENOSIS – MEDICATION ANALYSIS WITH BOOTSTRAPPING**

Ho-Joong Kim, Sung-Chan Kim, Kyoung-Tak Kang, Bong-Soon Chang, Choon-Ki Lee, Jin S. Yeom; Spine Center and Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital

**INTRODUCTION**: The purpose of this study was to investigate the influence of educational attainment on the level of pain intensity and disability in patients with lumbar
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spinal stenosis (LSS) and determine how coping behavior, such as catastrophizing, may mediate the association between educational attainment and clinical impairments.

METHODS: 155 patients who were diagnosed as degenerative LSS were participated in the study. Data on detailed medical history, physical examination, and series of questionnaires were collected, including Pain Catastrophizing Scale (PCS), Oswestry Disability Index (ODI), and Visual Analog Pain Scale (VAS) for back and leg pain. For measures of socioeconomic status, educational attainment and occupation were assessed. Radiologic analysis was performed using magnetic resonance imaging findings and computed tomography. After adjustment of covariates, multivariate regression analysis was used to assess each component of the proposed mediation models among VAS for back/leg pain, ODI, the level of education, occupation and PCS. Mediation was also assessed by the bootstrapping technique.

RESULTS: Educational attainment was negatively correlated with pain intensity, disability, and catastrophizing. Pain catastrophizing were also significantly correlated with disability and pain intensity for back/leg pain in the patients with LSS. In the relationship among variables, the mediation analysis with bootstrapping clearly showed the role of catastrophizing in the mediation between VAS for back pain/leg pain, ODI and the level of education (Figure 1).

DISCUSSION: The present study demonstrated that lower educational attainment was associated with increased pain intensity and disability in patients with LSS, which was mediated by the coping mechanism, catastrophizing.

SP40
THE INFLUENCE OF ASYMPOTOMATIC STENOSIS ON FIVE-YEAR RESULTS OF SELECTIVE DECOMPRESSION OF ONLY SYMPTOMATIC LEVELS FOR LUMBAR SPINAL STENOSIS

Kazuyuki Watanabe, Koji Otani, Takuya Nikaio, Kinshi Kato, Shoji Yabuki, Shin-ichi Kikuchi, Shin-ichi Konno; Department of Orthopaedic Surgery, Fukushima Medical University School of Medicine

INTRODUCTION: In lumbar spinal stenosis (LSS), the findings of stenosis (dural tube compression) on MRI does not always relate with clinical symptoms. Therefore, we apply selective decompression for only symptomatic levels even if multiple stenosis was observed on MRI. The purpose of this study was to examine the influence of asymptomatic stenosis on outcomes of selective decompression for only symptomatic level.

METHODS: Fifty seven LSS patients who underwent decompression at L4/5 were included in this study. The follow-up period was 5 years. Cross sectional area of the dural sac in L3/4 disc level was calculated on preoperative MRI by imaging software. The cross sectional area less than 50 mm2 was defined as stenosis. The existence of symptoms originated from L3/4 stenosis and additional surgery for L3/4 stenosis were examined. Roland-Morris Disability Questionnaire (RDQ) and numerical rating scales (NRS) of low back pain, leg pain, and leg numbness were also examined. Statistical analysis was performed by Mann-Whitney’s U test and Chi square test. A p value less than 0.05 was considered significant.

RESULTS: Nine patients showed spinal canal stenosis at L3/4 disc level on preoperative MRI (Stenosis group) and others did not show stenosis (non-stenosis group). One
patient in stenosis group (11.1%) and 4 patients in non-stenosis group (8.3%) presented new onset of L4 symptoms. The additional surgery for L3/4 stenosis was performed for 1 of 9 patients in stenosis group (11.1%). There were no significant differences in RDQ and NRS of low back pain, leg pain, and leg numbness before and 5 years after surgery.

**DISCUSSION:** These results indicated that asymptomatic L3/4 stenosis on preoperative MRI did not always induce symptoms during at least five years after L4/5 decompression. Asymptomatic L3/4 stenosis had little influence on 5-year outcomes of L4/5 selective decompression.

**SP41**
**THE IMPACT OF DIABETES MELLITUS IN SURGICAL OUTCOMES AFTER LUMBAR SPINE SURGERY**

*Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center*

**INTRODUCTION:** Diabetes Mellitus (DM) is prevalent among patients undergoing spine surgery. However, the impact of DM on the outcomes, costs, and mortality after lumbar spine surgery (LSS) is not well characterized.

**METHODS:** The Nationwide Inpatient Sample (NIS) database was queried from 2002-2011. Patients undergoing elective lumbar decompression (LD) or lumbar fusion (LF) were identified. The selected cohorts were divided into three groups: 1) Non diabetics, 2) Diabetics without end-organ damage (Uncomplicated), and 3) Diabetics with end-organ damage (Complicated). Patient demographics, comorbidity burden (CCI), length of stay (LOS) and costs were assessed. Regression analysis with a 95% confidence interval was utilized to identify DM as a predictor of postoperative complications after controlling for demographics and hospital variables. SPSS v.20 was utilized for statistical analysis and a p-value of <0.001 denoted statistical significance.

**RESULTS:** A total of 292,833 LDs and 263,263 LFs were identified in the NIS database. Diabetic patients represented 15.1% (n=44,357) and 14.5% (n=38,067) of the LD and LF cohorts respectively. In both cohorts, diabetics were significantly older and demonstrated a greater CCI. Patients with DM incurred a significantly greater LOS, costs, postoperative complications and mortality than non-diabetics in both the surgical cohorts. Regression analysis demonstrated that DM was a predictor of postoperative neurologic complications, urinary tract infections, ileus, hemorrhagic anemia, and gastrointestinal bleeds, pulmonary emboli, and infections.

**DISCUSSION:** Diabetics who underwent a LD or LF incurred a greater LOS, total costs, postoperative complications and mortality than non-diabetics. In addition, DM was an independent predictor of multiple postoperative complications. Further research is warranted to determine if preoperative blood glucose control will help mitigate the risk of postoperative complications and mortality.

**SP42**
**COMPARISON OF PERI-OPERATIVE OUTCOMES FOR LUMBAR DECOMPRESSION: ORTHOPAEDIC SURGERY VERSUS NEUROSURGERY**

*Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA*

**INTRODUCTION:** Very few studies have examined the influence of the training specialty (Orthopaedic surgery versus Neurosurgery) on the surgical management of the spine. The purpose of this study was to analyze the peri-operative outcomes associated
with a lumbar decompression (LD) based upon the primary surgeon’s specialty.

**METHODS:** The National Surgical Quality Improvement Program (NSQIP) database was searched to identify patients undergoing a LD between 2006 and 2011. The selected cohort was divided based upon the primary surgeon's specialty (Orthopaedic surgery or Neurosurgery). Preoperative patient characteristics and perioperative outcomes were assessed. SPSS v.20 was utilized for statistical analysis with a p-value of \(= 0.05\) to denote significance.

**RESULTS:** A total of 14,701 LDs were identified from 2006-2011, of which 4,641 (31.6%) were done by Orthopaedic surgeons and 10,060 (68.4%) by Neurosurgeons. There were significant differences in patient comorbidities between Orthopaedic and Neurosurgery patients. The Neurosurgery cohort demonstrated longer operative times, while Orthopaedic patients demonstrated greater intraoperative blood transfusions and incurred a longer hospitalization. In addition, there were significant differences in the incidence and type of postoperative complications between specialties. However, the mortality rate did not significantly differ between the surgical cohorts.

**DISCUSSION:** This study demonstrated significant differences in patient comorbidities between Neurosurgery and Orthopaedic patients. Although, Neurosurgery patients incurred longer operative times, Orthopaedic patients demonstrated greater intraoperative blood transfusions, postoperative complications, and a longer hospitalization. Further research is warranted to better characterize each specialty’s patient comorbidity profile and determine its impact on the surgical outcomes and hospital resource utilization following a LD.

**SP43**

**EFFECT OF PHYSIOLOGIC LOADS ON COR-TICAL AND TRADITIONAL PEDICLE SCREW FIXATION**

Daniel A. Baluch, MD (a), Alpesh A. Patel, MD (b), Brett Lullo, BS (c), Robert M. Havey, BS (a,d), Leonard I. Voronov, MD, PhD (a,d), Ngoc-Lam Nguyen, MD (a), Gerard Carandang, MS (d), Alexander J. Ghanayem, MD (a), Avinash G. Patwardhan, PhD (a,d); (a) Department of Orthopaedic Surgery and Rehabilitation, Loyola University Medical Center, 2160 S. First Ave, Maywood, IL, 60153 (b) Department of Orthopaedic Surgery, Northwestern University Feinberg School of Medicine, 676 N. St. Clair St, Ste 1350, Chicago, IL, 60611 (c) Loyola University Stritch School of Medicine, 2160 S. First Ave, Maywood, IL, 60153 (d) Musculoskeletal Biomechanics Laboratory, Edward Hines, Jr. VA Hospital, 5000 S. Fifth Ave, Hines, IL, 60141

**INTRODUCTION:** Lateral trajectory cortical pedicle screws have been described as a means of obtaining improved fixation while minimizing soft tissue dissection during lumbar instrumentation. Biomechanical data have demonstrated equivalent strength in a quasi-static model; however, no biomechanical information is available.
SP44
THE ROLE OF BMP-2 ON POSTOPERATIVE FUSION AND SUBSIDENCE RATES AFTER LATERAL LUMBAR INTERBODY FUSION: A COHORT CONTROLLED STUDY
Alexander Aichmair, MD; Marios G. Lykissas, MD, PhD; Paul D. Kiely, MD; Alexander P. Hughes, MD; Andrew A. Sama, MD; Darren R. Lebl, MD; Frank P. Cammisa, MD; Federico P. Girardi, MD; Department of Orthopaedic Surgery, Spine and Scoliosis Service, Hospital for Special Surgery, Weill Cornell Medical College, New York, NY

INTRODUCTION: The ability of BMP-2 to significantly enhance interbody fusion and to decrease post-operative cage subsidence compared to autograft and allograft remains to be further elucidated in a large series of LLIF patients. This study assessed the rates of fusion and cage subsidence after lateral lumbar interbody fusion (LLIF) supplemented by bone morphogenetic protein-2 (BMP-2), autograft, or allograft.

METHODS: Patients who underwent LLIF at a single institution between 03/2006 and 04/2012 were retrospectively reviewed and divided into three groups based on the bone graft material that was used (group A: BMP-2; group B: autograft; group C: allograft). Included patients were matched (2:1) for age, gender, body mass index (BMI), number of treated levels, and absence of posterior segmental instrumentation (i.e. standalone LLIF).

RESULTS: Sixty-four patients were included (32, 16, and 16 patients in groups A, B, and C, respectively), whose post-operative radiographs were evaluated for the rates of fusion and cage subsidence by two blinded co-authors. There were no statistically significant differences both with regard to post-operative fusion and cage subsidence rates between the three study sub-groups at 6 months after surgery, and at the last post-operative radiographic follow-up. At the last follow-up, the fusion rate was
95.0% in the BMP-2 group, compared to 90.3% and 86.2% in the autograft and allograft groups, respectively \( (p=0.354) \). Additionally, 28.8% of the patients had evidence of cage subsidence in the BMP-2 group, compared to 31.3% and 37.9% in the autograft and allograft groups, respectively \( (p=0.747) \).

**DISCUSSION:** According to our findings, there was no statistically significant difference between the BMP-2, autograft, and allograft groups both with regard to the fusion and subsidence rates. Although not statistically significant, BMP-2 consistently resulted in the highest fusion and the lowest subsidence rates compared to autograft or allograft.

**SP45**

**THE PULLOUT STRENGTH OF PEDICLE SCREWS FOLLOWING RE-DIRECTION AFTER LATERAL WALL BREACH OR END-PLATE BREACH**

Yuichiro Goda*, Kosaku Higashino*, Shunichi Toki*, Daisuke Suzuki**, Takuma Kobayashi**, Tetsuya Matsuura*, Mineko Fujimiya***, Natsuo Yasui*, William C. Hutton****, Koichi Sairyo*; * Department of Orthopaedics, University of Tokushima, Tokushima, Tokushima, Japan; ** Department of Orthopaedics, Sapporo Medical University School of Medicine, Sapporo, Hokkaido, Japan; *** Department of Anatomy, Sapporo Medical University School of Medicine, Sapporo, Hokkaido, Japan; **** Atlanta Veterans Affairs Medical Center and the Department of Orthopedic Surgery, Emory University School of Medicine, Atlanta, USA

**INTRODUCTION:** Screw malposition, such as lateral wall breach or end-plate breach, is one of the main pitfalls of inserting pedicle screws. Intraoperatively a malpositioned screw is often removed and then re-directed and inserted along the correct axis. The purpose of our study was to test the pullout strength of a re-directed screw following: 1) lateral wall breach; and 2) end-plate breach.

**METHODS:** From 10 fresh spines 28 vertebrae (T9-L4) were harvested (all male, mean age 85.0 years). In each vertebra on one pedicle the screw was inserted correctly down the axis of the pedicle, while on the other pedicle the screw was inserted to breach the lateral wall (14 vertebrae) or the end-plate (14 vertebrae). Left and right pedicles were alternated on each successive vertebra. The breached pedicle screws were then removed and re-directed along the correct axis of the pedicle. Each screw (56 total) was then pulled out and the force was measured (Shimadzu AG Universal Testing Machine, Japan). In each vertebra, each left and right pedicle received a screw (6.5 mm diameter) inserted to the same depth. Mann-whiteny U test was used to compare the pullout strength of the re-directed screw versus the correctly aligned screw in each individual vertebra.

**RESULTS:** 1) The mean pullout strength for the re-directed screws following lateral wall breach was 20.9% less as compared to the correctly aligned screws \( (P < 0.05) \). The average pullout force was 576.3 N for the re-directed and 665.7 N for the correctly aligned screws; 2) The mean pullout strength for the re-directed screws following end-plate breach was 18.7% less as compared to the correctly aligned screws. The average pullout force was 572.2 N for the re-directed and 825 N for the correctly aligned screws.

**DISCUSSION:** Re-directing a pedicle screw after lateral pedicle breach or end-plate breach results in a significant drop in pullout strength as compared to the pullout strength for a correctly aligned screw.
SP46
CAN BONE MINERAL DENSITY AFFECT INTRA-OPERATIVE ESTIMATED BLOOD LOSS OF MINI-INVASIVE POSTERIOR LUMBAR INTERBODY FUSION?
Zhao Fengdong, M.D., He Yong, M.D., Chen Huanhuan MSc, Shan Zhi MSc, Suyou Letu MSc, Fan Shunwu M.D.; Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, ZheJiang University, Hangzhou 310016, China

INTRODUCTION: To investigate the impact of bone mineral density (BMD) on intra-operative estimated blood loss (EBL) of mini-invasive posterior lumbar interbody fusion (PLIF).
METHODS: 120 consecutive patients suffering from mono-segment low back disorders and being treated by mini-invasive PLIF were recruited. The demographic, body habitus and surgical data of each patient, such as age, sex, body mass index (BMI), BMD, operative time (OT), intra-operative mean arterial pressure (MAP), EBL and coagulation function of blood, were collected. The correlation between EBL and each of the other parameters was analyzed. Moreover, a statistical model predicting EBL was constructed.
RESULTS: The Pearson correlation coefficients of EBL & BMD and EBL & OT were -0.28 (p=0.002), and 0.41 (p=0.001), respectively. However, the correlation between EBL and any of the other parameters was not significant. By stepwise linear regression analysis, a statistical model: EBL=316.68+2.88×OT-460.16×BMD, was constructed which accounted for about 54% of the variability of EBL with 2 variables: BMD and OT.
DISCUSSIONS: BMD might play some roles in the prediction of the blood loss during the procedure of spine surgery. Therefore, BMD should be considered as an important parameter before operation.

SP47
PREOPERATIVE FACET EFFUSION CORRELATES WITH CRANIAL ADJACENT SEGMENT INSTABILITY FOLLOWING POSTERIOR LUMBAR INTERBODY FUSION-A MINIMUM 2-YEAR FOLLOW UP-
Chikara Ushiku M.D. PhD, Shigeru Soshi M.D. PhD., Takeshi Inoue M.D., Yoshikuni Kida M.D., Akira Shinohara M.D., Kurandos Hashimoto M.D., Reo Ishizuka M.D., Keishi Marumo M.D. PhD.; Department of Orthopaedic Surgery, The Jikei University School of Medicine

INTRODUCTION: Some articles report recently facet effusion (FE) detected on MRI would indicate instability. However, it is not well known whether pre-operative FE would affect on post-operative instability at cranial adjacent segment following posterior lumbar interbody fusion (PLIF). The purpose of this study is to analyze the association between pre-operative FE (Pre FE) and post-operative instability.
METHODS: Thirty-eight patients who underwent single level of PLIF in L4/5 for degenerative spondylolisthesis were enrolled. All parameters were measured at L3/4, cranial adjacent segment for L4/5 PLIF. ROM, translation and disc height at both pre-operation and final examination were measured. Axial T2 MR images in L3/4 were evaluated for Pre FE. We divided into 2 groups according to Pre FE on MRI: Negative [FE(-), n=14, Male/Female 5/9, Mean age 65yr] and Positive [FE(+), n=24, Male/Female 11/13, Mean age 65yr]. We compared comorbidity, pre- and post-operative ROM, translation, disc height, and %ROM (Post/Pre) in each group. For another inspection, we divided into 2 groups according to post-operative L3/4 ROM: High ROM group (more than 10 degree) [n=12, Male/Female 4/8, Mean age 66yr] and Low ROM group (and or less than 10 degree) [n=26, Male/Female 11/15, Mean age 65yr],
and we compared the pre-operative characteristics.

RESULTS: The post-operative ROM in FE(+) was greater than in FE(-) [FE(+): 8.3°, FE(-): 4.2°, p <0.05]. ROM (post/pre) was 70.2% in FE(-) and 138.9% in FE(+) (p<0.05). The incidence rate of High ROM was 7.1%(1/14) in FE(-) and 45.8%(11/24) in FE(+) respectively (p<0.05). In High ROM, pre-operative ROM was 8.3°, and 5.7° in Low ROM (p <0.05). Rate of Pre FE was 90%(11/12) in High ROM and 50%(13/26) in Low ROM respectively (p <0.05).

CONCLUSION: Pre FE on MRI is highly predictive of developed post-operative cranial adjacent segment instability following PLIF. Pre-operative degree of ROM and FE affect on post-operative development of ROM.

SP48
A RANDOMIZED CONTROLLED TRIAL OF LUMBAR POSTEROLATERAL FUSION IN COMBINATION WITH PLATELET-RICH PLASMA (PRP)
Go Kubota, Hiroto Kamoda, Kazuyo Yamauchi, Sumihisa Orita, Yoshihiro Sakuma, Yasuhiro Oikawa, Kazuhide Inage, Takeshi Sainoh, Jun Sato, Toshiki Fujimoto, Kazuhisa Takahashi, Sadao Arai, Seiji Ohtori; Dept. of Orthopaedic Surgery, Graduate School of Medicine, Chiba University Arai Orthopedic Clinic

INTRODUCTION: Platelet-rich plasma (PRP) has been reported to be a source of autologous growth factors (PDGF and TGF-beta) that enhance bone formation. However, PRP has failed to improve fusion rates, perhaps due to suboptimal levels of growth factors. We began a Phase 1 study in July, 2009, the purposes of which were to produce highly concentrated PRP enriched in growth factors, to monitor side effects, and to determine subsequent fusion rates. This is the first randomized controlled trial to investigate the potential advantages of using PRP in posterolateral fusion.

METHODS: Thirty-nine patients diagnosed with spinal canal stenosis were divided equally into “PRP” and “control” groups. The PRP patients underwent posterolateral fusion with instrumentation using autograft bone plus PRP, while control patients underwent the same procedure minus PRP. In the PRP group, one unit of whole blood (400 mL) was drawn from each patient at the beginning of surgery and centrifuged to extract platelets. Twenty mL of PRP was obtained, to which thrombin and CaCl2 were added to form a platelet gel for application to the surgical field. Bone fusion was periodically assessed using X-ray and CT.

RESULTS: The average platelet concentration was 7.7-fold higher in the PRP than plasma. Growth factors released from the platelet gel were more than 50-fold concentrated compared to blood levels. No significant adverse events were observed. Bone union was observed in all patients. The average period was 7.8 months in the PRP group, and 9.8 months in the control group.

CONCLUSION: In the present study, bone union was achieved more rapidly in the PRP group, which suggests that enhanced bone formation was achieved by providing an elevated concentration of PRP. However, further research is required.

SP49
CHANGE IN THE POSITION OF THE SPINAL NERVE RELATIVE TO THE SPINE WITH DIFFUSION TENSOR TRACTOGRAPHY
Oikawa, Yasuhiro1; Eguchi Yawara2; Watanabe, Atsuya1; Orita Sumihisa1; Yamauchi Kazuyo1; Sakuma, Yoshihiro1; Kubota, Go1; Inage, Kazuhide1; Sainoh, Takeshi1; Sato, Jun1; Fujimoto, Kazuki1; Arai, Sadao3; Suzuki Miyako1; Takahashi Kazuhisa1; Ohtori, Seiji1;; 1. Department of Orthopaedic Surgery, Graduate School of Medicine Chiba University, Japan 2. Department of Orthopaedic Surgery, Graduate School of Medicine Chiba University, Japan 3. Arai Ortho-
INTRODUCTION: Direct lateral interbody fusion (DLIF) has been reported as a new surgical procedure with the minimally invasive lateral transpsoas approach, but there are reports of a high rate of complications related to lumbar spinal nerve and lumbosacral plexus injury. Diffusion tensor imaging (DTI) and diffusion tensor tractography (DTT) are new imaging tools to evaluate and visualize highly anisotropic peripheral nerve fiber tracts; we have reported the efficacy of DTT for an anatomical evaluation of the spinal nerve course. The purpose of this study is to visualize the change in positional relationship between the spinal nerve and spine using DTT.

METHODS: Ten healthy volunteers underwent DTT with 3.0T MR imaging in 3 positions; supine with hip flexion, supine with hip extension, and lateral with hip flexion. The tractography of L3, L4 and L5 and the location on each spinal nerve root at the L3-4, L4-5 and L5-S levels were evaluated in each position. Nerve root locations were categorized into zones: 1 through 4, the disc space divided into quartiles from anterior to posterior; A, anterior to the disc space; and P, posterior to the disc space.

RESULTS: In the supine position with hip flexion, the nerve roots were located in the most posterior quarter of the vertebral body and dorsally at L3-L4, and in the mid posterior and dorsally at L4-L5. However, the nerve roots moved forward at each level in the supine with hip extension position, and moved backward in the lateral position. In each case the width of the nerve transfer was within a quarter of the vertebral body.

DISCUSSION: DTT can visualize lumbar spinal nerve. It is safe to access the anterior half of the disc space during DLIF, but there is a risk of nerve injury for the posterior half. Nerve roots tend to move backward in the position with hip flexion. It is important to flex the hip joint to avoid the risk of nerve injury. DTT can be used to visualize the nerve distribution for presurgical imaging.

SP50

MECHANOBIOLOGY OF COMPLEX LOADING IN FUNCTIONAL SPINAL UNITS: FLEXION/EXTENSION WITH COMBINED TORSION

Hartman RA (1,2), Ngo K (3), Yurube T (3), Schneider MJ (4), Debski RE (2), Kang JD (3), Sowa GA (1,2,3); University of Pittsburgh, 1-Department of Physical Medicine & Rehabilitation; 2-Department of Bioengineering; 3-Department of Orthopaedic Surgery, 4-Department of Physical Therapy, Pittsburgh, PA, USA

INTRODUCTION: Complex loading in lumbar motions, including combined torsion and bending, is associated with elevated risk of injury and back pain. It involves entire functional spinal units (FSUs): intervertebral disc, facet joints, and surrounding ligaments. Cellular responses to complex loading have not been investigated. The objective of this study was to elucidate the effect of axial torsion (AT) combined with flexion/extension (FE) ex-vivo in viable FSUs.

MATERIALS AND METHODS: Fresh rabbit L4-5 FSUs are mounted to a six-axis robot and preserved at physiologic conditions as previously described [Hartman, 2012]. FSUs are grouped by amount of AT—0, 0.4 or 0.8Nm—which reflect neutral, mild (20% torsional failure), and severe (40% torsional failure) rotations. FSUs are subjected to three cycles of AT and undergo three cycles of FE to 0.5/0.15Nm at the final rotated position. Complex kinematics are repeated for 1 h at 0.33 °/s. Unloaded FSUs (L2-3) serve as controls. Annulus fibrosus (AF, n=3 per group), nucleus pulposus (NP, n=3 per group) and facet cartilage (FC, n=1-3 per group) are isolated to assess load-responsive relative mRNA expression of...
catabolic (MMP-1, 3, ADAMTS-5), inflammatory (COX-2), and anabolic (AGC) genes.

**RESULTS:** In FC, COX-2 increases ~2-fold in small and large AT relative to neutral FE; catabolic and anabolic genes show no effect of AT. AGC expression in AF tends to increase in response to AT; catabolic and pro-inflammatory genes show no clear trend. In NP, AT shows no effect on expression. No difference in expression is observed in comparing small to large AT in any tissue.

**DISCUSSION:** This study is the first to investigate biological responses in disc and facet simultaneously under combined AT and FE. Data suggest an inflammatory response in facet cartilage that may be important in in-vivo complex loading associated with back pain. Increased and prolonged loading are required to confirm results and assess inflammatory mediator protein expression.

**SP51**
**BIOACTIVE PEDICLE SCREWS PRODUCED BY CHEMICAL AND HEAT TREATMENTS HAVE IMPROVED BIOCOMPATIBILITY AND BONE-BONDING ABILITY**
Koji Akeda1, Koichiro Murata1, Norihiko Takegami1, Tomiharu Matsushita2, Seiji Yamaguchi2, Tadashi Kokubo2, Mikinobu Goto1, Akihiko Matsumine1, Atsumasa Uchida1, Akihiro Sudo1; 1. Department of Orthopaedic Surgery, Mie University Graduate School of Medicine 2. Department of Biomedical Science, College of Life and Health Science, Chubu University

**INTRODUCTION:** Titanium (Ti)-6Al-4V alloy, widely used in spinal instrumentation with a pedicle screw (PS) system, does not form a chemical bond with bone; therefore a significant clinical problem, including the loosening and back-out of PSs, exists. Bioactive Ti metal produced by chemical and heat treatments, induces the spontaneous formation of a layer of hydroxyapatite (HA) on its surface. The purpose of this study was to examine the effect of bioactivation of Ti-6Al-4V PSs on the ability of HA to form in vitro and its bone-bonding ability in vivo.

**METHODS:** PSs (diameter: 2.5 mm; length: 14 mm) were prepared from Ti-6V-4Al alloy and bio-activated by NaOH-CaCl2-heater treatments. The HA-forming ability of bioactive PSs, examined by incubation in simulated body fluid, was evaluated by FEsEM and EDX analyses. Animal study: Three 11-month-old female beagle dogs were used: bioactive and control (without bioactivation) PSs were placed from L1 to L6. Three months after surgery, lumbar spines were removed, followed by biomechanical (torsional screw extraction and pull-out strength) and histological analyses.

**RESULTS:** In vitro: HA deposits, containing small amounts of Mg, Na and C, in addition to Ca and P, covered the entire surface of bioactive PSs. In vivo: The mean extraction torque was 1.4 times higher for bioactive PSs compared to controls (p<0.05); there was no significant difference in pull-out strength between control and bioactive PSs. Histologically, bone tissue was closely attached to the surface of bioactive PSs. The ratio of contact area between bone tissue and screw surface was 1.5 times higher in bioactive PSs compared to controls.

**DISCUSSION:** Bioactive PSs prepared by chemical and heat treatments form a layer of HA on the surface of screws in vitro and increase biocompatibility and bonding ability with bone in vivo. Bioactive PSs may prevent screw-loosening and improve clinical outcomes of spinal instrumentation surgery.

**SP52**
**THE DISTRIBUTION OF BONE MASS IN THE LUMBAR VERTEBRAE: ARE WE MEASURING THE RIGHT TARGET?**
Yue Wang, MD, PhD,1,2 Tapio Videman, MD, PhD,2 Steven K. Boyd, PhD,3 and Michele C. Battié, PhD,2; 1 Department of Orthopedic Surgery, The 1st 1 Hospital of Zhejiang University, Hangzhou, China 2 Fac-
INTRODUCTION: The ideal target of bone mineral density (BMD) measurements of the spine is the trabecula-rich vertebral body. Yet, spine BMD measurements routinely obtained with dual energy X-ray absorptiometry (DXA) also include the posterior elements of the vertebra, which are mainly cortical bone and insensitive to bone loss. We compared the bone mass of the vertebral body and posterior elements to determine the magnitude of this limitation.

METHODS: From a spine archive, 144 cadaveric lumbar vertebrae (L1-L5) from 48 male human spines (mean age 50 years) were scanned in air using micro-CT (µCT) to measure bone volume, bone mineral content (BMC) and BMD of the vertebral body, posterior elements, and entire vertebra. The contributions of the vertebral components to the total vertebral BMC and volume were compared, and the correlations between the BMC and BMD of the vertebrae and their components were examined.

RESULTS: Overall, the vertebral body contributed only about 1/3 of the total vertebral BMC, but 2/3 of the total vertebral volume, and the posterior elements contributed the remainder. The vertebral body BMC and BMD were poorly correlated to those of the posterior elements (r=0.39 for BMC and r=0.34 for BMD, p<0.0001), and moderately correlated to those of the whole vertebra (r=0.77 and 0.75, respectively, p<0.0001). The BMC and BMD of the posterior elements and whole vertebra were more strongly correlated (r=0.89 and 0.84, respectively, p<0.0001).

DISCUSSION: The posterior elements are the primary contributor to vertebral BMC and BMD measurements. DXA spine BMD measurements are likely to be more representative of the posterior elements than the targeted vertebral body. The findings elucidate the extent of the limitation of DXA spine BMD measurements.

SP53
REPRODUCIBLE DISC DEGENERATION SCALE IN A LARGE ANIMAL MODEL
Vadala G 1, Russo F 1, De Strobel F 2, Bernardini M 2, De Benedictis G 2, Musumeci M 1, Eglin D 3, Denaro L 2, Alini M 3, Denaro V 1.; 1 Department of Orthopedic and Traumatology, University Campus Bio-Medico of Rome, Rome - Italy 2 University of Padua, Padua - Italy 3 AO Research Institute, Davos - Switzerland

INTRODUCTION: To study novel regenerative strategies is necessary to develop new models that do not implement annulus fibrosus (AF) damage.
We hypothesize that an ideal preclinical model to study nucleus pulposus (NP) regeneration can be achieved by approaching the NP via the endplate (EP) route through a minimal invasive transpedicular approach. The aim of the study is to characterize a preclinical ovine model triggering EP damage and repair with or without mechanical nucleotomy, whilst keeping the AF intact.

MATERIAL AND METHODS: 12 Sheep were used. A 2mm transpedicular tunnel was drilled to the NP and nucleotomy performed. The tunnel was sealed using a porous polyurethane cylinder. Lumbar discs were assigned to different groups: EP tunnel (A); EP tunnel + nucleotomy (B); EP tunnel + repair with PU (C); EP tunnel + nucleotomy + repair (D); no treatment (E). X-ray and MRI were performed at 0, 1, 3 and 6 mths after. Disc height, MRI indexes, disc macro- and micro-morphology were analyzed. MRI images and gross anatomy were graded using both Pfirrmann and Thompson grading systems.

RESULTS: NP signal intensity at MRI decreases with different degrees of degeneration. According to Pfirrmann degenerative...
grade, C group showed grade II; group A - grade III; group D - grade IV; group B - grade V. Morphologically, all stages of the degenerative process from Thompson grade I to grade V were also observed with the same association. Histological analysis showed progressive disc narrowing, fragmentation of NP matrix in D and B group.

**DISCUSSION:** This stepwise model could be suitable for studying pathogenesis and pathophysiology of IDD evaluated at different stages of degeneration. Keeping the AF intact, different degrees of IDD have been observed according to Pfirrmann and Thompson grading systems. The sealing of the tunnel prevents NP leakage allowing the restoration of intradiscal pressure. The model can be used to test safety and efficacy of novel treatments for IDD.

**SP54**

**A PROSPECTIVE STUDY OF CORRELATION BETWEEN CLINICAL DISABILITY AND RADIOLOGICAL FEATURES IN DEGENERATIVE LUMBAR CANAL STENOSIS (LCS)**

Prof. S. Rajasekaran, PhD, Dr. N. Kannippan, Dr. Rishi M Kanna, Dr. Ajoy P Shetty; Department of Spine Surgery, Ganga Hospital, Coimbatore, India.

**INTRODUCTION:** The relationship between clinical disability and various parameters like degree of constriction of dural sac, radiological pelvic parameters, facet joint orientation in patients with degenerative LCS has not been clearly defined. Methodology: Fifty patients with LCS were selected prospectively and divided into two groups (20 patients responding to conservative therapy and 30 requiring surgery) and compared with 16 controls. Patients were clinically evaluated by ODI, SF-12 and Neurogenic Claudication outcome score (NCOS). All patients underwent anteroposterior, lateral dynamic radiographs of lumbar spine and whole spine standing lateral radiograph. The spino pelvic parameters measured were spinosacral angle, thoracic kyphosis, lumbar lordosis, pelvic incidence, sacral slope and pelvic tilt. Dural sac cross sectional area, lateral recess angle and height and facet joint orientation were assessed in MRI.

**RESULTS:** Between conservative and operated group, the mean ODI score (55.5 vs 62.99, p=0.014) and NCOS (37.7 vs 29.47, p=0.06) were significantly different. Dural sac area significantly differed (p<0.001) between control (113.97/-57.58), conservative (47.57/-24.77) and operated group (20.66/-14.49). NCOS had significant positive correlation with dural sac area (r=0.296, p=0.037) than ODI. In patients with degenerative spondylolisthesis, there was a significant sagittal orientation of facet joints, high pelvic incidence (58.79 vs 50.57, p=0.047) and an increased pelvic tilt (18.99 vs 11.25, p=0.045).

**CONCLUSION:** Degree of dural sac stenosis corresponds to clinical disability and NCOS is a better indicator of dural sac compression than ODI score. LCS patients with sagittal facet orientation, high pelvic incidence and high pelvic tilt develop spondylolisthesis.

**SP55**

**DO UNILATERAL MODIC TYPE III CHANGES ON CORONAL MRI INDICATE THE SYMPTOMATIC LEVEL OF THE FORAMEN IN PATIENTS WITH LUMBAR FORAMINAL STEnosis?**

Y. Fujiwara M.D., S. Kotaka M.D., B. Izumi M.D., H Manabe M.D.; Department of Orthopaedic Surgery, Hiroshima City Asa Hospital.

**INTRODUCTION:** There have been numerous papers about Modic changes, but most of them have evaluated sagittal images. There have been few papers that have evaluated the findings of coronal MRI. In our experience, some foraminal stenosis patients have Modic type III changes around
the symptomatic level of the foramen on coronal MRI. Therefore, in this study, we evaluated the unilateral Modic changes of type III on coronal MRI in patients with lumbar foraminal stenosis.

METHODS: Thirty patients who underwent microscopic lateral foraminotomy for lumbar foraminal stenosis at single level, either of L3/4, L4/5 or L5/S were included in this study. The unilateral Modic type III changes on preoperative coronal MRI were evaluated for the symptomatic and asymptomatic L3/4, 4/5 and 5/S. In one of the cases with Modic type III changes, a biopsy and pathological evaluation was performed. We also evaluated 100 cases with lumbar canal stenosis as a control group.

RESULTS: Unilateral Modic type III changes on the symptomatic side were observed in 22 of the 30 cases (73.3%). There were 8.9% of cases with the same finding on the asymptomatic side, and 1.7% of the patients in the control group had the same findings. Twenty-one of the 22 patients with unilateral Modic type III changes on the symptomatic side were consistent with symptomatic level of the foramen where lateral foraminotomies were performed. When we evaluated them in detail, these Modic type III changes were found to be surrounded by thin Modic type I lesions. The pathology could be examined in one case, and there was bone necrosis surrounded by inflammation. The sensitivity and specificity for diagnosing the symptomatic level based on the unilateral Modic type III changes was 70% and 98.3%, respectively.

DISCUSSION: Coronal MRI was previously reported to be useful for diagnosing foraminal stenosis, but the nerve root was usually evaluated, while the vertebral body was not. Using our method, we evaluated the

SP56
PATHOGENOMONIC RADIOLOGICAL INDICATORS FOR DIAGNOSIS OF LUMBAR-CRANIAL FORAMINAL STENOSIS
Shinozaki Y1)3), Ishii K2)3), Takahashi Y1)3), Nishida M1)3), Nakashima D1)3), Toyama Y2)3), Matsumoto M2)3), Ogawa J1)3); 1) Spine Center, Shizuoka Red Cross Hospital, Shizuoka, Japan 2) Dept. of Orthopaedic Surgery, Keio University, Tokyo, Japan 3) Keio Spine Research Group (KSRG)

INTRODUCTION: The detailed etiology of foraminal stenosis at L5/S1 (LSFS) remains unknown. Here, we performed a radiological study to elucidate the pathological conditions of LSFS.

METHODS: The subjects comprised of 114 patients (72 men, 42 women; mean age of 65.4 years) who underwent surgery for L5 radiculopathy due to LSFS. A total of 132 foramina with L5 radiculopathy were retrospectively reviewed. We measured foraminal height (FH), interval between L5 pedicle and posterolateral vertebral osteophyte (P-PLVO), and foraminal width (FW) of each L5/S1 foramen using reconstructed multidetector-row computed tomography (MDCT). The foramina were classified into 3 types: Type1 (transverse stenosis: 6mm≧FH), Type2 (vertical stenosis: 6mm≧FH or P-PLVO), and Type3 (combination of Type1 and 2). Each foramen was divided into 3 zones: Zone1 (medial foramen), Zone2 (lateral foramen), and Zone3 (extra-foramen). Pedicle-root angle (PRA) was measured using L5 radiculography.

RESULTS: Twenty-five foramina were classified as Type1, 70 as Type2, and 34 as Type3 in total of 129 foraminal stenosis. Main stenosis lesion was localized at Zone1 in Type1 and at Zone2 (especially in transition between Zone2 and 3) in Type2. Six mm or
less of FH was observed only in 18 foramina. The osteophytes (mean length 5.3±1.8mm) were observed in 104 foramina in Zone2 or transitional Zone2/3, and 6mm or less of P-PLVO was observed in 99 of those 104 foramina. Mean PRA of Type2 (14.0°) and Type3 (16.5°) were significantly smaller than that of Type1 (35.4°) (P<0.01).

CONCLUSION: Foraminal stenosis of 6mm or less was observed in MDCT may be a diagnostic indicator for LSFS. The osteophyte in Zone2 and transitional Zone2/3 may be associated with Type2 foraminal stenosis, causing pinching and horizontalization of L5 nerve root by L5 pedicle and the osteophyte. In contrast, Type1 (transverse stenosis) lesion is generally localized in Zone1 and running route of L5 nerve root was not affected on radiculography.

SP57

RADIOGRAPHIC EVALUATION OF THE FACET JOINT PRESERVATION AND POSTOPERATIVE BONE RE-GROWTH IN MICROSCOPIC BILATERAL DECOMPRESSION VIA A UNILATERAL APPROACH FOR DEGENERATIVE LUMBAR DISEASE. — MINIMUM FIVE-YEAR FOLLOW-UP -
Dohzono S, Toyoda H, Terai H, Suzuki A, Yasuda H, Shinohara Y, Tamai K, Nakamura H; Department of Orthopaedic Surgery, Osaka City University Graduate School of Medicine

INTRODUCTION: This study aimed to assess the effects on surgical outcomes of postoperative bone re-growth and the preserved facet joint after microscopic bilateral decompression via a unilateral approach (MBDU) for the patients with degenerative lumbar disease.

METHODS: 52 patients underwent MBDU at L4-5 (21 with lumbar spinal canal stenosis (LSS), 14 with L4 degenerative spondylolisthesis (DS) and 17 with degenerative lumbar scoliosis (DLS)) were retrospectively reviewed. The minimum follow-up period was 5 years. Clinical outcomes were assessed before surgery and final follow-up period by JOA score for low back pain. The following radiographic parameters were assessed at the L4-5 segment: (1) % slip in neutral position and disc arc before surgery and at final follow-up (2) percent of facet joint preservation calculated on pre- and postoperative CT (3) bone re-growth at supra-articular process (SAP) portion and infra-articular process (IAP) portion of facet joint on CT at final follow-up (figure).

RESULTS AND DISCUSSION: The improvement ratio of JOA score at the latest follow-up in DLS group (54.4%) was significantly lower than that of LSS and DS group (72.2/73.5%). Percent of facet joint preservation on approach side in DS group (70.0%) was significantly smaller than that of LSS and DLS group (83.2/82.5%). On the other hand, facet joint preservations on the contra-approach side were not significantly different between groups (94.7/95.8/95% LSS/DS/DLS). The average value of bone re-growth at IAP portion was significantly higher than that of SAP portion, however there was not significantly different between groups (IAP portion; 2.8/3.7/3.8mm SAP portion 1.2/0.9/1.7mm). Facet joint
SPECIAL POSTERS

preservation was not correlated with the % slip progression and the improvement ratio of JOA score.

CONCLUSION: The MBDU prevent postoperative spinal instability due to the good preservation of facet joint, and which is thought to be the main cause of less bone re-growth after surgery.

SP58
ENDOSCOPIC LUMBAR FORAMINOTOMY: POSTOPERATIVE CHANGES OF FORAMINAL PARAMETERS ON MAGNETIC RESONANCE IMAGE
Yong Ahn, M.D., Ph.D.,* Hyun-Kyong Oh, R.N.,† Sang-Ho Lee, M.D., Ph.D.,* Ho Kim, B.S.†; Departments of *Neurosurgery, Wooridul Spine Hospital, Seoul, Korea Departments of †Clinical Research Team, Wooridul Spine Hospital, Seoul, Korea

INTRODUCTION: Endoscopic lumbar foraminotomy (ELF) is a novel minimally invasive technique to treat lumbar foraminal stenosis. This prospective study assessed the postoperative changes of foraminal parameters on magnetic resonance image (MRI) after ELF and evaluated the correlation between foraminal widening and pain improvement.

METHODS: Posterolateral ELFs using working channel endoscope were performed for the patients with foraminal or extraforaminal lumbar stenosis. Pre- and immediate postoperative MRIs were performed in all patients. The images of total 34 patients were blindly measured by 2 observers for foraminal stenosis grade and foraminal dimensions such as foraminal height (FH), superior foraminal width (SFW), middle foraminal width (MFW), posterior disc height (PDH) and cross-sectional area (CSA). The inter-observer correlation coefficient (ICC) and the k statistic were calculated to determine the inter-observer reliability.

RESULTS: The mean age of 34 patients (18 females and 16 males) was 58.53 year (range, 20-81 years) and 39 foramens were evaluated. There were significant increases in mean FH from 11.36 to 13.47 mm, in mean SFW from 6.43 to 9.27 mm, in mean MFW from 1.47 to 78 mm, and in mean CSA from 50.05 to 92.03 mm2 respectively (p = 0.000). In contrast, the disc heights (PDHs) were not changed. The mean foraminal stenosis grade was significantly improved from 2.66 to 0.74. The mean VAS improved from 8.44 at baseline to 3.28 at 6 weeks and 2.50 at months. The changes in CSA was negatively associated with those in VAS (r = -0.401; p = 0.021, moderate to strong). The inter-observer reliabilities for preoperative and postoperative measurements were excellent to moderate (ICCs ranging between 0.516 and 0.898, 95% CI).

DISCUSSION: Foraminal dimensions and foraminal stenosis grade were significantly improved after ELF. These data indicate that the ELF technique used is efficient for decompressing the exiting nerve root in the lumbar foramen.

SP59
CT EXPOSURE AND ENERGY EFFECTS ON BONE MINERAL DENSITY ESTIMATION FROM CALIBRATION PHANTOMS
1Hugo Giambini, 1Ahmad Nassr, 1Paul M. Huddleston III, 2Dan Dragomir-Daescu and 1+Kai-Nan An; 1+ Biomechanics Laboratory, Division of Orthopedic Research, Mayo Clinic, Rochester, MN USA 2 Division of Engineering, College of Medicine, Mayo Clinic, Rochester, MN USA

INTRODUCTION: Areal bone mineral density measured using DEXA is the gold standard for osteoporosis diagnosis/fracture risk estimation. Patient-specific QCT (quantitative computed tomography) finite element (FE) models may be used to predict fracture under physiological loading. Material properties for FE models are obtained by converting grayscale values from the CT into
volumetric BMD (vBMD) using a phantom. Errors arising from the CT acquisition protocol will have an effect in the vBMD estimation and material property assignment, thus, resulting in a false fracture risk prediction. The purpose of this study was to investigate the effect of CT exposure and energy on vBMD estimation.

**METHODS:** A phantom was scanned 6 times using QCT. Exposures (110/450 mAs) and energies (80/120/140 kVp) in the scan were varied. Mean CT number values (HU, Hounsfield unit) and standard deviation (noise) were measured. Regression curves estimating vBMD from HU values were obtained and extrapolated to cover trabecular and cortical bone density.

**RESULTS:** ANOVA revealed differences (*: P<0.0001) for both HU and noise parameters (Fig. 1) when comparing the energy acquisition. Differences were observed in all rods (*: P<0.0001), except between 120-140 kVp for rod 3 (exposure 110 mAs, P=0.024). Noise values differed in all rods (*: P<0.0001). Regression lines (Figure 1.d) obtained from same energies but different exposures overlap at all HU values.

**DISCUSSION:** Significant difference was found in the estimation of vBMD related to the energy of the scans. Exposure was found to have a minor effect on vBMD estimation, as shown by the regression curve overlap. These results will lead to a false estimation of strength in FE models. It will also misclassify patients putting them at risk of vertebral fracture. Further work is needed to develop a protocol that will optimize the exposure and energy to allow for better estimation of fracture risk/vBMD while reducing the radiation exposure to patients.

**SP60**
**ASSOCIATION BETWEEN ENDPLATE SIGNAL CHANGE AND SCHMORL’S NODES WITH DISC DEGENERATION IN THE LUMBAR REGION AND LOW BACK PAIN IN A POPULATION-BASED COHORT IN JAPAN: THE WA-KAYAMA SPINE STUDY**

Masatoshi Teraguchi1, Noriko Yoshimura2, Hiroshi Hashizume1, Shigeyuki Muraki3, Hiroshi Yamada1, Hiroyuki Oka2, Akihito Minamide1, Yuyu Ishimoto1, Keiji Nagata1, Ryohei Kagotani1, Toru Akune3, Munehito Yoshida1; 1 Department of Orthopaedic surgery, Wakayama Medical University, Wakayama, Japan.
2 Department of Joint Disease Research, 22nd Century Medical & Research Center, Faculty of Medicine, The University of Tokyo, Tokyo, Japan.
3 Department of Clinical Motor System Medicine, 22nd Century Medical & Research Center, Faculty of Medicine, The University of Tokyo, Tokyo, Japan.

Introduction: Disc degeneration (DD) reportedly causes low back pain (LBP), and is often concomitant with endplate signal change (ESC) and/or Schmorl’s node (SN) on spinal images. ESC and SN also reportedly cause LBP. Therefore, the association between DD and LBP is precisely not clear. The purpose of this study is to examine the association between DD and LBP, considering the presence of ESC and/or SN, in a population-based cohort.

Methods: Sagittal T2-weighted images were used to assess the intervertebral space from L1/2 to L5/S1. DD was classified based on Pfirrmann’s classification system (grade 4 and 5 indicated degeneration); ESC was defined as a diffuse high signal change along either area of the endplate, and SN was defined as a small well-defined herniation pit with a surrounding wall of hy-
pointense signal. We assessed the prevalence of DD alone, DD and ESC, DD and SN, and a complex of DD, ESC, and SN in the lumbar region. Multiple logistic regression analysis was used to determine the association of DD alone, DD and ESC, DD and SN, and a complex (of DD, ESC, and SN) with LBP compared to those without radiographic change after adjusting for age, body mass index, and gender.

Results: The prevalence of DD alone, DD and ESC, DD and SN, and a complex of DD, ESC, and SN was 30.4%, 26.6%, 12.3%, and 19.1%, respectively. The complex of DD, ESC, and SN was significantly associated with LBP (odds ratio [OR], 2.17/95% confidence interval [CI], 1.2–3.9). However, the other groups were not significantly associated with LBP (DD alone: OR, 1.35/95% CI, 0.8–2.3; DD and ESC: OR, 1.51/95% CI, 0.9–2.6; DD and SN: OR, 1.26/95% CI, 0.7–2.3).

Discussion: This is the first study to assess the associations between these groups, and provided essential information on the association between DD and LBP considering the presence of ESC and SN. Although we only examined T2-weighted magnetic resonance images, the data provide vital information on LBP.
**GENERAL POSTERS**

**GP1**

**BIOMECHANICAL EVALUATION OF KINE-MATIC BEHAVIOR AND LOAD SHARING OF A PEDICLE-BASED SLIDING ROD FIXATION**

Qingan Zhu, Zhousheng Lin, Zhiping Huang, Jiaying Chen; Department of Spine Surgery, Nanfang Hospital, Southern Medical University, Guangzhou, China

**INTRODUCTION:** There are few studies focusing on the distinct design characteristics of sliding mechanism in dynamic fixation. We developed a pedicle-based sliding rod device which comprised of traditional polyaxial pedicle screws and rods articulated with a linear bearing. The purpose of the present study was to determine the effect of sliding rod fixation on kinematics and load sharing and compare it to a rigid pedicle screw rod system.

**METHODS:** Flexibility test under a pure moment of 5Nm was performed on 7 fresh cadaveric spine specimens. The sliding rod fixation and rigid fixation were applied to each specimen following facetectomy and PLIF at L4-L5 level, respectively. The polyaxial pedicle screw was cemented in place using PMMA to ensure that there was no loosening at the bone-screw interface. Single axis strain gauges were attached to L4 and L5 vertebral bodies on the lateral aspects. The range of motion (ROM), neutral zone (NZ), the sliding distance between the rod and the bearing, and strain were analyzed.

**RESULTS:** The sliding rod fixation reduced ROM significantly in all directions, but constrained lesser than the rigid fixation, particularly in flexion, extension and lateral bending (P<0.05) following facetectomy. On average, the sliding rod length increased 1.24 mm in flexion, decreased 1.29 mm in extension, and +2.56/-2.22 mm in lateral bending, while little changed in axial rotation. The vertebral body sustained higher strain with the sliding rod fixation.

**DISCUSSION:** This study is unique in that it is, to our knowledge, the first evaluation of the kinematical characteristics of sliding rod in the pedicle screw fixations. The sliding distance was identified. The sliding rod fixation constrained the motion and sustained load lesser, suggesting the sliding mechanism be used in both non-fusion and dynamic pedicle screw fixation.

**GP2**

**STABILIZATION OF THE LUMBAR SPINE IN VARIOUS 3-D POSTURES BY SPINAL MUSCLE CONTRACTION PATTERN CREATING COMPRESSIVE FOLLOWER LOAD**

Tianjiao Wang; Tae-Hong Lim; Department of Biomedical Engineering The University of Iowa, Iowa City, Iowa, 52242, USA

**INTRODUCTION:** It was shown the lumbar spine in flexion can be stabilized by spinal muscles (SM) creating the compressive follower load (CFL) in the lumbar spine. The purpose of this study was to investigate if CFL creating SM can also stabilize the lumbar spine in laterally bent and axially rotated postures.

**METHODS:** 3-D finite element (FE) model incorporating 232 SM was used to obtain the lumbar spine in various postures in neutral standing, 40 degree flexion, 30 degree right lateral bending, and 10 degree left axial rotation. The directions of SM corresponding to each posture were imported into 3-D optimization model (OPT), which was used to predict CFL creating SM forces in each posture under the influence of the trunk weight (350N). SM forces were then applied into the FE model as loading conditions. Lumbar spine stability was estimated as a trunk sway (±5mm) based on the translation of trunk center of gravity predicted from the FE model in response to the CFL creating SM forces.

**RESULTS:** Multiple combinations of CFL creating SM forces (CFLSMF) were feasible depending on the location of CFL path relative
to the reference path made by connecting vertebral body centers (T12-S1). FE predictions showed that CFLSMF, resulting in minimum CFL, induced trunk sway greater than 10 mm. In contrast, CFLSMF with CFL path close to the reference path (>2mm) produce small (stable) deformation of the lumbar spine in all tested postures, while they increased the CFL magnitudes at all lumbar levels. Outside that range, the spine tends to have a large unstable deformation (trunk sway > 10 mm).

**DISCUSSION:** Results of this study show that it is feasible for SM to create CFL in the lumbar spine in 3-D postures and to stabilize the spine in various 3-D postures as well. These indicate that in-vivo the lumbar spine may be stabilized by SM forces which create CFL paths within a range close to the reference path although further studies are required for a complete test of this postulation.

**GP3**

**THE CORRELATION BETWEEN CAGE SUBSIDENCE, BONE MINERAL DENSITY, AND CLINICAL RESULTS IN POSTERIOR LUMBAR INTERBODY FUSION**

Kyu Won Oh, MD,1 Jae Hyup Lee, MD,1 Ji‐Ho Lee, MD,1 Do‐Yoon Lee, MD,1 Hyeong‐Seok Lee, MD,2 Choon‐Ki Lee, MD,1 Bong‐Soon Chang, MD,1; 1Department of Orthopedic Surgery, College of Medicine, Seoul National University, Seoul, 156‐707, Korea 2Department of Orthopedic Surgery, Marynoll Medical Center, Busan, 600‐730, Korea

**INTRODUCTION:** Cage subsidence might result in recurrent foraminal stenosis and deteriorate the clinical results in PLIF. Therefore, the information on the correlations between cage subsidence, bone mineral density (BMD) and clinical results will be of great significance. This study aimed to investigate the relationship between cage subsidence and BMD, and to reveal the clinical implications of cage subsidence.

**METHODS:** Retrospective review of prospectively collected radiographic and clinical data was conducted. A total 139 segments (102 patients) was included in this retrospective study. Plain standing anteroposterior and lateral radiograph were taken at pre- and postoperatively and during follow-up. Preoperative BMD and subsidence measured by postoperative 1 year three‐dimensional computed tomography (3D CT) were achieved and their correlation was assessed. We examined functional rating index (Visual Analogue Scale for pain, Oswestry Disability Index, SF‐36 score) preoperatively, and investigated their changes after postoperative 1 year. Correlation between cage subsidence and clinical scores was investigated.

**RESULTS:** All postoperative clinical scores improved significantly compared to preoperative ones (pain VAS: 7.34 to 2.89, ODI: 25.34 to 15.86, SF‐36: 26.45 to 16.46, all p<0.001). BMD showed significant weak correlation with subsidence (r=-0.285, p<0.001). Severe osteoporotic segments (T score < -3.0) had more risk to develop severe subsidence (> 3mm) compared to the segments which T score were higher than -3.0 (p=0.012), and its odds ratio was 8.444. Subsidence had no significant correlation with all clinical scores.

**DISCUSSION:** This study revealed that cage subsidence is relevant to BMD. However, it was demonstrated that subsidence is not related to the clinical deterioration. Therefore, PLIF procedure which is conducted carefully can be a good surgical option to treat lumbar degenerative disease for osteoporotic patients.
GP4
DEVELOPMENT AND VALIDATION OF A THREE DIMENSIONAL SUBJECT SPECIFIC MODEL OF LUMBAR VERTEBRAL FRACTURE PROPAGATION
1Hugo Giambini, 2Xiaoliang Qin, 1Andrew Thoreson, 4,5Dan Dragomir-Daescu, 1,3Ahmad Nassr, 1Kai-Nan An; 1Bio-
mechanics Laboratory, Division of Orthopedic Research, Mayo Clinic, Rochester, MN, USA; 2Simulia, Dassault Systemes, Providence, Rhode Island USA; 3Department of Orthopedic Surgery, Mayo Clinic, Rochester, Minnesota USA; 4Division of Engineering, Mayo Clinic, Rochester, MN USA, 5College of Medicine, Mayo Clinic, Rochester, MN USA

INTRODUCTION: Clinical imaging tools for predicting fracture risk, dual x-ray absorptiometry (DXA) and quantitative computed tomography (QCT), are limited in that some individuals with sub-threshold bone mineral density (BMD) present with osteoporotic fractures. Furthermore, BMD values obtained from DXA are not well-correlated with bone strength. While finite element models have been developed for accurate mechanical property distribution and determination of crack-induced discontinuities, validation activities remain challenging. The aim of this study was to develop and validate a specimen-specific QCT/XFEM model of the lumbar vertebra using novel tools for predicting fracture strength and crack propagation.

METHODS: Four cadaveric specimens were obtained and their L3 vertebrae were isolated. Vertebrae were compressed to failure and force-displacement data were recorded at 100 Hz. Axial compressive strength and stiffness for each specimen was then calculated. Pre-mechanical testing, QCT was performed on the specimens and DICOM images were imported into Mimics for segmentation and voxel model development. HU-dependent Young’s modulus was assigned to each voxel. The models were exported into Abaqus and crack initiation and propagation was modeled using the extended finite element (XFEM) method and by applying a user-defined yield strain failure criterion. Loading and boundary conditions similar to the experiment were modeled.

RESULTS: Measured and predicted stiffness and failure loads are shown on Fig. 1a. A good correlation was found between the experimental and predicted results. The predicted crack location and failure pattern matched all vertebrae in the experimental testing, failing at the superior vertebral rim (Fig 1b).

DISCUSSION: The QCT/XFEM method used to predict vertebral compression fractures is a promising tool that can improve fracture risk prediction and fracture location, and should be considered in future studies of vertebral strength.

GP5
KISSING SPINE IS NOT PATHOLOGICAL CHANGE
Keiji Ishii, MD, Kazuhiro Hasegawa, MD, Haruka Shimoda, MD and Takao Honma, MD; Niigata Spine Surgery Center 2-5-22 Nishi-machi, Konan-ku, Niigata 950-0165, JAPAN

INTRODUCTION: Since kissing spine (KS) was reported as Baastrop disease causing
back pain, some symptomatic cases related with KS had been reported. But it is still unclear that KS is pathological or physiological alteration. We hypothesized that the frequency and number of KS increased by age if it was physiological change, and that symptom deteriorated as the number of KS increased if it was pathological. The purpose of this study is to clarify if it is pathological or physiological change.

METHODS: One hundred and twenty-three cases (male 58 female 65) were retrospectively investigated. Patients who had back surgery in past and cases of lumbar disc herniation were excluded. They were divided into two groups according to the presence of KS. Age and symptom evaluated by Japan Orthopedic Association Back Pain Questionnaire (JOABPEQ) of KS group and non-KS (NKS) group were compared. A relationship among the age, the number of KS, the location of KS, and spondylolisthesis were investigated.

RESULTS: KS group had 74 cases (male 31 and female 43) and NKS group had 49 cases (male 27 and female 22). The average age were 69.5 and 62.9 respectively (P<0.001). The average score of JOABPEQ in KS group were greater than that in NKS group in whole category and Visual Analogue Scale (VAS) in KS was lower than that in NKS group without statistically significance. The number of KS and age were positively correlated (R=0.34, P<0.001). L3/4 was the most frequent segment of KS. KS tend to present at upper adjacent segment of spondylolisthesis (P<0.001).

DISCUSSIONS: The frequency of KS increased by age and the presence of KS did not deteriorate clinical symptoms, suggesting that KS is age-related change. The result that cases with spondylolisthesis tend to have KS at upper adjacent segment was expected to contribute stabilizing the unstable segment or sustaining spinal alignment.

GP6
SUPPRESSIVE EFFECT OF LOW-DENSITY LIPOPROTEIN RECEPTOR-RELATED PROTEIN-1 (LRP1) ON SCHWANN CELL APOPTOSIS AFTER SCIATIC NERVE INJURY IN MICE
Sumihisa Orita*/**, Elisabetta Mantuano*, Kazuyo Yamauchi*/**, Seiji Ohtori**, Sadao Arai**, Kazuhiisa Takahashi**, Steven Goniass*, Wendy Campana*; *Dept. of Anesthesiology, University of California, San Diego, USA **Dept. of Orthopaedic Surgery, Graduate School of Medicine, Chiba University, Japan

INTRODUCTION: Schwann cells (SCs) play an essential role in nerve regeneration, and therefore, their survival after peripheral nerve injury (PNI) is important. PNI causes endoplasmic reticulum stress and activates the adaptive unfolded protein response (UPR). The UPR results in expression of C/EBP homology protein (CHOP); CHOP acts as a proapoptotic transcription factor in SCs, unless it is counteracted by low-density lipoprotein receptor-related protein-1 (LRP1), which serves as a major activator of phosphatidylinositol 3-kinase (PI3K). Thus, UPR can delay and disrupt peripheral nerve regeneration. The present study aimed to explore the role of LRP1 in SCs after UPR activation.

METHODS: Sciatic nerve crush injury was induced in C57BL/6J mice (n = 5), and 24 hours after surgery, the injured nerve was resected to obtain SCs. UPR was induced using TNF-alpha (50 ng/ml) and was confirmed by detecting expression of CHOP, an apoptosis biomarker. The role of LRP1 following UPR induction was examined by assessing CHOP levels after addition of the activation ligand of LRP1 (alpha-2M receptor binding domain [RBD]) and after genetic silencing of LRP1. We considered p < 0.05 as significant.

RESULTS: TNF-alpha addition resulted in increased CHOP expression, indicating UPR
induction. Addition of RBD significantly increased levels of phospho-PI3K and decreased CHOP levels (p < 0.05). Further, CHOP expression was significantly increased by both PI3K inhibition and LRP gene silencing, which indicates an association of LRP1 with the UPR pathway.

**CONCLUSION:** Our results support a model in which UPR-activated signaling pathways pose a major challenge to SC survival after PNI. Further, they support the idea that LRP1 functions as a potent activator of PI3K in SCs, thereby limiting SC apoptosis resulting from the increased CHOP expression after PNI.

**GP7**

**SHIFT OF THE PEDICLE SCREW IN THE VERTEBRA ACCOMPANIED WITH CHANGE IN THE DISC ANGLE FOLLOWING INSTRUMENTED FACET FUSION FOR DEGENERATIVE LUMBAR SPONDYLOLISTHESIS**

Tomohiro Miyashita *1, Hiromi Ataka *2, Kei Kato *1, Takaaki Tanno *2; *1: Spine Center, Matsudo City Hospital, Matsudo, Japan *2: Spine Center, Matsudo Orthopaedic Hospital, Matsudo, Japan

**INTRODUCTION:** Based on a long-term clinical and radiological follow-up study of facet fusion (FF) for degenerative lumbar spondylolisthesis (DLS), we reported that FF is a minimally invasive and suitable method for DLS. However, the disc angle (DA) at the fused level, which became lordotic immediately after surgery owing to the prone operative position, decreased gradually within 6 months to the same as that in the preoperative neutral position. In this study, we assessed the shift of the pedicle screws (PS) in the vertebra to identify the mechanism of the change in the DA.

**METHODS:** Twenty-six patients who underwent FF for single-level DLS and CT immediately after surgery and 6 months later were retrospectively reviewed. From these, 7 patients, in whom the DA had decreased by more than 4° after surgery to the same as that in the preoperative neutral position, were selected to capture the shift of the PS. The patients in whom CT showed PS loosening and/or pseudarthrosis were excluded.

We reconstructed a CT plane, which was vertical to the cranial endplate of the vertebra in which the PS was inserted and passed through a cannula of percutaneous PS. We measured the angle between the cranial endplate and the cannula on the plane.

**RESULTS:** Of 14 PSs, the angle of only 1 changed by more than 2° in the upper vertebra of the fused level. The tip of the shifting PS moved cranially. However, in the lower vertebra, the angle of 10 out of 14 PSs changed by 2-5°, and the tip of all these PSs shifted caudally.

**DISCUSSION:** The change in the DA after FF is thought to be caused by the PS shifting in the vertebra without loosening and by remodeling of the bone around it according to the biomechanical load. In other words, the PS itself is limited in its ability to maintain a lordotic DA, and even with a cage, lumbar alignment would return to the preoperative neutral position owing to sinking of the cage. We conclude that in situ fusion is a rational approach in the management of DLS.

**GP8**

**ANATOMICAL BACKGROUND OF “PSEUDOSCIATICA” IN CLUNEAL NEURALGIA**

Tomoyuki Konno, MD1, Yoichi Aota, MD2, Hiroshi Kuniya, MD1, Tomoyuki Saito, MD1, Nei Kyoku, MD3, Shougo Hayashi, MD3, Shinichi Kawada, PhD3, Masahiro Itoh, MD2; 1Department of Orthopaedic Surgery, Yokohama City University Graduate School of Medicine, Yokohama, Kanagawa, Japan; 2 Spine and Spinal cord center Yokohama stoke and brain center, Yokohama, Kanagawa, Japan, 3Department of Anatomy, Tokyo Medical University, Shinjyuku, Tokyo, Japan
INTRODUCTION: Superior cluneal nerves (SCN) are cutaneous nerves distributed at the gluteal region. Medial branch of SCN can become spontaneously entrapped under fascia over iliac crest and cause low back pain. Surgical reports were few and limited to a small number of subjects with low back and/or buttock pain. On the other hand, Trescot stated that SCN entrapment can cause a referred pain dawn the leg, potentially all the way to the foot and this “pseudosciatica” would clinically mimic a radiculopathy (Pain physician 2003). Previous anatomical studies cannot explain why this clinical entity can cause “pseudosciatica” because the medial branch of SCN comprises the cutaneous branches of the dorsal rami of the upper three lumbar nerves. The purpose of the present anatomical study was to improve the understanding of “pseudosciatica” in SCN entrapment.

METHODS: Bilateral branches of SCN were observed macroscopically on 6 cadavers (male 3 bodies, female 3 bodies) with a mean death age of 89 years (81-100) were investigated. All branches of SCN were exposed around the iliac crests (figure). Special attention was paid to preserve thin branches and anastomoses. All branches of SCN were proximally explored to identify its emergence from nerve roots.

RESULT: SCN was originating from dorsal roots of from T12 to L5. The medial branch of SCN emerged at three different levels; L3 (n=1), L4 (n=5), and L5 nerve root (n=4).

DISCUSSION: In this anatomical study, the medial branch of SCN emerged predominantly from L4 and L5, which was unlike most previous studies concluding its emergence from T11-L4 nerve roots. SCNs are potentially an underdiagnosed source of leg pain.

GP9
STENOSIS IN THE LUMBAR SPINE IS ASSOCIATED WITH INCREASED HINDFOOT DEGENERATION AND ANKLE OSTEOARTHRITIS: A STUDY OF 720 CADAVERIC SPECIMENS
Joshua T. Anderson, BS (1,2), Alex V. Boiwka, BS (1,2), Navkirat Bajwa, MD (1), Nicholas U. Ahn, MD (1); 1 University Hospitals Case Medical Center Department of Orthopaedic Surgery 2 Case Western Reserve University School of Medicine

INTRODUCTION: Neural compression due to lumbar spinal stenosis (LSS) is associated with motor and sensory changes and radicular pain in the lower extremities, which can lead to gait changes. This alteration may ultimately lead to deterioration of the ankle and hindfoot joints.

METHODS: 720 adult cadaveric specimens age 20-70 were selected from a collection of human skeletons. All had intact bony elements. In each subject, canal area was calculated at each lumbar level using a previously validated formula. Ankle arthritis and hindfoot arthritis (i.e., arthritis across the talonavicular [TN], subtalar [ST], and calcaneocuboid joints [CC]) was quantified using the Kellgren-Lawrence classification system, as determined by presence and size of osteophytes on the articular surfaces. Linear regression analyses, correcting for confounding factors such as age, sex, race, and height were performed to identify the
association between canal area throughout the lumbar spine and presence and severity of hindfoot arthritis and/or ankle arthritis.

**RESULTS:** A significant negative association was found between total canal area and both the severity of ankle arthritis (p=0.02) and severity of hindfoot arthritis of the TN and CC joints (p=0.01). LSS in the more distal segments (L4-S1) was more strongly associated with severity of ankle arthritis than stenosis in the upper lumbar segments, with higher correlation coefficients. Both were associated with presence and severity of ankle arthritis (p<0.05) and hindfoot arthritis (p<0.05). Subjects with severe LSS (canal area less than 2 SD below the mean) had markedly increased degeneration across the ankle joint, even at ages less than 40.

**DISCUSSION:** The presence of LSS is associated with degeneration across the ankle joint and joints of the hindfoot. The association was most strongly identified at the lower lumbar levels. This correlates physiologically, as the lower lumbar levels innervate the distal lower extremities.

**GP10**

**STRESS ANALYSIS IN OSTEOPOROTIC LUMBAR VERTEBRA WITH MICRO-SCALED BEAM-SHELL TRABECULAR-CORTICAL STRUCTURE: A FINITE ELEMENT ANALYSIS**

Yoon Hyuk Kim1, Mengying Wu1, Kyungsoo Kim2; 1Department of Mechanical Engineering, Kyung Hee University, Korea 2Department of Applied Mathematics, Kyung Hee University, Korea

**INTRODUCTION:** Due to the difficulties associated with obtaining bones for in vitro experiments and the limitations on the control of the experimental parameters, finite element (FE) models including the trabecular and cortical parts have been developed to investigate biomechanical properties of osteoporotic vertebrae. In this study, FE models of normal and osteoporotic lumbar vertebrae that incorporate the micro-scaled trabecular structure of lattice models and the cortical area of shell elements were developed. The von-Mises stress was analyzed to predict the risk of the burst fracture in osteoporotic bones of various grades.

**METHODS:** Trabecular models composed of vertical and horizontal struts were developed for different age groups (young, middle-aged, and old), two endplates, and the cortical part of the vertebra were developed. The trabecular lattice was tied with the cortical shell and endplates. The von-Mises stress in the trabecular lattice was then analyzed for the three age groups under compressive loadings of 0.15MPa, 0.3MPa, 0.45MPa, 0.6MPa and 0.75MPa.

**RESULTS:** The von-Mises stress substantially increased as the osteoporosis was getting severe, regardless of the compressive loadings. The maximum stress was greater than 50% of the yield stress when compressive loading exceeded 0.45 MPa for middle-aged group and 0.3 MPa for the old group; in contrast, the maximum stress did not reach 50% of the yield stress even under 0.75 MPa for the young group.

**DISCUSSION:** The results suggest that osteoporosis can affect the stress acting on the vertebra even during routine daily activities because the 0.45MPa of compressive loading on the endplate is similar to that produced during daily activities. The vertebra model that incorporates a realistic trabecular structure is advantageous because it permits simulation of in vivo specimens for the study of osteoporosis.

**GP11**

**BIOMECHANICAL ANALYSIS OF COMBINED MOTION EXERCISE IN THE LUMBAR SPINE**

Won Man Park1, Dae Kyung Choi1, Kyungsoo Kim2, Yoon Hyuk Kim1, Jae Lak Yang3; 1Department of Mechanical Engineering, Kyung Hee University, Korea 2Department of Applied Mathematics,
**INTRODUCTION:** Spine exercise has been used as one of the most common conservative treatments for low back pain. However, relatively little is known about the effects of spine exercise on lumbar spine biomechanics. In this study, we investigated biomechanical effects of combined motion spine exercise, which consists of the axial traction and the local decompression, on the lumbar spine.

**METHODS:** A validated three-dimensional finite element model of the lumbar spine was used. Only flexion-extension motion of the L1 and sacrum, and axial translation of L1 were allowed in the finite element analysis. One-third of body weight was applied on the center of the L1 vertebra toward the superior direction for axial traction. Translation of L4 spinal bone toward anterior direction was considered as the local decompression. Changes in spine biomechanics, such as lordosis angle, intradiscal pressure, and stress on fibers of annulus fibrosus and ligaments, during combined motion spine exercise were investigated using three-dimensional finite element model of the lumbar spine.

**RESULTS:** The lordosis angle between the superior planes of the L1 vertebra and sacrum was 44.6° at baseline, 35.2° with global axial traction, and 46.4° with local decompression. The highest average stresses on the fibers of annulus fibrosus were mainly shown in the posterior region during axial traction, and decreased during local decompression. The intertransverse and posterior longitudinal ligaments experienced stress primarily during global axial traction, these stresses decreased during local decompression.

**DISCUSSION:** A combined motion spine exercise of global axial traction and local decompression would be helpful for reducing tensile stress on the fibers of the annulus fibrosus and ligaments, and intradiscal pressure in traction therapy. The present study could be used to develop a safer and more effective spine exercise program.

**GP12**

**INCREASE IN TRUNK MUSCLE LOADING WITH SAGITTAL PLANE DEFORMITY: A FINITE ELEMENT ANALYSIS**

Yoon Hyuk Kim1, Kyungsoo Kim2, Dae Kyung Choi1, Yongjung J. Kim3; 1Department of Mechanical Engineering, Kyung Hee University, Korea 2Department of Applied Mathematics, Kyung Hee University, Korea 3School of Physicians and Surgeons, Columbia University, USA

**INTRODUCTION:** Sagittal plane deformity has been known to produce significant pain, disability, and poor self-image in upright posture, which could deteriorate efficiency of energy expenditure by increasing trunk muscle loading in maintaining the posture from biomechanical viewpoint. There is no study to quantify relationship between the sagittal plane deformity and the trunk muscle loading. The purpose of this study is to investigate trunk muscle loading in sagittal plane deformity in the upright posture.

**METHODS:** A three-dimensional finite element model of the intact whole spine by using CT images was developed. Three sagittal plane deformity models (mild, moderate, and severe) by deforming the intact model were obtained. Sagittal plane deformity was classified based on sagittal vertical axis (SVA). Sagittal imbalance was defined if SVA is 80 mm or larger from patients’ X-ray images. In each model, 117 pairs of trunk muscles (59 pairs of paraspinal muscles and 58 pairs of superficial muscles) were included. The muscle forces in an upright posture were investigated, where the upper body weight was applied along C7 plumb line.

**RESULTS:** The trunk muscle loadings were 72%, 164%, 251%, and 351% of the body
weight (BW) in SVA of 0 mm (intact), 80 mm (mild), 155 mm (moderate), and 240 mm (severe), respectively. The paraspinal muscle loadings were 36% (intact), 88% (mild), 174% (moderate), and 256% (severe) of the BW, respectively.

DISCUSSION: The results indicated that the larger SVA, the more trunk muscle over-loadings. Excessive trunk muscle over-loadings, especially for the paraspinal muscle group, is needed to maintain the posture which might induce the muscle fatigue, or regional and global posture change to reduce the trunk muscle loading. The findings help to understand biomechanical principles in trunk muscle loading related to sagittal plane deformity.

GP13
EFFECT OF LIGATURE PRETENSION IN INTERSPINOUS PROCESS SURGERY
Dae Kyung Choi1, Won Man Park1, Yoon Hyuk Kim1, Kyungsoo Kim2; 1Department of Mechanical Engineering, Kyung Hee University, Korea 2Department of Applied Mathematics, Kyung Hee University, Korea

INTRODUCTION: Ligatures to prevent the instability in the flexion movement by wrapping around upper and lower spinous processes are used with many types of interspinous process spacer (IPS). However, the effects of ligature pretension in IPS on the surgical outcomes from the biomechanical point of view have not been analyzed yet. In this study, we investigated the effects of pretension of ligatures on biomechanics of functional spinal unit after interspinous process surgery.

METHODS: Three-dimensional (3D) finite element (FE) models of one pedicle screw system and four different IPSs were developed. Spinal fusion and interspinous process surgeries were virtually performed based on the clinical protocol using the developed L3-L4 FE models. Flexion-extension moments of 7.5 Nm were applied with a compressive force of 400 N along the direction from upper vertebra center to the lower one on the superior plane of L3 vertebra. The ligature pretension was varied from 0 N to 400 N with an increment of 100 N. Range of motions (ROMs) in flexion and the maximum von-Mises stresses at the spinous process in extension were analyzed.

RESULTS: The ROMs in flexion were substantially reduced as the ligature pretension was increased while ROMs in flexion in all IPS cases were larger than that in the fusion case, though they were smaller than that in the intact case, regardless of the ligature tension. In contrast, the maximum von-Mises stresses at spinous process were increased by 22% - 54% in all IPS cases as the ligature tension was increased.

DISCUSSION: The results of this study showed that excessive pretension of ligature could increase the risk of subsidence of the osteoporotic bone by increasing maximum von-Mises stresses at spinous process and improve the spinal stability by decreasing the ROMs of flexion-extension movement. Therefore the magnitude of pretension of ligature should be carefully considered in the interspinous process surgery.

GP14
THE RELATIONSHIP OF THE FRONTAL PLANE TRUNK AND PELVIC MOTION DURING GAIT AND THE RADIOGRAPHIC SPINOPELVIC MEASUREMENTS OF PATIENTS WITH A UNILATERAL COMPLETELY DISLOCATED HIP
Masatsugu Tsukamoto, Tadatsugu Morimoto, Tomohito Yoshihara, Masaya Ueno, Shuichi Eto, Shunsuke Kawano, Masaru Kitajima, Motoki Sonohata, Masaaki Mawatari; Department of Orthopedic Surgery, Faculty of Medicine, Saga University, Saga, Japan 5-1-1 Nabeshima, Saga 849-8501, Japan

INTRODUCTION: Patients with a unilateral completely dislocated hip (CDH) often have
GP15
TRANSFORMING GROWTH FACTOR-ß BLOCK THE CONTRIBUTION OF ADAMTS-1 TO INTERVERTEBRAL DISC DEGENERATION THROUGH THE SMAD/MAPK PATHWAY: A POSSIBLE DEGENERATION REPARATIVE WAY?
Zheng Zhaomin, Wang Hua, Wang Jianru, Liu Hui; Department of Orthopedic, The First Affiliated Hospital of Sun Yat-sen University

OBJECTIVE: To investigate how transforming growth factor ß (TGF-ß) regulation of ADAMTS-1 expression in nucleus pulposus (NP) cells of the intervertebral disc.

METHODS: qRT-PCR and Western blot were used to measure expression of ADAMTS-1/4/5 in NP cells treated with TGF-ß. Transfections were used to measure the effect of Smad3, MAPKs, and activator protein 1 (AP-1) on TGF-ß-mediated ADAMTS-1 promoter activity. Lentiviral knockdown of Smad2/3 was performed to assess the role of Smad2/3 in ADAMTS-1 expression. Besides, ADAMTS-1 role in aggrecan and versican degradation was investigated.

RESULTS: TGF-ß decreased the expression of ADAMTS-1/4/5 mRNA and protein level in nucleus pulposus cells, besides TGF-ß suppressed ADAMTS-1 promoter activity. TNF-a increased aggrecan or versican degradation, which was inhibited by TGF-ß, TGF-ß alone can also decrease aggrecan or versican degradation. Besides, when NP cells were infected with LV-shADAMTS1, TGF-ß dependent suppression in NITEGE and G1 secreted protein is significantly blocked. Next to evaluate the potential pathway. Suppression of ADAMTS-1 promoter activity was evident when the NP cells were co-transfected with smad2/4 construct, but not smad3. On the other hand, co-transfection of smad7 restored ADAMTS-1 promoter activity, and similar result in A-Fos construct. Supporting the promoter studies, lentiviral delivery of sh-
smad2 significantly blocked TGF-β suppression in ADAMTS-1 expression, but no sh-smad3. Treatment of cells with MAPK inhibitors partially abolished the suppressive effect of TGF-β on ADAMTS-1 mRNA and protein expression, suggesting involvement of these signaling pathways in the regulation of ADAMTS-1. Gain and loss of function studies confirmed the contribution of JNK1/2 and ERK1/2 to TGF-β dependent suppression of ADAMTS-1 promoter function.

**CONCLUSIONS:** TGF-β, through Smad2, JNK1/2 and ERK1/2, serve as a negative regulator of ADAMTS-1 expression in the NP, which can inhibit the role of ADAMTS-1 on NP

**GP16**

**PLIF EXPANDABLE CAGES EFFECTIVELY STABILIZE THE SPINE BETTER THAN TLIF CAGE**

1Kodigudla, M; 1Desai, D; 1Agarwal, A; 1Momeni, N; 1Goel, VK; 1Agarwal, AK; 2Schultz, C; 1Engineering Center for Orthopaedic Research Excellence (E-CORE) Departments of Bioengineering and Orthopaedic Surgery Colleges of Engineering and Medicine University of Toledo, Toledo, OH 43606 2Apex Spine, Munich, Germany

**INTRODUCTION:** PLIF is a widely used technique in spinal fusion. Expandable cages are currently being explored in stabilizing the spine, especially as standalone device. The main objective of this study was to biomechanically evaluate expandable PLIF cages vs. a standard TLIF cage in fucncional spinal units (FSUs) with and without additional posterior fixation.

**MATERIAL AND METHODS:** Twelve ligamentous L23 and L45 FSUs were used. The potted caudal (L3/L5) end was fixed to the testing apparatus and pure moments up to 10 Nm at the cranial level were applied in extension (ext), flexion (flex), left and right lateral bending (lb & rb) and left and right axial rotations (lr & rr). Motion was tracked using the Optotrak motion capture system (NDI, Waterloo, Canada). Following the biomechanical testing of intact specimens, 1 TLIF (Aesculap, Germany) or bilateral expandable PLIF (Medyssey, Elk Grove, IL) cages were inserted and tested. Next, pedicle screw system (PSS) was implanted to stabilize the segments before further testing. TLIF was performed in 6 L2-L3 specimens and PLIF was performed in 6 L4-L5 specimens.

**RESULTS:** Standalone TLIF procedure increased the motion of the segments in ext (26%), lb (16%), rb (10%), lr(25%) and rr(37%) and decreased in flex(7%), compared to intact motion. Standalone bilateral PLIF cages reduced the motion in flex (36%), ext (70%), lb (64%), rb (58%), lr (22%) and rr (5%). The reduction due to standalone PLIF was significant in all loading modes except axial rotation (Figure 1). Implantation of pedicle screw system reduced the motion significantly in all loading modes in TLIF and PLIF groups.

**DISCUSSION:** The expandable cages effectively stabilized the spine in all modes, except axial rotation. Addition of pedicle screw fixation system would further stabilize the spine, especially in rotation. Thus, expandable cages may need additional stabilization, especially in axial rotation to provide favorable environment for spinal fusion.
GP17
PEEK TRANSLAMINAR FACET SCREWS PROVIDE LONG TERM STABILITY OF THE LUMBAR SPINE AFTER MICRODISCECTOMY
1Kodiqudla, M; 1Desai, D; 1Agarwal, A; 1Goel, VK; 1Agarwal, AK; 2Wanderley, JGPV; 1Engineering Center for Orthopaedic Research Excellence (E-CORE)Departments of Bioengineering and Orthopaedic Surgery Colleges of Engineering and Medicine University of Toledo, Toledo, OH 43606 2Spine Soft Fusion, Brazil

INTRODUCTION: Translaminar facet screw fixation in spine surgery is a minimimmy invasive alternative. However the clinical success rate is suboptimal. It might be due to the use of Titanium (Ti) screws which are stiffer than the adjoining bone. The main objective of this study was to evaluate the stabilization of Ti Vs PEEK screws in functional spinal units (FSUs), pre and post cyclic loading.

MATERIAL AND METHODS: 12 ligamentous L2-L3 FSUs were tested in this study. The potted caudal (L3) end was fixed to the testing apparatus and pure moments were applied in all loading modes up to 10 Nm at the cranial (L2) end. Motion was tracked using the Optotrak. Following the testing of intact specimens, micro discectomy was performed from right lateral side and tested. Next, translaminar facet screws (TLFS) were inserted bilaterally to stabilize the segments and re-tested. Ti screws were used in 6 motion segments and PEEK screws were used in the other 6 specimens. Following Optotrak testing, all motion segments were loaded cyclically by applying 7.5 Nm in flexion and extension and 5 Nm in axial rotation up to 50,000 cycles at 2 Hz. Post fatigue, the specimens were again tested for range of motion to evaluate the increase in motion if any.

RESULTS: TLFS of Ti and PEEK stabilized the segments with micro discectomy. Fatigue loading increased the motion significantly in flexion, extension, right bending and left rotation without preload and, in flexion with preload for Ti group (Figure 1). The increase in motion post-fatigue was not significant in all loading modes except in left bending for PEEK group.

DISCUSSION: Post fatigue, the increase in instability in Ti group may be attributed to the loosening of the screw due to high elastic modulus of Ti than bone. In PEEK group the instability was less than Ti suggest that bone screw interface for PEEK screws is more rigid than Ti post fatigue. Thus, PEEK translaminar screws perform better than Ti screws in the short and long-term.

GP18
POSTURAL ACTIVITY OF THE PSOAS MAJOR AND QUADRATUS LUMBORUM MUSCLES IS LESS PRECISELY CONTROLLED IN PEOPLE WITH RECURRING BACK PAIN
Rachel J. Park1,2, Henry Tsao1, Andrew G. Cresswell1,2, and Paul W. Hodges1; 1The University of Queensland, NHMRC Centre of Clinical Research Excellence in Spinal Pain, Injury and Health, School of Health and Rehabilitation Sciences, Brisbane, Queensland, Australia. 2The University of Queensland, Centre for Sensorimotor Neuroscience, School of Human Movement Studies, Brisbane, Queensland, Australia

INTRODUCTION: The mechanically unique regions of the psoas major (PM) and quadratus lumborum (QL) muscles are controlled
independently by the nervous system. Sophisticated coordination of these regions may be modified in the presence of recurring low back pain (LBP).

**METHODS:** Nine volunteers with recurring episodes of LBP and thirteen pain-free controls performed rapid bilateral arm flexion and extension, to impose a postural perturbation to the spine. Individuals with LBP were subgrouped into those with high and low erector spinae (ES) electromyography (EMG) when sitting with a lumbar lordosis. Fine-wire electrodes were used to record EMG from the regions where PM fascicles arise from the transverse process (PM-t) and vertebral body (PM-v) and the anterior (QL-a) and posterior (QL-p) layers of QL on the right side.

**RESULTS:** Activity of QL-a did not differ between directions of arm movement in the LBP groups, unlike controls who had earlier QL-a EMG onset during arm extension. EMG onset of regions of PM and QL-p activity did not differ between groups, but the pattern of QL-p activity differed between LBP subgroups. Activity did not differ between PM regions, unlike controls who displayed individual control of these regions.

**DISCUSSION:** One interpretation of these data is that people with LBP use a more simplified control strategy for the deep trunk muscles. This strategy involved less discrete control of individual regions of PM and QL, and activation of some regions differed less between tasks that differed with respect to the directions of reactive moments from limb movement. This may represent a simplified strategy to protect the spine in people with recurring LBP and could require consideration in prevention of back pain recurrence.

**GP19**

**THE EFFECTS OF NEUROMUSCULAR ELECTRICAL STIMULATION (NMES) ON CHANGE IN THICKNESS OF DEEP TRUNK MUSCLES IN PATIENTS WITH LOW BACK PAIN.**

*Seung Ok Baek, M.D., Hee Kyung Cho, M.D., Gil Su Jung, Su Min Son, M.D., Yun Woo Cho, M.D., Sang Ho Ahn, M.D., PhD; Departments of Physical Medicine and Rehabilitation, College of Medicine, Yeungnam University, Daegu 705-717, Korea*

**INTRODUCTION:** Neuromuscular electrical stimulation (NMES) can preferentially stimulate contractions in deep lumbar stabilizing muscles and restore muscle function. In current study, we attempted to investigate relation between deep lumbar stabilizing muscles and NMES during each sessions using real time ultrasound imaging.

**METHODS:** Thirty patients with LBP (12 males, 18 females, mean age 49.2 ± 13.6 years, range 19-69 years) were recruited. NMES was delivered through abdominal and lumbar electrical stimulation. Abdominal electrical stimulation include 4 hydrogel surface electrodes (5cm X 5cm) located on both sides of the anterolateral abdominal wall. Lumbar electrical stimulation include 4 surface electrodes according to the cross line on L4/5 interspinous process. Session 1 was abdominal electrical stimulation only, session 2 was lumbar electrical stimulation only and session 3 was concurrent stimulation of abdominal and lumbar. During each session, images of abdominal muscle and lumbar multifidus muscles were captured using real time ultrasound imaging (RUSI).

**RESULTS AND DISCUSSION:** To investigate relationship between deep lumbar stabilizing muscles and NMES, we set the specific NMES sessions and used relatively small electrodes. Thicknesses of abdominal muscles (transverse abdominis, obliquus internus, and obliquus externus) and lumbar multifidus muscles were significantly larger...
during each NMES than at rest for all three sessions (p<0.05). However, there were no significant different between session 1 and 3 in abdominal muscles. And no significant difference was observed between session 2 and 3 in LM. TrA, OI and LM were significantly activated together during session 3. The session 3 stimulation optimally activated deep spinal stabilizing muscles, that is, the TrA, OI and LM, as evidenced by RUSI. The authors recommend that NMES on abdominal wall and lumbar area together would help patients with LBP who had problems with contractions in deep stabilizers.

**GP20**

**ABDOMINAL HOLLOWING DURING GAIT CAN SELECTIVELY ACTIVATE LOCAL TRUNK STABILIZING MUSCLES: A CROSS-SECTIONAL STUDY.**

Ah Young Lee, M.D., Eun Hyuk Kim, M.D., Seung Ok Baek, M.D., Yun Woo Cho, M.D., Sang Ho Ahn, M.D.; Departments of Physical Medicine and Rehabilitation, College of Medicine, Yeungnam University, Daegu 705-717, Korea

**INTRODUCTION:** Trunk muscle exercises are widely performed during clinical and rehabilitation programs, and many studies have been performed to examine their effects on different low back pains. However, the effect of trunk muscles activations during gait with AH on low back pain experienced during daily activities has not been clarified. To investigate whether gait with abdominal hollowing (AH) is more effective for promoting local trunk muscle activation than gait without AH using surface electromyography (EMG).

**METHODS:** A cross-sectional comparative study of local trunk muscle activations during gait with and without AH in 20 participants. Twenty healthy men with no history of a cervical, thoracic, or a lumbar spine disorder participated in the study. EMG amplitudes were normalized by having participants perform maximal voluntary contractions (MVC). Surface electrodes were attached to multifidus (MF), lumbar erector spinae (LES), thoracic erector spinae (TES), transverse abdominus - internal oblique abdominals (TrA-IO), external oblique abdominals (EO), and rectus abdominis (RA). The amplitudes of electromyographic signals were measured during gait with or without AH.

**RESULTS:** AH during gait was found to result in significant increases in the normalized MVCS of MFs and TrA-IOs in both sides (p <0.05). Ratios of local muscle activity to global muscle activities were increased during gait with AH, and both TrA-IO/EO were significantly increased by AH (p < 0.05).

**DISCUSSION:** Gait with AH resulted in significantly more recruitment of local trunk muscles. The study suggests that AH during gait be recommended for low back pain patients in an outpatient setting to improve spinal dynamic stabilization.

**GP21**

**THE RELATION BETWEEN EXPERIMENTAL PAIN AND SPINAL STIFFNESS - A PILOT STUDY**

Arnold Wong, Greg Kawchuk, Christopher Huang; University of Alberta

**INTRODUCTION:** A subset of people with low back pain (LBP) have increased spinal stiffness, which decreases as LBP subsides. Currently, the relation between LBP intensity and spinal stiffness remains unclear. As such, this study investigated the effect of pain on temporal changes of spinal stiffness.

**METHODS:** In separate sessions, nine healthy subjects received injections of hypertonic (0.3ml, 5% NaCl) or isotonic saline (0.3ml, 0.9% NaCl) in random order. On both occasions, saline was injected into the L3/4 and L4/5 interspinous ligaments. Subjects were blinded to saline concentration.
Spinal stiffness at L3 spinous process was measured by a mechanical indentation device before, immediately after, and 25-minute after injection. Pain intensity at the three time points was recorded. Pain intensity and spinal stiffness were compared between each saline condition using repeated measures analysis of variance adjusted for Fear of Pain Questionnaire-III scores. Trend analysis and tetrat difference calculation were used as post-hoc tests. The significance level was set at 0.05.

RESULTS: Both hypertonic and isotonic saline injections caused significant temporary increase in LBP (p < 0.05). Hypertonic saline induced significantly higher LBP intensity than isotonic saline (p < 0.05). Although there were no significant differences in spinal stiffness between the two saline concentrations at all time points, there was a significant interaction between saline concentrations and time points after adjusting for the Fear of Pain Questionnaire-III scores (p < 0.05). Post-hoc tests showed that both saline injections tended to temporarily increase spinal stiffness but hypertonic saline increased spinal stiffness more than isotonic saline alone.

DISCUSSION: Experimental LBP resulted in a transient increase in spinal stiffness beyond pain caused by an inert injection volume. Future work will explore if pain-related spinal stiffness increases are associated with reflexive muscle activity.

GP22
THE IMPORTANCE OF POSTERIOR OSTEOLIGAMENTS STRUCTURE TO LUMBAR SPINE STABILITY: AN IN-VITRO BIOMECHANICAL INVESTIGATION
Uphar Chamoli [1,2], Mert H. Korkusuz[1], Ashutosh B. Sabnis[1], Andrei R. Manolescu[1], Ashish D. Diwan[1]; 1. Spine Service, Department of Orthopaedic Surgery, St. George Hospital Clinical School, University of New South Wales, Kogarah, Sydney NSW 2217, Australia.

2. School of Mechanical and Manufacturing Engineering, University of New South Wales, Kensington campus, Sydney NSW 2052, Australia.

INTRODUCTION: Biomechanical implications of sequentially sacrificing posterior osteoligamentous structure in a multisegment (T12-S1) lumbar spine have not been comprehensively studied before, especially for any compensatory changes in kinematics at caudal and cranial adjacent levels. The main aim of this study was to evaluate the contribution of posterior ligaments and facet joints in stabilizing the lumbar spine during flexion-extension (FE), lateral bending (LB), and axial torsion (AxT) motions.

METHODS: Six fresh frozen cadaveric kangaroo lumbar spines were tested in a six-degrees-of-freedom kinematic spine simulator, and the 3D segmental motion was recorded using an infrared motion tracking device. A sinusoidal load (0.01 Hz) of ±5Nm was applied in FE, LB, and AxT motion planes, without a compressive preload. Specimens were tested in the following order: (1) intact state (D0), (2) after interspino-pelvis and supraspinous ligament sacrifice between L4-L5 (D1), (3) further bilateral facetectomy between L4-L5 (D2). Load vs. deformation curves were plotted to quantify % changes in range of motion (ROM) and neutral zone (NZ) between D0-D1, and D0-D2 states. Paired samples t-test was used to detect significance in % change (a = 0.05).

RESULTS: Global kinematic differences between D0-D1 states in all loading planes were found to be small and insignificant, but were highly significant between D0-D2 states during AxT motion (p<0.01). Between D0-D1, compensatory decrease (p<0.05) in segmental FE ROM at caudal adjacent, and LB NZ at cranial adjacent levels were observed. Between D0-D2 states, a compensatory decrease in AxT ROM at caudal adjacent level was also observed (p<0.01).
CONCLUSIONS: Supraspinous and interspinous ligaments play a modest role in restricting global spinal motions within physiologic limits, possibly due to low stiffness and straightening of collagen fibrils. Bilateral facetectomy affects AxT motion the most, both at the damage and adjacent levels.

GP23
INFRARED THERMOGRAPHY IN SPATIAL EVALUATION OF BACK MUSCLE ACTIVITY
R Lasanen (1,2), O Airaksinen (3), J Karhu (4), J Töyräs (1,5) and P Julkunen (1,5); 1Department of Applied Physics, University of Eastern Finland, Kuopio, Finland 2Thermidas Ltd, Rovaniemi, Finland 3Department of Physical Medicine and Rehabilitation, Kuopio University Hospital, Kuopio, Finland 4Department of Physiology, Institute of Biomedicine, University of Eastern Finland, Kuopio, Finland 5Department of Clinical Neurophysiology, Kuopio University Hospital, Kuopio, Finland

INTRODUCTION: Computer work related musculoskeletal symptoms are highly common. Ergonomic work stations which could reduce these symptoms are needed but designing such work stations require quantitative methods for measuring the related muscle stress. In this study, the muscle activities in upright and traditional working postures were compared. Our hypothesis was that the upright working posture would decrease the work-related muscle activity.

METHODS: For this purpose quantitative infrared thermography (IRT) and surface electromyography (sEMG) were utilized. With both working postures, full working day measurements were made for 11 female office workers. Before measurements in upright posture, participants had one month to adjust to the working station. Before and after each measurement day, IRT images were acquired and sEMG was continuously recorded during those days. Furthermore, the participants answered to questionnaires on their neck pain (NDI-questionnaire) and daily working routines before the first and after the second measurement day.

RESULTS: We found that spatial variation in upper back temperature measured with IRT was higher (p<0.05) when working in traditional posture and that upright working posture reduced (p<0.05) the upper back muscle activity. Moreover, also the NDI-value was significantly lower (p < 0.05) after participants had worked in upright posture. In low back there was no significant temperature difference between the first and last working hours in either of the postures.

DISCUSSION: Based on present findings, IRT was found to have potential for evaluating muscle activity with promising spatial separation ability. Furthermore, upright working posture seems to increase the satisfaction of office workers during normal working day.

GP24
ESTROGEN RECEPTOR ON THE LIGAMENTUM FLAVUM IN DEGENERATIVE LUMBAR STENOSIS
In-Soo Oh, MD1, Kee-Yong Ha, MD2; Department of Orthopaedic Surgery, Incheon St. Mary’s Hospital1, Seoul St. Mary’s Hospi-
**INTRODUCTION:** Although DLS may have several anatomical variations including hypertrophy of the LF, facet joint destruction, and osteophytes, few attempts have been made to investigate the causes of these anatomical variations through an immunohistochemical study. The prevalence of DLS in the female population and estrogen-related degeneration of ligament and articular cartilage raise the possibility with the varying expression of the ER.

**METHODS:** A total of 40 patients diagnosed with DLS and who have undergone decompressive laminectomy were considered in this study. 40 patients were divided into 2 groups according to gender with same age. During the surgery, LF was harvested. The expression of the ER-α and ER-β were evaluated through immunohistochemistry. Likewise, enzyme immunoassay was analyzed using an antiestrogen receptor.

**RESULTS:** Enhanced expressions of the estrogen receptor were observed in the LF. The amount of the estrogen receptor was 8.7±1.5 fmol in the hypertrophy group and 5.7±3.4 fmol/ml in the control group. The difference was statistically significant (p<0.05). In the facet joint capsule, the amounts of the estrogen receptor were significantly different (p<0.05) for the degenerative group (8.1±4.5 fmol/ml) and for the control group (4.9±3.3 fmol/ml).

**DISCUSSION:** The varying expression of the ER may be related to the morphological difference in DLS.

**GP25**

IN-VITRO BIOMECHANICAL IMPLICATIONS OF A BILATERAL PAR INTERARTICULARIS DEFECT: DO WE NEED A DIFFERENT SPINAL IMPLANT?

*Alan S. Chen*[1], *Uphar Chamoli*[1,2], *Ashish D. Diwan*[1]; 1. Spine Service, Department of Orthopaedic Surgery, St. George Hospital, University of New South Wales, Kogarah, Sydney NSW 2217, Australia. 2. School of Mechanical and Manufacturing Engineering, University of New South Wales, Kensington campus, Sydney NSW 2052, Australia.

**INTRODUCTION:** The main aim of this study is to further elucidate in vitro biomechanical implications of a bilateral pars defect on global as well as segmental kinematics during physiological bending motions, and to further define design requirements for the development of a spinal implant for direct repair of pars interarticularis defect.

**METHODS:** Seven fresh-frozen kangaroo lumbar spine specimens (L1-Sacrum) were tested in flexion-extension, bilateral bending and left-right axial torsion under pure moments of ±5 Nm at 0.01 Hz without compressive preload. Two experimental models were tested: 1) intact; 2) L4 bilateral pars interarticularis defect. The range of motion (ROM) and neutral zone (NZ) were measured for the entire spine, at the damaged level, and at the cranial adjacent level. Interpedicular displacement (ID) and interpedicular travel (IPT) were also measured at the cranial and damaged levels. Differences between intact and damaged state were quantified as percentage change from the intact state. Non-parametric two-tailed sign testing was performed at 5% level of significance (α=0.05).

**RESULTS:** The median global ROM increased significantly by two orders of magnitude in axial torsion. The median ROM and ID at the cranial adjacent level increased and decreased significantly by two orders of magnitude in axial torsion and flexion-extension respectively. The median ROM, NZ and ID at the damaged level increased significantly by at least two orders of magnitude in all loading directions. IPT results revealed no significant differences.

**DISCUSSION:** The results suggest that the pars defect alters the kinematics most se-
GP26
APOPTOSIS AND AUTOPHAGY AFTER SPINAL CORD INJURY IN RAT
Jun-Yeong Seo, MD, ‡Young-Hoon Kim, MD, †Jang-Woon Kim, †Kee-Yong Ha, MD; Department of Orthopaedic Surgery, Jeju National University Hospital, School of Medicine, Jeju National University, Jeju, Korea. ‡Department of Orthopaedic Surgery, Seoul St. Mary’s Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea.

INTRODUCTION: Neuroprotective effect of moderate systemic hypothermia(MSH) has been an important topic in spinal cord injury. The purpose of this study is to investigate the autophagy and apoptosis in MSH compared to the steroid treatment for the spinal cord injury model in rat. And, which of the intrinsic and extrinsic pathway of apoptosis is more affected by those treatments.

METHODS: 69 animals underwent spinal cord contusion with the Multicenter Animal Spinal Cord Injury Study(MASCIS) impactor by 25 g·cm at T9. Control groups (N=23) have no further treatment after SCI. Group 1(N=23) received MSH treatment for 4 hours; Group 2(N=23) received high dose methylprednisolone treatment after injury. Rats were killed 2 days and 7 days. Apoptosis and autophagy was analyzed by immunohistochemistry, western blotting and transmission electron microscopy between three groups. Weekly assessment of locomotor function was performed over 6-week survival period by using the Basso-Beattie-Bresnahan locomotor rating scale.

RESULTS: Intrinsic and extrinsic pathways of apoptosis in the injured spinal cord were significantly reduced in the MSH and the steroid treated group than the control at 2 days post injury. The intrinsic and extrinsic pathways were still significantly reduced in the MSH group than the steroid treated group and the control at 7 days post injury. In addition, the induction of MSH and steroid treatment significantly decreased the expression levels of LC3 than the control group. The Basso, Beattie, Bresnahan scale in both MSH and steroid treated groups were significantly higher than the control from 3 to 6 weeks.

DISCUSSION: MSH and steroid treatment can provide neuroprotective effect on injured spinal cord by inhibiting both apoptosis and autophagy. MSH reduced extrinsic pathways and intrinsic pathways much more than steroid treatment for 7 days after injury. The application of MSH is thought to be superior to the steroid treatment in acute spinal cord injury.

GP27
CAN IN VITRO BIOMECHANICS EXPLAIN THE DEGENERATION OF ADJACENT SEGMENTS? - A SYSTEMATIC ANALYSIS-
David Volkheimer[1], Masoud Malakoutian[2], Thomas R. Oxland[2,3], Hans-Joachim Wilke[1]; [1] Institute of Orthopaedic Research and Biomechanics, Center of Musculoskeletal Research, University of Ulm, Germany [2] Department of Mechanical Engineering, University of British Columbia, Vancouver, Canada [3] Department of Orthopaedics, University of British Columbia, Vancouver, Canada

INTRODUCTION: Due to concerns about accelerated degeneration of adjacent seg-
ments post-fusion, motion preserving implants are increasingly promoted. Although in vitro biomechanical studies are frequently used to support new technologies, they show conflicting results. Our goal in this study is to systematically analyse these in vitro studies to shed light on the strengths and weaknesses of this research.

**METHODS:** A systematic MEDLINE search using the keywords 'adjacent', 'in vitro', and 'spine' identified 227 articles, of which 54 articles contained sufficient detail for analysis. In addition, a mechanical spine model with variable intersegmental stiffness was developed to assess the effect of different test protocols identified in the published studies (Fig. 1).

**RESULTS:** The analysis identified the test protocol and the method of load application to be the main factors determining the contrasting results. When the flexibility protocol is used with pure moments, theoretically no effect on adjacent segments should be found, independent of the implant technology. With the stiffness- and hybrid method, it is obvious that the adjacent segments have to compensate the motion loss of the treated segment. These findings were validated with the mechanical spine model.

**DISCUSSION:** The findings of these tests are depending on the choice of the test protocols which are defined by the assumption of the post-operative motion behavior of the patient. The flexibility protocol implies that he accepts the postoperative confinements to avoid overloading of the spine. For the stiffness- and hybrid testing, it is assumed that the patient tries to reproduce the pre-operative range of motion of the spine, forcing adjacent segments to compensate for the motion loss of the treated segment. Interpretation of biomechanical in vitro experiments investigating adjacent segment effects requires consideration of the test protocol and load application. Otherwise they may be misleading.

**GP28**

**OSTEOCLASTS INDUCE SENSORY NERVE UPREGULATION OF A NOCICEPTIVE NEUROTTRANSMITTER PEPTIDE IN VITRO**

Kazuyo Yamauchi, Sumihiisa Orita, Miyako Suzuki, Yoshihiro Sakuma, Yasuhiro Oikawa, Go Kubota, Kazuhide Inage, Takeshi Sainoh, Jun Sato, Kazuki Fujimoto, Sadao Arai, Kazuhsisa Takahashi, Seiji Ohtori; Department of Orthopaedics Surgery, Chiba University

**INTRODUCTION:** We previously reported that postmenopausal osteoporotic pain was reduced after the use of risedronate. However, the cause of and mechanism underlying pain due to osteoporosis is unclear. In a recent study, we reported that osteoclasts induce the tumor necrosis factor-a (TNF-a) inflammatory cytokine in vitro. However, to our knowledge, no studies have reported whether osteoclasts play a role in the sensory nerves in the transmission of osteoporotic pain. Therefore, the aim of this study was to determine the influence of osteoclasts on sensory nerves in vitro.

**METHODS:** RAW264.7 cells as hemopoietic stem cells were cultured with a-MEM and 10% FBS. They were then differentiated into osteoclasts by using macrophage colony stimulating factor (50 ng/mL) and activated by using RANKL (50 ng/mL). Activated osteoclasts and isolated rat dorsal rat ganglion cells (DRGs) (P7); 0.7 × 105 cells/mL were co-cultured for 48 hrs. After culturing, the cells were fixed and subjected to immunocytochemistry with class III betatubulin
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(Tuj1) and calcitonin gene-related peptide (CGRP), a nociceptive neurotransmitter. We investigated the following three groups: 2 × 106 cells/mL, 5 × 106 cells/mL, and 10 × 106 cells/mL of activated osteoclasts. The length of nerve growth of Tuj1-IR was not statistically different between groups, while the percentages of CGRP-IR DRG cells did differ significantly between groups.

RESULTS: The length of nerve growth did not differ significantly between groups. The percentage of CGRP- and Tuj1-IR DRG cells increased significantly as the numbers of cultured osteoclasts increased.

DISCUSSION: It was reported that postmenopausal osteoporosis is regarded as a high turnover osteoporosis. Therefore, many activated osteoclasts exist in postmenopausal patients with osteoporosis. We found that inflammatory cytokines in osteoclasts sensitized sensory neurons and upregulated CGRP. These results suggest a particular mechanism for osteoporotic pain.

GP29
SINGLE LEVEL LUMBAR LAMINECTOMY ALTERS SEGMENTAL BIOMECHANICAL BEHAVIOR WITHOUT AFFECTING ADJACENT SEGMENTS
Arno Bisschop (1), Susanne J. P. M. van Engelen (2), Idsart Kingma (2), Roderick M. Holewijn (1), Agnita Stadhouder (1), Albert J. van der Veen (3), Jaap H. van Dieen (2) and Barend J. van Royen (1); 1. Research Institute MOVE, Department of Orthopedic Surgery, VU University Medical Center, Amsterdam, The Netherlands 2. Research Institute MOVE, Department of Human Movement Sciences, VU University, Amsterdam, The Netherlands 3. Department of Physics and Medical Technology, VU University Medical Center, Amsterdam, The Netherlands

INTRODUCTION: Lumbar laminectomy is a commonly used treatment for symptomatic degenerative spinal stenosis. However, it is still unknown if and to what extent single level lumbar laminectomy affects the stability of treated and adjacent segments.

METHODS: Twelve cadaveric human lumbar spines were obtained. After preloading (250 N), spines were tested by applying a 4 Nm load in flexion and extension (FE), lateral bending (LB) and axial rotation (AR) (see Figure for test setup). Subsequently, single level lumbar laminectomy, analogous to clinical practice, was performed. Thereafter, load-deformation tests were repeated. The range of motion (ROM) and stiffness of the treated motion segments and adjacent segments were calculated before and after laminectomy. Untreated segments were used as control group. Repeated measures ANOVAs with level as between subject factor and laminectomy as within subject factor were used.

RESULTS: ROM at the level of laminectomy increased significantly for FE (7.3 %), LB (7.5 %), and AR (12.2 %). ROM of adjacent segments was not affected significantly, with exception of LB (-7.7 %). Control segments were not affected. Spinal stiffness of treated, adjacent, and control segments was not affected by laminectomy.

DISCUSSION: Despite increased ROM at the level of laminectomy, no substantial effects on adjacent segments were demonstrated. The increase in ROM of 7 - 12 % does not seem to indicate the use of additional instrumentation to stabilize the lumbar spine. However, if in an individual case the use of spinal instrumentation is considered, its primary focus should be on re-stabilizing the level at which the laminectomy was performed.
GP30
PRECLINICAL EVALUATION OF POSTERIOR SPINAL FIXATORS
Luigi La Barbera 1,2, Fabio Galbusera 2, Tomaso Villa 1,2, Francesco Costa 3, Annette Kienle 4, Nicolas Graf 4, Hans-Joachim Wilke 5; 1 LaBS, Department of Chemistry, Materials and Chemical Engineering “G.Natta”, Politecnico di Milano, Milano, Italy 2 IRCCS Istituto Ortopedico Galeazzi, Milano, Italy 3 Department of Neurosurgery, Humanitas Clinical and Research Center, Rozzano (MI), Italy 4 SpineServ GmbH & Co. KG, Ulm, Germany 5 Institute of Orthopaedic Research and Biomechanics, Center of Musculoskeletal Research Ulm (ZMFU), Ulm University, Germany

INTRODUCTION: Preclinical evaluation of spinal implants is a necessary step to ensure their reliability and safety before implantation. The American Society of Testing and Materials reapproved a standard for the assessment of mechanical properties of posterior spinal fixators [F1717-2013] which simulates a vertebrectomy model and recommends to use polyethylene blocks to mimic vertebral bodies. The geometrical configuration (distances and angles) should represent the clinical use, but available data in the literature are a few. This study aims at investigating whether the suggested values correctly describe the physiological anatomy and how the parameters affect the stress arising in the device.

METHODS: Anatomical parameters varying from patient to patient and depending on the spinal level, were compared to published data or measured on 14 patients. Others mechanical variables (design of the device) were considered and all parameters were investigated by means of a numerical model. Stress values were calculated either considering the combination of the average values for each parameter and their worst case combination depending on the spinal level.

RESULTS: The standard recommends a set of values which represents quite well the anatomy of an average thoracolumbar segment. The stress on the fixator is significantly influenced by the lever arm of the applied load, the position of the center of rotation of the functional spine unit and the pedicular inclination with respect to the sagittal plane. The worst case combination of parameters demonstrates that devices implanted below T5 could undergo higher stresses than according to standard suggestions (Fig. 1), with a maximum increase of 15.2% at L1 level.

DISCUSSION: We propose to revise F1717 standard in order to describe the worst case condition we found at L1 level: this will guarantee a higher safety of the implant for a wider population of patients.

GP31
INJECTABLE HYDROGEL TREATMENT STABILIZES HUMAN DISC RANGE OF MOTION UNDER PHYSIOLOGIC CYCLIC LOADING
Brent L. Showalter, Dawn M. Elliott, Neil R. Malhotra; University of Pennsylvania and University of Delaware
INTRODUCTION: We recently developed an injectable nucleus pulposus (NP) implant that restored disc compressive (comp.) range of motion following injury (Malhotra et al, Spine, 2012), can deliver therapeutic agents and be a vehicle for cell delivery (Smith et al, Tissue Eng., in press). Evaluating implant containment and longer-term mechanical function under physiological loading is the next important assessment of a NP implant before testing in large animal models.

METHODS: Human L5-S1 bone-disc-bone segments (n=14) underwent: 1) Overnight hydration, 2) 10,000 cycles cyclic loading between 0.12 -0.96 MPa compression (~2x Body weight) and 3) Overnight hydration. Comp. modulus and strain were measured after each step. Comp. strain is the disc height lost during cyclic loading. Each sample was tested while intact, following nucleotomy (1.75±0.36 g), and after injection of either saline (PBS, n=7) or implant (hydrogel, n=7).

RESULTS: The implant was not ejected from the discs for any samples. Nucleotomy decreased comp. modulus by 15%, increased comp. strain by 24%, and increased creep strain by 43%. After treatment, modulus of sham samples continued to decrease by 3%, strain increased 3% (Fig 1A), and creep increased 15% (Fig 1B) compared with their nucleotomy values. In contrast, implant samples maintained modulus, decreased comp. strain by 1% (Fig 1A), and decreased creep 3% (Fig 1B). These trends were maintained after cyclic loading, but there were no differences between treatments after the second hydration.

DISCUSSION: The implant was contained, despite the large annular injury and extensive loading. Implant treatment inhibited deterioration of creep strain, a key indicator of successful degeneration treatment. Compressive strain indicates the implant is initially superior to sham treatment, but did not rehydrate. Future bench tests will explore rehydration, along with drug delivery, cell delivery, and implant mechanical function in a large animal model.

GP32
STRESS CONCENTRATION DEPENDS ON DEFECT ORIENTATION IN BIAxIAL TENSION OF FIBER-REINFORCED TISSUE
John M. Peloquin¹ and Dawn M. Elliott²; ¹University of Pennsylvania, Philadelphia, PA ²University of Delaware, Newark, DE

INTRODUCTION: Fiber-reinforced soft-tissues such as intervertebral disc annulus fibrosus have great strength and stiffness, yet may fail at unexpectedly low stress if a crack is present. The presence of a crack produces stress concentrations, potentially causing local failure and crack propagation. These stress concentrations are uncharacterized for the annulus fibrosus. This study was designed to examine how the annulus fibers affect crack-induced stress concentrations; in particular, to identify the crack angle, relative to the fibers, that produces the maximum stress concentration.

METHODS: Finite element analysis was conducted, with FEBio, of a center-cracked transversely isotropic material with properties representative of annulus fibrosus. Equibiaxial stretch was applied, representing in situ loading. The fiber angle (with respect to the crack) was varied from 0° to 90° in 15° increments, and the Cauchy stress at the tip of the crack was calculated relative to a crack-free sample.

RESULTS AND DISCUSSION: The maximum stress concentration was observed for cracks angled 45° with respect to the fibers.
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Standard fracture tests orient the crack 90° to the fibers, but this produces a minimal stress concentration. The crack in the 90° case opens widely, blunting the crack and reducing its stress concentration. Samples with angled cracks exhibit local rotations that sharpen the crack and realign the notch roots perpendicular to the fibers (see figure; 45° case). These effects are greatest for the 45° sample, producing the most severe stress concentration and therefore, presumably, the highest risk of failure. This is particularly relevant to the annulus fibrosus, where fiber alignment is 25–45°, as it may influence crack propagation. The smaller stress concentration in the standard 90° oriented fracture test configuration means that this type of test may overestimate the tissue’s resistance to fracture.

GP33

Spine Function Before and After Two Weeks of Soft Lumbar Bracing

Greg Kawchuk, Tiffany Edgecombe, Arnold Wong, Martha Funabashi, Alex Cojocaru, Narasimha Prasad; University of Alberta

Introduction: A recent province-wide survey suggests that clinicians’ beliefs about soft lumbar bracing for low back pain (LBP) vary between “useful” and “causes muscle atrophy”. While previous investigation has shown that two weeks of soft lumbar bracing does not alter lumbar muscle volume, this study was designed to determine if muscle function, rather than volume, changed over a two week period.

Methods: Three groups were studied: asymptomatics who did not wear a brace (-LBP, n = 19), asymptomatics who were braced (-LBPbr, n = 18) and LBP subjects who were braced (+LBPbr, n = 17). Braced subjects were instructed to wear the brace continually for two weeks with the exception of bedroom and bathroom time. Immediately before and after the 2 week period, three measures of spine function were performed: spinal stiffness via mechanized indentation, a modified Sorensen test (timed lumbar extension against gravity), and the Oswestry Disability Index (ODI). Repeat measures analyses of variance were conducted for all three outcomes with a significance level of 0.05.

Results: No significant change in spinal stiffness was observed in any of the three groups. The time of held lumbar extension increased significantly in the –LBP group over the two week period (p = 0.004). Oswestry scores decreased significantly for only the +LBPbr group (p = 0.003) with an average mean decrease approaching the minimal detectable change of the ODI.

Discussion: Similar to our prior results that described a lack of change in lumbar muscle volume after two weeks of soft lumbar bracing, this study demonstrated that lumbar function does not worsen in these same bracing conditions. These data add to a growing body of knowledge that suggest that soft lumbar bracing is not harmful, and may be beneficial, for short-term use in LBP.

GP34

Biomechanical Rationale for Variations in the Prevalence of Low Back Pain and Schmorl’s Nodes Found in Different Patterns of Multi-Level Disc Degeneration

Gregory A. Von Forell, MS* Trevor K. Stephens* Todd G Nelson* Dino Samartzis, DSc, †Anton E. Bowden, PhD*; *Department of Mechanical Engineering, Brigham Young University, Provo, Utah, United States of America †Department of Orthopaedics and Traumatology, The University of Hong Kong, Pokfulam, Hong Kong, SAR, China
**INTRODUCTION:** Previously published research has shown that contiguous multi-level disc degeneration (CMDD) has been noted to significantly increase the likelihood of severe low back pain in comparison to skipped levels of disc degeneration (SLDD). Clinical studies have also shown that Schmorl’s nodes are more common in patterns of SLDD than with CMDD and that such nodes increase the likelihood of disc degeneration. As such, the purpose of this study was to utilize a nonlinear finite element model of the lumbar spine to investigate various patterns of multi-level disc degeneration and to investigate correlations with clinical incidence of low back pain and Schmorl’s nodes.

**METHODS:** A previously validated hexahedral finite element model of a T12-S1 lumbar spine was adapted to simulate the 13 cases shown in the figure. The degenerated discs were modeled based on published material properties. Biomechanics data for each SLDD and CMDD case were compared against each other, against the single-level degeneration cases, and against the control (non-degenerated) case. These results were also compared with data from a large cohort of patients (the Hong Kong Study) reporting low back pain and MRI prevalence of Schmorl’s nodes.

**RESULTS:** The finite element study indicated that CMDD resulted in higher ligament stresses, pedicle stresses, and facet contact forces as compared to the SLDD conditions. Interestingly, comparisons of sequential patterns of disc degeneration (control vs single level degeneration vs contiguous 2 level degeneration vs skipped level 3 level degeneration) showed that the addition of a skipped-level degenerated disc to a contiguous level degenerated case actually decreased stresses. Vertebral strain energy was also shown to be a possible predictor in the development of Schmorl’s nodes.

**DISCUSSION:** These results provide insight into the variation in clinical studies of symptomatic and asymptomatic multi-level disc degeneration.

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**GP35**

**DO IN VIVO KINEMATIC STUDIES PROVIDE INSIGHT INTO THE DEGENERATION OF SEGMENT ADJACENT TO A SPINAL FUSION? -- A SYSTEMATIC ANALYSIS**

Masoud Malakoutian1, David Volkheimer3, John Street2, Marcel F.S. Dvorak 2, Hans-Joachim Wilke3, Thomas R. Oxland1,2; 1 Department of Mechanical Engineering, University of British Columbia, Vancouver, Canada. 2 Department of Orthopaedics, University of British Columbia, Vancouver, Canada. 3 Institute of Orthopaedic Research and Biomechanics, Center of Musculoskeletal Research, University of Ulm, Germany

**INTRODUCTION:** Some researchers consider degeneration adjacent to a spinal fusion as a natural progression, while others believe it is an accelerated process that has roots in altered biomechanics. Many in vitro biomechanical studies reported adjacent level hypermobility; a parallel analysis of in vitro biomechanical studies revealed that many of those studies are based on unproven assumptions. The purpose of this study was to review and critically analyze the clinical studies that investigated the in vivo kinematics of the adjacent segments.
and total lumbar spine in patients receiving spinal fusion.

**METHODS:** A systematic search in PubMed database was conducted using the keywords “adjacent” and “lumbar” in combination with one of the following keywords: “range of motion”, “ranges of motion”, “kinematic”, “kinematics”, “instability”, “mobility”, “hypermobility”, or “angulation”. Among the 697 articles identified, 29 studies addressed the in vivo kinematics of the segments adjacent to instrumented or non-instrumented fusion in lumbar spine. Most studies used static radiography for range of motion (ROM) assessment.

**RESULTS:** None of the studies noted a significant change of motion at the caudal adjacent segment post-surgery while two noted a motion decrease. For the cranial segment where ROM was measured, twelve studies observed no change, nine studies found a significant increase, and three studies reported a significant decrease in sagittal plane ROM after fusion surgery. Four studies noted the development of excessive motion at the adjacent segment to a spinal fusion in a small subset of patients (~20-30%). Among the six studies that analyzed total lumbar spine motion, five studies showed a significant decrease and one study reported no change.

**DISCUSSION:** Kinematic changes adjacent to a spinal fusion seem to be rare, but some patients appear to be adversely affected. The detection of such susceptibility should be a focus of future research efforts.

**GP36**

**THE CATABOLIC EFFECTS OF ENDOTHELIAL CELL-DERIVED MICROPARTICLES ON INTERVERTEBRAL DISC CELLS**


**INTRODUCTION:** Microparticles are cell-secreted microvesicles or exosomes, particles smaller than 1 µm that contain membrane and subcellular components of their parental cells. Endothelial cells (ECs) are a primary producer of endothelial microparticles (EMPs). Since ECs are essential for neoangiogenesis and neoangiogenesis has been reported in degenerated discs and considered pathological, the objective of this study is to investigate how secreted products of ECs, including EMPs and secreted proteins, influence the catabolic activities of AF cells in a cell culture model system.

**METHODS:** Endothelial cell line, HMEC-1, was cultivated in monolayer for isolation of EMPs by ultracentrifugation. EMPs, confirmed by electron microscopy, were and labeled with a membrane DiO (Invitrogen) for live cell imaging (LCI). Human annulus fibrosus (AF) cells were treated with 250µg of EMPs or 250µg of SUP protein for 72 hrs. MRNA (qRT-PCR), protein (Western), and enzymatic activity (fluorophore assay) of key MMPs were measured.

**RESULTS:** LCI revealed that AF cells readily ingested EMPs. PCR analysis demonstrated increased mRNA expression of MMP1 (36 fold), MMP3 (5 fold) and MMP13 (6 fold) in AF cell cultures treated with EMPs compared to untreated control. Western analysis confirmed similar increases in MMP protein levels. MMP enzymatic activities in conditioned media were also significantly increased in EMPs-treated AF cells compared to untreated AF cells.

**DISCUSSION:** Cellular communication between ECs and the resident disc cells is expected during the pathological process of disc neovascularization. In this study, we found that ECs produced protein factors and EMPs, which dramatically up regulated MMP expression and activity in AF cells. These findings suggest a possible mecha-
nism of disc matrix catabolism during neo-vascularization and the contributive roles of ECs and their EMPs.

GP37
QUANTIFICATION OF WALL PLANK AND ROLL TEST
Chiyul Yoon1, Keewon Kim, MD2, Hee Chan Kim, PhD3, Sun Gun Chung, MD, PhD2; 1. Interdisciplinary Program of Bioengineering, Seoul National University Graduate School, Seoul, Korea 2. Department of Rehabilitation Medicine, Seoul National University Hospital, Seoul, Korea 3. Institute of Medical and Biological Engineering, Medical Research Center and the Department of Biomedical Engineering, Seoul National University College of Medicine, Seoul, Korea

INTRODUCTION: Dynamic lumbar stability was investigated by quantification of postural changes of the lumbar spine during wall plank and roll (WPR) activity in healthy young participant and low back pain (LBP) patients.

METHODS: Ten LBP patients and 16 controls conducted WPR test with inertial sensors attached to the thoracic spine and sacrum. Relative angles between the two sensors characterized lumbar posture as axial twist (AT), kyphosis-lordosis (KL) and lateral bending (LB). Angular excursions were compared between two groups to reveal any significant differences.

RESULTS: The lumbar lordosis increased, and thoracic spine bent away from the wall in both group. The average excursion angles of AT, KL, and LB in LBP patients were 8.3°±14.1, -15.3°±5.6, and 11.1°±5.9, and those of controls were 6.9°±12.0, -9.5°±6.5, and 7.9°±4.9, respectively. The excursions of KL and LB were significantly larger in LBP than control subjects (p=0.003 and 0.046).

DISCUSSION: Both LBP and control subjects demonstrated common lumbar motion patterns: increased lordosis, and lateral bending of the thoracic spine away from the wall. However, LBP patients had larger excursions in sagittal and coronal planes. This finding could be originated from either lumbar instability or compensatory mechanism of LBP patients. With appropriate modification and further studies, quantification of WPR test using inertial sensors may provide a relatively simple solution to assess lumbar stability in clinical practice.

GP38
LUMBAR MULTIFIDUS MUSCLE PRESERVATION FOLLOWING LUMBAR INTERSPINOUS IMPLANTATION
Marek Szpalski, MD; Laurent G. Fabeck, MD; Robert Gunzburg, MD, PhD; Christopher J. Colloca, DC; Jeb McAviney, DC; Mostafa Affi, PhD; Brian J. Freeman, MD; Department of Orthopedics, Centre Hospitalier Molière Longchamp, Brussels, Belgium and Departments of Orthopaedics and Traumatology, Université Libre de Bruxelles, Brussels, Belgium; PhD; Department of Orthopaedic Surgery, Edith Cavell Clinic, Brussels, Belgium; Kinesiology Program, School of Nutrition and Health Promotion, Arizona State University, Tempe, Arizona, U.S.A; Faculty of Kinesiology, University of Calgary, Alberta, Canada; Adelaide Centre for Spinal Research, Adelaide, Australia; School of Medicine, Faculty of Health Sciences, University of Adelaide, Australia

INTRODUCTION: This study examined the effect of an interspinous implant on lumbar spine multifidus muscle responses in an in vivo ovine model.

METHODS: Eight anesthetized adolescent Merino wethers (68.4 kg, s.d.=4.5 kg) were biomechanically tested in vivo in the prone and recumbent positions before and following insertion of an InSwing® interspinous device at L3-L4 secured by a tension band. Two, 6, and 12 Hz 40 N oscillatory loads were randomly applied to the L3 spinous process in the prone and oblique positions using a previously validated mechanical...
testing technique. Needle electromyographic (nEMG) electrodes inserted into the multifidus muscles at the level of L3 and L4 were used to determine the number of responses above 3.5x baseline during testing in each position and frequency from the filtered nEMG data. Positive (>3.5x baseline) nEMG responses for each position, condition, testing frequency were compared using one-way ANOVA with repeated measures and post-hoc analyses.

**RESULTS:** In each testing position (prone vs recumbent) and testing condition (normal vs implant) 2 Hz testing was found to have the largest number of positive nEMG responses and significant differences between 2 Hz and 20 Hz testing were observed (p<.01). Significant decreases in the number of positive nEMG responses also were recorded in the recumbent position for all frequencies examined (p<.01). Positive nEMG responses remained consistent in the implant condition with no significant differences observed when comparing to normal for prone or recumbent positions nor at or any frequency examined.

**DISCUSSION:** This experimental model provides novel evidence of muscle preservation following the implantation of an interspinous device. The results confirm differences in muscle activation among the frequency and axis which the lumbar spine is mechanically challenged, but neither of these variables were found to be influenced by interspinous implantation.

**GP39**

**UP-REGULATION OF PAIN BEHAVIOR AND GLIAL ACTIVITY IN THE SPINAL CORD AFTER SCIATIC NERVE COMPRESSION AND APPLICATION OF NUCLEUS PULPOSUS IN RATS**


**INTRODUCTION:** Mechanical compression and inflammation caused by prostaglandins and cytokines at disc herniation sites induce pain. Structural changes and pain-associated cytokines in the dorsal root ganglia and spinal dorsal horn contribute to prolonged pain. Glial cells in the spinal dorsal horn may also function in pain transmission. The purpose of this study is to evaluate pain-related behavior and changes in glial activity in the spinal dorsal horn after combined sciatic nerve compression and nucleus pulposus (NP) application in rats.

**METHODS:** The sciatic nerve was compressed with NP for 2 seconds using forceps in the NP + nerve compression group; the sham-operated group received neither compression nor NP, and the control group received no operation. Mechanical hyperalgesia was measured for 3 weeks using von Frey filaments. Glial activity in the spinal dorsal horn was examined 7 and 14 days postsurgery using anti-GFAP and anti-Iba-1 antibodies to detect astrocytes and microglia, respectively.

**RESULTS:** Mechanical hyperalgesia was detected throughout the 14-day observation in the NP + nerve compression group, but not in control or sham-operated groups (P < 0.05). Both astrocytes and microglia were significantly increased in the spinal dorsal horn of the NP + nerve compression group compared to control and sham groups on days 7 and 14 (P < 0.05).

**DISCUSSION:** Nerve compression with NP application produces pain-related behavior, and up-regulates astrocytes and microglia in the spinal dorsal horn, suggesting that nerve compression with NP application may induce glial activity and contribute to pain transmission in the spinal cord.
GP40
NOTOCHORDAL CELL-SECRETED FACTORS STIMULATE MATRIX PRODUCTION BY CANINE NUCLEUS PULPOSUS CELLS AND BONE MARROW DERIVED STROMAL CELLS
S.A.H. de Vries(1), E. Potier(1), M. van Doesselar(1), B.P. Meij(2), M.A. Tryfonidou(2), K. Ito(1); (1) Orthopaedic Biomechanics, Department of Biomedical Engineering, Eindhoven University of Technology, Eindhoven, Netherlands (2) Department of Clinical Sciences of Companion Animals, Faculty of Veterinary Medicine, Utrecht University, Utrecht, Netherlands

INTRODUCTION: Intervertebral disc degeneration is characterized by failure to maintain a healthy matrix. Recently, bone marrow derived stromal cells (MSCs) have been proposed to replenish the decreasing number of nucleus pulposus cells (NPCs) in the disc. Bioactive factors, secreted by notochordal cells (NCs) into conditioned medium (NCCM) have also been reported to stimulate proteoglycan production. Thus, we assessed, in a canine in vitro model, the stimulatory effects of NCCM on NPCs, MSCs and their mixture (NPCs+MSCs), as well as the effect of MSCs on NPCs alone.

METHODS: MSCs and NPCs were harvested from chondrodystrophic (CD) dogs. NCCM was produced from NP tissue of non-CD dogs. MSCs or NPCs alone (3 million cells/ml) and NPCs+MSCs (6 million cells/ml; 1:1) were cultured for 4 weeks in 1.2% alginate beads and received base medium (BM, high glucose DMEM + 5% stripped FCS + 1% pen/strep) or NCCM (+ 5% stripped FCS + 1% pen/strep). Beads were assessed for GAG and DNA contents by biochemical assays, GAG deposition by Alcian Blue staining, and gene expression (collagen 2, aggrecan, and SOX9) with RT-qPCR.

RESULTS: GAG content increased in NCCM single cell groups compared to BM (Fig. 1A), whereas it did not with addition of MSCs to NPCs. Alcian Blue staining confirmed these findings. DNA content decreased in time for all BM groups (Fig. 1B), and did not change for NPCs cultured in NCCM. At day 28, collagen 2, aggrecan, and SOX9 gene expression increased in NCCM treated NPCs and NPC+MSCs compared to day 0 and BM, whereas no differences were observed for NCCM treated MSCs.

DISCUSSION: NCCM induced increased NPC GAG production and directed NPCs towards a healthier phenotype. NCCM also stimulate MSCs, but combining NPCs+MSCs did not have an additive effect. The use of NC-secreted factors is promising, and identification of these factors is of interest.

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Figure 1: A) GAG per bead content at day 28 and B) DNA per bead content at day 0 and day 28. • p < 0.05 compared to BM, * p < 0.05 compared to Day 0.

GP41
INCREASED LEVELS OF NERVE GROWTH FACTOR AND BRAIN-DERIVED NEUROTROPHIC FACTOR IN HUMAN HERNIATED INTERVERTEBRAL DISCS
Yasuchika Aoki MD1, Arata Nakajima MD1, Fusako Watanabe MS1, Masato Sonobe MD1, Fumiaki Terajima MD1, Hiroshi Takahashi MD1, Shinji Taniguchi MD1, Manabu Yamada MD1, Kazuhisa Takahashi

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MD2, Seiji Ohtori MD2, Koichi Nakagawa MD1; 1Department of Orthopaedic Surgery, Toho University Sakura Medical Center 2Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University

INTRODUCTION: Annular rupture has been reported to trigger discogenic pain. Neurotrophic factors, such as nerve growth factor (NGF) and brain-derived neurotrophic factor (BDNF), may play an important role in the generation of discogenic pain. In the present study, the protein levels of NGF and BDNF in discs from patients with disc herniation were examined, and compared with those from discs of patients with other lumbar degenerative disc diseases.

METHODS: Patients (n=55) with lumbar degenerative disc disease treated by surgical intervention were included. Nucleus pulposus tissue (or herniated disc tissue) was surgically removed and homogenized; protein levels were quantified using ELISAs for NGF and BDNF. Levels of NGF and BDNF in the discs were compared between 1) patients with disc herniation and those with other lumbar degenerative disc diseases, 2) patients with back pain and those with slight or no back pain, and 3) moderately degenerated discs (Pfirrmann grades 2-3) and severely degenerated discs (Pfirrmann grades 4-5).

RESULTS: Mean levels of NGF and BDNF in discs of patients were: NGF (herniation: 83.4; others: 64.8, pg/mg total protein); BDNF (herniation: 36.5: others 16.2, pg/mg total protein). Herniated discs showed significantly higher levels of NGF and BDNF (p<0.05). No significant differences in levels of NGF and BDNF were found between patients with and without back pain, or between moderately and severely degenerated discs. No significant differences were observed when subgroup analysis was performed dividing the discs into herniated discs and others.

DISCUSSION: This study reports that protein levels of NGF and BDNF, which are recognized as pain generators, increased in human herniated intervertebral discs. The finding suggests these neurotrophins are involved in the generation of discogenic pain. Our results suggest that increased levels of neurotrophins after annular rupture may play an important role in the generation of discogenic pain.

GP42

EVALUATION OF PAIN BEHAVIOR AND CGRP IMMUNOREACTIVE SENSORY NERVE FIBERS IN THE SPINAL DORSAL HORN AFTER SCIATIC NERVE COMPRESSION AND APPLICATION OF NUCLEUS PULPOSUS IN RATS.

Yoshihiro Sakuma, MD, Miyako Suzuki, MD, PhD, Sumihisa Orita, MD, PhD, Kazuyo Yamauchi, MD, PhD, Gen Inoue, MD, PhD, Yasuchika Aoki, MD, PhD, Tetsuhiro Ishikawa, MD, PhD, Masayuki Miyagi, MD, PhD, Hiroto Kamoda, MD, PhD, Gou Kubota, MD, Yasuhiro Oikawa; Department of Orthopaedic Surgery, Graduate School of Medicine Chiba University.

INTRODUCTION: The pathomechanisms of lumbar-disc herniation pain have not been fully elucidated. Pain-associated neuropeptides, including Substance P and calcitonin gene-related peptide (CGRP), are produced in DRG neurons and transported to spinal dorsal horn nerve terminals where they function in pain transmission. However, changes in CGRP-immunoreactive (IR) sensory nerve terminals have not been reported in models of disc herniation. This study evaluated pain-related behavior and changes in CGRP-IR terminals in the spinal dorsal horn after combined sciatic nerve compression and nucleus pulposus (NP) application.

METHODS: Three groups of rats underwent either sciatic nerve compression with NP (n = 20), sham operation with neither compression nor NP (n = 20), or no operation.
(controls, n = 20). Mechanical hyperalgesia was measured every second day for three weeks. CGRP-IR terminals in each spinal dorsal horn lamina were examined 7 and 14 days post-surgery. Pain behavior and CGRP immunoreactivity were compared among the three groups.

RESULTS AND DISCUSSION: Mechanical hyperalgesia was only found in the NP + nerve compression group (P < 0.05). CGRP-IR nerve terminals in the superficial laminae (I and II), the deep laminae (III-VI), and lamina X were significantly increased in the NP + nerve compression group compared to control and sham groups (P < 0.05). Our results indicate that nerve compression plus NP application produces pain-related behavior. CGRP-IR nerve terminals increased in laminae I and II which transmit pain and in laminae III-VI which transmit proprioception. Findings suggest that nerve compression plus NP application induces changes in CGRP expression in the superficial and deep laminae, and these changes are partly responsible for pathological disc herniation pain.

GP43

EXPRESSION OF THE RANK/RANKL/OPG SYSTEM IN THE RAT INTERVERTEBRAL DISC

Norihiro Takegami, Koji Akeda, Koichiro Murata, Akihiro Sudo; Department of Orthopaedic Surgery, Mie University Graduate School of Medicine

INTRODUCTION: Receptor activator of NF-kB ligand (RANKL), a member of the TNF ligand superfamily, is known to regulate bone metabolism. Binding of RANKL to RANK activates T-RAF6, which stimulates the expression of proinflammatory cytokines through NF-.B pathways. The RANK-RANKL signal is considered to be associated with bone matrix catabolization by osteoclasts. Osteoprotegerin (OPG) is a decoy receptor for RANKL. It has been recently reported that RANKL is expressed by human articular cartilage and IVD. However, the expression of each component of the RANK/RANKL/OPG system in the IVD has not been examined in detail. The purpose of this study was to examine the mRNA and immunohistochemical expression of the RANK/RANKL/OPG system in the rat IVD.

METHODS: 12-week-old male Sprague-Dawley rats were used in this study. Anulus fibrosus (AF) and nucleus pulposus (NP) cells isolated from dissected thoracolumbar discs were monolayer-cultured. RANK/RANKL/OPG expressions in rat IVDs were examined using real-time polymerase chain reaction (cultured cells) and immunohistochemistry (cultured cells and IVD tissues, including cartilaginous endplates).

RESULTS: mRNA expression levels of RANK, RANKL and OPG were clearly identified in both AF and NP cells. Immunoreactivity to RANK was mainly found in cell membranes of both AF and NP cells, while that to RANKL and OPG was distributed in the cytoplasm of both AF and NP cells. Each component of the RANK/RANKL/OPG system was clearly identified in rat IVD tissues. Intense immunoreactivity to RANK, RANKL and OPG was found in the NP and cartilaginous endplate.

DISCUSSION: Our study showed that the expression of the RANK/RANKL/OPG system was confirmed both by mRNA and protein levels. To elucidate the association between disc degeneration and this expression, future studies are needed to clarify the function of the RANK/RANKL/OPG system in pathological conditions and differences in its expression in normal and degenerated human IVD tissues.

GP44

ASSOCIATION BETWEEN VERTEBRAL FRACTURE AND DEGENERATIVE CHANGES IN ADJACENT INTERVERTEBRAL DISCS

Norihiro Takegami, Koji Akeda, Koichiro Murata, Akihiro Sudo; Department of Orthopaedic Surgery, Mie University Graduate
GENERAL POSTERS

School of Medicine

INTRODUCTION: Endplate sclerosis (ischemic vertebra), found in vertebral collapse/pseudarthrosis, is considered a factor responsible for intervertebral disc (IVD) degeneration. The effect of vertebral fracture (VF) on degenerative changes of adjacent IVDs has not been investigated. The purpose of this study was to examine whether VF has an effect on the degenerative changes of adjacent IVDs.

METHODS: In 98 patients (50 male, 48 female; mean age: 68.2 yrs [23-90]), 584 discs (T12/L1-L5/S1) were analyzed. The presence and type (wedge, biconcave, crush) of VF were classified using a semi-quantitative technique. To examine the association of VF with adjacent IVD degeneration (DD), IVDs were classified into 3 groups: VF cranial to IVD (cranial); VF caudal to IVD (caudal); VF both cranial and caudal (bilateral). IVDs with no adjacent VF (cranial and caudal) were used as controls. The extent of DD was evaluated by MRI (444 discs) and classified into 2 groups (early and advanced). The presence of vacuum phenomena (VP) was analyzed by multi-detector CT. The association between the presence of VF and extent of DD or the presence of VP was statistically analyzed.

RESULTS: VF was identified in 118 vertebrae (20.2%) (wedge: 10.3%, biconcave: 7.7%, crush: 2.2%). 278 IVDs (62.6%) were classified as advanced DD. Advanced DD in VF-positive groups (cranial: 59%, caudal: 65%, bilateral: 47%) was significantly higher compared to control (29%) (P<0.05). VP was found in 226 IVDs (38.7%). VP incidence was significantly higher in VF-positive groups (cranial: 59%, caudal: 65%, bilateral: 47%) compared to control (29%) (P<0.01). VP incidence was significantly higher in biconcave than in wedge type VF (P<0.01).

DISCUSSION: The incidence of advanced DD and VP was significantly higher in IVDs with adjacent VF compared to those without adjacent VF. The results of this study suggest that VF affects the micro-environment of adjacent IVDs, leading to DD and/or disc rupture.

GP45

IMMUNOHISTOCHEMICAL ANALYSIS OF HYPOXIA- AND GLUCOSE METABOLISM-RELATED FACTORS IN A RABBIT LUMBAR ARTERY LIGATION MODEL

Koichiro Murata, Koji Akeda, Norihiko Takegami, Takao Imanishi, Akihiro Sudo; Department of Orthopaedic Surgery, Mie University Graduate School of Medicine

INTRODUCTION: In a rabbit lumbar artery ligation model for investigating the effect of ischemia of lumbar vertebra on intervertebral disc (IVD) degeneration, we found that diminished flow in lumbar arteries affects changes in the extracellular matrix (ECM) metabolism of the IVD. Hypoxia inducible factor (HIF)-1a and its target gene, glucose transporter (GLUT)1 are important for the maintenance of anaerobic-glycolysis and the response to hypoxia and nutrient stress by nucleus pulposus (NP) cells. The purpose of this study was to examine the immunohistological distribution of HIF-1a and GLUT1 in a rabbit lumbar artery ligation model.

METHODS: In 12-week-old female New Zealand White rabbits (n=4), the 3rd and 4th lumbar arteries were ligated. At 4 weeks after surgery, lumbar spines were separated into disc-vertebra units. L4/5 discs were used as the ischemic group and L2/3 discs were used as the control (non-ischemic) group. Sections were stained with antibodies (anti-HIF-1a, anti-GLUT1). Immunoreactive cells were manually counted in each of five fields randomly selected from the following areas: 1. nucleus pulposus (NP), 2. anterior annulus fibrosus (AAF), and 3. posterior annulus fibrosus (PAF). Immunoreactive cells were divided into two groups ac-
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cording to the intensity of staining: grade 1 (lower) and grade 2 (higher).

RESULTS: In the NP, the percentage of grade 2 immunoreactive cells for HIF-1α tended to be higher in the ischemic discs (65%) than in the control discs (31%). The percentage of GLUT1 immunoreactive cells in the NP was significantly higher in the ischemic group (88%) than in the control group (57%). The percentage of grade 2 immunoreactive cells for GLUT1 tended to be higher in ischemic discs (37%) compared to that in the control discs (20%).

DISCUSSION: Ischemia of the lumbar spine produced by ligation of lumbar arteries may induce anaerobic and low-nutrition environment, especially in the NP, leading to the enhanced expression of HIF-1α and GLUT1.

GP46
ALENDRONATE CHONDROPROTECTIVE EFFECTS ON DISC CELLS AND ARTICULAR CHONDROCYTES IN VITRO: DOSE-RESPONSE STUDIES

Shigeru Kobayashi MD, PhD, Tsuyoshi Miyazaki MD, PhD; Department of Orthopaedics and Rehabilitation Medicine, Faculty of Medical Sciences, The University of Fukui

INTRODUCTION: Bisphosphonates have been widely used for treatment of osteoporosis. In this study, we examine how concentrations of alendronate (ALN) influence the rate of glycosaminoglycan (GAG) accumulation in disc and cartilaginous cells in a three-dimensional culture system.

METHODS: Cells were obtained from nucleus pulposus (NP) of caudal discs and articular cartilage (AC) of metacarpal phalangeal joints of bovine. Cells in alginate beads were cultured in DMEM containing 6% FCS at 370 mOsmol at cell densities of 4 million cells/ml. They were then cultured for 5 days under 21% oxygen with 10-1-10-12 mol/L-ALN, and, without ALN as control. Lactate production was measured enzymatically and GAG accumulation was measured using a DMB assay. Rate of sulfate GAG synthesis was measured using a standard 35S-sulfate radioactive method.

RESULTS: A bimodal response in NP and AC group was evident with the concentration of GAG accumulated rising as ALN concentration was increased from 0 to 10-6 mol/L, through it appeared to diminish at very high concentration in 5 days culture. NP and AC samples from control (ALN: 0mol/L) showed GAG concentration in the beads reaching 287.7 and 175.8 μg/ml respectively. At 10-8mol/L of ALN, the concentration of GAG in the beads reached 332.2 and 305.9μg/ml, respectively, in 5 days. Evidence of greater cellular activity for NP and AC cells cultured at 10-10 to 10-6 mol/L was seen from measurement of lactate production per live cell. The potentiated effect of sulfate incorporation rate was maximal at 10-8 mol/L in the both group.

DISCUSSION: The largest stimulation of GAG accumulation and energy metabolism was seen after 5 days of culture in cultures containing 10-8 mol/L-ALN. It has been suggested that ALN might have either direct or indirect effects on NP and AC cells. This study suggested that treatment with ALN may exert chondroprotective effects on disc and cartilaginous cells, helping to prevent disc degeneration and osteoarthritis.

GP47
DISC HERNIATION DECREASES EXPRESSION OF SEROTONIN RECEPTORS IN THE DORSAL ROOT GANGLION IN A TNF-DEPENDENT MANNER – A GENE EXPRESSION ANALYSIS IN A RAT MODEL OF DISC HERNIATION.

INTRODUCTION: Disc herniation is a common cause of low back pain and sciatica. During recent decades the knowledge of its pathophysiology has drastically improved, now considered a complex interaction between leaked nucleus pulposus and the tissue in the spinal canal. An inflammatory interaction has also been demonstrated, with TNF-inhibition being suggested as a possible future treatment. However, the exact mechanisms of the pathophysiology of disc herniation still remain largely unknown. The object of the present study was to investigate if experimental disc herniation affects expression of 24 pain-related genes in the dorsal root ganglion, and if TNF-inhibition may inhibit any of these changes, following experimental disc herniation in the rat.

METHODS: A total of 20 rats were evenly divided into four groups – naïve, sham, disc herniation and disc herniation with TNF-inhibition (infliximab 4mg/kg i.p. after surgery). Disc herniation was performed by puncturing the L3-4 disc and then slightly displacing the adjacent nerve root. The dorsal root ganglion of the affected nerve root level was harvested 24 hours after surgery and analyzed with a tLDA quantitative real-time PCR assay.

RESULTS: Tendencies of regulation associated with disc herniation and improvement with treatment could be observed in several genes (Grin2B, Grm3, IL-1a, Bdkrb2, 5ht2aR). A significant (p<0.05) down-regulation of the serotonin receptor 2C was seen after disc herniation. This was significantly inhibited by TNF-inhibition.

DISCUSSION: Our results suggest that changes in expression of several genes may contribute to the pathophysiology of disc herniation. In particular, changes in serotonergic transmission may contribute to both the pathophysiology as well as the improvement seen in previous studies when treating with TNF-inhibition. Further evaluation on the role of serotonin in disc herniation is warranted.

GP48

BIOLOGICAL EVALUATION OF HUMAN DEGENERATED NUCLEUS PULPOSUS CELLS IN FUNCTIONALIZED SELF-ASSEMBLING PEPTIDE NANOFIBER HYDROGEL SCAFFOLD

Hui Tao, Yan Zhang, Chaofeng Wang, Deli Wang, Chao Zhang, Qin He, Dike Ruan; Department of Orthopedics, Navy general hospital, Beijing, China

INTRODUCTION: Nucleus pulposus tissue engineering (NPTE) has been proposed as an ideal biological approach for intervertebral disc degeneration. In this study, we firstly linked the short functional motif (KPSSAPTQLN) of BMP7 to the C-terminal of RADA16-I as a functionalized self-assembling peptide RKP, then mixed with RADA16-I at a volume rate of 1:1 (RAD-RKP). Our purpose was to study the effects of RKP and RAD-RKP for human degenerated nucleus pulposus cells (hNPCs).

METHODS: The hydrogelation ability of RADA16-I, RKP and RAD-RKP were firstly observed. Then, the Circular dichroism (CD), atomic force microscopy (AFM) and scanning electron microscopy (SEM) were used to observe the microstructures of RADA16-I, RKP and RAD-RKP. Furthermore, the attachment, cytotoxicities, migration, proliferation and gene expression of hNPCs in RADA16-I, RKP and RAD-RKP were determined in vitro.

RESULTS: All the peptides could self-assemble and form transparent viscous hydrogels under physiological conditions. CD spectra showed that both RADA16-I and RAD-RKP had typical β-sheet structures, while RKP exhibited a random structure. AFM and SEM confirmed that all the peptides could self-assemble into nanofibers scaffolds, and had excellent attachment for hNPCs. All the scaffolds had extremely low cytotoxicities (<14%) for hNPCs.
The results also showed that the RKP and RAD-RKP could increase the proliferation and migration of hNPCs after 7 days in comparison with RADA16-I (p<0.05). QRT-PCR demonstrated that the expression of collagen II, Sox-9 and aggrecan were up-regulated, while collagen I were down-regulated in RKP and RAD-RKP after 28 days (p<0.05). Moreover, it also confirmed RAD-RKP with higher proliferation, migration and expression of Sox-9 and aggrecan than RKP (p<0.05).

**DISCUSSION:** The BMP7 designed functional self-assembling peptide nanofiber hydrogels had excellent biocompatibilities and bioactivities for hNPCs, and RAD-RKP might be have more potential application in human NPTE.

**GP49**

**IMMUNOHISTOCHEMICAL ANALYSIS OF THE RENIN-ANGIOTENSIN SYSTEM IN THE HUMAN INTERVERTEBRAL DISC**

Tatsuhiko Fujiwara1, Koji Akeda2, Tetsuji Kondo1, Koichiro Murata2, Norihiko Takegami2, Tatsuya Kurata1, Akihiro Sudo2; Department of Orthopaedic Surgery, 1Murase hospital and 2Mie University Graduate School of Medicine

**INTRODUCTION:** Angiotensin II (Ang II), the primary effector of the renin-angiotensin system (RAS), is known as an endocrine regulator of blood pressure. Locally produced Ang II, called the “tissue renin-angiotensin system (tRAS), contributes to the process of inflammatory diseases, and importantly, induces proinflammatory cytokines in several types of tissues. We hypothesized that tRAS is expressed by IVD cells and is involved in the progression of intervertebral disc (IVD) degeneration. However, the expression of tRAS by the human IVD is undetermined. In this study, we assessed the expression of Ang II and its receptors, Ang II receptor type1 (AT1) and type2 (AT2) by human intervertebral discs.

**METHODS:** Human IVD tissues obtained during surgery (lumbar disc herniation: LDH (n=10, 49.7 yrs-old [27-77]) or degenerative disc diseases: DD (n=10, 64.3 yrs-old [41-81]) were used. Tissues, fixed in 4% paraformaldehyde, were processed for paraffin sectioning. Sections were assessed immunohistologically using anti-Ang II, AT1 and AT2 antibodies. Using light-microscopy (×200), immunoreactive cells were manually counted in each of five fields randomly selected. Immunoreactive cells were divided into two groups according to the intensity of staining: grade 1 (lower) and grade 2 (higher). The percentage of immunoreactive cells relative to the number of total cells was calculated.

**RESULTS:** Immunoreactivity for Ang II, AT1 and AT2 was clearly identified in human IVD tissues. Positive rates for Ang II (LDH: 79%, DD: 76%) and AT2 (LDH: 44%, DD: 39%) were similar; however that of AT1 tended to be higher in DD compared to LDH (LDH: 41%, DD: 58%). The positive rate for AT1-immunoreactive cells (grade 2) tended to be higher in DD than in LDH.

**DISCUSSION:** For the first time, we have identified immunoreactivity for Ang II, AT1, AT2 in human disc tissues. The association between IVD degeneration and the expression of tRAS components should be examined in a future study.

**GP50**

**PRO-INFLAMMATORY CYTOKINES PRODUCTION INDUCED BY MACROPHAGE-LIKE THP-1 CELLS IN INTERVERTEBRAL DISC CELLS DEPENDS ON THE ACTIVATION OF MITOGEN-ACTIVATED PROTEIN KINASES**

Joo Han Kim, M.D., Ph.D., Jin Hyun Park, BS., Hong Joo Moon, M.D., Ph.D., Taek Hyun Kwon, M.D., Ph.D., Youn Kwan Park, M.D., Ph.D.; Department of Neurosurgery, Guro Hospital, College of Medicine, Korea University, Seoul, South Korea
GENERAL POSTERS

INTRODUCTION: Recent data have suggested that macrophages are involved in the pathogenesis of intervertebral disc (IVD) degeneration and enhance the secretion of inflammatory mediators in IVD cells. To determine the role of mitogen-activated protein kinase (MAPK) signaling in the interactions between macrophages and IVD cells, we hypothesized that MAPK activation will modulate the production of pro-inflammatory cytokines related to symptomatic disc degeneration.

METHODS: Human annulus fibrosus (AF) cells and nucleus pulposus (NP) cells were co-cultured with phorbol myristate acetate-stimulated macrophage-like THP-1 cells with and without SB202190, SP600125, and PD98059. IVD cells and conditioned media from the co-cultured cells and the stimulated cells were assayed by western blotting and enzyme-linked immunosorbent assays (ELISAs).

RESULTS: These MAPK inhibitors successfully suppressed the phosphorylation of MAPK. IL-6, IL-8, and NO were secreted in greater quantities by the co-culture group. TNF-α and IL-6 production in NP co-cultured with macrophages (NP-M.) were significantly lower than in AF-M.. SB202190 dose-dependently suppressed IL-6 secretion in AF-M. and NP-M.. 10 μM SP600125 and PD98059 suppressed the production of TNF-α and IL-8 in AF-M. and NP-M.. IL-6 production in M.-exposed NP was significantly blunted by SB202190 and PD98059, while IL-8 production was significantly blunted by SB202190 in both cell types after M. exposure.

DISCUSSION: Symptomatic IVD degeneration can result in macrophage infiltration in the AF and NP, which can cause enhanced inflammatory mediators in these regions. The MAPK pathway signals are selectively responsible for cytokine production in IVD cells exposed to macrophage-like cells. Specifically, p38 MAPK is responsible for IL-6 and IL-8 production in IVD cells previously exposed to macrophages, suggesting that the selective blockade of these signals may serve as a therapeutic approach to symptomatic disc degeneration.

GP51

DOES THE HIGH-INTENSITY ZONE (HIZ) OF LUMBAR INTERVERTEBRAL DISC REALLY MEAN ANNUAL TEAR?
Zhao Fengdong, M.D., Chen Huanhuan MSc, Shan Zhi MSc, Suyou Letu MSc, Fan Shunwu M.D.; Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University, Hangzhou 310016, China

INTRODUCTION: The exact essence of HIZ of lumbar intervertebral disc need to be reassessed according to clinical findings and some literatures. By means of CT, MRI and histomorphology: the HIZ was investigated to confirm whether it is annular tear, or calcification of annular fibrosus?

METHODS: the HIZ of the lumbar disc on MRI in 41 patients with low back pain were identified and divided into two groups according to the characteristics of HIZ: group A, with high intensity on T2-weighted MRI and low intensity on T1-weighted MRI; 29 patients; group B, with HIZ on both T2-Weighted MRI and T1-Weighted MRI, 12 patients. All these patients underwent CT scan on the targeted level. 26 patients from group A, 6 patients from group B, were performed discography and provocative test; 15 patients from group A and 7 cases from group B underwent surgery and the posterior annulus fibrosus containing HIZ were harvested for histologic analysis to confirm the essence of HIZ.

RESULTS: For these 26 patients of group A who underwent discography, 21 were positive and annular tear, and 15 of them accepted operation. Histomorphology examination showed annular tear combined with granulation tissue in the outer annulus fibrosus. In group B, all those targeted discs
showed calcified or ossified lesion on the posterior annular on CT scan, HE staining showed calcification or ossification of the posterior annulus fibrosus with frontier line.

**DISCUSSIONS:** The HIZ on T2-Weighted MRI which was found as low intensity zone on T1-weighted MRI possibly refers as annular tear combined with granulation in-growth, on the other hand, the HIZ both on T2-weighted MRI and T1-weighted MRI might be calcification or ossification of the posterior annulus fibrosus of the targeted discs. From this point of view, the conventional concept of HIZ should be modified as HIZ on T2-weighted MRI, but low intensity zone on T1-weighted MRI, in addition, CT scan might be helpful in the distinguished diagnosis.

**GP52**  
**EXOGENOUS SIRT1 INHIBITION OF APOPTOSIS VIA AUTOPHAGY UNDER LOW NUTRITIONAL CONDITION IN HUMAN NUCLEUS PULPOSUS CELLS**

Miyazaki, S; Kakutani, K; Maeno, K; Takada, T; Zhang, Z; K; Yurube, T; Hirata, H; Kurakawa, T; Terashima, Y; Kurosaka, M; Nishida, K; Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan

**INTRODUCTION:** Previously we reported the role of SIRT1 on disc degeneration characterized by the disturbance of nutrition supply. Autophagy is a physiological self digestive process, maintaining energy homeostasis in response to calorie restriction. The aim of this study was to elucidate the effect of exogenous SIRT1 on autophagy and apoptosis under low nutritional (LN) condition in human nucleus pulposus (NP) cells.

**METHODS:** Twenty-three NP cells were obtained from patients (13-73 years old) during surgical procedures. After the preculture, NP cells were cultured in the following condition; 10% FBS (Group N), 1% FBS (Group LN), 1% FBS with 10µM recombinant human SIRT1 (rhSIRT1) (Group LN+rSIRT1), and 1% FBS with 10µM rhSIRT1 and 10mM 3MA, specific inhibitor of autophagy (Group LN+SIRT1+3MA).

The total number of NP cells was counted using a microscope. Autophagic activity was assessed by measuring absorbance of MDC and immunostaining for LC3. Apoptotic incidence was assessed by flow cytometry to count apoptotic cells staining positive for Annexin V-FITC and propidium iodide.

**RESULTS:** On day 7 and 14 after treatment, the total number of NP cells in Group LN and LN+SIRT1+3MA were significantly decreased than in Group LN+SIRT1 (day14; Group LN:-21%, Group LN+SIRT1:-7%, Group LN+SIRT1+3MA:-33%, vs Group N). Autophagic activity in Group LN and LN+SIRT1 were significantly up-regulated than in Group N, whereas this up-regulation was not seen in Group LN+SIRT1+3MA on day 3 (Group LN:+67%, Group LN+SIRT1:+136%, Group LN+SIRT1+3MA:+21%, vs Group N). The same trend was confirmed by immunostaining for LC3. Both Group LN and LN+SIRT1+3MA showed significant apoptotic alterations compared with Group LN+SIRT1 on day 3, 7, and 14 (day14; Group LN:+99%, Group LN+SIRT1:+47%, Group LN+SIRT1+3MA:+139%, vs Group N). This study revealed that LN condition induced the apoptosis in human NP cells. Moreover rhSIRT1 prevented the apoptosis by accelerated autophagy in LN condition.

**GP53**

**DOWN-REGULATED MIR-382 CONTRIBUTES TO HUMAN INTERVERTEBRAL DISC DEGENERATION BY TARGETING MMP-16**

Hai-Qiang Wang, Yong-Zhao Zhang, Yu-Fei Cheng, Wei-Lin Zhang, Zhen Sun, Dino Samartzis, Zhuo-Jing Luo; Department of Orthopaedics, Xijing Hospital, Fourth Military Medical University; Department of Orthopaedics and Traumatology, University of...
**GP54**

**SIMULATION OF DEGENERATIVE AND PRO-INFLAMMATORY CONDITIONS FOR TESTING OF CELL THERAPY APPROACHES IN A DISC ORGAN CULTURE SYSTEM**

*G.Q. Teixeira1,2,3, R. Goncalves2, A. Boldt1, C. Jahn1, J.A. Mollenhauer4, H.J. Wilke1, M.A. Barbosa2,3, A. Ignatius1, C. Neidlinger-Wilke1; 1Institute of Orthopaedic Research and Biomechanics, Center for Musculoskeletal Research, University of Ulm, Ulm, Germany, 2Institute of Biomedical Engineering-INEB, R. Campo Alegre, 823, 4150-180 Porto, Portugal, 3Instituto de Ciências Biomédicas Abel Salazar (ICBAS), R. Jorge Viterbo Ferreira, 228, 4050-313 Porto, Portugal, 4NMI Natural and Medical Sciences Institute at the University of Tuebingen, Reutlingen, Germany*

**INTRODUCTION:** A bovine disc organ culture system with simulation of degenerative and pro-inflammatory conditions was evaluated with regard to its suitability for testing the fate of injected cells.

**METHODS:** Disc punches (each 6 from 12 bovine tails) were exposed to needle-puncture and pro-inflammatory factors (LPS, IL1β) while untreated samples served as controls. PGE2 was determined in culture supernatants and gene expression of IL-6, IL-8, MMPs, aggrecan and collagen 2 was measured in isolated disc cells. The metabolic profile of disc punches was traced by quantification of glucose and lactic acid. To simulate normal versus degenerative conditions cultures were maintained at 5 mM glucose and 400 mOsm or exposed to low-glucose (0.05 mM) and reduced osmolarity (300 mOsm). PKH67-labeled cells were injected in disc explants using an albumin-based hydrogel as vehicle. Discs were analyzed by histochemistry and determination of glycosaminoglycan (GAG) content.

**RESULTS:** LPS or IL1β treatment significantly increased the production of PGE2 (around 6-fold, p<0.0001), while treated discs pre-
sented similar metabolic profile as controls. However, IL1β increased the expression of IL-6 (around 3-fold), IL-8 (around 2-fold), MMP-1 and MMP-3 (both 2-4-fold), while collagen 2 and aggrecan expression was decreased (0.3-0.1-fold and 0.7-0.4-fold respectively). GAG content of the disc explants decreased (62.4±9 %) within 2 weeks. Fluorescent cells could be detected at each sampling time point with only little differences between culture conditions.

**DISCUSSION:** Simulation of degenerative or inflammatory conditions increased PGE2 release and expression of MMPs and interleukins and decreased matrix protein expression by disc cells. Monitoring of injected fluorescence-labelled cells allows characterization of cell reactions in a simulated degenerative environment. This approach is suitable for in vitro testing of regenerative or anti-inflammatory treatment strategies of disc degeneration.

**GP55**

**BONE MARROW MESENCHYMAL STEM CELLS PROTECTS NUCLEUS PULPOSUS CELLS FROM DEGENERATION BY SUPPRESSING NF-κB SIGNALING VIA TGF-β1**

Jun Zou, Cheng Cao, Chunshen Wu, Chenxi Yuan, Qin Shi, Huilin Yang; The First Affiliated Hospital of Soochow University

**INTRODUCTION:** Many researches have confirmed that BMSCs can arrest degenerative changes in nucleus pulposus cells (NPCs), but its mechanism is not yet clear. It has been reported that immune reactions could play a key role in intervertebral disc degeneration. The purpose of this study is to explore the underlying mechanism of BMSCs for delaying the degenerative process of NPCs.

**METHODS:** Human bone marrow mesenchymal stem cells and nucleus pulposus cells of lumbar spine were harvested and co-cultured. The experiment was divided into three groups: pure NPCs culture group (Group A), pure BMSCs culture group (Group B), NPCs and BMSCs (1:1) co-culture group (Group C). CCK8 determined the cell proliferation of the three groups of 3, 5 and 7 days. mRNA expression of Collagen II and Aggrecan were detected by PCR, TGF-β1 levels were measured using ELISA, content of NF-κB and I.B. was detected by Western-blot methods, and Collagen II expression was assayed via immunohistochemical staining among groups at each time point.

**RESULTS:** The ability of cell proliferation of group C was greater than the other groups after 3 days. The expression of Aggrecan and Collagen II of group C was higher than the other groups after 7 days. The content of TGF-β1 and I.B. of group C was higher than the other groups, and the content of NF-κB was lower after 7 days. Immunohistochemical staining of Collagen II in group C showed strong positive expression on the 7th day.

**CONCLUSION:** TGF-β1 is a multifunctional factor that regulates cell growth, adhesion, and differentiation in a wide variety of cell types. It is also a strong immune suppressor. In this study, our results indicate that BMSCs would promote proliferation and the expression of Aggrecan, Collagen II and TGF-β1 of NPCs. BMSCs delaying NPCs degeneration through inhibiting the NF-κB pathway via up-regulated TGF-β1. TGF-β1 suppressed NF-κB activation, maintained levels of the inhibitor I.B. expression for preventing degeneration.

**GP56**

**IN VITRO ASSESSMENT OF THE PROLIFERATIVE AND CHEMOTACTIC POTENTIAL OF BMP-13 ON A CHONDROCYTE CELL LINE**

Frank Zhou; Aiqun Wei; Ashish Diwan; Spine Service, St. George Hospital Campus, University of New South Wales, Sydney, Australia

**INTRODUCTION:** Disc degeneration, a major cause of lower back pain, arises mainly from
matrix and cellular depletion in the nucleus pulposus (NP). Signalling molecules such as BMPs (including BMP-13) have been theorised to reverse the degenerative process. This project investigates the potential effect of BMP-13 on cellular proliferation, proteoglycan (PG) production and cell motility on a human chondrocytic cell line in vitro.

**METHODS:** A chondrocytic cell line, C28/I2 was cultured in monolayer until confluence. Cells were seeded with/without rhBMP-13, then analysed for cellular proliferation using MTS assay, PG synthesis using Alcian blue staining, and cellular migration using Boyden chamber assay. In assessing transcriptional effects, RNA of cells with/without BMP-13 was extracted and purified. RT-PCR was used to evaluate the expression of chondrogenic markers (Col2, COMP, aggrecan and Sox9), BMP receptors (BMPR-1a, BMPR-1b and BMPR-2) and migration markers (SNA1, SNA2 and β1-integrin).

**RESULTS:** BMP-13 (100 ng/ml) stimulation for 48hrs resulted in significantly increased C28/I2 proliferation and proteoglycan synthesis (p<0.05) compared to control. Cellular migration significantly increased with BMP-13 (100 ng/ml) stimulation (4-fold increase, p<0.05) and under a BMP-13 (100 ng/ml) induced chemotactic gradient (3-fold increase, p<0.05). Further, cells cultured with BMP-13 had upregulated expression of Sox9 (20% increase) and BMPR-1b (25% increase) compared to control.

**DISCUSSION:** The study demonstrates BMP-13 as a proliferative and chondrogenic agent and a potential chemoattractant/stimulator for chondrocytes. The study highlights the potential of BMP-13 to be a chemoattractant to cells of interest when injected into the disc in vivo.

**GP57**

INTEGRIN ALPHA5/BETA1 MECHANO-TRANSDUCTION IS INVOLVED WITH NOTO-

**CHORDAL-CELL DISAPPEARANCE IN EARLY INTERVERTEBRAL DISC DEGENERATION.**

Takuto Kurakawa1, Kenichiro Kakutani1, Yusuke Morita2, Yuki Kato2, Yoshiki Terashima1, Shingo Miyazaki1, Hiroaki Hira-ta1, Takashi Yurube1, Toru Takada1, Koichi ro Maeno1, Masahiro Kuroskaka1, Koichi Masuda3, Nozomu Inoue4, Kotaro Nishida1; 1. Dept. of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan. 2. Dept. of Biomedical Engineering, Doshisha University, Kyoto, Japan. 3. Department of Orthopaedic Surgery, University of California, San Diego, La Jolla, USA 4. Department of Orthopedic Surgery, Rush University Medical Center, Chicago, USA

**INTRODUCTION:** In many cell types, transmembrane receptors are considered to transmit mechanical stress to cytoskeleton. We previously reported the role of α5β1 integrin on early intervertebral disc (IVD) degeneration using an ex-vivo culture system in which IVDs were exposed to dynamic mechanical loading. In this study, we hypothesised that α5β1 integrin is involved with notochordal cell (NC) disappearance because it is considered a key alteration in the early IVD degeneration.

**METHODS:** Forty-eight coccygeal IVDs were dissected from rats. Each IVD explant was cultured for 6 days in one of following conditions, Group C; unloaded (control group), Group L; with axial mechanical loading (1.3MPa, 1Hz at initial state), Group T; unloaded with an inhibitor for α5β1 integrin (GRGDSP), Group TL; loaded with the inhibitor. Cell viability analysis was examined using dead/alive staining. Histomorphology was assessed by a degeneration scale. Immunopositivity of a NC marker (cytokeratin-8) and α5/81 integrins were evaluated by the percentage of positive cells. mRNA expressions of aggrecan, collagen type-I/-II, MMP-3/-13, and α5/81 integrins were calculated by real-time RT-PCR.
RESULTS: Cell viability of Group L (69.9%) and Group TL (79.7%) was decreased than Group C (91.6%, P<0.05) in the nucleus pulposus (NP). Histological grades of Group L and TL were increased than Group C, but Group TL was significantly lower than Group L. Immunopositivity of cytokerin-8 was decreased in Group L (5.4%) and TL (22.1%) compared to Group C (85.3%, P<0.05). Immunopositivity of a5/ß1 integrins were significantly decreased with NC disappearance. mRNA expressions of aggrecan and collagen type 2 were up-regulated in Group TL compared to Group L (P<0.05), whereas significant up-regulation of MMPs and integrins in Group L was not seen in Group TL.

DISCUSSION: Our results suggested that the loss of NCs due to dynamic mechanical loading was affected by a5ß1 integrin expressions in rat IVDs.

GP58
ELEVATED VEGF IN DEGENERATIVE INTERVERTEBRAL DISCS IN RATS WITH INJURED INTERVERTEBRAL DISCS OF THE CAUDAL VERTEBRAE

INTRODUCTION: Recently, inflammatory cytokines, which are elevated in degenerative intervertebral discs, have been recognized as targets of drug therapy for discogenic back pain. Some reports have shown that the level of vascular endothelial growth factor (VEGF), a protein involved in angiogenesis, is elevated at inflamed sites, and we believed that VEGF could be a target for the treatment of discogenic back pain. Thus, we investigated the presence of VEGF in degenerative intervertebral discs in rats with injured intervertebral discs of the caudal vertebrae.

METHODS: Forty male rats (age, 8 weeks) were divided into 2 groups: injured group (intervertebral discs between the 5th and 6th, and 6th and 7th caudal vertebrae were punctured 10 times using a 26G needle) and non-injured group (intact discs). The intervertebral discs were collected at 1, 4, 7, and 14 days after the procedure (n=5 from each group at each time point), and quantitative evaluation of VEGF was performed using ELISA.

RESULTS: The VEGF level was maximum 1 day after the procedure, and then the level gradually decreased. Additionally, the VEGF levels during the entire study period were significantly higher in the injured group compared to those in the non-injured group (p<0.05).

DISCUSSION: In this study, injury to the intervertebral discs resulted in elevated VEGF levels. This finding confirms the increased production of inflammatory cytokines in injured intervertebral discs and indicates that VEGF might be involved in discogenic back pain. Moreover, the presence of elevated VEGF levels during the study period shows that VEGF might be responsible for lingering pain. Anti-VEGF antibodies are already in use in the ophthalmic field. Based on the findings in this study, a clinical trial involving the administration of anti-VEGF antibodies into the intervertebral discs for the treatment of low back pain in humans was approved by the review committee in September 2013 and will be performed in the near future.

GP59
IS THERE ANY OSTEOARTHRITIC CHANGE OF FACET JOINT AT THE ADJACENT LEVEL AFTER LUMBAR FUSION? WITH COMPARISON OF ADJACENT DISC DEGENERATION (USING MINIMUM 5-YR FOLLOW-UP MRI)
Chang-Hoon Jeon, Nam-Su Chung, Han-Dong Lee, Hyun-Suhk Seo; Department of Orthopaedic Surgery, Ajou University School
**INTRODUCTION:** Although adjacent segment pathology (ASP) after lumbar fusion is commonly found, the etiology of ASP has not been identified yet. The aim of this study was to compare the occurrence of adjacent disc degeneration with osteoarthritic change of facet joint after lumbar fusion in comparison with non-fusion.

**METHODS:** There were 48 patients who had undergone posterolateral fusion (PLF) for lumbar degenerative diseases and had taken MRI at the time of index treatment and at least 5-year follow-up were included. The control cohort involved 56 patients with non-fusion (decompression 24, conservative treatment 32). The Pfirrmann classification was used to grade the adjacent disc degeneration. The osteoarthritis of facet joint was graded with Fujiwara’s criteria. On each group, degenerations of the disc and facet joint were evaluated. The correlation between disc degeneration and osteoarthritic change of facet joint were evaluated.

**RESULTS:** The mean follow-up duration was 90.5±29.1 months (range, 60~164 months). Disc degeneration at the adjacent level was found in 27.1% of PLF and 23.2% of non-fusion group (P=0.545). Osteoarthritic change of facet joint was found in 27.1% of PLF and 21.4% of non-fusion group (P=0.695). Osteoarthritic change of facet joint was not correlated with adjacent disc degeneration (R=-0.113, P=0.202).

**DISCUSSION:** Adjacent disc degeneration and osteoarthritic change of facet joint occurred similarly at both PLF group and non-fusion group. These results imply that natural course degeneration rather than spinal fusion is a more important etiology for adjacent segment pathology.

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**GP60**

**DOES THE LUMBAR FUSION GENERATE THE ADJACENT END PLATE PATHOLOGY? A COMPARATIVE STUDY WITH DISC DEGENERATION USING MINIMUM 5-YR FOLLOW-UP MRI**

Chang-Hoon Jeon, Nam-Su Chung, Hyun-Suhk Seo, Han-Dong Lee; Department of Orthopaedic Surgery, Ajou University School of Medicine, Suwon, Republic of Korea

**INTRODUCTION:** In the studies of adjacent segment pathology after lumbar fusion, much attention has been focused on the intervertebral disc. Subsequently less has been documented about the end plate pathology. A retrospective radiological study was performed to investigate the occurrence of adjacent end plate pathology and the correlation with the adjacent disc pathology after lumbar fusion in comparison with non-fusion.

**METHODS:** Forty-eight patients who had undergone posterolateral fusion (PLF) for lumbar degenerative diseases and had taken MRI at the time of index treatment and at least 5-year follow-up were included. The control cohort involved 56 patients with non-fusion (decompression 24, conservative treatment 32). Using preoperative and follow-up MRI, Modic grade and other end plate morphologic changes (Schmorl’s node, fracture, erosion, and other irregularity) were observed. The intervertebral disc and end plate degeneration after fusion were compared with those of non-fusion.

**RESULTS:** The mean follow-up duration was 90.5±29.1 months (range, 60~164 months). Modic grade change was found in 8.3% of PLF and 5.4% of non-fusion group (P=0.522). End plate morphologic changes was found in 14.6% of PLF and 14.3% of non-fusion group (P=0.582). Disc degeneration at the adjacent level was found in 27.1% of PLF and 23.2% of non-fusion group (P=0.545). The end plate changes were
highly correlated with adjacent disc degeneration (R=0.650, P<0.001).

**DISCUSSION:** Adjacent disc degeneration and end plate pathology occurred similarly at both PLF group and non-fusion group. These results imply that natural course of spinal degeneration rather than spinal fusion is a more important etiology for adjacent segment pathology.

**GP61**

**EXPRESSION OF SCLEROSTIN AND ROLE OF NON-CANONICAL (PKC) SIGNALING IN THE INTERVERTEBRAL DISC CELLS**

Young-Mi Kang 1, 2, Soo-In Lee2, Ji-Hye Kim 2, Byung-Ho Lee 2, Jin-Oh Park 2, Moon-Soo Park2 Jae-Ho Yang2, Sun-Young Kim2, Kyung-Soo Suk2, Hak-Sun Kim2, Hwan-Mo Lee 2, Seong-Hwan Moon 1, 2, *; 1BK21 Medical science Graduated School, College of Medicine, Yonsei University, Seoul, Korea 2Department of Orthopaedic Surgery, College of Medicine, Yonsei University, Seoul, Korea*shmoon@yuhs.ac

**INTRODUCTION:** Intervertebral disc degeneration (IDD) is caused by imbalance in the homeostasis of the extracellular matrix, including type II collagens and proteoglycan in the nucleus pulposus (NP) and leads to low back pain. It has been demonstrated that the activation of protein kinase C (PKC) plays a role in cell growth and differentiation on the intervertebral disc area. Also, it is reported that activation of Wnt signaling suppresses cell proliferation, induces senescence, and contributes to IDD in the NP region. However, it is not identified that relevance of the Wnt signaling and the non-canonical Wnt signaling in the homoeostasis of intervertebral disc (IVD). Therefore, the objective of this study is to evaluate that non-canonical pathway is activated by PMA affects on behavior of chondrocyte-like cells.

**MATERIALS AND METHODS:** Human disc tissues were collected during surgery from patients and cultured. The IVD cells were seeded at a cell density of 70 cells cm⁻¹ for protein and RNA isolation in condition treated with Phorbol 12-myristate 13-acetate (PMA, 200nM) for 24 hours. RT-PCR was performed to detect expressions of aggrecan, type II collagen GLUT-1, GAPDH, SOX9 and HIF-1a at the mRNA, enzyme linked immune-sorbent assay was used for sclerostin (Sost).

**RESULTS:** The expressions of type II collagen and SOX9 mRNA increased in condition treated with PMA comparing with condition without PMA. Furthermore, the expression of Sost at protein level was increased in condition treated with PMA.

**SUMMARY AND CONCLUSION:** The activation of PKC stimulates the expression of SOX9 and type II collagen and induces the expression of Sost on the chondrocyte-like cells in the IVD. Therefore, the activation of PKC on chondrocyte-like cells affects senescence and dedifferentiation, which provides the possibility of turnover for degenerated condrocyte-like cells. It is considered more observations on the relationship between Wnt signaling and their inhibitors and the signal of PKC downstream.

**GP62**

**DIFFERENTIATION OF HUMAN MESENCHYMAL STEM CELLS INTO DISCOCYGIC PHENOTYPE USING THREE DIMENSIONAL CULTURE**

Young-Mi Kang 1, 2, Soo-In Lee2, Ji-Hye Kim 2, Byung-Ho Lee 2, Jin-Oh Park 2, Moon-Soo Park2 Jae-Ho Yang2, Sun-Young Kim2, Kyung-Soo Suk2, Hak-Sun Kim2, Hwan-Mo Lee 2, Seong-Hwan Moon 1, 2, *; 1BK21 Medical science Graduated School, College of Medicine, Yonsei University, Seoul, Korea 2Department of Orthopaedic Surgery, College of Medicine, Yonsei University, Seoul, Korea*shmoon@yuhs.ac

**INTRODUCTION:** Intervertebral disc degeneration (IDD) is caused by imbalance in the
homeostasis of the extracellular matrix, including type II collagens and proteoglycan in the nucleus pulposus (NP). For disc tissue engineering, human mesenchymal stem cells (MSCs) provide plausible cell source. Alginites and PLGA are biocompatible materials and could support a stable cell phenotype. Therefore, the objective of this study is evaluated that human mesenchymal stem cells were differentiated into discogenic phenotype using alginites and PLGA fibers.

**MATERIALS AND METHODS:** Human disc tissues and bone marrow were collected during surgery from patients with lumbar spinal stenosis and the chondrocyte-like cells (CLCs) from disc tissues and MSCs from bone marrow were cultured. The CLCs and MSCs were seeded at a cell density of 104 cells mm-3 on alginites and PLGA fibers. Also, the alginate constructs were amassed two layers after one week. Each MSCs and CLCs were seeded on alginites and PLGA fibers were used as control. PLGA fibers were located in the center of Alginate construct. Total RNA was isolated from MSCs and CLCs following manufacturer’s instructions. The cDNA was amplified for collagen type II, and aggrecan. Glycosaminoglycan (GAG) was measured in protein level using manufacture instruction.

**RESULTS:** The MSCs and CLCs co-culture is increased in the expressions of type II collagen, aggrecan and GAPDH mRNA compared to control. Also the expression of sGAG in the MSCs and CLCs co-culture remained increase in the protein level.

**SUMMARY AND CONCLUSION:** The co-culture of MSCs and CLCs stimulates the expression of chondrocyte phenotype such as collagen type II and aggrecan and induces GAG expression. Therefore, the co-culture with MSCs and CLCs affects the MSCs were differentiated into CLCs in the three dimensional structure. Our study suggests that the MSCs can be differentiated into CLCs by co-culture, which provides excellent mechanism for MSC based tissue engineering.

**GP63**

**DIFFUSION TENSOR IMAGING FOR QUANTITATIVE EVALUATION OF LUMBAR INTERVERTEBRAL DISC DEGENERATION**

Oikawa, Yasuhiro1; Eguchi Yawara2; Watanabe, Atsuya1; Orita Sumihisa1; Yamauchi Kazuyo1; Sakuma, Yoshihiro1; Kubota, Go1; Inage, Kazuhide1; Sainoh, Takeshi1; Sato, Jun1; Fujimoto, Kazuki1; Arai, Sadao3; Suzuki Miyako1; Takahashi Kazuhas1; Ohtori Seiji1; 1. Department of Orthopaedic Surgery, Graduate School of Medicine Chiba University, Japan 2. Department of Orthopaedic Surgery, Shimoshizu National Hospital, Japan 3. Arai Orthopaedic Clinic, Japan

**INTRODUCTION:** Pfirrmann classification, T2 and T1. mapping using MRI are tools to evaluate intervertebral disc (IVD) degeneration. Diffusion tensor imaging (DTI) and diffusion tensor tractography(DTT) are neuroimaging tools for visualizing highly anisotropic tissues. Recently, DTI is used for evaluation of degenerated IVDs. The purpose of this study is to provide evidence for the efficacy of DTI and DTT in the quantitative evaluation of degenerated IVDs.

**METHODS:** Three patients with discogenic low back pain underwent DTI and DTT on a 3.0T MR scanner. We evaluated 12 discs from L2-3 to L5-S in each patient. Pfirrmann classification on conventional MR imaging, fractional anisotropy (FA) value, morphological classification on DTT, and number of tracking fibers were evaluated. IVD was divided into 3 layers in a concentric manner from the center; FA value was measured at each layer. DTT was classified into ring, donut and disk type.

**RESULTS:** With Pfirrmann classifications, 6, 2, and 4 discs were grade 2, 3 and 4, respectively. With DTT classification, 6, 1 and 5 discs were ring, donut and disk types, re-
spedtively. All grade 2 and 1 grade 3 discs corresponded to ring type, and all grade 4 and the other grade 3 discs corresponded to disk type. FA value of the intermediate layer was 0.10 for ring type, 0.21 for donut, and 0.23 for disk. FA value of the inner layer was 0.06 for ring type, 0.09 for donut, and 0.20 for disk. The number of tracking fibers was increased in disk types.

**DISCUSSION:** This study showed that shape on DTT correlated to Pfirrmann classification, and DTT of discs can describe the IVD degeneration process. A previous study showed that water content tended to decrease in IVD degeneration. The increasing FA value and number of the tracking fibers may reflect a decreased water content and tissue degeneration. Thus, DTI and DTT can visualize and quantitatively evaluate IVD degeneration. DTI and DTT may detect degeneration and evaluate repair and regeneration.

**GP64**

**IN VITRO LIFESPAN OF NUCLEUS PULPOSUS CHONDROCYTES IN DIFFERENT AGED HUMAN INTERVERTEBRAL DISCS**

Jun-Seok Lee, MD1,2, Seung-Chan Kim, MD1, Seo-Won Chung, BS2, Ki-Won Kim, MD1,2; 1Department of Orthopedic Surgery, Yeouido St. Mary’s Hospital, The Catholic University of Korea, Seoul, Korea 2Department of Orthopedic Research, Clinical Research Institute, Yeouido St. Mary’s Hospital, The Catholic University of Korea, Seoul, Korea

**INTRODUCTION:** Normal human cells undergo only a limited number of cell divisions in vitro. We performed a study to investigate the lifespan of NP chondrocytes in different aged human IVDs. We hypothesized that the lifespan of NP chondrocytes may decrease with increasing age or advancing disc degeneration.

**METHODS:** NP specimens remaining in the central region of the intervertebral disc were obtained from different-aged 18 patients (mean: 52.6 years, range: 32-78 years) undergoing discectomy. The specimens were divided into five groups based on patient’s age decades: 30s (n = 4), 40s (4), 50s (4), 60s (3), and 70s (3). Based on the preoperative magnetic resonance images, there were 6 patients with grade III degeneration and 12 patients with grade IV. We serially cultivated NPCs until the cells reached the end of their in vitro lifespan. During each subcultivation, we calculated NPC’s cumulative population doubling level (cPDL). The differences in cPDL among the age groups and between the degeneration grades were analyzed. Correlations between cPDL and age were also analyzed.

**RESULTS:** Mean cPDL of the NPCs in 30’s, 40’s, 50’s, 60’s and 70’s were 27.0 ± 6.8, 21.7 ± 0.9, 29.7 ± 2.0, 18.3 ± 3.2 and 14.3 ± 8.3, respectively. Mean cPDL in young group (in 30’s, 40’s and 50’s) were significantly higher than those in old group (in 60’s and 70’s) (26.1 ± 5.1 vs. 16.3 ± 6.0, P = 0.002). In addition, there was a significant negative correlation between cPDL and age (r = -0.49, P= 0.039). However, there was no difference in cPDL between the degeneration grades (p = 0.68).

**CONCLUSIONS:** Our study demonstrated that mean PDL of the NPCs in various age groups and in vitro lifespan of NPCs decreased with increasing age. Our results may provide baseline data for research in human IVD and be useful in developing biological treatment for regeneration of degenerative IVD.

**GP65**

**TELOMERE LENGTH AND TELOMERASE ACTIVITY OF NUCLEUS PULPOSUS CHONDROCYTES IN DIFFERENT AGED HUMAN INTERVERTEBRAL DISCS DURING LONG-TERM PASSAGE**

Jun-Seok Lee, MD1,2, Sung-Wook Cho, MD1,2, Seo-Won Chung, BS2, Ki-Won Kim, MD1,2; 1Department of Orthopedic Surgery,
**INTRODUCTION:** Normal human cells undergo only a limited number of cell divisions in vitro. We performed a study to investigate the changes of telomere length (TL), telomerase activity (TA), and senescence of nucleus pulposus chondrocytes (NPCs) obtained from different aged donors until the cells reached the end of replicative lifespan in standard cell culture conditions. **METHODS:** NP tissues were obtained from different-aged 18 patients (mean: 51.9 years, range: 32-72 years) undergoing discectomy. The tissues were divided into five groups based on donor’s age decades: 30s (n = 4), 40s (4), 50s (4), 60s (4), and 70s (2). Based on the preoperative magnetic resonance images, there were 7 tissues with grade III degeneration and 11 tissues with grade IV. We serially cultivated NPCs until the cells reached the end of their in vitro lifespan. During each subcultivation, we assessed TL, TA, cumulative population doubling level (cPDL), and expression of senescence-associated b-galactosidase activity (SA-b-gal). **RESULTS:** Mean values of initial TL and initial TA were 13.9 ± 4.1 kilobase pairs (kbp), 16.5 ± 7.0, respectively. Mean cPDL was 23.8 ± 7.9 (range, 5 - 37). Initial TL and TA declined as advancing passages but the percentages of the SA--gal-positive NPCs steadily increased with advancing passages, irrespective of patient’s age. Mean rate of telomere shortening was 319.5 ± 455.6 bp with each population doubling. There was a significant positive correlation between initial TL and last TL (r = 0.64, P = 0.005). In addition, there was a significant negative correlation between age and initial TA (r = -0.618, P = 0.006). However, there was no difference in mean initial TL and mean initial TA among the age groups and between the degeneration grades. **CONCLUSIONS:** The present study demonstrated that the human NPCs had a finite in vitro lifespan. TL and TA declined as advancing passages and contributed to senescence of NPCs, irrespective of patient’s age.

**GP66**

**DICHOTOMIZING SENSORY NERVE FIBERS INNERVATING BOTH THE LUMBAR VERTEBRAL BODY AND THE AREA SURROUNDING THE ILIAC CREST: A POSSIBLE MECHANISM OF REFERRED LATERAL BACK PAIN FROM LUMBAR VERTEBRAL BODY**

Yeouido Shiga, Tatsuya Fujii, Yoshihiro Sakuma, Kazuyo Yamauchi, Sumihisa Orita, Masayuki Miyagi, Miyako Suzuki, Yasuhiro Oikawa, Gou Kubota, Kazuhide Inage, Takeshi Sainoh, Jun Sato, Seiji Ohtori, Kazuhisa Takahashi; Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University

**INTRODUCTION:** Elderly patients with osteoporosis sometimes experience lumbar vertebral fracture and may feel diffuse non-localized pain in the back, the lateral portion of the trunk, and the area surrounding the iliac crest (ASIC). The pattern of sensory innervation of vertebral bodies remains unclear. DRG neurons with dichotomizing axons have been reported and are thought to be related to referred pain. The purpose of this study was to investigate the existence of dichotomizing axons to the lumbar vertebral bodies and the ASIC in rats. **METHODS:** Two kinds of neurotracers [1,1dioctadecyl-3,3,3,3-tetramethylindocarbocyanine perchlorate (Dil) and fluoro-gold (FG)] were used. Dil crystals were placed in the left ASIC, and FG was applied into the L2 vertebral body in 10 rats. Four weeks later, left DRGs from L1 to L6 were resected, sectioned and observed under a fluorescence microscope.
RESULTS: Dil-labeled DRG neurons innervating the ASIC and FG-labeled DRG neurons innervating the vertebral L2 body were distributed from L1 to L6. The ratio of total double-labeled per total Dil-labeled DRG neurons was 10.2%, and that of total double-labeled per total FG-labeled DRG neurons was 14.7%. These double-labeled DRG neurons innervating the L2 vertebral body had other axons that extended to the ASIC. 

DISCUSSION: This finding provides a possible neuroanatomical explanation for referred pain in the ASIC from vertebral bodies.

GP67
M1 MACROPHAGE EXISTS IN THE DEGENERATIVE DISC
T. Takada, K. Maeno, K. Kakutani, T. Yurube, H. Hirata, T. Kurakawa, S. Miyazaki, Y. Terashima, M Doita, M. Kurosaka, K. Nishida; Department of Orthopedic Surgery Kobe University Graduate School of Medicine

INTRODUCTION: We have been previously shown that macrophages and intervertebral disc interaction induces inflammatory pain. In this study, we clarified the existence of macrophages and phenotype of the macrophages in non-herniated disc and herniated disc.

METHODS: 33 non-herniated degenerative disc specimen and 23 herniated disc specimen slices were stained with anti CD68, CD14 and iNOS monoclonal antibody using immunohistochemical methods. The CD68 positive macrophages were counted in 10 consecutive high-power (>400) fields, and expressed as cells per high-power field. We compared correlation between Pfirrmann MRI grading scale and CD68-positive cells per high-power field using Mann-Whitney’s U test. Under CD14 (M1 and M2 commonly observed antigen) and iNOS (M1 specific antigen) multistaining procedure, we evaluated M1/M2 ratio in each samples.

RESULTS: In non-herniated degenerative specimens, 32 in 33 samples showed CD68 positive cells. There was no correlation between CD68 positive cells in high-power field and Pfirrmann MRI grading scale. M1/M2 ratio was 95.5/4.5. In herniated disc specimen, all of 23 samples showed CD68 positive cells. M1/M2 ratio was 95.6/3.4.

DISCUSSION: Non-herniated degenerative disc and herniated disc consists of macrophages which express CD68 and CD14. Almost of these macrophages are M1 macrophages. These macrophages are thought to be derived from extra disc. M1 macrophages induce inflammatory reaction and foreign body elimination. M1 macrophages in non-herniated disc can play important role in the etiology of disc degeneration and discogenic pain.

GP68
MOLECULAR CHARACTERIZATION OF CHORDOMA CELL LINE U-CH1-N: APPLICATIONS FOR INTERVERTEBRAL DISC RESEARCH
Nobuyuki Fujita(1), Naobumi Hosogane(2), Ken Ishii(1), Tomohiro Hitaka(1), Kota Watanabe(3), Yoshiaki Toyama(1), Takeshi Miyamoto(1), and Morio Matsumoto(1); 1 Department of Orthopaedic Surgery, Keio University School of Medicine, Japan 2 Department of Orthopaedic Surgery, National Defence Medical Collage, Japan 3 Department of Advanced Therapy for Spine and Spinal Cord Disorders, Keio University, Japan

INTRODUCTION: Immortalized cell lines are an important tool in disc biology research. However, few nucleus pulposus (NP) cell lines have been established. Our goal was to determine whether chordoma cell line U-CH1-N cells had similar molecular characteristics to primary notochordal nucleus pulposus (NP) cells. The second objective of the present study was to determine the gene expression profile of TNF-alpha-treated U-
CH1-N cells and identify the molecular target of treatment for intervertebral disc degeneration.

**METHODS AND RESULTS:** Real-time RT-PCR, immunocytochemistry, and flow cytometry analysis showed that notochordal cell marker, CD24 was specifically expressed in U-CH1-N over the other cell lines, 293T and MG63. Brachyury was also strongly expressed in U-CH1-N cells at the mRNA and protein levels. A reporter assay revealed the high transcripational activity of brachyury in U-CH1-N cells. Real-time RT-PCR analysis and immunocytochemistry showed that U-CH1-N cells also expressed high levels of aggrecan and type II collagen. Moreover, U-CH1-N cells cultured for a long time were positive for Alcian blue staining. Microarray analysis of TNF-alpha-treated U-CH1-N cells showed that the scale signal of IL-6 was the strongest in proinflammatory cytokines. Real-time RT-PCR analysis and ELISA confirmed the marked induction of IL-6 expression by the TNF-alpha treatment in U-CH1-N cells. Moreover, a robust scale signal of STAT3 was identified in these cells. Ten human samples of degenerative discs confirmed the high expression of both IL-6 and STAT3 in NP.

**DISCUSSION:** The molecular phenotype of U-CH1-N cells was similar to that of notochordal NP cells. In the present study, we interestingly found that the expression level of IL-6 and STAT3 was high in degenerative NP. These findings suggest that U-CH1-N is a useful tool for understanding the molecular mechanisms of disc degeneration and that IL-6-STAT3 signal may be also involved in intervertebral disc degeneration.

**GP69**

**INTRACELLULAR CALCIUM SIGNALING IN FIBROUS TISSUES IS BOTH STRAIN- AND MICROENVIRONMENT-DEPENDENT**

Woojin M. Han (1), Su-Jin Heo (1,2), Randall L. Duncan (3,4), Robert L. Mauck (1,2), Dawn M. Elliott (3); (1) Department of Bioengineering, (2) Department of Orthopaedic Surgery, University of Pennsylvania, Philadelphia, PA, USA; (3) Department of Biomedical Engineering, (4) Department of Biological Sciences, University of Delaware, Newark, DE, USA

**INTRODUCTION:** Mechanotransduction involves modulation of intracellular calcium. However, the relationship between tissue-level mechanical deformation and cell response remains unclear in fibrous tissues. Also, many studies query this biologic response using cells that have been isolated from their native microenvironment, potentially neglecting critical cell-matrix interaction effects. The objective of this study was to test the hypothesis that the intracellular calcium response of cells is dependent on tensile strain and on the microenvironment.

**METHODS:** Fresh circumferential samples were harvested from bovine fibrocartilage. While knee meniscus fibrocartilage was used here, the same principles will apply for annulus fibrosus. Cells were seeded onto aligned poly(e-caprolactone) scaffolds. Samples were stained with 15-µm Cal-520AM for 1-h. A custom tensile testing device mounted on a confocal microscope was used to monitor intracellular calcium. Each sample was preloaded to 30-mN. Base line cell response was recorded for 15-min at 0.25-Hz. Subsequently, grip-to-grip strain for 0, 3, 6, or 9% (n=4 per strain) was applied at 0.05%/sec, followed by another 15-min imaging.

**RESULTS:** Cells in both groups showed calcium transients. At baseline, significantly more cells were spontaneously responding in the native (25%) compared to the scaffold group (10%). With increasing strain, the number of responding cells steadily increased. Amplitude of calcium transients significantly increased in the native group with strain, but not in the scaffold group. Average transient duration in native tissue
was ~100 seconds, compared to ~40 seconds in scaffolds. Transients were significantly more frequent and rapid in scaffolds compared to native tissues.

**DISCUSSION:** This study highlights differences in strain-dependent cell signaling between in situ and in vitro environments, which may be due to differences in cell attachment, pre-stress, cell-matrix interactions, and local strain.

**GP70**

**CHEMOKINE EXPRESSION BY ANNULUS FIBROSUS AND NUCLEUS PULPOSUS CELLS**

Ana V. Chee, PhD 1; David K. Liu, MS 1; Peng Shi, DDS, PhD 1; Ding Chen, MD 2; Zemin Li, MD 3; Di Chen, MD, PhD 4; Howard S. An, MD 1; 1. Department of Orthopedic Surgery, Rush University Medical Center, Chicago, IL, USA; 2. Department of Orthopedics, Xiangya Hospital of Central South University, Hunan, P.R. China; 3. Department of Spine Surgery, First Affiliated Hospital of Sun Yat-Sen University, Guangzhou, P.R. China; 4. Department of Biochemistry, Rush University Medical Center, Chicago, IL, USA.

**INTRODUCTION:** Higher levels of pro-inflammatory cytokines and macrophage markers have been detected in the intervertebral disc tissues of patients with disc degenerative disease and discogenic pain. These studies suggest that macrophage recruitment into the disc plays a role in inflammation and back pain. The aims of these studies are to determine 1) the expression profile of chemokines in annulus fibrosus (AF) and nucleus pulposus (NP) cells, 2) the responsiveness of chemokine expression to the treatment of interleukin (IL)-1, and 3) the correlation of chemokine expression with macrophage recruitment into the disc.

**METHODS:** Cells were isolated from the NP and AF tissues of 6 donor spines. NP and AF monolayer cells were treated with human recombinant IL-1 for 24 hours. RNA analysis was performed on chemokine (C-C motif) ligands, CCL2, CCL3 and CCL5, using real-time PCR. Protein levels of these chemokines were determined using a Luminex multiplex assay. Chemotaxis of fluorescently labeled human monocytic cells (THP-1) was assayed using 3 μm BD fluoroblok inserts and the supernatants of the NP and AF cells after treatment.

**RESULTS:** After IL-1 treatment, NP and AF cells up-regulated the gene expression of CCL2 (51- and 37-fold), CCL3 (326- and 35-fold) and CCL5 (655- and 543-fold), respectively. Protein levels were also up-regulated in NP and AF cells: CCL2 (178- and 193-fold), CCL3 (from undetectable to 831 and 447 pg/mL) and CCL5 (126- and 165-fold), respectively. Lastly, supernatants of IL-1 treated cells were able to induce a higher migration rate of THP-1 cells than control supernatants.

**DISCUSSION:** These studies show that NP and AF cells express chemokines that attract macrophages into the disc and the expression of these chemokines can be induced by IL-1 at the RNA and protein level. Migration of human monocytes can also be induced by the chemokines released by IL-1 treated NP and AF cells.

**GP71**

**AXONAL GROWTH POTENTIAL INDUCED BY INTERACTIONS BETWEEN IVD AND DRG IN RESPONSE TO IL-1β**

Hyunchul Kim 1, Tyler W. Caspar 1, Sameer B. Shah 2, Adam H. Hsieh 1,3; 1 Fischell Department of Bioengineering, University of Maryland, College Park, USA; 2 Department of Orthopaedic Surgery & Bioengineering, University of California, San Diego, USA.
GENERAL POSTERS

Department of Orthopaedics, University of Maryland, Baltimore, USA

INTRODUCTION: Sensory nerve fiber originated from dorsal root ganglia (DRG) has been found within degenerated intervertebral disc (IVD) in association with low back pain. Pro-inflammatory cytokines are one of regulating factors correlated with innervation in the IVD. For better understanding of pain mechanism, we investigated the role of IL-1ß on the interactions between AF cells and DRG neurons responsible for nerve ingrowth.

METHODS: AF cells obtained from Sprague-Dawley rat were isolated and pre-cultured for 1 day, and then replaced with NGF-free neurobasal media or NGF-supplemented media containing 0, 1 and 10 ng/ml of IL-1ß. Harvested adult lumbar DRGs were seeded onto collagen gel construct in Transwell inserts, then were co-cultured with AF cells in NGF-free media or cultured in AF cell conditioned media (CM). After 7 days, neurofilament immunostaining was performed to identify neurite outgrowth.

RESULTS: Positive neurofilament expression was identified in DRGs cultured in CM extracted from AF cell cultures with NGF-free media stimulated by IL-1ß (1 and 10 ng/ml), but there was little immunoreactivity without IL-1ß treatment. Neurite growth was consistently observed in all co-cultured groups without NGF and IL-1 ß effect. Co-cultured DRGs showed more axonal outgrowths than DRGs in NGF-free CM. NGF-supplemented CM group exhibited high density of axons compared to other groups.

DISCUSSION: IL-1ß had stimulatory effect on AF cells to induce a regulatory soluble factor enhancing axonal growth. Our results suggest that bidirectional crosstalk between AF cells and DRG neurons amplify neuronal growth. We speculate that IL-1ß plays a role in mediating the nerve growing pathway between IVD and DRG via primary response and bidirectional crosstalk. Neurite length will be analyzed using Simple Neurite Tracer (Fiji/ImageJ). The potential synergism between the inflammatory environment, IVD, and DRG can be assessed using our in vitro culture system.

GP72

CHLOROQUINE INCREASES CELLULAR APOPTOSIS, SENESCENCE, AND EXTRACELLULAR MATRIX DEGRADATION IN INTERVERTEBRAL DISC CELLS: POSSIBLE ADVERSE EFFECTS OF AUTOPHAGY INHIBITION

Takashi Yurube (1,2), William J. Buchser (3), Michael T. Lotze (3),Nam Vo (1), Gwendolyn A. Sowa (1,4), James D. Kang (1); 1. Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA 2. Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan 3. Department of Surgery, University of Pittsburgh, Pittsburgh, PA 4. Department of Physical Medicine & Rehabilitation, University of Pittsburgh, Pittsburgh, PA

INTRODUCTION: A common antimalarial agent, chloroquine (CQ), has recently gained increased attention because of its antitumor effect. This principally results from inhibiting the lysosomal protein degradadion step of autophagy. However, the role of autophagy on disc cells is largely unknown. Therefore, we designed a study to elucidate the effect of CQ on disc cell fate and matrix homeostasis.

METHODS: Rabbit annulus fibrosus cells were cultured with CQ. To characterize cellular responses, cell proliferation and viability were measured. To assess autophagy, autophagic flux was longitudinally monitored by imaging cytometry and Western blotting. To analyze cell fate, apoptosis and senescence levels were determined. To evaluate matrix metabolism, catabolic and anti-catabolic molecule expression and activity and matrix synthesis were investigated.
RESULTS: Cell proliferation and viability decreased in response to 30-μM but not 15-μM CQ. Thus, we selected 15 μM for the remainder of experiments. 15-μM CQ demonstrated apparent inhibition of autophagy (assessed by LC3, HMGB1, and p62/SQSTM1). 15-μM CQ showed increased apoptosis at 24 h (by TUNEL, PARP, and caspase-3) and senescence at 48 h (by p16/INK4a). Furthermore, CQ exhibited a dose-dependent increase of apoptosis (0–240 μM) and senescence (up to 60 μM). 15-μM CQ displayed 22.1-, 5.0-, and 0.77-fold up-regulation of MMP-3, -13, and TIMP-1 mRNA levels. In zymography, fluorescent assay, and Western blotting, activity and expression of MMP-2, -3, -9, and -13 increased while those of TIMP-1 and -2 decreased. Radioactivity of newly synthesized proteoglycans and collagens decreased in 15-μM CQ.

DISCUSSION: CQ decreases cell proliferation and viability, suppresses autophagy, increases apoptosis and senescence, and shift matrix metabolism toward catabolism when remaining within a non-toxic level. This study leads to a possible new treatment strategy for disc disease through understanding the effect of autophagy on disc cells.

GP73

THE ROLE OF DIABETES TYPE I IN INTERVERTEBRAL DISC DEGENERATION
Fabrizio Russo, Pedro Pohl, Kevin Ngo, Takashi Yurube, Qing Dong, Yong Fan, Trucco Massimo, Gwendolyn Sowa, James Kang, Nam Vo; Department of Orthopaedic Surgery, School of Medicine, University of Pittsburgh

INTRODUCTION: Diabetes Mellitus (DM) affects 25.8 million people of all ages. Previous studies suggest a link between DM and several connective tissue pathologies including those of cartilage and bone, however the role of DM in intervertebral disc degeneration (IDD) is unclear. The goal of this study was to measure disc degenerative changes in a murine model of human type I diabetes to establish the contributive role of DM in IDD.

METHODS: Intervertebral discs (IVDs) were obtained from spines of Wt (C57Bl/6) mice and B6 Akita mouse model of type I DM. B6 Akita mice are hyperglycemic due to the Ins2Akita insulin mutation, which causes the insulin producing beta cells to undergo apoptosis. Total disc proteoglycan (PG) content was measured by DMMB assay and safranin O/fast green histology. Glut1, a major glucose transporter in discs, was measured by quantitative RT-PCR, and cell death was assessed by TUNEL assay.

RESULTS: DMMB assay and Safranin-O staining both showed decreased disc GAG content in diabetic B6 Akita mice compared to that in age-matched nondiabetic Wt controls. Discs of B6 Akita mice also exhibited decreased level (~5 fold) of Glut1 mRNA and increased level of TUNEL-positive cells.

DISCUSSION: IVDs of diabetic B6 Akita mice exhibit an overall decrease in PG content and increased cell death. These changes correlate with a decrease in Glut1 gene expression. Experiments are being done to evaluate that increased cell death in the IVDs of B6 Akita mice is a result of diminished glucose uptake (decreased Glut1) in disc tissue. These diabetic mice may represent a useful model to explore the mechanism of how diabetes affects IDD through its impacts on glucose metabolism in disc tissue.

GP74

REMOVAL OF ADAMTS-5 PREVENTS TOBACCO SMOKING-INDUCED DISC AGGREGAN BREAKDOWN AND MATRIX PROTEOGLYCAN LOSS
INTRODUCTION: Tobacco smoking is a major risk factor of intervertebral disc degeneration (IDD). We recently discovered proteolytic destruction of aggrecan and matrix proteoglycan (PG) loss in the intervertebral discs of a mouse model of chronic human tobacco smokers. However, it is still unclear which matrix metalloproteinase(s) are responsible for driving these detrimental effects. Because ADAMTS5 is the major aggrecanase in cartilaginous tissue, the goal of this study is to examine the contributive role of ADAMTS-5 in smoking-induced IDD.

METHODS: Three-month old Wt (C57BL/6) and ADAMTS5 knockout (ADAMTS5−/−) mice were exposed to tobacco smoke by direct inhalation (4 cigarettes/day, 5 day/week for 6 months). ADAMTS-mediated cleavage of disc aggrecan interglobular domain (IGD) terminating in NITEGE-373 was analyzed by Western using whole disc protein extract. Disc PG content were analyzed by dimethyl methylene blue (DMMB) for total glycosaminoglycan (GAG) and by safranin O/fast green histology.

RESULTS: Western analysis revealed increased ADAMTS-mediated disc aggrecan proteolysis in Wt mice (Fig.1A, lane 3) but not ADAMTS5−/− mice (Fig.1A, lane 5) following exposure to tobacco smoke. Compared to unexposed Wt control, smoke-exposed Wt mice showed a substantial reduction (~40%) in total disc GAG content while smoke-exposed ADAMTS5−/− mice showed only a modest reduction (~20%) in disc GAG content (Fig.1B, 1C).

DISCUSSION: Chronic exposure to tobacco smoke promotes disc aggrecan breakdown and matrix PG loss in Wt mice. ADAMTS-5−/− mice were largely protected from these detrimental effects, indicating that ADAMTS-5 is a primary aggrecanase mediating smoke-induced disc aggrecanolysis and matrix loss. Hence, ADAMTS-5 represents an important target for the development of therapeutic inhibitors aimed at delaying the onset or ameliorating the severity of IDD in chronic smokers.

GP75 EFFECTS OF THE ANTI-AGING AGENT RAPAMYCIN ON DISC MATRIX HOMEOSTASIS
Vo, Nam; Ngo, Kevin; Yurube, Takashi; Pohl, Pedro; Dong, Qing; Miller, Richard; Roughley, Peter; Sowa, Gwendolyn; Kang, James; Department of Orthopaedic Surgery, School of Medicine, University of Pittsburgh

INTRODUCTION: Aging is a major etiologic factor of intervertebral disc degeneration (IDD). Rapamycin has been shown to significantly extend lifespan in mice. Rapamycin is a bacterial antifungal product that selectively inhibits mTOR, a central protein kinase that integrates cellular activities in response to nutrients, stress, and extracellular signals which ultimately modulate the organism aging progression. In this study we investigated the effects of rapamycin on disc aging and matrix homeostasis.

METHODS: Genetically heterogeneous M-HET3 mice (n=6) were fed with food containing rapamycin at dose previously demonstrated to extend life span (14 ppm) starting from the age of 4 months until the age of 12 months. Disc proteoglycan (PG) content (DMMB assay), aggrecan proteolysis (Western), proteoglycan synthesis (35S-sulfate incorporation), and cellular senescence (p16INK4a IHC) were measured.
GENERAL POSTERS

RESULTS: Disc PG remained unchanged by rapamycin treatment (Fig. 1A). Disc PG synthesis was decreased by 36% in rapamycin-treated mice compared to controls (Fig. 1B)Interestingly the levels of disc aggrecan proteolysis (Fig. 1C) as well as the cellular senescence marker p16INK4a (Fig. 1D) decreased in rapamycin-treated animals compared to untreated controls.

DISCUSSION: Rapamycin-mediated suppression of disc PG synthesis is consistent with the well-known action of rapamycin in inhibiting general protein synthesis through the mTOR pathway. Overall, systemic treatment of mice with rapamycin reduced age-related disc degenerative changes, including disc aggrecanolysis and cellular senescence. Senescent cells are known to produce many catabolic factors such as MMPs. Hence, the reduction in disc aggrecanolysis might be a result of suppression of disc cellular senescence by rapamycin, though additional confirmatory studies are needed. Rapamycin is a potential therapeutic drug for delaying age-related disc degenerative conditions.

GP76
NEURONAL NITRIC OXIDE SYNTHASE INHIBITION ATTENUATES INTERVERTEBRAL DISC DEGENERATION
Helton L A Defino, Ana Carolina Yssi, Victor Castania, Elaine Del Bell; Department of Biomechanics, Medicine and Rehabilitation of the Locomotor System, Ribeirão Preto Medical School, University of São Paulo, Brazil

ABSTRACT: Intervertebral disc degeneration (IDD) is thought to result from multifactorial causes and is characterized by serial progressive morphologic and biomechanical functions changes. Although nitric oxide (NO) synthesized through the inducible isoform of NO synthase enzyme (iNOS) was associated with the discal degenerative process, the implication of neuronal isoform of NOS (nNOS) to IDD process is still unclear. Using caudal puncture, a method of intervertebral disc degeneration, the involvement of the neuronal isoform of NOS in the discal degeneration was investigated.

METHODS: Adult male Wistar rats were anesthetized and submitted to percutaneous disc puncture with 21G needle on levels 6-7 and 8-9 of coccyges vertebras. The 30-gauge needle was used for NOS inhibitors injection immediately after the intervertebral disc puncture. The NO source from nNOS was selectively inhibited using NPLA, a preferential nNOS inhibitor, or a synthetic small-interfering RNA (siRNA) against nNOS injected intra disc. Constitutive inhibition of NOS using L-NAME also was carryout. Results: The mRNA level for nNOS is increased in 4 times 5 hours after the punctured disc. Pharmacological inhibition of the neuronal NOS through the NPLA caused a significant improvement in the histological and image discal features, while the intradiscal siRNA did not produce a significant difference in the magnetic resonance signal, or in the histological evaluation.

CONCLUSION: This study provides evidence that modulation of nNOS may participate in the intervertebral disc degenerative process. Therefore, a selective NO inhibition could represent a new therapeutic tool to minimize the disc degeneration, and further investigation is thus required.

GP77
PT MODIFIER OF SRS-SCHWAB ADULT SPINAL DEFORMITY CLASSIFICATION AND MODE OF PELVIC COMPENSATION
Tetsuya Kobayashi, Kiyoshi Aono, Shizuo Jimbo, Issei Senoo, Yuji Atsuta, Hiroshi Itou; Asahikawa Medical University, Dept. of Orthopaedic Surgery

INTRODUCTION: Pelvic tilt (PT) represents pelvic retroversion and compensation for sagittal spinal deformity, however, the magnitude of compensation has not been
GENERAL POSTERS

well-documented. Purpose of this study was to clarify the mode of pelvic compensation among community-based volunteers using SRS-Schwab classification.

METHODS: A final total of 159 healthy female subjects were recruited from population register. Upright entire spine radiographs were used to measure sagittal spinopelvic parameters including LL, SS, PI, SVA and PT. Clinical evaluation included HRQOL, range of back extension (prone-press), active back extension test (BET), trunk flexor and extensor muscle power using isometric device, and trunk inclination angle at standing (sTIA) and walking (wTIA) using surface markers.

RESULTS: Subjects’ age was 50-79 (mean 64.9) years, and radiographic parameters were as follows; LL 39.6±15.2°, SS 30.7±11.8°, PI 55.2±10.3°, SVA 22.0±35.4 mm, and PT 24.0±11.0°. SVA correlated with both standing TIA (sTIA; r=0.31, p=0.0001) and walking TIA (wTIA; r=0.42, p<0.0001). PT correlated not with sTIA but with wTIA (r=0.48, p<0.0001). SRS-Schwab PT modifier (0 for PT<20°; + for PT 20-30°; ++ for PT>30°) showed significant relationship with wTIA (6.1±3.4°; 7.4±4.3°; 10.5±6.6°, p<0.0001), LL (44.4±9.9°; 42.2±12.9°; 29.2±20.5°, p<0.0001), PI (50.6±7.9°; 55.8±7.9°; 60.9±12.7°, p<0.0001), SVA (10.1±23.1mm; 14.1±25.4mm; 51.0±46.7mm, p<0.0001), trunk muscle (780.4±237.3N; 736.5±195.9N; 643.7±224.5N, p=0.0046), and HRQOL (p=0.0031).

CONCLUSIONS: Pelvic compensation with PT++ was expressed as; 15.2° decrease in LL, 18% loss of trunk muscle power, 40.9mm forward shift in SVA, and increased wTIA equivalent to additional 13 mm of SVA at walk. Kyphogenic modification with PT++ was inconspicuous at static upright posture, and became significant at walk. SRS-Schwab classification should be weighed when treating adult spinal deformity.

GP78

02-13 PROLONGED EXPANSION OF HUMAN NUCLEUS PULPOSUS CELLS EXPRESSING HUMAN TELOMERASE REVERSE TRANSCRIPTASE MEDIATED BY LENTIVIRAL VECTOR

Deli Wang, Jianhong Wu, Dike Ruan, Qing He, Yan Zhang, Chaofeng Wang, Hongkui Xin, Department of Orthopedics, Navy general hospital, Beijing, China

INTRODUCTION: Lower back pain is a major public health problem in modern society. HNP cells can be expanded in vitro with limited life span. After serial passages in vitro, HNP cells undergo replicative senescence marked with the changes on cell morphology, gene expression, and metabolism; and eventually they also lose their ability to synthesize and secret collagen II and aggrecan. One of strategies to extend the expansion of functional HNP cells in vitro is to ectopically express human telomerase reverse transcriptase (hTERT) in HNP cells.

METHODS: To construct a L-hTERT/EGFP lentiviral transfer vector, Normal HNP tissue was obtained from a lumbar intervertebral disc of a 19-year-old man, after washing with PBS, after 12 hours, the HNP cells were harvested. Viral transduction was carried out in an incubator for overnight. We used a semi-quantitative RT-PCR to measure the expression of hTERT in lentiviral vector-transduced HNP cells. Telomerase activity and cellular telomeric length were determined. real-time PCR was used to measure Type II collagens and aggrecan expression in HNP cells. We used enzyme-linked immunosorbent assay to measure the protein levels of collagen II and aggrecan.

RESULTS: no difference of the telomere length from L-hTERT/EGFP, L-EGFP, mock-transduced HNP cells was observed. But, at day 120 and 210 post viral infection, the telomere length from L-hTERT/EGFP-transduced cells was apparently longer than
the one from bothL-EGFP- and mock-transduced cells although the telomere length from either group of cells was shorter at these time points than at day 7 post viral infection. These results suggest that ectopic expression of hTERT extended the expansion capacity of HNP cells in vitro.

**DISCUSSION:** We demonstrated that lentiviral vectors can be used to efficiently deliver hTERT gene into HNP cells and to extend these cells' expansion in vitro without the loss of their function.

**GP79**

**EFFICACY OF ANTIBIOTICS SPRAYED INTO SURGICAL SITE FOR PREVENTION OF THE CONTAMINATION IN THE SPINAL SURGERY**

Bo-Kyung Suh, 1 Seong-Hwan Moon, 2 Hwan-Mo Lee, 2 Seok Woo Kim, 3 Tae-Hwan Kim, 3 Yong Shin Kwon, 3 Moon Soo Park, 3; 1Medical Corps Unit 6878, Republic of Korea Armed Forces San 1-bunjji, Geumgok 2-ri, Beobwon-eup, Paju-si, Gyunggi-do, 413-873 Republic of Korea 2Department of Orthopaedic Surgery Yonsei University College of Medicine 250 Seongsan-ro, Seodaemun-gu Seoul 102-752 Republic of Korea 3Department of Orthopaedic Surgery Hallym University Sacred Heart Hospital Medical College of Hallym University 896, Pyeongchon-dong, Dongan-gu, Anyang-si Gyeonggi-do, 431-070 Republic of Korea

**INTRODUCTION:** Postoperative infection is one of the most devastating complications of lumbar surgery. There are few reports regarding benefits of additional intrawound application of antibiotics during the surgery. However, there is controversy on clinical effectiveness of local antibiotic installation. The purpose is to evaluate effects of intrawound application of antibiotics on preventing surgical wound contamination during instrumented lumbar surgery.

**METHODS:** Eighty-six patients underwent instrumented lumbar spinal surgery. Mean age was 65.19 years old (range 23-83 years old). There were 67 females and 19 males. During the surgery, vancomycin powder was applied into surgical site before closure in 43 patients (antibiotic group) and was not applied in 43 patients (control group). Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) were measured on the 1st, 3rd, 7th, 14th day and one month after operation. The tip of the surgical drain was cultured to evaluate surgical wound contamination. The cultures for the specimens of blood, urine, stool and sputum were performed for the identification of other origins of infection if the patient had fever.

**RESULTS:** Preoperative values of ESR and CRP did not show significant difference between the two groups. However, on the 3rd postoperative day, ESR of the antibiotic group decreased significantly more than that of the control group, while CRP did not show significant difference. We found two patients with contaminated tip culture of surgical drain in antibiotic group, and contamination in one patient in control group.

**DISCUSSION:** Intraoperative appliance of powdered vancomycin into the spinal wound did not significantly decrease the contamination of operative wound in the patients with instrumented lumbar fusion.

**GP80**

**THE PREVALENCE OF IDIOPATHIC SCOLIOSIS IN ELEVEN YEAR-OLD KOREAN ADOLESCENTS: A 3 YEAR EPIDEMIOLOGICAL STUDY**

Moon Soo Park, 1 Seong-Hwan Moon, 2 Han Jo Kim, 3, Bo-Kyung Suh, 1 Ji Hoon Nam, 1 Hwan-Mo Lee; 1 Department of Orthopaedic Surgery Hallym University Sacred Heart Hospital Medical College of Hallym University 896 Pyeongchon-dong, Dongan-gu, Anyang-si Gyeonggi-do, 431-070 Republic of Korea 2 Department of Orthopaedic Surgery Yonsei University College of Medicine 250 Seongsan-ro, Seodaemun-gu Seoul 102-752 Republic of Korea 3Spine and Scoliosis Service Hospital for Special Surgery 535 East 70th Street New York, NY, USA
INTRODUCTION: School screening enables early detection and early treatment, with the purpose of reducing the patients requiring surgical treatment. Candidates of school screening test for scoliosis are reported to be between 10 and 14 years old. The prevalence of idiopathic increased with the increased age of screened population. Therefore screening might be more effective in the younger age and the age between 11 and 12 is reported the most appropriate for school screening test. The purpose is to evaluate the epidemiological findings of idiopathic scoliosis in the eleven years-old Korean adolescents.

METHODS: A total of 37,856 eleven-years-old adolescents were screened for scoliosis. There were 17,110 girls and 20,746 boys. The adolescents who were abnormal by the Moiré topography were assessed subsequently by standardized clinical and radiological examinations. The scoliotic curve was defined as 10° or more.

RESULTS: The prevalence of scoliosis was 0.19% and most of the curves were small (10° to 19°). The ratio of boys to girls was 1:5.5 over-all. Sixty adolescents (84.5%) had single curvature. Thoracolumbar curves were the most common type of curve identified, followed by thoracic and lumbar curves.

DISCUSSION: The prevalence of idiopathic scoliosis in the eleven years-old Korean adolescents was 0.19%.

GP81
ENHANCED BONE REGENERATION EFFICIENCY OF BMP-2 WITH CONCURRENT REDUCTION OF HETEROTOPIC OSSIFICATION: EVALUATION OF A NEW BMP-2 CARRIER IN A LARGE ANIMAL MODEL OF LUMBAR INTERBODY FUSION
Ming Wang1; Sunny Akogwu Abbah2; Hu Tao1; Soo Yein Toh1; Raymond Wing Moon Lam1; James Goh1,3; Hee-Kit Wong1; 1. Department of Orthopaedic Surgery, Yong Loo Lin School of Medicine, National University of Singapore 2. Network of Excellence for Functional Biomaterials, National University of Ireland 3. Department of Bioengineering, Faculty of Engineering, National University of Singapore

INTRODUCTION: Low dose of BMP-2 delivered with heparin surface modified alginate microbeads(microbeads) has been shown to achieve consistent fusion with concurrent reduction of heterotopic ossification and seroma formation in rodent model. In the present study, this new combination was further evaluated in porcine lumbar interbody fusion model.

METHODS: L3-L6 three level interbody fusion with anterior instrumentation was performed on 6 pigs (average weight 50kg): 1)50 µg/level(n=6);2)150 µg/level(n=6);3)300 µg/level(n=6). BMP-2 was delivered by microbeads in a bioabsorbable cage. Spine specimens were harvested for fusion evaluation 3 months after surgery.

RESULTS: Manual palpation and microCT imaging demonstrated clinically consistent fusion in all three dosage groups. The quality of the fusion mass was comparable among different groups as demonstrated by bone volume/tissue volume (BV/TV) (50 µg 0.579 ± 0.108;150 µg 0.645±0.004;300 µg 0.365±0.041). However, significant thickening of the transverse process was observed on the operated side compared to the non-operated side (quantified as thickness ratio:50 µg 1.356±0.364;150 µg 1.601±0.292;300 µg 4.749±0.948) due to heterotopic ossification. Different degrees of bony overgrowth beyond the cage were also observed in all groups. But most importantly, the severity of heterotopic ossification and transverse process thickening were significantly reduced by lowering the BMP-2 dosage and superior localization was achieved in 50 µg group.

DISCUSSION: Porcine interbody fusion results supported the previous study that the
therapeutic efficiency of BMP-2 was significantly enhanced by the new carrier. Moreover, heterotopic ossification was reduced when lower dose of BMP-2 was applied. Although BMP-2 dose tested in porcine model cannot be directly translated to human usage, significant reduction of efficacious BMP-2 dosage (1/240 of the FDA approved dose) by the new carrier represents a promising strategy in spinal fusion surgery.

**GP82**

**THERAPEUTIC EFFICACY OF PREGABALIN FOR LOW BACK AND LEG PAIN ASSOCIATED WITH LUMBAR DISEASE**

Sakuma, Yoshihiro1; Ohtori, Seiji1; Inoue, Gen2; Yamauchi, Kazuyo1; Orita, Sumihisa1; Kamoda, Hiroto1; Miyagi, Masayuki1; Ishikawa, Tetsuhiro1; Arai, Gen1; Suzuki, Miyako1; Oikawa, Yasuhiro1; Kubota, Go1; Image, Kazuhide1; Saino, Takeshi1; Satoh, Jun1; Na; Dept. of Orthopaedic Surgery, Graduate School of Medicine, Chiba University1 Dept. of Orthopaedic Surgery, Kitasato University, School of Medicine2

**INTRODUCTION:** Pregabalin(PGB) is increasingly used in Japan to treat neuropathic pain. However, few reports have described its effect in treating the neuropathic pain of lumbar disease. The purpose of this retrospective study was to evaluate the efficacy and tolerability of PGB for low back and leg pain in patients with lumbar disease.

**METHODS:** Between Dec 2010 and Dec 2011, 171 patients (88 males, 83 females) mean age, 68.5 years (range, 20-91 years) were prescribed PGB to treat low back and leg pain associated with lumbar disease, including lumbar spinal canal stenosis, disk herniation, spondylolisthesis, and compression fractures. The starting dose was 25 mg once daily or 50 mg twice daily. If there was no effect, the dose was increased in increments of 25 mg. Visual analog scale (VAS) pain scores were investigated. Patients were divided into two groups: those under 64 years (the younger group) and those more than 65 years (the elderly group).

**RESULTS:** Pain improvement was observed in 67 patients (39.1%): in the younger group, 28 of 64 cases (43.6%); in the elderly group, 39 of 107 cases (36.4%). The mean VAS scores were 70-21 mm in the younger group and 83-35 mm in the elderly group. The mean dose at which pain improvement was seen was 98.9 mg (range, 25-300 mg):113.8 mg in the younger group; 102.6 mg in the elderly group. Side effects occurred in 26 patients (15%). The frequency of side effects was 17.2% in the younger group and 15.9% in the elderly group. The most common side effect was vertigo, and in 16 patients discontinued due to side effects. No significant differences in pain improvement or side effect frequency were seen between groups.

**DISCUSSION:** PGB provided acceptable pain relief in 40% of patients with lumbar disease. While the reported frequency of side effects is typically 30%, we observed lower rates, suggesting the benefit of using a low starting dose of PGB.

**GP83**

**EFFECTIVENESS OF OUTPATIENT MYEOGRAPHY FOR PATIENTS WITH LUMBAR DISEASE**

Sakuma, Yoshihiro1; Ohtori, Seiji1; Inoue, Gen2; Yamauchi, Kazuyo1; Orita, Sumihisa1; Kamoda, Hiroto1; Miyagi, Masayuki1; Ishi-
INTRODUCTION: In Japan, myelography is generally performed during hospitalization for spinal surgery and is associated with substantial medical expenses and other problems. However, few studies have investigated the usefulness of performing myelography in the outpatient setting in Japan. The aim of this study was to investigate outpatient myelography in more detail and compare it with inpatient examinations.

METHODS: Between Aug 2011 and May 2012, 30 patients (13 men, 17 women) mean age, 64 years; (age range, 14-81 years) underwent myelography before surgeries associated with lumbar disease. Depending on the mode of examination, the patients were divided into the outpatient and inpatient group. During myelography, intravenous drip replacement was performed for all patients. A 22 gauge spinal needle was used along with 10 ml of Omnipaque-240 as the contrast medium. While outpatients rested for 30 minutes following the examination before returning home, inpatients underwent the examination during hospitalization and were discharged the following day. The occurrence of adverse events including headache, the expenses involved, and patient satisfaction were recorded using a questionnaire and compared between the 2 groups.

RESULTS: There were 21 and 9 patients in the outpatient and inpatient groups, respectively. Adverse events were observed in 4 cases (19%) in the outpatient group and 1 case (11%) in the inpatient group. The average expenditure was approximately 104 dollars and 142 dollars in the outpatient and inpatient groups, respectively. Patient satisfaction was generally good in both groups, with 7 inpatients (76%) and 16 outpatients (78%) reporting satisfaction.

DISCUSSION: The incidence of adverse events in this study population was similar to that in other reports, and patient satisfaction in both groups was generally good. Furthermore, outpatients paid approximately 40 dollars less, thus indicating that outpatient examinations are associated with lower medical cost.

GP84
STUDY OF THE FACTORS AFFECTING THE LUMBOSACRAL FLEXIBILITY
Masaki Imuta, Naoki Ishigaki, and Takato Aihara; Funabashi Orthopedic Hospital, Funabashi-city, Japan

INTRODUCTION: The purpose of this study was to determine the factors affecting the lumbosacral flexibility (LF).

METHODS: Thirty-one male without a previous lumbar nor hip disorder (mean age, 24.8±1.85 years) were included in this study. All subjects were provided informed consent and the study was approved by our institutional review board. LF was evaluated using the modified Schober’s test (MST: Fig.). We measured the hardness of three muscles (Fig.), distance from fingertips to floor at maximal flexion position to evaluate the flexibility of the lower leg and the trunk, straight-leg raising angle to evaluate the flexibility of the hamstrings, and flexion angle of the hip joint (FAH). All measurements were repeated three times and averaged. Bivariate Pearson’s product-moment correlations were used to determine the relationship between the MST and the other six measurements. Objective variable was MST and explanatory variables were the other six measurements. Multiple linear regression analysis (MA) was conducted with stepwise procedure. A P value <0.05 was considered statistically significant.
RESULTS: Mean value of MST was 6.2±0.9 cm. There was a negative correlation between the values of MST and the hardness of both sides of the thoracic longissimus muscle (TLM, hard side: r = -0.556 and soft side: r = -0.368). There was a positive correlation between the values of MST and the both sides of FAH (small side: r = 0.557, large side: r = 0.444). From the result of MA, the hardness of the hard side of TLM and the small side of the FAH were the factors affecting the LF.

DISCUSSION: From the results of this study, we think that the hard TLM directly restricts the lumbosacral flexibility, and the small FAH was caused by the hardness of the gluteus maximus muscle in young adult which restricts the anterior inclination of pelvis and can lead to the restriction of LF. Therefore, it is important to evaluate and treat the hardness of TLM and FAH for LF.

GP85
THE TOTAL CARE INCLUDING A PRONE EXERCISE AND DIET THERAPY IN LOW BACK SCHOOL WAS EFFECTIVE FOR THE IMPROVEMENT OF THE PHYSICAL AND THE PSYCHOSOCIAL PROBLEMS IN THE ELDERLY PATIENTS WITH CHRONIC LOW BACK PAIN.
Katsuhiro Sato, Yasufumi Sekiguchi; Dept. of Orthopaedic Surgery, Ohara General Hospital, Fukushima, Japan

INTRODUCTION: The elderly people having low back pain increase with the advent of an aged society in Japan. The feature is that the low back pain of the elderly person is accompanied by the spinal kyphosis with intervertebral disc degeneration, back muscle weakness, a lack of proper nutrition, and venous stasis of the lower part of the body due to the disturbance of venous return associated with cardiac dysfunction and the lower limbs muscle atrophy. For the low back pain of such an elderly person, exercise therapy and appropriate diet therapy are required. We devised a prone exercise lying on the bed for the low back pain of the elderly person newly. We introduce our method and report the intervention effect.

METHODS: The subjects consisted of 43 patients having chronic low back pain with the degenerative disease in 70 years old or more (38 women, 5 men). In the low back school, the patients were educated mechanisms of the low back pain, the theory of exercise therapy, and how to get nourishment. The patients carried out a prone exercise and a diet therapy by oneself under the instruction every day for two months. The physical measurement and the evaluation (VAS and JOABPEQ) of the low back pain were performed before and after the intervention. Changes between before and after the intervention were evaluated statistically.

RESULTS: As for the weight and the BMI, there was a significant difference. The power of back muscle was significantly increased after intervention, and the improvement of the posture was accepted, too. However, there was no difference in the pain (VAS). As for JOABPEQ, there was a significant improvement in the criteria of social life and psychological disorder.

DISCUSSION: This study indicated that a prone exercise was useful for the physical improvement of the elderly person. And, the possibility that the total care may improve the social life and the psychosocial problem of the elderly with low back pain was shown.
GP86
CAN BE ABI IN THE LUMBAR SPINAL STE- 
NOSIS DIAGNOSIS SUPPORT TOOL SUBSTI- 
tuted by palpation of posterior tibi- 
al artery? - A MULTICENTER CROSS- 
SECTIONAL STUDY (DISTO-PROJECT) 
Takuya Nikaido1, Miho Sekiguchi1, Koji 
Yonemoto2, Kazuyuki Watanabe1, Kinshi 
Kato1, Koji Otani1, Tatsuyuki Kakumo2, Sho- 
ji Yabuki1, Shin-ichi Kikuchi1, Shin-ichi Kon- 
no1, and DISTO-project working group; 
1Department of Orthopaedic Surgery, Fuku- 
shima Medical University School of Medi- 
cine 2Biostatistics Center, Kurume Universi- 
ty

INTRODUCTION: Intermittent claudication is a common symptom of both lumbar spinal stenosis (LSS) and peripheral arterial disease (PAD) in middle-aged and elderly people. The ankle brachial pressure index (ABI) measurement is required to exclude PAD with the Lumbar Spinal Stenosis Diagnosis Support Tool (LSS-DST) which the Japanese Society for Spine Surgery and Related Research developed (Konno S et al, 2007). However, all doctors may not measure ABI exactly in outpatient department. The purpose of this study is to clarify whether ABI measurement in LSS-DST can be substituted by posterior tibial artery palpation.

METHODS: This study enrolled subjects who were 50 and over from the survey of lumbar spinal stenosis diagnosis support tool (DIS- 
TO)-project in 2,177 hospitals and general practices nationwide. We compared the sensitivity and specificity of the diagnosis of LSS by the LSS-DST (28,883 effective number of cases) and by the method that substituted by posterior tibial artery palpation in ABI measurement of the LSS-DST (26,998 effective number of cases).

RESULTS AND DISCUSSION: Sensitivity 88.2% of LSS diagnosis by LSS-DST, the specific- ity was 83.9%. By the method that substituted by posterior tibial artery palpation in ABI measurement, for as 87.7% of sensi-
tivity, the specificity was 78.3%. From the above results, it was shown that the sensitivity and specificity of the diagnosis of LSS by the LSS-DST and by the method that substituted by posterior tibial artery palpation in ABI measurement of the LSS-DST are approximately equal. Therefore in LSS-DST, ABI measurement can be substituted by posterior tibial artery palpation, and it may be said that it is useful as a screening tool for LSS. The burden of the doctor reduces by substituting by posterior tibial artery palpation instead of ABI measurement and can expect the further spread of LSS-DST.

GP87
THE PREVALENCE AND RELATED FACTORS 
OF LUMBAR LESION IN RHEUMATOID AR- 
THRITIS PATIENTS 
Akinobu Suzuki, MD., PhD., Hiroyuki Yasuda, 
MD., PhD., Kentaro Yamada, MD., PhD., 
Shinji Takahashi, MD., PhD., Hidetomi Terai, 
MD., PhD., Hiromitsu Toyoda, MD., PhD., 
Hiroaki Nakamura, MD., PhD.; Department 
of Orthopaedic Surgery, Osaka City Universi- 
ty Graduate School of Medicine

INTRODUCTION: Rheumatoid arthritis (RA) involves not only peripheral joints but also spine. Many previous studies have demonstr- 
ated high prevalence of cervical lesion in RA patients, however, lumbar lesion in RA has not well studied. The purpose of this study is to investigate the current prevalence of lumbar lesion in RA patients and to clarify the related factors of the lesion.

METHODS: Between September 2010 and June 2011, 201 patients who fulfilled the revised criteria of the American Rheuma- 
tism Association were recruited and includ- 
ed in this study. We examined radiographs and magnetic resonance images (MRI), and collected clinical data with regard to RA. Low back pain was assessed by visual analog scale (VAS). Lumbar lesion including degenerative lumbar spondylothesis (DLS), lumbar spondylolisthesis (LS) and vertebral fracture
(VF) was evaluated on plain X-ray, and the disc degeneration and endplate erosion were evaluated on MRI. Multiple logistic regression analysis was performed to investigate the related factors with the lumbar lesion.

RESULTS: The prevalence of DLS, LS and VF were 34.8%, 31.8% and 16.4% respectively. At least one lesion was found in 56.7% of the patients. VAS of low back pain was significantly higher in the patient with lumbar lesions than without. Multiple logistic regression analysis revealed that age, disc degeneration, and endplate erosion are the related factors of lumbar lesion.

DISCUSSION: The result of the present study revealed that the prevalence of lumbar lesion, especially DLS and LS, was high in RA patients compared to that previously reported in elder general population. The result of multivariate analysis suggests that endplate erosion in addition to age related factors synergistically affect the high incidence of lumbar lesion in RA patients.

GP88

COMPARISON OF THE EFFICACY OF SPINAL NERVE ROOT INfiltrATION FOR LUMBAR FORAMINAL STENOSIS AND LUMBAR CANAL STENOSIS

Takaaki Tanno 1; Hiromi Ataka 1; Tomohiro Miyashita 2; Kei Kato 2; 1 Matsudo Orthopaedic Hospital, Spine Center, Chiba, Japan; 2 Matsudo City Hospital, Spine Center, Chiba, Japan

OBJECTIVE: lumbar foraminal stenosis (LFS) is sometimes difficult to differentiate from central lumbar canal stenosis (LCS), even using modern imaging technology. To characterize the clinical features of LFS, we compared the efficacy of spinal nerve root infiltration (NRI) for radicular symptoms caused by LFS and LCS.

MATERIALS AND METHODS: Thirty consecutive cases of LFS (L5/S1 lesion, LFS group) with L5 radicular symptoms treated by NRI since April 2009 were reviewed and compared with 63 cases of LCS (L4/5 lesion, LCS group). There was no statistical difference in sex, mean age at the time of treatment, and RDQ score before treatment between the two groups. NRI was repeated upon patients’ request, and the number of treatments noted. The efficacy of NRI was investigated for at least 2 months after final NRI. The efficacy of NRI was classified into three grades as follows: excellent, pain scale 0–2 (10 being the most severe symptoms before NRI) or no need for analgesic medication; good, pain scale 3–6 or less need for medication; and poor, pain scale 7–10 or continuous need for medication. Results: In the LFS group, the mean number of NRI treatments was 2.8 (range, 1 to 5), in LCS group was 2.7 (range, 1 to 6). There was no relationship between the treatment frequency and efficacy in either group. The efficacy for the LFS group was: excellent, 8 cases (27%); good, 6 (20%), and poor, 16 (53%), 14 of 16 poor cases required surgical treatment. The efficacy for the LCS group was: excellent, 37 cases (59%); good, 18 (28%); and poor, 8 (13%). The efficacy of NRI for the LFS group was significantly lower than for the LCS group (P < 0.005).

CONCLUSION: NRI was less effective for radicular symptoms caused by LFS, compared with LCS. In the LFS group, the poor outcome was more than 50%, although NRI was markedly effective in the LCS group. Therefore, the evaluation of the efficacy of NRI provides useful guidance to avoid missing lesions of LFS.

GP89

SURVIVAL PROGNOSIS OF SYMPTOMATIC AND ASYMPTOMATIC SPINAL METASTASES BY USE OF TOKUHASHI AND TOMITA SCORES: A RETROSPECTIVE ANALYSIS OF 266 PATIENTS.

Kawai Takuya1), Aota Yoichi1), Yamashita Takayuki3), Kono Motonori1), Niimura Takanori1), Thomas E. Mroz3), Isador H.
GENERAL POSTERS

INTRODUCTION: Most patients with spinal metastasis have a limited life expectancy. Therefore, survival prognosis at an early time is desirable to consider their future treatment strategies in advance. Prognosis systems of Tokuhashi and Tomita for patients with spinal metastases are widely used. However, these systems were formulated by analyzing only symptomatic cases who required surgery or anticipated for early death. The purpose of this study is to correlate the Tokuhashi and Tomita Scores with patients with spinal metastases including asymptomatic cases.

METHODS: A total of 266 patients with spinal metastases detected on MR images or bone scans was retrospectively analyzed. The Tokuhashi and Tomita Scores at detection of their spinal metastases and survival period from detection were reviewed. Patients were divided into 3 Tokuhashi and 4 Tomita prognostic groups according to both total scores and survival rate in each group was analyzed. Univariate and multivariate analyses were performed to analyze the relationship between survival period and 6 categories of the revised Tokuhashi Score. Results: At the latest follow-up, 200 patients died, while 66 were alive. The median survival period was 10.1 months. Kaplan-Meier curves revealed significant differences in the mean survival period among Tokuhashi 3 groups (p<0.05). There was significant differences among Tomita 4 groups (p<0.05), except that survival rate in short-term group was higher than that in middle-term group. Both Scores were moderately correlated with the actual survival period (Tokuhashi: p<0.05, r=0.57, Tomita: p<0.05, r=0.51). Multivariate analysis revealed that only performance status, visceral metastases, and primary site of the cancer were significantly associated with survival period (p<0.01).

CONCLUSION: In assessment of life expectancy for patients with spinal metastases including asymptomatic cases, the revised Tokuhashi Score system is likely to be better than Tomita’s system.

GP90
IMPACT OF THE GLUTEAL MUSCLES STRETCH ON LUMBAR REGION
Ryousuke Mochizuki, Naoki Ishigaki, and Takato Aihara; Funabashi Orthopedic Hospital, Funabashi-city, Japan

INTRODUCTION: In our daily practice, when we could not directly treat lumbar region for patients with low back pain because of the posture and severe pain, we often experienced that their low back pain decreased by gluteal muscles stretch. The purpose of this study was to assess the impact of the gluteal muscles stretch on lumbar region.

METHODS: Forty-two subjects without a previous and present lumbar and hip disorder were included in this study. All subjects were provided informed consent, and the study was approved by our institutional review board. They were allocated to either the stretch group (S group: n=23) or the control group (C group: n=19). First, for the purpose of loading on the right low back, all subjects were performed the two sets of 1 minute exercise: four-point kneeling with left arm and right leg extension (Fig.). Then, we measured the lumbar multifidus muscle hardness (MH1) at the point of 2 cm towards the lateral from the tip of the L4 spinous process using the muscle hardness meter. Secondly, the subjects in the S group were performed the five sets of 30 seconds gluteal muscles stretch (Fig.) and the subjects in the C group were performed the 5 minutes rest at supine position. Then, we
remeasured the lumbar multifidus muscle hardness (MH2) at the same point of the former. The muscle hardness was measured five times independently and averaged. All measurements were statistically compared between MH1 and MH2, and between S and C groups.

RESULTS: MH2 was significantly lower than MH1 in the S group (Fig.). MH2 was significantly lower in the S group than in the C group (Fig.).

DISCUSSION: From the results of this study, lumbar multifidus muscle hardness was significantly decreased after the gluteal muscles stretch. We think this is because, with the gluteal muscles stretch, we could stretch the piriformis muscle, and could lead to decrease the tonus of the lumbar multifidus muscle through the sacrum.

GP91
DOES THE MORPHOLOGY OF THE FACET JOINT AFFECT UNILATERAL SPONDYLOLYSIS?
Hayato Ishitani, Naoki Ishigaki, Ryosuke Mochizuki, and Takato Aihara; Funabashi Orthopedic Hospital, Funabashi-city, Japan

INTRODUCTION: There have been few reports concerning the morphology of the facet joint associated with unilateral spondylolysis. This study was undertaken to determine whether the morphology of the facet joint contributes to unilateral spondylolysis.

METHODS: Thirty-six junior athletes (JA) with low back pain were reviewed. They were classified into two groups according to CT and MRI: S group (18 JA [13 males and 5 females] with L5 unilateral spondylolysis); and C group (18 JA [12 males and 6 females] without spondylolysis and finally, their low back pain disappeared). The ages of the S and C groups ranged from 12 to 17 years and from 11 to 18 years, respectively, showing no significant differences between them. Using multislice CT, the same observer measured the sagittal orientation of the L4/5 and L5/S1 facet joint angles from the axial sections. In the C group, there was no significant difference between the left and right measurements, therefore, all of the measurements were given as the mean of them. Facet joint angles were statistically compared using Tukey’s test for differences among the spondylolysis side (SS) and the other side (OS) in the S group, and normal side (NS) in the C group.

RESULTS: The L4/5 facet joint angles were significantly more coronally orientated in SS than in NS (P=0.006), and were more coronally orientated in OS than in NS (P=0.051) (Fig.). There were no significant differences between SS and OS concerning the L4/5 facet joint angles, and among the three groups concerning the L5/S1 facet joint angles (Fig.).

**Fig.** Facet Joint Angles (Degrees)

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<tr>
<th></th>
<th>NS</th>
<th>OS</th>
<th>SS</th>
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<tr>
<td>L4/5</td>
<td>46.5±7.8</td>
<td>52.4±6.7</td>
<td>54.4±7.5</td>
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<tr>
<td></td>
<td><em>P=0.006</em></td>
<td><em>P=0.003</em></td>
<td><em>P=0.005</em></td>
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<tr>
<td>L5/S1</td>
<td>52.1±9.8</td>
<td>53.7±9.6</td>
<td>55.9±10.7</td>
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<tr>
<td></td>
<td><em>P=0.103</em></td>
<td><em>P=0.710</em></td>
<td><em>P=0.308</em></td>
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<table>
<thead>
<tr>
<th></th>
<th>NS = normal side in the C group</th>
<th>OS = the other (normal) side in the S group</th>
<th>SS = spondylolysis side in the S group</th>
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<tr>
<td></td>
<td>* = statistically different between NS and OS</td>
<td>* = not significant</td>
<td>* = statistically different between NS and SS</td>
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162
DISCUSSION: We think that a more coronal orientation of the L4/5 facet joint is likely to increase the point loading through the L5 pars interarticularis in extension and rotation. Therefore, if a subject has coronally orientated L4/5 facet joint, spondylolysis at L5 may be occurred on the more coronally orientated side, and the other coronally orientated side may be the risk of L5 spondylolysis.

GP92
VALIDATION OF A DIAGNOSTIC SUPPORT TOOL FOR LUMBAR SPINAL CANAL STENOSIS FOR OSTEOARTHRITIS OF THE HIP
Morimoto T, Tsukamoto M, Yoshihara T, Sonohata M, Mawatari M; Department of Orthopedic Surgery, Faculty of Medicine, Saga University

INTRODUCTION: A diagnostic support tool (DST) for lumbar spinal stenosis (LSS) based on a self-administered questionnaire was recently developed (Konno 2007). Since LSS and osteoarthritis of the hip (OAH) demonstrate similarities in terms of the affected age group and the initial symptoms, both diseases may often lead to a mistaken diagnosis. The purpose of this investigation was to evaluate the predictive value of the DST in patients with OAH

METHODS: The subjects included in this study consisted of 108 patients with OAH who were treated by total hip arthroplasty (THA) (14 males and 94 females; average age 61 years, range: 36-88). The hip intensity was evaluated using a numerical rating scale (NRS). We applied the DST to these patients preoperatively and two months after the operation. The paired t-test was used to identify changes in the DST before and after THA and the correlations between parameters were evaluated by a regression analysis. A value of P< 0.05 was considered to be significant.

RESULTS: The positive rate for the DST was 33% (36 patients) preoperatively and 8% (nine patients) at two months after THA (P <0.05). The correlation coefficient between the DST and NRS preoperatively was 0.332 (P<0.001).

DISCUSSION: The positive rate for the DST in OAH patients decreased from 33% preoperatively to 8% at two months after THA, because THA could improve the clinical symptoms of OAH. Therefore, the reason why the positive rate for DST was 33% preoperatively may not be the high coexistence rate of LSS in patients with OAH, but the similarities of the clinical findings of both diseases as a lower leg pain. As a result, if this DST is applied to patients with OAH, then 33% of the OAH patients may be considered to have LSS. This finding suggests that OAH should be included in the differential diagnosis of LSS.

GP93
INITIAL DIAGNOSIS OF RUPTURED ABDOMINAL AORTIC ANEURYSM AND RUPTURED INFECTED ABDOMINAL AORTIC ANEURYSM WITH LUMBAGO
Morimoto T, Tsukamoto M, Yoshihara T, Sonohata M, Mawatari M; Department of Orthopedic Surgery, Faculty of Medicine, Saga University

INTRODUCTION: An infected abdominal aortic aneurysm (IAAA) is a rare and potentially fatal, but poorly recognized, disease. However, the reports of IAAA have been increasing in recent years due to the aging of society and increase in compromised hosts. It has been reported that IAAA, as well as ruptured abdominal aortic aneurysm (AAA), can present as lumbago, and the diagnosis was usually missed in the early stages in these cases. However, few papers have investigated the incidence of lumbago and the participation of orthopedists in the diagnosis of both diseases. The objective of this study was to determine the accuracy and frequency of diagnosing of IAAA and AAA with lumbago.
**METHODS:** The medical records of patients with IAAA (n=3, all male, average age 72 years old) and AAA (n=37, 24 males and 13 female, average age 70 years old), the diagnosis of which was confirmed by surgery from 2000 to 2010 were reviewed.

**RESULTS:** The initial symptoms were lumbago, abdominal pain, consciousness disorder, and vital shock in 100%, 33%, 0%, 0% of IAAA cases, and in 44%, 60%, 15%, 22% of AAA cases, respectively. The frequency of the initial examination being performed by orthopedists and the diagnostic accuracy rate by orthopedists were 3% and 100% in AAA cases, 100% and 0% in IAAA cases. The misdiagnoses of IAAA were degenerative spondylosis, lumbago and cholecystitis.

**DISCUSSION:** All IAAA cases presented with lumbago without consciousness disorder or shock vital as the primary symptom, which was less severe than AAA. Therefore, all IAAA cases were initially examined by orthopedists, and all were misdiagnosed. These results suggest that orthopedists played an important role in the diagnosis of cases of IAAA, and that elderly and compromised patients with lumbago should be rapidly investigated and treated IAAA if IAAA is a likely possibility.

**GP94**

**TOTAL DISC REPLACEMENT IN THE TREATMENT OF RECURRENT LUMBAR DISC HERNIATION**

*Nan Kang, Yong Hai, Shibao Lu, Qingyi Wang, Chao Kong; China*

**OBJECTIVE:** To evaluate Biomechanical benefits of Total Disc Replacement (TDR) including both the restoration of normal segmental range of motion and the prevention of physiological lumbar lordosis encourage spine surgeons to perform TDR for recurrent lumbar disc herniation.

Methods: A total of twenty first patients (mean age: 44) who had recurrent lumbar disc herniation were operated on between 2000 and 2008. Anterior lumbar discectomy with TDR placement via a extraperitoneal approach were performed. Each patient was evaluated using a VAS and the Oswestry index. Clinical and radiographic results of these patients were evaluated at each follow-up time(1, 3, 6, 12, 24 months after operation and the latest).

**RESULTS:** The average visual analogue scales score for pain was 9.40 before operation, changed to 4.30 one month after operation, further declined to 2.70 two years after operation and finally to 1.90 at the latest follow-up evaluation (P < 0.001). Meanwhile, the average Oswestry Disability Index was 50.8 before operation, 29.6 one month after operation, 13.5 two years after operation and 9.2 at the latest follow-up evaluation (P < 0.001). All operated levels maintained mobile and there was no significant loss of range of motion observed. Complications such as implant dislocation or significant subsidence of the prosthesis occurred in none case of this group. 96% patients were satisfied with the surgery at the latest follow-up evaluation.

**CONCLUSIONS:** Results from this series are promising and indicate that placement of TDR for recurrent lumbar disc herniation is a valuable alternative to conventional techniques. The main advantages of this application are preservation of spinal stability, early mobilization, restoration of normal segmental range of motion and elimination of problems related to intervertebral disc tissue such as discogenic pain and recurrence of disc herniation.

**METHODS:** We performed an observational study of patients undergoing fluoroscopy-guided L5 TFESI in the prone position. A total of 80 patients (40 men and 40 women) with radiating pain of lower limbs were enrolled. During TFESI, we measured the angle that the L5 vertebral body forms the rectangular shape and compared between men and women. Then, we measured area of
safe triangle in tilting angle of fluoroscopy from 15. to 35. and compared between men and women.

RESULTS: The mean cephalo-caudal angle, where the vertebral body takes the shape of rectangle, was 11.0° in men and 13.9° in women. (P=0.007). In men, it was 18.3 mm² at an oblique view angle of 25°, being the greatest. In women, it was 23.6 mm² at an oblique view angle of 30°. At an oblique view angle of 30° and 35°, the area was significantly greater in women (P<0.05).

DISCUSSION: This results might be due to a difference in the anatomy of the pelvis between men and women. It can be inferred that the TFESI might be more advantageously used in women as compared with men because the vertebral body cannot be masked by the iliac crest and the area of the target site is greater at a higher degree. Conclusively, when TFESI is performed at the L5 region in the prone position, it would be most reasonable that fluoroscopy is placed at cephalo-caudal angle of 11.0° and an oblique angle of 25° in men, cephalo-caudal angle of 13.9° and an oblique angle of 30° in women.

GP95

SURVIVAL PROGNOSIS IN SYMPTOMATIC AND ASYMPTOMATIC PATIENTS WITH SPINAL METASTASES BY USE OF THE REVISED TOKUHASHI SCORE


INTRODUCTION: Predicting survival for patients with spinal metastases at early time is desirable to consider their treatment strategies. The revised Tokuhashi Score is widely used mainly for symptomatic patients who require surgery, while there are no reports regarding the relationship between the Tokuhashi Score and asymptomatic cases. The purpose of this study is to correlate the revised Tokuhashi score with symptomatic and asymptomatic patients with spinal metastases.

METHODS: A total of 266 patients with spinal metastases detected on MR images or bone scans was retrospectively analyzed. They were classified into symptomatic patients (group A: 187 cases) and asymptomatic ones (group B: 79 cases). The Tokuhashi Score at detection of their spinal metastases and survival period from detection were reviewed. According to the total score (TS), patients in both groups were stratified into 3 categories (TS: 0-8, 9-11, 12-15) and survival rate in each category was analyzed. The Spearman’s correlation coefficient between total Tokuhashi Score and survival period was calculated in both groups.

RESULTS: The mean total Tokuhashi score at diagnosis was 7.8 points in Group A and 9.0 in Group B (p<0.05). At the latest follow-up, 146 patients died and 41 were alive in Group A, while 49 patients died and 30 were alive in Group B. The median survival period was 7.4 months in Group A, 23.4 months in Group B (p<0.05). Kaplan-Meier curves revealed significant differences in the mean survival period among three categories in both groups (p<0.05). The total score was significantly correlated with the actual survival period in both groups. (Group A: p<0.05, r=0.58, Group B: p<0.05, r=0.48)

DISCUSSION: So far, there has been no study analyzing survival in asymptomatic cases with spinal metastases. This study revealed the revised Tokuhashi Score was significantly correlated with survival period in asymptomatic patients as well as symptomatic ones.
**GP96**

**TRANSVERSE PROCESS AND NEEDLES OF MEDIAL BRANCH BLOCK TO FACET JOINT AS LANDMARKS FOR ULTRASOUND-GUIDED SELECTIVE NERVE ROOT BLOCK**

Yongsoo Choi MD, Dahee Kim MD; Department of Orthopaedic Surgery, Kwangju Christian Hospital, Gwangju, Korea

**INTRODUCTION:** This study evaluated the usefulness of longitudinal view of transverse process and needles for medial branch block as landmarks under ultrasonography.

**METHODS:** We performed selective nerve roots block for 96 nerve roots in 61 patients under guidance of ultrasound. A curved probe was used to identify the facet joints and transverse processes. Identifying the lumbar nerve roots under skin surface and ultrasound landmarks, the cephalad and caudal medial branch blocks were undertaken under transverse view of sonogram first and a needle for nerve root block was inserted between the two transverse processes under longitudinal view while estimating the depth with the needles for medial branch block. Then we injected 1.0ml of contrast medium and checked the distribution of the nerve root with C-arm fluoroscopy to evaluate the accuracy. The visual analog scale (VAS) was used to access the clinical results.

**RESULTS:** Seven SNRBs were performed for the L2 nerve root, 15 for L3, 49 for L4, and 25 for L5 respectively. 86 SNRBs (89.5%) showed successful positioning of the needles. We failed one case for the L2 nerve root, 2 for L3, 3 for L4, and 4 for L5. The failed needles positioned at wrong leveled segments in 4 cases and inappropriate place in 6 cases. VAS was improved from 7.6±0.6 to 3.5±1.3 after the procedure.

**DISCUSSION:** A needle, which was the same length with the needles for medial branch block, for selective nerve root block was inserted between the two transverse processes under longitudinal view with the same angle of the needles for medial branch block as short axis out of plane approach. To conform for final depth of the needle, it is possible to get an image for motion echo of final needle tip in ultrasound by small movement of the needle tip. For SNRB in lumbar spine, transverse processes under longitudinal view as ultrasound landmark and the needles of medial branch block can be a promising guidance.

**GP97**

**APPLICATION OF ELECTRIC NERVE STIMULATOR FOR LUMBAR TRANSFORAMINAL EPIDURAL BLOCK**

Yongsoo Choi, MD, ChaeHyun Lim, MD, Dahee Kim, MD; Department of Orthopedic Surgery, Kwangju Christian Hospital, Gwangju, Korea

**INTRODUCTION:** The nerve stimulation of nerve roots can recreate the symptoms in the middle of procedure, and can therefore identify the level involved with radicular pain. However, how much amplitude is enough has not been adequately determined. The purpose of this study is to evaluate the clinical feasibility of electric nerve stimulator in lumbar transforaminal epidural block (TFEB).

**METHODS:** Using an electric nerve stimulator, the TFEB were performed in 103 segments among 49 patients who presented with lower back pain with radiating pain to lower extremities. After positioning an insulated needle at the intervertebral foramen under fluoroscopic guidance, contrast medium was injected to delineate the nerve root. Then, the nerve root was electrically stimulated with the insulated needle to confirm whether or not the same radiating pain was evoked.

**RESULTS:** Of the 103 foraminal segments, the same radiating pain was evoked at 0.5 mAh in 49 (47.6%), at 1.0 mAh in 20(19.4%), at 1.5 mAh in 3(2.9%), at 2.0 mAh in
17(16.5%), and at 3.0 mAh in 5 segments (4.9%). No response was observed in 9 segments (8.7%). The patients evoked the radiating pain over 2.0 mAh, fluoroscopy revealed successful positioning of the needle. Visual analogue scale (VAS) for pain improved from a mean of 7.5 to 2.7 after the block (p=0.001). In the 9 cases without response to electrical stimulation, the patients also showed improvement of VAS, from 7.8 to 3.4 (p=0.008).

**DISCUSSION:** There were many studies to establish the relationship between evoked responses and the needle tip-nerve distance. According to our results, the patients evoked the radiating pain over 2.0 mAh for successful TFEB as a safety zone, fluoroscopy revealed successful positioning of the needle. Nerve stimulator can help to predict the accuracy of needle positioning as a supplemental aid for a successful lumbar transforaminal epidural block. It is enough to initiate proper stimulation amplitude of the nerve at 2 mAh.

**GP98 ARE HIGH-HEEL SHOES ASSOCIATED WITH DISC DEGENERATION?**


**INTRODUCTION:** Although high-heeled shoes seem to be related with body posture, most studies report static posture analysis. And few include the consideration of life-style and occupation. It remains unclear whether women wearing high-heeled shoes during their day-time may progress sagittal imbalance and disc degeneration or not. We investigated the changes of global sagittal balance, pelvic parameters, and disc degeneration using standing lateral radiographs and MRI in women who frequently wear high-heeled shoes.

**MATERIALS AND METHODS:** Our survey asked women, who work in our hospital and visit our out-patient clinics for medical reasons, about their use of high-heeled shoes. Among them, we chose women between the ages of 20 and 35 who has not suffered from back pain or radiculopathy. A total of 18 patients who had worn high-heeled shoes for more than 5 hours a day, more than three times a week, and more than 3 years (H group) were compared with a control group who had not worn high-heeled shoes. The changes of global sagittal balance and pelvic parameters were examined through standing lateral radiographs. The difference of disc degeneration was compared using Pfirrmann grading system in MRI.

**RESULTS:** The C7 plumb line of H group was located more anteriorly than that of control group (P<0.001). The pelvic incidence (PI) between two groups was not statistically different. The pelvic tilt (PT) in H group was increased and the sacral slope (SS) in H group was decreased compared with control group, but not statistically significant. Pfirrmann grading system showed that disc degeneration was more aggravated in H group (P<0.001).

**DISCUSSION:** As previous reports show that high-heeled shoes seem to be related with body posture in static state, women who wear high-heeled shoes during their day-time for a long period have the changes in sagittal balance and degrees of disc degeneration.

**GP99 PROSPECTIVE STUDY OF SUPERIOR CLUNEAL NERVE DISORDER AS A POSSIBLE CAUSE OF LOW BACK AND LEG PAIN**

Hiroshi Kuniya, MD*, Yoichi Aota, MD**, Takuya Kawai, MD**, Kanichiro Kaneko, MD*, Tomoyuki Konno, MD*, Tomoyuki Saito, MD*; *Department of Orthopaedic Surgery, Yokohama City University Graduate School of Medicine, Yokohama, Japan
**Department of Spine center, Yokohama Stroke and Brain Center, Yokohama, Japan**

**INTRODUCTION:** Although superior cluneal nerve (SCN) can become spontaneously entrapped under fascia over iliac crest, previous surgical reports were very few and limited to a small number of subjects with low back and/or buttock pain. Trescot in 2003 stated in a review of interventional pain management that cluneal neuralgia is more commonly the result of an entrapped nerve than a nerve injury during iliac crest bone harvest and this clinical entity may be underdiagnosed and should be considered as a potential cause of chronic low back pain (LBP) or leg pain. The purpose of this prospective study was to elucidate the prevalence of SCN disorder and to evaluate the outcomes of trigger point injection.

**METHODS:** A total of 820 consecutive patients suffering from LBP and/or leg pain who visited authors’ spine clinic were registered. SCN disorder was suspected when; 1) The maximal tender point was on the posterior iliac crest 70 mm from the midline, and 2) Palpation of the maximal tender point reproduced their chief complaint. For all patients with suspicion of SCN disorders, trigger point injection was done with 5ml of 1% lidocaine.

**RESULTS:** Of 820, 101 patients met the criteria 1) and 2). The mean VAS score was 68.9 ± 19.3 mm and the mean RDIQ score was 11.6 ± 7.0 before injection. The mean VAS score significantly decreased to 31.1 ± 27.1 mm at 15 minutes and 45.7 ± 29.1 mm at one week after injection (p<0.05). Stringently diagnosed SCN disorder patients were 87 (11%), provided that patients experienced more than 20 mm decrease of VAS. Of 87, 44 (51%) had leg symptoms.

**CONCLUSION:** SCN disorder was not rare clinical entity and should be considered as a potential cause of chronic LBP or leg pain. We propose importance of knowledge in this clinical entity.

**GP100**

**DOES LOW BACK PAIN IN PATIENTS WITH EARLY-STAGE SPONDYLOLYSIS HAVE SPECIFIC CHARACTERISTICS?**

Shiro Sugiura1, Satoru Nishikawa1, Takeshi Toyooka1, Tetsuo Shiga1, Kazumi Otsubi1, Kazuhisa Kitou1, Yuka Takata1, Tohru Ishizaki1, Yasutaka Omori1, Akito Takata1, Ayako Kote1, Yasuchika Aoki2; 1Nishikawa Orthopaedic Clinic 2Department of Orthopaedic Surgery, Toho University Sakura Medical

**INTRODUCTION:** Magnetic resonance imaging (MRI) is useful for diagnosing early-stage spondylothesis (ESS). However, MRI cannot be utilized in all adolescent patients with low back pain (LBP). To diagnose ESS as early as possible, it would be helpful to clarify specific characteristics of the symptoms. The purpose of this study was, focusing on qualities, extent, and location of LBP, to elucidate the characteristics of LBP in patients with ESS.

**METHODS:** Patients (n=43, <18 yrs-old) with acute LBP were included (<1 month). All patients were evaluated by plain radiography and MRI; patients who showed obvious pathological findings other than ESS (e.g., disc herniation, infection, etc.) were excluded. All patients were evaluated by the following examinations: hyperextension and hyperflexion tests (pain provocation tests in standing position), pain quality (sharp/dull), pain extent (fingertip-sized area/palm-sized area) and pain location (unilateral/center). To evaluate the usefulness of the tests, positive rates for each test were compared between patients with and without ESS.
RESULTS: Of 43 patients, 28 had ESS (ESS group: mean age: 14.1 yrs-old; 25 male/3 females) and 15 had no pathological findings that explained the LBP origin [nonspecific LBP group (NS-LBP): mean age: 14.6 yrs-old; 8 males/7 females]. Positive rates for each test (ESS/NS-LBP) were: hyperflexion test (61%/66%, p=0.167); hyperextension test (92%/100%, p=0.106); pain quality: sharp (71%/39%, p=0.0835), dull (25%/54%, p=0.0699); pain extent: (finger/palm: 59%/41%, 19%/81%, p=0.0133), and pain location: (unilateral:center: 86%/14%, 19%/81%, p=0.0133).

DISCUSSION: Pain provocation on hyperextension is generally recognized to be a useful physical sign of ESS. However, our study revealed that positive rates were similar between ESS and NS-LBP patients, suggesting that it is not useful for diagnosing ESS. Our results indicate that finger-sized pain and unilateral LBP may be specific characteristics of ESS.

GP101
THE FEATURES OF DEGENERATIVE LUMBAR SCOLIOSIS IN RHEUMATOID ARTHRITIS PATIENTS - MATCHED COHORT STUDY

Hiroyuki Yasuda, Akinobu Suzuki, Kentaro Yamada, Shinji Takahashi, Sho Dozono, Yoshikazu Shinohara, Hidetomi Terai, Hiro-mitsu Toyoda, Kohji Tamai, Tatsuya Koike, Hiroaki Nakamura; Department of Orthopedic Surgery, Osaka City University Graduate School of Medicine

INTRODUCTION: The lumbar lesion in rheumatoid arthritis (RA) have been paid less attention, but some previous studies demonstrated the high prevalence of lumbar spondylolisthesis and lumbar scoliosis. The lumbar lesion accompanied with RA is often difficult to treat, and it is important to know the characteristics of lumbar lesion in RA patients. The purpose of this study is to clarify the features of lumbar scoliosis in RA patients compared with degenerative lumbar scoliosis in non-RA patients.

MATERIAL AND METHODS: A total of 54 patients (44 women and 10 men, 69.3 ± 5.4 years, Cobb angle: 14.6 ± 5.9) with scoliosis (Cobb angle of > 10°) who fulfilled the revised criteria of the American Rheumatism Association were included in this study. As control, age, sex, and Cobb angle matched 54 patients without RA were selected and also included. We evaluated superior/inferior end vertebra, apical vertebra and osteophyte formation using Nathan’s classification (1-4) on plain X-rays. These parameters were compared between two groups using Man Whitney U-test.

RESULTS: The level of apical vertebra was significantly upper in RA than non-RA group. The level of superior end vertebra was also significantly upper in RA group, but there was no significant difference in the level of inferior end vertebra between two groups. The levels of curve was more wide in RA groups (RA group: 4.9 ± 1.1 levels, non RA group: 3.6 ± 0.7 levels, P<0.01). The degree of osteophyte formation was significantly greater in non RA group.

DISCUSSION: The present results showed the differences between lumbar scoliosis with RA and that without RA. These differences may indicate that the process or cause of scoliosis development in RA is different from that of degenerative scoliosis. Further, the less osteophyte formation may suggest that the lumbar scoliosis with RA is more likely to have instability, and these differences should be taken into consideration in the treatment of lumbar scoliosis with RA.

GP102
DO WE NEED HIGH FIELD MR-SCANNER FOR ROUTINE IMAGING OF THE LUMBAR SPINE

Assheuer J.*, Forutan F.*, Golfman C.*, Trümmler K.H., **Castro W. **; * Instutut f. Kernspintomographie, Cologne ** Sie-
AIM: The aim of this study is to compare image quality and diagnostic reliability of the MR examination of the lumbar spine carried out with low, intermediate and high field strength.

MATERIALS AND METHODS: Each of 8 volunteers (7 female, 1 male, ageing from 24 to 57 y) were scanned with 0.3 T, 1.5 T and 3.0T scanner with sequences adjusted to give similar tissue contrast. The image quality of the following structures were estimated with a 4 point scale ( 0 = not recognized, 1 = recognized with flat contours, 2 = recognized and well delineated, 3 = recognized, well delineated and with high contrast to adjacent tissues): neuroforaminal structures as fat pad, nerve root and ganglion; dural sack and spinal canal; facet joint with the lig. flavum; the disc and lumbar vertebra. Pfirrmann scale was used to classify disc degeneration. Hydration of the disc was determined by the quotient mean pixel value of the disc devided by mean pixel value of the adjacent liquor. The evaluation was done by 2 radiologist and 1 orthopaedic spinal surgeon.

RESULTS: The review for all 8 volunteers were the same for 3 different scanners regarding the disc degeneration and herniation, facet joint and the lig. flavum. Changes of vertebra signal intensities were detected by all scanners. There were some differences in scaling between the scanners for example the lig. longitudinale was better delineated by the 1.5 and 3.0 T scanner in the T2 weighted images, whereas more details of the disc were seen by the 0.3 T in the T1 weighted images. Scan time was 45 min for the 0.3 T, 29 min for the 1.5 T and 31 min for the 3.0 T machine. The annual costs calculated for the German market for 7 years of amortization are 135750 Euro for the 0.3 T, 286050 E

GP103
FEASIBILITY OF THE NIJMENGEN DECISION TOOL TO SUPPORT SPINE SURGEONS IN THE TRIAGE OF CHRONIC LOW BACK PAIN PATIENTS
M.L. van Hooff (1); J. van Loon (1); M. de Kleuver (1;2); (1) Sint Maartenskliniekh, Nijmegen, The Netherlands (2) VU medical Center, Amsterdam, The Netherlands

INTRODUCTION: In Western Europe Chronic Low Back Pain (CLBP) is responsible for the greatest global burden of all diseases. The CLBP population is heterogeneous and it is unclear who benefits from spinal surgery. The Nijmegen decision tool has been developed to support patient-triage and is based on evidence and professional (Delphi) consensus. It consists of a web-based screenings questionnaire and a decision algorithm. Since April 2012 all patients complete the questionnaire and are systematically followed over time. In this study pre-intervention patient profiles based on indicators predicting successful outcome (functional status [ODI=22]) of spine surgery and of a Combined Physical and Psychological (CPP) program, are evaluated.

METHODS: Cross-sectional design. Diagnostics and decision-making ‘as usual’. All (1,106) consecutive patients completed the questionnaire, based on 47 predictive indicators: 82 (7.4%) indicated for surgery and 97 (8.8%) for CPP program. Chi2-tests for categorical and t-tests for continuous variables are used to evaluate baseline differences.

RESULTS: Surgical patients reported more leg pain (t=2.5,p<0.05), larger number of previous surgeries (.2=14.7,p<0.05), and a shorter duration of CLBP (.2=8.1,p<0.05). No differences were found for the number of ‘red flags’ and comorbidities (.2=3.1,p=0.80).

DISCUSSION: The screenings questionnaire seems feasible to use. Although some differences were found, large cohorts with
long follow-up periods are needed to be conclusive about the probability of success in different treatment modalities. At the time of the conference one-year follow-up results are available and longitudinal analyses will be performed to identify patient profiles predicting successful treatment outcome. If indeed these profiles can be identified, an efficient referral and treatment allocation may be achieved. This would improve outcomes, and lead to more appropriate use of limited health care resources.

GP104
THE EFFECTS OF DYNAMIC STRETCH FOR TIGHT- HAMSTRINGS ON SPINO-PELVIC RHYTHM
Kiyotaka Hasebe(1,2), Yu Okubo(3), Yasushi Hada(1) Kohei Takada(3), Daisuke Suzuki(3) Akira Dezawa(4), Koji Kaneoka(2), Koichi Sairyo(4); (1)Department of Rehabilitation, Teikyo University Mizonokuchi Hospital, Kawasaki, Japan (2)Faculty of Sports Science, Waseda University, Japan (3)Faculty of Health and Medical Care, Saitama Medical University, Saitama, Japan (4)Department of Orthopedic Surgery, Teikyo University Mizonokuchi Hospital, Kawasaki, Japan (5) Department of Orthopedics, The University of Tokushima

INTRODUCTION: Studies have shown that tight hamstrings are related to low back pain. Theoretically, to achieve hamstrings flexibility is essential to prevent low back pain. In this study, we investigated the effects of stretch intervention on spino-pelvic rhythm, and discussed the effects of stretching on the prevention.

METHODS: Twelve healthy men volunteered to participate. The dynamic stretching machine (Never-Tight-Ham; Hogrel Inc., Tokyo, Japan) was used for stretching the hamstrings; stretching was performed for 3 days per week for 6 weeks. The finger-to-floor distance (FFD), straight leg raising (SLR) angle were measured before and after the intervention. Using a SPINAL MOUSE (Index Ltd., Tokyo, Japan), spinal alignment was measured and the spino-pelvic rhythm was evaluated.

RESULTS AND DISCUSSION: After the 6-week stretching protocol, all subjects achieved hamstrings flexibility. Significant improvements (p < 0.01) were observed in FFD from 5.8 to -2.5 cm and in SLR from 71.2° to 79.3°. During complete flexion, total pelvic motion significantly (p < 0.01) increased from 31.9° to 42.3°, indicating after the stretching intervention, participants could use their pelvis efficiently compared to that before stretching. On the other hand, total lumbar motion remained the same. The lumbar motion increased only during early flexion phase. It is reasonable to use the lumbar spine in the early flexion phase, since this phase is neutral zone at which very less loading to the spine is required. Pelvic motion increased, especially in the late flexion phase. Lumbo-pelvic rate was also significantly changed. With improved hamstring flexibility, participants used pelvic motion but not lumbar motion, indicating that dynamic stretch could change the spino-pelvic rhythm to the pelvic dominant pattern. In conclusion, after achieving hamstrings flexibility, the participants could use the pelvis efficiently. Using stretch exercises, the lumbo-spine-rhythm can be changed.

GP105
INTRADISCAL ADMINISTRATION OF THE INTERLEUKIN-6 RECEPTOR ANTIBODY TOCILIZUMAB IMPROVES INTRACTABLE DISCOGENIC LOW BACK PAIN
INTRODUCTION: Currently, inflammatory cytokines such as interleukin 6 (IL-6) and tumor necrosis factor a (TNFα) are gaining attention as important factors causing discogenic lower back pain (LBP). We have previously performed intradiscal administration of a TNFα inhibitor in cases of refractory discogenic LBP with a degenerated intervertebral disc (IVD), and found that it was safe and effective. In the present study, we aimed to assess the outcomes and adverse events of intradiscal administration of IL-6 receptor antibody in patients with LBP.

METHODS: We examined 30 cases with LBP who were resistant to conservative treatment for >3 months and with 1 degenerated IVD lesion (17 males, 13 females; average age, 57.6 years). We injected tocilizumab (TCZ; 40 mg) and bupivacaine into the degenerated IVD (TCZ group). The following items were evaluated: (1) comparison of the numerical rating scale (NRS) score between the TCZ group and the control group (bupivacaine injection alone) before, the following day, and 1, 2, and 4 weeks after administration, and of the Oswestry disability index (ODI) score before and 4 weeks after administration; (2) comparison of the efficacy of pain relief according to the degree of disc degeneration in the TCZ group; and (3) presence or absence of adverse events.

RESULTS: In the TCZ group, the NRS and ODI exhibited significant improvements during the 4 weeks of treatment. However, with regard to the comparison of the NRS according to the degree of disc degeneration, no significant difference was noted. Local infection (discitis) was observed in 1 of 30 cases.

DISCUSSION: We hypothesized that the intradiscal administration of TCZ would have an effect on discogenic LBP. Moreover, we noted a significant improvement in pain and activities during the 4 weeks of treatment. However, we did not identify a difference in efficacy according to the degree of IVD degeneration. Thus, we suggest that IL-6 is possibly involved in discogenic LBP.

GP106
UTILITY OF THE KNEE-LIFTING TEST FOR SELECTING THE APPROPRIATE DIAGNOSING LUMBAR FACET SYNDROME
Kazuji Aoki 1, Toru Uehara 2, Shota Yamada 2, Junko Oishi 2, Atsushi Inada 3; 1 Faculty of Rehabilitation Sciences, Nagoya Gakuin University, Seto, Aichi, Japan. 2 Departments of Rehabilitation, NTT-West Tokai Hospital, Nagoya, Aichi, Japan. 3 Department;

INTRODUCTION: In general, therapy for lumbar disc herniation (LDH) and lumbar facet syndrome (LFS) involves lumbar extension and flexion exercises, respectively. However, the symptoms of patients with LFS closely resemble those of patients with LDH; therefore, both diagnosis and choice of therapeutic exercises to apply can be very difficult. This study investigated the usefulness of a knee-lifting test (KL-t) that we devised as an estimation method for diagnosing LFS.

METHODS: For the KL-t, the patient assumes an upright position against a wall, making contact with the back of their head, thoracic spine, buttocks, and heels. They then try to push their lumbar spine to the wall and alternate lifting each knee. Concerning symptoms after this test, a reduction in LBP represented a positive reaction, while no reduction represented a negative reaction. Subjects in the study comprised 129 outpatients (77 patients with LFS and 52 patients with LDH) requiring therapeutic exercises. All patients performed the KL-t before being assigned therapeutic exercises. In addition, 13 patients with LFS and 5 patients with LDH underwent measurement of spinal alignment with SpinalMouse, both before and after KL-t.

RESULTS: In patients with LDH, 17 (32.7%) showed positive results and 35 (67.3%) showed negative results. In patients with
LFS, 57 (74%) showed positive results and 20 (26%) showed negative results. The positive rate was significantly higher for LFS than for LDH patients (p<0.0001). Lumbar lordosis was also significantly decreased in LFS patients showing positive results after KL-t (p<0.005). In addition, angles of thoracic kyphosis and sacral slope tended to decrease, but not significantly.

DISCUSSION: The KL-t relaxes tension in the hip flexors and reduces lumbar lordosis, decreasing mechanical stress on the lumbar facet joints and thereby reducing LBP. Our results suggest that the KL-t is useful for selecting therapeutic exercises for patients with LDH or LFS.

GP107
EARLY REHABILITATION IS EFFECTIVE IN REDUCING THE RISK OF DISUSE SYNDROME IN PATIENTS WITH VERTEBRAL FRACTURES AS A RESULT OF OSTEOPOROSIS

INTRODUCTION: Many patients are affected by osteoporotic vertebral fractures (OVF) as risk increases with age and life expectancy. Since there is no consensus on conservative treatments for OVF, this study was designed to compare two conservative treatments for OVF.

METHODS: This study evaluated 68 out of 441 patients who were diagnosed with OVF and treated in a hospital from 2007 to 2011. Diagnosis was based on radiography and magnetic resonance imaging (MRI) of the lumbar spine. Study exclusion criteria included non-OVF pathological fractures, non-ambulatory prior to OVF, pre-existing unhealed vertebral fractures, inability to undergo rehabilitation or follow-up for six months, and acute paralysis. The 34 patients treated via a regimen of prolonged bed rest (PBR) underwent rehabilitation wearing a Jewett brace after three weeks of bed rest. In contrast, the other 34 patients underwent rehabilitation as early as possible wearing a Jewett brace in what was referred to as the stir-up (SU) regimen. The time course of pain was assessed on the basis of a numeric rating scale (NRS), the activities of daily living (ADL) questionnaire, imaging technologies, hospital length of stay (LOS), and medical costs.

RESULTS: There was no significant difference in the average NRS through a six month period for the PBR vs. SU regimen. Significantly more SU vs. PBR regimen patients maintained their pre-injury ADL (p < 0.05). Imaging results for the SU regimen showed the average vertebral compression ratio over time was significantly larger than for PBR. Pseudoarthrosis occurred in two SU regimen patients who presented with mild pain which had little influence on their daily lives. The average hospital LOS was significantly shorter for patients on the SU vs. PBR regimen resulting in reduced medical costs.

DISCUSSION: We suggest the SU regimen is useful as a conservative treatment for OVF to minimize the risk for disuse syndrome, maintain pre-injury ADL status, and reduce medical costs.

GP108
THE RELATION BETWEEN EARLY STAGE MRI FAT SUPPRESSION IMAGE AND PROGNOSIS OF ACUTE OSTEOPOROTIC VERTEBRAL COMPRESSION FRACTURE
Nobuyuki Suzuki, Muneyoshi Fukuoka, Jun Mizutani, Seiji Otsuka, Takanobu Otsuka; Department of Orthopaedic Surgery, Nagoya City University Graduate School of Medical Sciences

INTRODUCTION: The vertebral body fracture is the most frequent type of osteoporotic fractures. We reported more than 4/5 patients were suffering long-lasting pain
over the year. That is very unsatisfying outcome from the view of the fracture treatment. If the prognosis of this fracture can predict in early stage, we might be able to choose other treatment options. The purpose of this study was to classify this fracture by first visit MR and predict the prognosis of pain, ADL and QoL after this fracture.

METHODS: All the patients over 40 years who visited our department and were diagnosed having fresh osteoporotic vertebral fracture were enrolled in this study. Plain X-ray, CT and MR images were underwent within one week from the first visit and also at 3weeks, 3months and 6months. Pain, ADL and QoL were evaluated by 3 different questionnaires at 3weeks, 3months and 6months. The treatment in all cases was conservative using hard corset.

RESULTS: A total of 20 patients were enrolled in this study. Mean age was 79.4. All of the case had T2 low intensity at first visit MR image. On the fat suppression image, four cases had diffuse high, four cases had diffuse low, two cases had spot low and ten cases had linear low intensity at first visit. Diffuse fat suppression low and spot low cases had become pseudarthrosis and severe collapse. And those patients had severe pain and lower QoL at 6months. Otherwise the patients who had diffuse high intensity had generally good course.

DISCUSSION: This study showed the patients who had diffuse fat suppression low intensity had worse prognosis. The region of the fat suppression low intensity was supposed to cause temporary bone necrosis. If the area of the necrosis was extensive, the repair of fracture might become difficult and cause pseudarthrosis or severe collapse. So to prevent pseudarthrosis or severe collapse, we might be able to apply another treatment options i.e. the vertebro- or kypholasy in early stage.

GP109
VACUUM PHENOMENON OF SACROILIAC JOINT: CORRELATION WITH LUMBO PELVIC ALIGNMENT
Yoichiro Takata, Toshinori Sakai, Kosaku Higashino, Yuichiro Goda, Koichi Sairyo; Department of Orthopedics, The University of Tokushima

INTRODUCTION: Lumbo pelvic alignment is reported to be associated with pathomechanisms of various spinal disorders. Although the mobility of the sacroiliac joint (SIJ) is small, the vacuum phenomenon (VP), which explains the mobility of SIJ, is often observed in the clinical practice. We analyzed the prevalence of the VP of SIJ from computed tomographic (CT) images, and relationship between lumbo pelvic alignment and this phenomenon.

MATERIALS AND METHOD: We analyzed multi-detector CT images of 100 subjects (65 men and 35 women). 7 subjects (6 men and 1 woman), who had a transitional vertebra or metastatic pelvic tumor, were excluded. Pelvic incidence (PI), pelvic tilt (PT) and lumbar lordosis (LL) were measured from multi-detector computed tomographic (CT) images using 3-dimentional reconstruction method. VP of SIJ and intervertebral disc at L5-S were analyzed from CT images. Originally modified Japanese Orthopedic Association (JOA) score, which focused on subjective symptoms and restriction of ADL, and Roland-Morris Disability Questionnaire (RDQ) scores were obtained.

RESULT: There were 36 subjects with VP of SIJ (VP+ group) and 57 subjects without VP of SIJ (VP- group). VP of SIJ was observed in 91% of female subjects, whereas only 8.5% of male subjects had VP of SIJ. Male subjects with VP had significantly lower PI than male without VP (35.1° vs. 46.3°, p < 0.05). There was no correlation between VP of SIJ and JOA score, and RDQ, respectively.

DISCUSSION: Almost all female subjects (> 90%) had VP of SIJ, which indicate
childbearing is the most important factor of VP of SIJ. This finding suggests mechanical stress is a major factor of development of VP on SIJ. Significantly lower PI was observed in male subjects with VP of SIJ. Low PI might bring stress concentration on SIJ, which causes VP.

**GP110**
**DIAGNOSTIC ACCURACY OF THE SELF-ADMINISTERED, SELF-REPORTED HISTORY QUESTIONNAIRE FOR LUMBAR SPINAL STENOSIS PATIENTS –A MULTICENTER CROSS-SECTIONAL STUDY (DISTO-PROJECT)—

Kinshi Kato1; Miho Sekiguchi1; Takuya Nkaido1; Kazuyuki Watanabe1; Koji Yonemoto2; Tatsuyuki Kakumo2; Koji Otani1; Shoji Yabuki1; Shin-ichi Kikuchi1; and Shin-ichi Konno1; 1Department of Orthopaedic Surgery, Fukushima Medical University School of Medicine, Fukushima, Japan 2Biostatistics Center, Kurume University, Fukuoka, Japan

**INTRODUCTION:** Diagnostic support tools for lumbar spinal stenosis (LSS) such as the self-administered, self-reported history questionnaire (SSHQ) have been developed in Japan (Konno et al., 2007). However, the diagnostic accuracy of the SSHQ for LSS patients in Japanese primary-care settings has yet to be reported. Therefore, the present study aimed to evaluate and improve the diagnostic accuracy of the SSHQ in Japanese primary-care settings.

**METHODS:** The LSS Diagnosis Support Tool (DISTO) Project was conducted to evaluate the nationwide diagnostic accuracy of the SSHQ in Japan from 2011 to 2013. We enrolled consecutive adults (defined as individuals =50 years old) from physicians, including non-orthopaedic general practitioners (GPs) and orthopedic GPs, and other individuals (defined as those =20 years old) with low back pain from hospital-based orthopedic surgeons. Diagnostic accuracy of

the SSHQ with both initial and new cut-off points in classifying patients according to presence of LSS was assessed in terms of sensitivity and specificity.

**RESULTS:** A total of 36,321 patients were analyzed. Among these patients, 10,034 (29.0%) were diagnosed with LSS by physicians. The SSHQ with a new cut-off point was more sensitive than the SSHQ with the initial cut-off point (80.0% vs. 68.0%, respectively) and less specific (68.2% vs. 75.6%, respectively) for LSS diagnosis. The negative predictive values were 89.5% and 85.6%, respectively.

**DISCUSSION:** The SSHQ with the initial cut-off would have missed about 15% of LSS patients in primary care settings. We therefore expect that the SSHQ with the new cut-off would be more sensitive than the SSHQ with the initial cut-off, and its use would result in a lower misdiagnosis rate in primary care settings.

**GP111**
**EFFICACY AND SAFETY OF OXYCODONE/NALOXONE IN KOREAN PATIENTS WITH CHRONIC SPINAL DISORDERS**

Seong-Hwan Moon1, Sung Soo Chung2, Kyu-Yeol Lee3, Jae Hyup Lee4, Chang Ju Hwang5, Jin-Hyok Kim6, Kyu-Jung Cho7, Jae-Sung Ahn8, Dong-Soo Kim9, Ye-Soo Park10, Hyung-Jin Jung11; 1 Department of Orthopedic Surgery, Yonsei University College of Medicine, Seoul, Korea 2Department of Orthopedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea 3Department of Orthopedic Surgery, College of Medicine, Dong-A University, Busan, Korea 4Department of Orthopedic Surgery, College of Medicine, Seoul National University, SMG-SNU Boramae Medical Center 5Department of Orthopedic Surgery, Asan Medical Center, Seoul, Korea 6Seoul Spine Institute, Inje University Sanggye Paik Hospital, Seoul, Korea 7Department of Orthopedic Surgery, Inha University Hospital, Incheon,
GENERAL POSTERS

Korea 8 Department of Orthopedic Surgery, Chungnam National University Hospital, Daejeon, Korea 9 Department of Orthopedic Surgery, Chungbuk National University Hospital, Cheongju, Korea 10 Department of Orthopedic Surgery, Hanyang University Guri Hospital, Guri, Korea 11 Medical Affairs, Mundipharma Korea Ltd, Seoul, Korea

INTRODUCTION: The use of opioids for chronic noncancer pain has increased in recent years. The purpose of this study is to evaluate the efficacy and safety of oxycodone/naloxone (Targin®) in chronic, moderate to severe pain due to spinal disorders.

METHODS: A multicenter, single-arm, interventional study was conducted in patients with chronic spinal disorders not adequately controlled with weak opioid and/or non-steroidal anti-inflammatory drugs (NSAIDs) (Pain Numeric Rating Scale 0-10; NRS score=4 at baseline). Oxycodone/naloxone was started with 5/2.5mg twice daily, then up-titrated at the discretion of investigators. The primary endpoint was the difference in mean NRS score at 8 weeks from baseline with last observation carried forward method.

RESULTS: Total 240 patients were enrolled and 220, 209 patients were included in safety set and full analysis set, respectively. Mean age was 62.3±10.4 years and 61.8% of patients were female. The patients had been treated with weak opioids (62.7%), NSAIDs (58.6%) and adjuvant medications like pregabalin or gabapentin (35%) before enrollment and the baseline mean NRS score was 6.5±1.4. NRS score was reduced to 4.8±2.0 at 8 weeks (difference; -1.7±2.2, p<0.05) with mean 18.2±10.2mg dose of oxycodone. EQ-5D and EQ-VAS were increased from 0.40±0.33 to 0.55±0.29 and from 50.2±19.5 to 61.2±18.1 at 8 weeks, respectively (p<0.05). 66.5% and 64.1% of the investigators and patients were satisfied with overall pain control at 8 weeks, respectively. 120 adverse events were reported in 77 patients (35.0%) and common adverse drug reactions (ADRs) were nausea (9.1%), dizziness (5.5%), and constipation (5.5%). Most of ADRs were mild and recovered during the study period.

DISCUSSION: Oxycodone/naloxone of relatively low dose effectively reduced the pain, improved the quality of life and showed tolerable safety profiles in patients with chronic spinal disorders, whose pain was not properly controlled by weak opioids and/or conventional NSAID.

GP112

THE RELATIONSHIP BETWEEN ROTATION AND TILTING OF VERTEBRAL BODY IN CASES WITH DEGENERATIVE LUMBAR SCOLIOSIS

Bunichiro Izumi, Yasushi Fujiwara, Akira Miyachi, Shinji Kotaka, Hideki Manabe; Department of Orthopaedic Surgery, Hiroshima city Asa hospital

INTRODUCTION: In degenerative scoliosis patient, vertebral tilt and rotation are common findings. It is very important to realize the relationship between rotation and tilt of vertebral body, when we do the surgical treatment, especially microscopic posterior decompression surgery, for the lumbar canal stenosis accompanied with degenerative scoliosis (LCSDSc). However, there are few reports about the relationship. Therefore, the purpose of this study was to investigate the rotation and tilting of the vertebral body using the imaging findings of preoperative computed tomography (CT).

METHODS: Twenty-six patients (9 male and 17 female) who underwent microscopic decompression surgery because of LCSDSc. The range of preoperative Cobb angle was between 10 and 20 degrees. The mean age at the time of operation was 70 years old. The mean follow-up period was 3.3 years. The Cobb angle before and after operation, L4 tilt, level of apex of scoliosis, each verte-
bral rotation and tilt, deformities of facet joints were evaluated in preoperative CT.

RESULTS: The mean Cobb angle before operation was 14.4 degree (10 ~ 18 degree) and mean angle at the final follow up was 16.5 degrees (12 ~ 21 degree). The mean L4 tilt angle was 8.3 degree (0 ~ 19 degree). The vertebral rotation was observed in 77% levels, and the degenerative change of facet joints were observed in 69% levels. Maximum intervertebral rotation is most frequently observed at L3/4, Maximum tilt of the vertebral body was more common at L2/3 and L4/5 than L3/4.

DISCUSSION: Our results demonstrated that surgeons have to take care of rotation at L3/4 and vertebral tilt at L2/3 and L4/5. It is very difficult to do the decompression surgery because the deformity of the degenerative scoliosis is very complex. It is very important to analyze the deformity well when we treat the degenerative scoliosis.

GP113
SAGITTAL SPINO-PELVIC ALIGNMENT IN PATIENTS WITH OSTEOARTHRITIS OF THE HIP
Yoshihara T, Morimoto T, Tsukamoto M, Sonohata M, Mawatari M; Department of Orthopedic Surgery, Faculty of Medicine, Saga University

INTRODUCTION: Few papers have adequately investigated the spino-pelvic alignment in patients with osteoarthritis of the hip (HOA). The present investigation examined the sagittal alignment of the spine and pelvis in patients with HOA using the SRS-Schwab classification.

METHODS: The subjects included 32 male and 154 female patients with an average age of 65 years treated by total hip arthroplasty due to unilateral HOA. The objects were divided into three groups. Group A included patients under the age of 60 years, group B included those 60-69 years old and group C included those over the age of 70.

Lateral whole spine radiographs were prospectively taken of all patients before surgery. The parameters of the sagittal spine-pelvic alignment examined were the sagittal vertical axis (SVA), pelvic tilt (PT), lumbar lordosis (LL) and pelvic incidence (PI). The findings of PI-LL > 20°, SVA > 9.5 cm and PT > 30° were considered to indicate marked sagittal alignment based on the SRS-Schwab classification. The significance of differences among the three groups were evaluated by the analyses of variance (ANOVA) with the Bonferroni 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 0%, 0% and 0% in group A, 9.3%, 3.1% and 1.6% in group B and 28.1%, 21.9% and 15.6% in group C, respectively. The frequency of marked sagittal alignment in group C was significantly higher than that in group A (P<0.05) and group B (P<0.05).

DISCUSSION: In elderly patients with HOA, concurrent disease in both the lumbar spine and hip was not infrequent, and the sagittal spino-pelvic alignment was decompensated in these cases. Our study suggests that long-term HOA may affect the sagittal alignment of the spine, or the presence of a spinal deformity may rotate the pelvis backwards and exaggerate the stress on the femoral head, finally causing HOA, which is referred to as secondary hip-spine syndrome.

GP114
CORONAL SPINO-PELVIC ALIGNMENT IN CROWE TYPE IV
Hirata H, Morimoto T, Yoshihara T, Tsukamoto M, Kawano S, Kitajima M, Sonohata M, Mawatari M; Department of Orthopedic Surgery, Faculty of Medicine, Saga University

INTRODUCTION: A leg length discrepancy (LLD) can cause pelvic tilt (PT) and lumbar scoliosis (LS). However, it is controversial whether LS can compensate for LLD with
the convex shift toward the shorter leg side, probably owing to the fact that these patients might have a short LLD. We have investigated the influence of marked LLD in patients with complete hip dislocation of Crowe type IV (more than 100% subluxation), on the coronal spino-pelvic alignment.

**METHODS:** The subjects were 51 patients with unilateral complete hip dislocation who were treated by total hip arthroplasty (46 females and 5 males; average age 64 years, range: 49-84 years). The frontal view of the pelvis and spine in the erect posture were photographed. Measurements were made of the LLD, pelvic tilt (PT), and lumbar scoliosis (LS). The correlation was judged to be positive in cases where there was PT and convexity of the LS toward the side with the hip dislocation, and the findings were otherwise judged to be negative. The correlations between parameters were evaluated by a regression analysis. A value of p<0.05 was considered to be significant.

**RESULTS:** The mean LLD, PT and LS were 5.6 cm, 9.2° and 15.1°. The correlation coefficients between the LLD and PT, LLD and LS and LS and PT were 0.17(p>0.05), 0.015(p>0.05) and 0.393(p<0.05), respectively.

**DISCUSSION:** In patients with unilateral complete hip dislocation, the LLD did not correlate with the presence of LS and PT. These findings suggest that marked LLD can cause PT and LS due to compensatory changes to maintain the body balance, but that this did not impact the severity of the findings.

**GP115**

**EFFECT OF THE ROCKER EXERCISE ON THE FLEXIBILITY OF THE LEG AND TRUNK, AND ON THE STATIC BALANCE AT STANDING**

Naoki Ishigaki and Takato Aihara; Dept. of Physical Therapy and Orthopedic surgery, Funabashi Orthopedic Hospital, Funabashi city, Japan

**INTRODUCTION:** The purpose of this study was to compare the flexibility of the leg and trunk, and the sway of the center of gravity (COG) between the conventional crunch exercise (CE) and the rocker exercise (RE).

**METHODS:** Approval of this hospital’s ethics committee and informed consent to inclusion in this study from 40 healthy adults were obtained. They were randomly allocated to either the CE group (n=18) or the RE group (n=22). They were repeated these exercises for 30 seconds and 3 times over (Fig.). Finger-floor distance (FFD) and straight-leg raising angle (SLA) were measured as the indexes of the flexibility of the trunk and leg. The displacement of COG (DOC) and the total length of the sway of COG (LOC) were measured using a posturography. The results were statistically compared between before and after the two exercises, and between the CE and RE groups.

**RESULTS:** FFDs were significantly increased after the CE and RE (Fig.). The SLA after the RE was significantly increased than before the RE (from 69.1° to 80.5°). DOCs were significantly shifted to forward after the CE and RE than before the CE and RE. The LOC after the RE was significantly decreased than before the RE (from 198.8mm to 183.9mm), however, there were no significant differences between before and after the CE concerning the SLA and LOC (Fig.). The increase in SLA and the decrease in LOC in the RE group were significantly larger than those in the CE group, however, there were no significant differences between the CE and RE groups concerning the increases in FFD and DOC (Fig.).

**DISCUSSION:** The results indicated that the increase in SLA and the decrease in LOC of RE were significantly larger than those of CE. There have been often reported that the decreased SLA which was caused by the tight-hamstrings and increased the sway of the COG were the risk factors for low back pain. Therefore, we think that RE can lead
to a better clinical outcome than CE for the prevention of low back pain.

RESULTS: Endplate degeneration was recognized in 22 cases (51%) in group A and 17 cases (23%) in group B, and the cases with endplate degeneration were observed cartilaginous endplate with high frequency (P<0.05). No significant differences were noted in disc degeneration, HIZ and vertebral corner defect between two groups. In group A (60%), significantly higher percentages of cartilaginous endplate were found than in group B (31%) (P<0.05). Calcification had a significantly higher incidence in group A (21%) than in group B (11%) (P<0.05). Myxoid change and inflammatory granulation tissue show no significant difference between two groups.

DISCUSSION: In elderly patients, avulsion-type disc herniation caused by endplate degeneration was frequently seen, indicating that the mechanism of the occurrence of disc herniation may be different with the young patients. Furthermore, considering the result of inflammatory granulation tissue for herniation tissue, clinical symptoms and natural course may be prolonged in elderly patients including hard tissues with high frequency.

GP117
CAN BRIEF SCALE FOR PSYCHIATRIC PROBLEMS IN ORTHOPAEDIC PATIENTS (BS-POP) PREDICT FUNCTIONAL MRI FINDINGS IN PATIENTS WITH CHRONIC LOW BACK PAIN

INTRODUCTION: Regional gray matter atrophy, cognitive changes, and unique patterns of brain activity have been demonstrated in patients with chronic low back pain (cLBP). Psychological factors related to abnormal brain conditions are associated with cLBP. The Brief Scale for Psychiatric Problems in Orthopaedic Patients (BS-POP) is a questionnaire to assess psychiatric problems.
The aim of this study was to investigate the utility of BS-POP for predicting functional MRI findings in patients with cLBP.

**METHODS:** The subjects were twenty-two cLBP patients who had suffered from persistent LBP for more than 3 months. The patient version of the BS-POP was conducted and the subjects were classified into two groups by BS-POP score, 17 or over (High score: HS group) and under 16 (Non-high score: Non-HS group). Each subject was placed in the prone position on a 3 Tesla MRI scanner, and stimulated by manual pressure with the tail of an air-filled, 20-ml syringe at 5 cm left of the fourth-fifth lumbar spinal interspace. Three blocks of 30-second painful stimulus, calibrated at either 5 on the numeric rating scale (NRS), were applied with intervening 30-second rest conditions during whole-brain echo-planar imaging. NRS of unpleasantness was evaluated after each session. Functional imaging was analyzed using a multisubject general linear model with Bonferroni multiple comparisons at p<0.05.

**RESULTS:** Activation was observed at the nucleus accumbens (NAc), the prefrontal, insular, and supplementary motor. The subjects in the HS group showed smaller activation cluster in the NAc than that in the Non-HS group. There were no difference of activation clusters in other area.

**DISCUSSION:** It is reported that dysfunction of NAc is found in the patients with cLBP. The cLBP patients with psychiatric problems showed reduction of activation in the NAc in cluster size than the cLBP patients with less psychiatric problems.

**INTRODUCTION:** We often feel low back pain when we sit with our legs crossed, however, there have been few reports concerning the trunk muscle activities at cross-legged sitting posture (CLS). The purpose of this study was to compare the trunk muscle activities at CLS with those at chair sitting posture (CS).

**METHODS:** Approval of this hospital’s ethics committee and informed consent to inclusion in the study from 13 healthy men who did not have any previous back and lumbar disorders were obtained. The surface electromyogram Myosystem 1400 was used for the measurement of the muscle activities. The activities of rectus muscle of abdomen (RA), lumbar multifidus muscle (MF), and the lumbar part of the iliacostalis lumbarum muscle (IL) were evaluated. The measurement postures were CS with their pelvis at neutral position and with their hip and knee joints at 90 degrees flexion, and the CLS (Fig.). All subjects were instructed to maintain a comfortable posture with their arms in front of the chest. Average amplitudes were normalized to the amplitude in maximal voluntary contraction (MVC) with their CS and CLS for 20 seconds and %MVC values were calculated. All %MVC values were statistically compared between at CS and at CLS by Mann-Whitney U test. A P value <0.05 was considered statistically significant.

**RESULTS:** The %MVC of MF at CS (mean, 8.17) was significantly larger than that at CLS (mean, 3.68). The mean %MVC of IL at CS was 6.63 and that at CLS was 9.41, and the mean %MVC of RA at CS was 5.78 and that at CLS was 4.92. There were no statistically significant differences between at CS and at CLS concerning the %MVC of IL and RA.

**DISCUSSION:** These findings suggest that the activity of the MF was lower at CLS than at CS. There are many reports that MF is important to stabilize the lumbar spine. Therefore, cross-legged sitting posture...
could lead to low back pain because of the low activity of lumbar multifidus muscles.

GP119
CT CLASSIFICATION AND CLINICAL SIGNIFICANCE OF VACUUM PHENOMENON FOR THE LUMBAR INTERVERTEBRAL DISC
K. Nishida, K. Maeno, K. Kakutani, T. Takeda, H. Hirata, T. Kurakawa, S. Miyazaki, T. Yurube, Y. Nakanishi, *T. Yano, *J. Yamamoto, *T. Iguchi, M. Kurosaka; Dept. of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan *Dept. of Orthopaedic Surgery, Hyogo Rehabilitation Center Hospital, Kobe, Japan

INTRODUCTION: Vacuum phenomenon (VP) in the intervertebral disc has been a well-recognized phenomenon in the disc degeneration process. However, its clinical significance has been obscure. Our objective was to classify VP into 5 grades in order to clarify the characteristics and clinical significance.

METHODS: The study involved 180 lumbar discs from 36 patients (mean 69.7 years) with VP detected by reconstructed sagittal CT images. VP was classified into 5 grades: Grade 1, dot-like or trace changes in the nucleus pulposus (NP); Grade 2, linear cleft in the NP; Grade 3, massive defect in the NP; Grade 4, massive defect from the NP through the annulus fibrosus (AF); and Grade 5, linear cleft through the disc or collapsed disc. Disc height was measured by CT. Segmental instability was evaluated by flexion/extension radiographs. Correlation of VP grades with Pfirrmann degeneration grades were evaluated. Time course of the grade was evaluated 1 year after the first evaluation.

RESULTS: VP was detected in 86 of 180 discs, which were classified into Grade 1, 13; Grade 2, 10; Grade 3, 11; Grade 4, 24; and Grade 5, 26. Disc height was significantly decreased in Grade 4 and 5, and ROM was decreased in Grade 5. In comparison between VP grades and Pfirrmann grades, while no disc with Pfirrmann Grade 1-2 was observed, 77% of discs with Grade 4 vacuum were identified as Pfirrmann Grade 4, and 100% of discs with Grade 5 vacuum were classified as Pfirrmann Grade 5. In functional radiographs, 9.1% of segments with vacuum Grade 3 disc and 16.7% of segments with vacuum Grade 4 disc showed translation over 3mm. Twenty-one discs were evaluated at 1 year followup, and 6 of them showed progression of 1 grade.

DISCUSSION: Our grading system for VP facilitates classifying discs with advanced degeneration in MRI. Vacuum Grade 3-4 discs may result in segmental instability. It is speculated that the VP of the disc initiated at the NP extends to the AF in the time course.

GP120
ANTI-bFGF NEUTRALIZING ANTIBODY REDUCES GRIAL CELL ACTIVATION IN DORSAL HORN IN RATS CFA-INDUCED DISCITIS.
Gen Inoue, Kentaro Uchida, Hisako Fujimaki, Hiroyuki Sekiguchi, Masaki Ueno, Wataru Saito, Toshiyuki Nakazawa, Takayuki Imura, Naonobu Takahira, Masashi Takaso; Department of Orthopaedic Surgery, Kitasato University School of Medicine, Kanagawa, Japan

INTRODUCTION: Basic fibroblast growth factor (bFGF) is a potent trophic factor for neurons and astrocytes that has recently been reported to be a pain transmitter. We
evaluated the expression of bFGF and glial activation in the rat Complete Freund's adjuvant (CFA)-induced discitis model and investigated the potential of anti-bFGF neutralizing antibodies as a treatment for inflammatory pain.

METHODS: Sprague-Dawley rats (5 weeks old) underwent injection of total 20 ul of CFA to L5-6 disc. To evaluate the contribution of bFGF in inflammatory pain, we injected neutralizing antibodies against bFGF (40 ul) intrathecally twice a week (experimental group). Additional rats were injected with PBS (control group). Two weeks after surgery, bilateral L2 dorsal root ganglia (DRG), which is innervating the disc and spinal cords were processed for immunohistochemistry, western blotting, and RT-qPCR for bFGF, glial fibrillary acidic protein (GFAP, an astrocytic marker), and Iba1 (a marker of microglia or macrophages).

RESULTS: Following injection of the neutralizing antibody, bFGF expression was significantly suppressed in the experimental group at both the mRNA and protein levels. GFAP and Iba1 expression was also suppressed. In immunohistochemistry, bFGF expression in astrocytes in the dorsal horn and in neuronal cells in the DRG was suppressed. Significantly fewer astrocytes and microglia were present in the dorsal horn of the experimental group.

DISCUSSION: Neutralizing antibodies suppressed both peripheral and central expression of bFGF, reduced glial activation. These results suggest that bFGF may play an essential role in inflammatory pain, and that anti-bFGF treatment may facilitate recovery of inflammatory pain. bFGF could represent a novel therapeutic target for the treatment of inflammatory pain.

GP121
LOW BACK PAIN CAUSES DIFFERENT LEVEL OF DEPRESSIVE TENDENCIES IN VARIOUS LUMBAR DISEASES
1,2,12Shiono Yuta, 1,12Shii Ken, 3,12Hosogane Naobumi, 1,12Hikata Tomohiro, 1,12Yoshioka Kenji, 5,12lida Tsuyoshi, 6,12Ozaki Masahiro, 1,12Ishihama Hiroko, 1,12hiruichi Yosuke, 1,12Takahashi Yohei, 7,12Furukawa Mitsuru, 8,12Nagoshi Shigei, 6,12Shingo lizuka, 9,12Okada Eijiro, 5,12Kaneko Yasuhito, 10,12Yuichiro Takahashi, 1,12Fujita Nobuyuki, 6,12Kato Hiroyuki, 11,12Daisuke Ichihara, 8,12Kaneko Shinjiro, 1,12Watanabe Kota, 10,12Kuroro Fukuda, 4,12Kohmo Hitoshi, 7,12Kamata Michihiro, 5,12Koyanagi Takahiro, 1,12Nakamura Masaya, 1,12Toyama Yosiki, 1,12Matsumoto Maria Department of Orthopedic Surgery, School of Medicine, Keio University, Shinjuku, Tokyo, JAPAN2 Nerima General Hospital, Nerima, Tokyo, JAPAN3 Department of Orthopedic Surgery, National Defense Medical College, Tokorozawa, Saitama, JAPAN4 Keiyu Orthopedic Hospital, Tatebayashi, Gunma, JAPAN5 Kawasaki Municipal Hospital, Kawasaki, Kanagawa, JAPAN6 National Organization Saitama Hospital, Wako, Saitama, JAPAN7 Keiyu Hospital, Yokohama, Kanagawa, JAPAN8 National Organization Murayama Hospital, Musashimurayama, Tokyo, JAPAN9 Saiseikai Central Hospital, Minato, Tokyo, JAPAN10 Saiseikai Yokohamashi Tobu Hospital, Yokohama, Kanagawa, JAPAN11 Saitama Municipal Hospital, Saitama, Saitama, JAPAN12 Keio Spine Research Group (KSRG), Tokyo, JAPAN

INTRODUCTION: Chronic low back pain (LBP) is a common presenting symptom. Previous reports showed that depression tendency often causes LBP. However, the relation between LBP due to lumbar spine disorders and depression tendency remains unclear. Here, we investigated the correla-
tion between LBP due to various lumbar spine disorders and depression tendency.

**METHOD:** 149 patients with chronic LBP lasting for over 1 year (49 males, 100 females, mean age 69.5) who visited participating hospitals in Tokyo over a 2 week period were prospectively included. The subject consisted of spondylolisthesis in 15, lumbar canal stenosis in 62, degenerative lumbar scoliosis in 11, lumbar disc hernia in 8, spondylosis in 5, compression fractures in 7, and miscellaneous in 5. The numeric rating scale (NRS) and Center for Epidemiologic Studies Depression (CESD: full marks = 60 points) score were collected. We evaluated the correlation between pain and depression tendency in various in lumbar spine disorders.

**RESULTS:** 143/149 completed the survey. The average NRS and CESD scores were 4.1 and 16.2, respectively. Of all 143 patients, 69 patients (48%) revealed depressive tendency (cut off line: less than 17 points) by CESD. The average NRS scores for those diagnosed with or without depression tendency were 4.6 and 3.7, respectively (p<0.05). History of surgery or age did not affect the NRS and CESD scores. Lower NRS and Higher CESD scores were observed in patients with LCS, while higher NRS and lower CESD were found in patients with LDH. In contrast, patients with compression fractures tended to have relatively high NRS and CESD scores.

**DISCUSSION AND CONCLUSION:** The present study showed high prevalence of depression tendency in the patients with lumbar spine disorders with LBP. Relationship between NRS and CESD scores is different in each disease.

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**GENERAL POSTERS**

**GP122**

**CLINICAL COURSE OF MOTOR DEFICITS FROM LUMBAR RADICULOPATHY DUE TO DISC HERNIATION: ANALYSIS OF 6 MONTH OUTCOMES**

Venu Akuthota, Boimbo, Sandra, MPH. Santu, Kelly, MS, CCRP Schumacher, Alexandra, BS, Weitzenkamp, David, PhD; University of Colorado School of Medicine Anschutz Medical Campus

**INTRODUCTION:** Little is known about the natural history of motor deficits from lumbar radiculopathy (LR). The objective of this study is to prospectively follow motor deficits from LR for one year.

**METHODS:** 50 patients with LR and motor deficit will be followed at 3 month intervals over one year. During each visit, strength deficit is assessed via manual muscle test (MMT) and handheld dynamometer (HHD). A preliminary analysis of the 3 and 6 month data points for MMT, HHD and functional strength testing was conducted.

**RESULTS:** 28 subjects have been recruited. 20 subjects were available for 6 month data analysis. 16 of 20 underwent non-operative care while 4 subjects went on to lumbar surgery. With MMT, 11 reached maximal strength improvements at 3 months and 6 additional subjects reached maximal strength improvements at 6 months. 3 subjects worsened with MMT at 3 months. HHD detected more change compared to MMT. With the exception of plantarflexion (PF) strength, HHD showed mild decrement at 3 months and improvement of strength at 6 months. PF strength decreased over 3 and 6 months. Functional testing showed variable changes through 3 and 6 months with no specific trends. Functional testing of PF (heel raises), showing strength improvements, did not correlate with HHD of PF, showing strength deficits.

**DISCUSSION:** Subjects with motor deficit from LR showed improvement of strength at 6 months with MMT and HHD. HHD was
more sensitive than MMT in detecting motor deficits. HHD showed deficits reached their nadir at 3 months and improvements at 6 months. Functional testing did not provide additional sensitivity for strength deficit detection except for PF testing. HHD and functional testing of PF did not correlate, suggesting technical reasons for strength decrements with HHD for PF strength. This investigation suggests there is at least a 6 month window where strength deficits may improve even without surgery.

GENERAL POSTERS

GP123

ADOLESCENT AGONISTIC TENNIS AND SPINAL DESEASES, WHAT’S THE CONNECTION? RESULTS FROM A CROSS-SECTIONAL STUDY

Fabio Zaina (1), Elisa Vantellino (2), Sabrina Donzelli(1), Monia Lusini (1), Salvatore Minnella (1), Stefano Negrini (3)(4); (1) ISICO (Italian Scientific Spine Institute), Milan, Italy (2) Università Cattolica del Sacro Cuore, Milan, Italy (3) University of Brescia, Italy (4) IRCCS Don Gnocchi, Milan, Italy

INTRODUCTION: Tennis is widely practiced by adolescent in many countries. Many spinal deformities experts consider this activity, together with other asymmetrical sport as a risk factor for scoliosis development despite data are missing. Our aim was to verify the prevalence of spinal deformities and LBP in adolescent agonistic tennis players compared to healthy controls.

METHODS: We designed a cross-sectional study. A convenience sample of 100 adolescent tennis players (50 girls) was compared to 200 scholars (100 girls) of the same age (12y). We proposed a questionnaire to collect data on LBP and we measured the ATR according to Bunnell to screen for scoliosis, and the plumbline distances for kyphosis and lordosis. The cut-off defined in literature for spinal deformities detection has been used. Odds ratios (OR) and 95% Confidence Interval (95CI) have been calculated, and ANOVA was used.

RESULTS: Compared to control, tennis players showed a similar prevalence of low back pain. The OR was not significant. A significant difference was found for limitation of usual activity, that was higher for tennis players than controls. We found similar spinal deformities in both groups: ATR female: 3.2°±1 (tennis) vs 2.8°±1 (school), NS; ATR males: 2.8°±1 (tennis) vs 2.6°±1 (school), NS. No differences were found for kyphosis and lordosis.

DISCUSSION: There was no correlation between tennis and LBP, even if there were some differences among groups for limitations of the daily activities. Most relevant, the correlation between Tennis, an asymmetrical sport, and scoliosis that has been postulated by many experts was not confirmed by our data. This is a new finding, since until now literature had a grey area on this topic. Adolescent agonistic Tennis showed to be a safe sport without an increased risk of spinal deformities and LBP. Small limitation were noted in the tennis group, but the general effect of this is not so relevant.
GP124
QUALITY OF LIFE AND LOW BACK IN PAIN IN ADOLESCENT IDIOPATHIC SCOLIOSIS: A CROSS-SECTIONAL STUDY OF 1354 PATIENTS
Fabio Zaina (1), Francesco Negrini (2), Laura Rainoldi (3), Stefano Negrini (4,5); (1) ISICO (Italian Scientific Spine Institute), Milan, Italy (2) Vita-Salute San Raffaele University, Milan, Italy (3) Fondazione IRCCS Istituto Neurologico C. Besta, Milan, Italy (4) University of Brescia, Italy (5) IRCCS Don Gnocchi, Milan, Italy

INTRODUCTION: Adolescent Idiopathic Scoliosis (AIS) can affect the psychological well-being and quality of life of patients and according to some authors it can be related also to back pain. The SRS-22 Questionnaire is the actual standard to measure psychological well-being and quality of life in AIS patients, but it has been mainly used in surgical populations with severe scoliosis or in patients already diagnosed and/or treated. Our aim was to check the correlation between scoliosis and quality of life and back pain in a large sample of consecutive patients neither treated nor diagnosed.

METHODS: 1354 adolescents (75% female) completed the SRS-22 before their first evaluation. 5 groups were created: normals (<10° Cobb – AIS: 11-20°; 21-30°; 31-40°; >40°). To prevent sample size effect, ANOVA with Hochberg’s GT2 post-hoc correction was performed. The two genders were analyzed separately. Pearson correlations with Cobb degrees have been calculated.

RESULTS: In females, statistically significant differences among groups were found for all the domains and the total score; in males, Pain and Mental Health did not show statistically significant differences among groups. In all domains, AIS patients with curves >40° reported significant lower scores compared to normals. Even if statistically significant, the existing negative correlations between Cobb degrees and all domains scores were negligible (Rho<0.2). All groups showed the highest scores (median 4.80, range 1.40 – 5.00) for Pain and the lowest scores for Self-Image (median 3.60, range 1.20 – 5.00).

DISCUSSION: The high scores found showed that at the first visit no domain appeared really compromised, with a ceiling effect. Self-Image appears compromised also in normals, while Pain is not a real issue also in curves >40°. Before AIS diagnosis, significant differences between groups were found, but with negligible correlations between severity of scoliosis and SRS-22 domains.

GP125
LUMBAR FACET JOINT ORIENTATION IN DEGENERATIVE SPONDYLOLISTHESIS: THE ROLE OF ETHNIC VARIATION IN ASIA PACIFIC
| Department of Orthopaedic Surgery, Wakayama Medical University, Kihoku Hospital, Ito-gun, Japan | Department of Orthopaedics, Kasturba Medical College, Manipal University, Mani, Udupi, India |
| Department of Orthopedics, Jangra General Hospital, Seoul, South Korea | Department of Orthopedic Surgery, Fortis Hospital, Kolkata, India |
| Orthopedic Department, Chang Gung Memorial Hospital, Taoyuan, Taiwan | Department of Orthopedic Surgery, The Third Hospital of Hebei Medical University, China |
| Orthopedic Department, Sungkyunkwan University School of Medicine, Seoul, South Korea | Department of Neurosurgery, Fortis Hospital, Delhi, India |
| Department of Orthopedic Surgery, Sapporo, Japan | Department of Orthopedic Surgery, The Third Hospital of Hebei Medical University, China |
| Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine, Suita, Japan | Thai Institute of Orthopedic Surgery, Bangkok, Thailand |
| Department of Orthopaedics, Cebu Orthopaedic Institute, Cebu, Philippines | Department of Orthopedic Surgery, Bangkok, Thailand |
| Department of Orthopedics, Nebik University, Seoul, South Korea | Department of Orthopaedics, Kasturba Medical College, Manipal University, Mani, Udupi, India |
| Department of Orthopaedics and Traumatology, University of Hong Kong, Hong Kong, SAR China | Department of Orthopedic Surgery, Fortis Hospital, Kolkata, India |
| Department of Orthopaedic and Traumatology, Faculty of Medicine Airlargga University, Dr Soetomo Teaching Hospital, Surabaya, Indonesia | Department of Orthopaedics and Traumatology, Faculty of Medicine Airlargga University, Dr Soetomo Teaching Hospital, Surabaya, Indonesia |
| Department of Orthopaedics, Deenanath Mangeshkar Hospital, Jehangir Hospital, Pune, India | Department of Orthopaedics, Deenanath Mangeshkar Hospital, Jehangir Hospital, Pune, India |
| Department of Neurosurgery, Seoul National University Bundang Hospital, Seongnam, South Korea | Department of Orthopaedics, Deenanath Mangeshkar Hospital, Jehangir Hospital, Pune, India |
| Department of Orthopaedic Surgery, Xijing Hospital, the Fourth Military Medical University, Xi’an, China | Department of Orthopaedics, Deenanath Mangeshkar Hospital, Jehangir Hospital, Pune, India |

**INTRODUCTION:** Lumbar facet joint orientation has been reported to be associated with the development of degenerative spondylolisthesis (dSppl). The role of ethnicity regarding facet joint orientation remains uncertain. As such, the following study was performed across a wide-ranging population base to assess the role of ethnicity in facet joint orientation in patients with dSppl in the Asia Pacific region.

**METHODS:** A multi-national, multi-ethnic cross-sectional image-based study was performed in 34 institutions in Asia Pacific, identifying 448 cases. Lateral standing x-rays and axial MRIs and/or CT scans were obtained for patients with lumbar dSppl. Magnitude of slip displacement, level of dSppl, and left/right facet joint angulation, width-curvature ratio, and gap width were noted on image assessment. Facet joint measurements were performed at each
level from L3-S1. Gender, age, BMI, and ethnicity were also noted.

**RESULTS:** The study included 389 patients with known ethnic origin (mean age: 61.4 years; 36.7% males, 63.3% females). The mean BMI was 25.6 kg/m2. The level of dSpl was most prevalent at L4/L5 (72.4%). There were 28.8% Indian, 28.5% Japanese, 17.5% Chinese, 8.2% Korean, 6.2% Thai, 4.6% Caucasian, 2.3% Filipino, 2.3% Malay, and 1.3% of mixed Asian origin. Accounting for patient demographics and displacement, there was a statistically significant difference between ethnicity to that of left/right facet joint angulations, width-curvature ratios, and gap widths from L3-S1 between specific ethnic groups (p<0.05).

**DISCUSSION:** This is the largest study to address the role of ethnicity upon lumbar facet joint orientation in dSpl. Ethnicity plays a role in facet joint orientation and may influence the occurrence and severity of dSpl or be a potential consequence. An understanding of ethnic variability may be one factor which assists in identifying those patients at risk of postsurgical development or progression of dSpl.

**GP126**

**THORACOLUMBAR VERTEBRAL ENDPLATE LESIONS IN GYMNASTS: A COMPARISON OF MALE AND FEMALE GYMNASTS**

Makoto Urushibara, Takato Aihara, Kenji Hatakeyama; Funabashi Orthopedic Hospital

**INTRODUCTION:** Our previous reports indicate that young gymnasts demonstrated a higher rate of vertebral endplate lesions than non-gymnasts who play other sports (gymnasts 20.1%, non-gymnasts 1.9%). The present study was designed to evaluate the differences in the incidence of vertebral endplate abnormalities between male and female gymnasts.

**METHODS:** We performed radiological examinations of the thoracolumbar spine in 72 males (mean age, 15.5 years) and 128 females (mean age, 13.7 years). All gymnasts visited our hospital with a complaint of low-back pain. We investigated the incidences of radiological abnormalities in the anterior or posterior portions of the vertebral endplate. Furthermore, we divided the involved spinal segment into the following two groups: the thoracolumbar junction (TL) group with T11–L2 lesions and the lower lumbar region (LL) group with L3–S1 lesions. The incidence of the radiological abnormalities was compared between the two groups.

**RESULTS:** The results showed that 40 and 45 vertebral endplate lesions were observed in 23 (32%) male gymnasts and 27 (21%) female gymnasts, respectively. Thus, vertebral end-plate lesions were more common in the male gymnasts than in the female gymnasts. In addition, no difference was found in the locations of lesions in the male (20 lesions in both the groups) and female gymnasts (23 lesions in the TL group and 22 lesions in the LL group).

**DISCUSSION:** We believe that the differences in the nature of gymnastic events among male and female gymnasts can be a reason for the vertebral endplate lesions to be more common in male gymnasts. For example, male gymnasts perform swinging on the still rings at high velocity. This can lead to spinal hyperflexion or hyperextension, which in turn can exert excessive pressure or traction on the spine. It is important for clinicians to understand the features of gymnastics routines in preventing endplate lesions.

**GP127**

**LUMBAR SPINE MAGNETIC RESONANCE (MR) IMAGING IN CHINA: APPROPRIATENESS AND ASSOCIATED FACTORS**

Yue Wang, Daolie Yu, Xuanwei Wang, Xiangjin Lin; Spine lab, Department of Orthopedic Surgery, The 1st Hospital of
METHODS: Approximately 26% of Chinese adults suffer current back pain. MR is widely used in managing back problems, yet, most patients with back or leg pain do not need a MR scanning. Our clinical experience suggests that lumbar spine MR may be overused or even abused in China.

RESULTS: There are 2158 lumbar spines scanned with MR, which were prescribed by orthopedic surgeons (61.8%), neurologists/neurosurgeons (10.3%), various specialists of internal medicines (17.4%) and nurses at physical examination center (10.6%). Among them, 35.4% were diagnosed as normal spines and 38.8% had some positive MR findings. Disc bulging (25.8%) was the most common finding on lumbar MR images. Simple back pain is the most common complaint (37%) for lumbar spine MR imaging, followed by back and leg pain (27%), and simple leg pain (13%). Positive findings rates for walking difficulties, back injury and common physical examination are 67.5%, 65.7% and 10.3%, respectively. Positive MR findings were associated with greater age, but not the duration of various chief complaints.

CONCLUSIONS: In Hangzhou China, lumbar MR imaging is overused by various specialists. Lumbar spine MR imaging should not be routinely used for the purpose of common physical examination. Leg pain, walking difficulty and back injury are better indicators for lumbar spine MR imaging, as compared with simple back pain.

GP128
LONG-TERM PROGNOSIS OF OSTEOPOROTIC VERTEBRAL FRACTURE - ANALYSIS OF FACTORS AFFECTING MORTALITY, ADL, RESIDUAL BACK PAIN
Hoshino M.1, Terai H.2, Tsujio T.1, Suzuki A.2, Namikawa T.3, Kato M.3, Matsumura A.3, Takaoka K.1, Nakamura H.2.; 1Spine Center, Shiraniwa Hospital, Nara, Japan. 2Dept. of Orthopedic Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan. 3Dept. of Orthopedic Surgery, Osaka City General Hospital, Osaka, Japan.

INTRODUCTION: We have previously reported the factors affecting short-term outcomes 6 months after osteoporotic vertebral fracture (OVF) in a prospective multicenter study. The present study aimed to determine the factors affecting long-term prognosis in OVF patients followed up for a minimum of 5 years.

METHODS: A total of 107 OVF patients (17 men and 90 women; mean follow-up period, 7.1 years) were enrolled in this clinical study. Outcomes were evaluated at latest follow-up on the basis of survival, ADL, and back pain, which were used as response variables. Study 1: Factors at the time of injury (sex, age, BMI, middle column injury, previous spine fractures, BMD, level of fracture, dementia, previous use of steroids, and regular exercise before fracture) were evaluated as explanatory variables. Study 2: Factors 6 months after injury (sex, age, nonunion, and vertebral collapse) were evaluated. We performed multivariate logistic regression analysis and a survival analysis using the Kaplan-Meier method.

RESULTS: At latest follow-up, 26 patients died; 11 patients were bedridden, 19 were nearly bedridden, and 51 were living inde-
independently; and 32 patients had residual back pain. Study 1: Male sex and advanced age were significantly associated with mortality (P<0.05), and middle column injury was marginally associated with mortality (P=0.087). There was no significant factor for residual back pain and ADL. Study 2: Advanced vertebral collapse was significantly associated with ADL (bedridden) and was marginally associated with mortality and residual back pain (P=0.034, 0.74, and 0.69, respectively). In the survival analysis, male sex, advanced age, and advanced vertebral collapse were significant factors.

**DISCUSSION:** We investigated the long-term prognosis of OVF, in particular, mortality, ADL (bedridden), and residual back pain. Middle column injury at the time of OVF and advanced vertebral collapse 6 months after OVF were associated with poor long-term prognosis.

**GP129**  
**COMPARISON OF SPINOUS PROCESS–SPLITTING LAMINECTOMY VERSUS CONVENTIONAL LAMINECTOMY FOR LUMBAR SPINAL STENOSIS**

Masashi Uehara, MD1), Jun Takahashi, MD2), Hiroyuki Hashidate, MD3), Keijiro Mukaiyama, MD2), Shugo Kuraishi, MD2), Masayuki Shimizu, MD2), Shota Iyegami, MD2), Toshimasa Futatsugi, MD2), Nobuhide Oghara, MD4), Hiroki Hirabayashi, MD5), Hiroyuki Kato,; 1) Department of Orthopaedic Surgery, Yokohama Hospital 2) Department of Orthopaedic Surgery, Shinshu University School of Medicine 3) Department of Orthopaedic Surgery, Shinnoi General Hospital 4) Department of Orthopaedic Surgery, Ina Central Hospital 5) Department of Orthopaedic Surgery, Marunouchi Hospital

**INTRODUCTION:** Laminectomy is widely performed for treating lumbar spinal stenosis (LSS). However, invasion into the paravertebral muscle can cause major problems. To address these problems, we performed spinous process–splitting laminectomy. However, relatively few studies have reported the clinical effects of paraspinal preservation by lumbar spinous process–splitting laminectomy in the postoperative period. So we present a comparative study on decompression of LSS using either the conventional or spinous process–splitting approach.

**METHODS:** This study included 75 patients who underwent laminectomy without fixation for the treatment of LSS and who were observed for more than 2 years. Fifty-five patients underwent spinous process–splitting laminectomy (splitting group), and 20 patients underwent conventional laminectomy (conventional group). We evaluated the clinical and radiographic results of each surgical procedure.

**RESULTS:** In the splitting group, the mean preoperative and 2-year postoperative JOA scores were 12.8 points and 22.6 points, respectively. In the conventional group, the mean preoperative and 2-year postoperative JOA scores were 14.3 points and 20.5 points, respectively. JOA score improved significantly 2 years postoperatively in both the splitting and conventional groups (P = 0.0004 and 0.021, respectively). When comparing both groups, all clinical evaluation items were better in the splitting group than in the conventional group, but not significantly. Mean CRP level on the first postoperative day was significantly higher in the conventional group than in the splitting group (P = 0.006). Radiographic evaluation showed that the mean change in angulation 2 years postoperatively in the splitting group was significantly lesser than that in the conventional group (P = 0.007).

**CONCLUSIONS:** Compared with conventional laminectomy, spinous process–splitting laminectomy might be less invasive and less unstable in patients with LSS without instability.
INTRODUCTION: Rheumatoid Arthritis (RA) frequently affects the cervical spine, with the reported frequency of cervical instability or subluxation in RA varying from 50% to 70%. In contrast, lumbar involvement is rarely treated surgically, even though pathological studies have found inflammatory involvement of the lumbar facet and lumbar intervertebral discs. Our objective is to describe operative procedures, clinical outcome, postoperative complications, and clinical characteristics in patients with rheumatoid arthritis (RA) who underwent lumbar surgery.

METHODS: Nine RA patients with lumbar spinal diseases underwent surgery. These included four with spinal stenosis, three with degenerative spondylolisthesis, one with isthmic spondylolisthesis, and one with burst fracture. The patients were comprised of one man and eight women with a mean age of 60 years and mean follow-up of 58 months. The medical records and imaging studies of all patients were reviewed retrospectively.

RESULTS: The operative procedures involved posterior decompression in three patients and posterior decompression and fusion with instrumentation in six. The clinical outcomes at final follow-up, graded on the scale used by Herkowitz and Kurtz, were no excellent patient, good in three, fair in four and poor in two. Three patients with spinal instrumentations receiving steroid medication had postoperative complications, including deep infection in two patients and adjacent vertebral collapse in one. These patients underwent revision surgeries. Eight patients had concomitant spinal and/or diarthrodial diseases, all of whom were surgically treated.

DISCUSSION: Lumbar spine surgery for RA patients was followed by an unfavorable clinical outcome in our case series. Postoperative complications, concomitant spinal diseases, and/or diarthrodial diseases may be related to its clinical outcome.
GENERAL POSTERS

PURPOSE: To evaluate the clinical significance of lateral lumbar spinal canal stenosis (LLSCS), found by magnetic resonance imaging (MRI), through correlating the imaging findings with patient symptoms, walking capacity and electromyography (EMG) measurements.

METHOD: Eighty-eight patients with symptoms of LSS severe enough to indicate operative treatment were studied with MRI. Of these patients, subjects with distinct lateral LSS were included. Accordingly, 140 roots in 14 patients (mean age 58, range 48-76 years, male 43 %) were evaluated. In MR images the entrance and mid zones of the lateral lumbar nerve root canal were graded as normal, narrowed but not compressed, or compressed. In quantitative analysis, the minimal widths of the lateral recess and mid zone area were measured. Clinical symptoms were recorded with the Oswestry Disability Index (ODI), overall Visual Analogue Scale (VAS), specific low back pain (LBP; NRS-11), specific leg pain (LP NRS-11), Beck Depression Inventory (BDI) and walking distance in the treadmill test. Lumbar paraspinal (L2-S1) and lower limb needle EMG studies were performed. The findings were classified root by root as 1 = normal, 2 = abnormal. The associations between radiological, EMG and clinical findings were tested with each other.

RESULTS: Severity of the mid zone stenosis in MRI correlated with abnormal EMG findings (p = 0.015). Patients with abnormal EMG had also higher scores in the VAS (41.9 ± 25.7 vs 31.5 ± 18.1; p = 0.018), NRS leg pain (7.5 ± 1.5 vs 6.3 ± 2.1; p = 0.000) and BDI (9.8 ± 3.8 vs 8.0 ± 3.9; p = 0.014). However, no statistically significant correlations between MRI findings and clinical symptoms or walking capacity were found.

CONCLUSIONS: MRI findings correlated with abnormal EMG, indicating that a lateral stenosis seen by MRI is a clinically significant finding. However, no relationships between the MRI findings and symptoms or walking capacity were found, suggesting their multifactorial etiology.

GP132
IS IT REAL ADJACENT SEGMENT PATHOLOGY BY STRESS CONCENTRATION AFTER LIMITED FUSION IN DEGENERATIVE LUMBAR SCOLIOSIS?
Kee-Yong, Ha, Young-Hoon Kim, Joo-Hyun Ahn.; Department of Orthopaedic Surgery, Seoul St. Mary’s Hospital College of Medicine, The Catholic University of Korea, Seoul, Korea

INTRODUCTION: The appropriate surgical techniques for degenerative lumbar scoliosis (DLS) remain one of the most controversial topics in the spine surgery. However, there has been no study focusing on adjacent segment pathology (ASP) showing different patterns according to the different fusion levels. The purpose of this study is to investigate ASP after limited lumbar fusion in the treatment of DLS.

METHODS: Fifty nine patients were enrolled and divided into two groups according to the proximal fusion level: group I, consisted of 29 patients undergone fusion below the proximal end vertebrae and group II, consisted of 30 patients undergone fusion to the proximal end vertebrae. Clinical and radiological assessments were performed during an average 67 months follow-up. The number of radiological findings for ASP was determined based on a 7 radiologic findings and given 1 point for each radiological finding. The two groups were analyzed according to radiological ASP (RASP). The ODI and VAS were recorded prospectively.

RESULTS: RASP developed in 16 (27.0%). In group 1, 12(41.4%) of 29 patients and 4(13.3%) of 30 in group 2 showed RASP. Group I shows average 4.5 points and1.8 points in group II. RASP scores are much higher in group I than in group II with a statistical significance (p< 0.005). In group I, 4
patients underwent revision surgery, but 1 patient in group II.

CONCLUSIONS: RASP showed different patterns compared to RASP according to the different fusion level. RASP in group I showed similar patterns to natural progression of DLS. It is suggested that fusion be included at least over the proximal end vertebrae although RASP with different patterns in group II was shown.

KEY WORDS: Degenerative lumbar scoliosis, short fusion, adjacent segment failure, natural progression.

GP133
BONE CEMENT AUGMENTATION PROCEDURES FOR SPINAL PATHOLOGIC FRACTURE BY MULTIPLE MYELOMA.
Kee-Yong Ha, Young-Hoon Kim, Joo-Hyun Ahn.; Department of Orthopedic Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea.

INTRODUCTION: To evaluate efficacy and safety of bone cement augmentations for pathologic fractures related to multiple myeloma, the cohort was compared retrospectively with that of conservative treatment.

METHODS: Fifty seven patients with pathologic fractures of multiple myeloma were enrolled from 2009 to 2011. Fifty one vertebrae from 28 patients were treated with bone cement augmentation procedure (kyphoplasty 43, vertebroplasty 8). Forty eight vertebrae from 29 patients were treated with conservative supportive treatments. We assessed clinical results using visual analogue scale (VAS) and Oswestry disability index (ODI), and radiologic results using height loss of the affected vertebra and local kyphotic angle, respectively.

RESULTS: For clinical decisions on treatment of spinal pathologic fracture, bone scan or single photon emission computed tomography was done for 20 patients who underwent surgery. During mean 15.1 months follow-up from initial diagnosis of pathologic fracture or surgical intervention, 20 patients died from complications of multiple myeloma. At one year follow-up, cumulative survival rate were 77.4% and 74.7% in the operated and conservative groups, respectively (log rank test > 0.05). In terms of clinical results, immediate pain relief was superior in the operated group to that in the conservative group. ODI, maintenance of vertebral height and local kyphotic angle at the last follow-up were superior in the operated group to the conservative group. Among 58 vertebrae in 20 patients, 50 vertebrae (86.2%) showed abnormal uptake at the radionuclide images study.

CONCLUSIONS: Bone cement augmentation procedures were safe and effective additional support for pathologic spinal fracture of multiple myeloma. Radionuclide imaging study was useful for the surgical decision on these procedures.

GP134
LONG-TERM OUTCOMES OF IN SITU FUSION FOR DYSPLASTIC SPONDYLOLISTHESIS
Kazuhide Inage(1), Sumihisa Orita(1), Kazuyo Yamauchi(1), Miyako Suzuki(1), Yoshiiro Sakuma(1), Go Kubota(1), Yasuhiro Oikawa(1), Takeshi Sainoh(1), Jun Sato(1), Kazuki Fujimoto(1), Sadao Arai(2), Kazuhisa Takahashi(1), Seiji Ohtori(1); (1) Dept. of Orthopaedic Surgery, Graduate School of Medicine, Chiba University (2)Arai Orthopaedic Clinic

INTRODUCTION: We aimed to investigate the long-term outcomes of in situ fusion procedures performed in our hospital for treating dysplastic spondylolisthesis (DS).

METHODS: Among the cases who underwent in situ fusion for DS in our hospital from 1974 to 2004, we examined 12 patients being followed up in August 2013. Evaluation of the vertebral alignment at the preoperative, postoperative, and final ex-
aminations included lumbosacral angle and lumbar lordosis angle measurement, and X-ray assessment in the profile view in the neutral standing position. Moreover, low back pain and leg pain were assessed using the visual analog scale (VAS) at the different examination periods. We also evaluated the surgical complications.

**RESULTS:** The average follow-up duration, patient age at the final examination, and patient age at surgery was 20.0, 42.3, and 22.3 years, respectively. At the preoperative, postoperative, and final examinations, the average lumbosacral angle was 32.3°, 33.7°, and 36.5°, and the average lumbar lordosis angle was 51.0°, 48.6°, and 49.6°, respectively; no significant differences were noted among the values in any of the periods (P<0.05). The average VAS scores for low back pain and leg pain at the final were significantly lower than those at the preoperative (P<0.05). None of the patients exhibited any complications (paralysis).

**DISCUSSION:** We noted that the average lumbosacral angle was similar to that of the average angle of a healthy individual (35°), but the lumbar lordosis angle was significantly greater than the average angle of a healthy individual (27°); this indicated that the lumbar lordosis compensated for the kyphosis resulting from the advanced spondylolisthesis. And almost patients became free of the preoperative pain at the final. Thus, we recommend the use of in situ fusion to avoid nerve complications that are noted during repositioning surgery and to maintain appropriate sagittal aligment for a long duration (even 20 years after surgery).

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**GP135**

**PROSPECTIVE STUDY OF RISK FACTORS RELATED TO REOPERATION AFTER MICRO-SURGICAL BILATERAL DECOMPRESSION VIA A UNILATERAL APPROACH (MBDU) FOR TREATMENT OF DEGENERATIVE LUMBAR DISEASE.**

Minori Kato1, Akira Matsumura1, Takashi Namikawa1, Kazunori Hayashi1, Hiroaki Nakamura2; 1: Dept. of Orthopaedic Surgery. Osaka City General Hospital. 2: Dept. of Orthopaedic Surgery. Osaka City University Graduate School of Medicine.

**INTRODUCTION:** Some authors have reported good clinical outcomes following microsurgical bilateral decompression via a unilateral approach (MBDU). This approach entails a less invasive technique that preserves the posterior elements. However, there is no consensus about the inclusion criteria of MBDU for LCS in cases involving AP slippage, lateral listhesis, or scoliotic disc wedging. The purpose of this research was to evaluate the radiographic risk factors of required reoperations after MBDU prospectively.

**METHODS:** Between 2007 and 2010, we performed MBDU 255 patients with lumbar degenerative disease. We followed 207 patients of them (women/men: 88.119, mean age 70 years) 2 years after the surgery (follow-up ratio: 81.2%). We investigated the prevalence of cases that required reoperation, these cases’ clinical characteristics, and the risk factors associated with reoperation.

**RESULTS:** Reoperation was needed in 13 cases (6.3%). The cause of reoperation was intraforaminal stenosis in 6 cases, development of disc herniation in 4 cases, exacerbation of disc degeneration in 2 cases, and low back pain due to intraspinal facet cyst in 1 case. The duration from the initial operation to reoperations for intraforaminal stenosis or due to the development of disc herniation was 6 months. The L4/5 cases
with reoperation were significantly associated with scoliotic disc wedging and lateral listhesis in the prone position. The odds ratio of scoliotic disc wedging and lateral listhesis was 9.88 and 12.6, respectively.

**DISCUSSION:** From this study, surgeons should be cautious about indicating MBDU for cases with scoliotic disc wedging or lateral listhesis in L4/5.

**GP136**

**ANATOMY OF LAMINA IN THE THORACOLUMBAR SPINE WITH THE SPECIAL REFERENCE TO TRANSLAMINAR SCREWS: CT AND CADAVERIC ANALYSIS WITH SCREW SIMULATION**

Woojin Cho, MD, PhD; Jason T. Le, BS; Adam L. Shimer, MD; Brian C. Werner, MD; John A. Glaser, MD; Francis H. Shen, MD; Albert Einstein College of Medicine

**INTRODUCTION:** The use of translaminar (TL) screws has grown to almost all parts of the spine. In terms of examining the specific anatomy important for thoracic and lumbar spine insertion of TL screw, there has been no study to do so.

**METHODS:** T1 to L5 were harvested from 17 cadaveric spines and 3D reconstructions were acquired using 1-mm CT scans. Kodak Carestream/Pacs Ver 10.2 was used to simulate TL screw insertion points and trajectories bilaterally from T1 to L5. These TL screw simulations were created with the goal of obtaining optimal bony purchase with the 1st screw (1° screw) and the best allowable diameter with the 2nd screw (2° screw) taking into account the trajectory of the 1° screw. For the 2° screw, it was important to prevent cortical breakage even if the theoretical best diameter for purchase was not obtained. From the CT 3D reconstructions, anatomical measurements were made based on the simulated 1° and 2° screw trajectories. These measurements included the screw length, vertical angle, horizontal angle, thickness of the narrowest section of lamina, and the cancellous and cortical thickness of that thinnest portion. From the individually sectioned cadaveric thoracolumbar spine segments (11 out of 17), caliper measurements were obtained that mirrored those from CT.

**RESULTS:** There were no specimens that did not allow the use of the same size 2° screw as was used for the 1° screw. The lengths and the angles of the 1° and the 2° screws are illustrated in Table.

**DISCUSSION:** This study represents a description of the lamina anatomy in the thoracolumbar spine in terms of TL screw. This special reference to TL screw in the thoracolumbar spine takes into account the simulated trajectories of 1° and 2° screws using cadaveric and CT analysis. Future studies into the indications for clinical use
and effectiveness of inserting TL screw into actual thoracolumbar spines would be valuable.

**GP137**
**THE INSERTION TECHNIQUE OF TRANSLAMINAR SCREWS IN THE LUMBAR SPINE: CT AND CADAVERIC VALIDATION**
*Woojin Cho, MD, PhD; Jason T. Le, BS; Adam L. Shimer, MD; Brian C. Werner, MD; John A. Glaser, MD; Francis H. Shen, MD; Albert Einstein College of Medicine*

**INTRODUCTION:** One of the salvage techniques for revision or severe deformity cases is translaminar screws (TLS). The technique of TLS insertion in the lumbar spine has not been investigated.

**METHODS:** L1 to L5 were harvested from 11 cadaveric spines. The vertebrae were separated from the spine at each level for 7 of the cadavers (Group S), and 4 cadavers were left without separation (Group N-S). TLS were placed into each vertebral level along the proposed trajectories described in previous studies. The entry point for the 1° screw was at a screw distance above the spinolaminar (SL) jx’s inf margin. A drill was directed toward the middle portion of the contralateral transverse process (TP). The 2° screw entry point was at a screw distance below the SL jx’s sup margin. The screw was directed toward the contralateral TP inf margin. If the 2° screw could not fit due to the space occupied by the 1° screw, the 2° screw was downsized. The group S vertebrae were checked by observation for cortex breakage. CT scans were done for the group N-S.

**RESULTS:** There were no vertebrae that did not permit screw insertion. Group S experienced no cortical breakage from the screws. Group N-S had CT scans that showed only slight cortical breakages in 6 medial and 1 lateral cortex. There were also no facet injuries resulting from screw insertion seen in group N-S. The 2° screws never needed to be downsized because of 1° screw blockage.

**DISCUSSION:** The 1° screw starts at a screw distance above the spinolaminar junction’s inferior margin toward the center of the contralateral transverse process at its base. The 2° screw starts at a screw distance below the spinolaminar junction’s superior margin toward the contralateral transverse process inferior margin. Translaminar screws in the lumbar spine can be inserted relatively safely in the separated specimens, however, in N-S, medial cortical breakage can be a problem unless the screws are inserted percutaneously.

**GP138**
**ANATOMIC GUIDELINE FOR APPROACH TO LATERAL LUMBAR INTERBODY FUSION (LLIF)**
*Woojin Cho, MD, PhD; Gary A. Fantini, MD; Carlos A Castro, MD; Frank P. Cammisa, Jr, MD; Andrew A. Sama, MD; Alex P. Hughes, MD; Federico P. Girardi, MD; Albert Einstein College of Medicine*

**INTRODUCTION:** The LLIF has shown excellent surgical outcome with minimal morbidity. However, in certain settings, adequate lateral access to permit a proper working angle into the disc space may be difficult to achieve. The purpose of this investigation was to establish a clinically robust anatomic guideline for incision location, with respect to laterality and level.

**METHODS:** The operative reports and plain films of the thoraco-lumbar spine of 512 consecutive patients undergoing LLIF at our
institute between 2009 and 2011 by the mini-open transpsoas method were reviewed.

**RESULTS:** Distribution of operative levels is depicted in Table. Level of approach T11-12 and above: transthoracic approach T12-L1: 10th intercostal space (retropleural/retroperitoneal approach) L1-2: 11th intercostal space (retropleural/retroperitoneal approach) L2-3: below 12th rib (retroperitoneal approach) L3-4: midway between costal margin and iliac crest (retroperitoneal approach) L4-5: above iliac crest (retroperitoneal approach) L5-S1: not recommended, even when accessible. The primary determinant of laterality (side) of operative approach involving the L4-5 disk space was coronal angulation of the L4-5 disk space. A secondary determinant of feasibility of accessing the L4-5 disk space is a line drawn through the center of the L4 vertebra, parallel to the inferior end plate of L4. Extension of this line cephalad to the ipsilateral iliac crest indicates that this level will be surgically accessible. In the absence of segmental coronal angulation, the symptomatic side was chosen. In the setting of regional scoliosis, the concavity was the preferred side of approach, as up to three levels can be reached through a single small incision. There were no instances of approach failure using the method outlined above.

**DISCUSSION:** A clinically robust and worthwhile anatomic guideline to LLIF, with respect to level and laterality of incision placement, is presented.

**GP139**

**DEFORMITY CORRECTION AND MAINTENANCE BY EXTREME LATERAL LUMBAR INTERBODY FUSION (LLIF) AND ITS RELATED FACTORS**

Woojin Cho, MD, PhD; Carlos A Castro, MD; Frank P. Cammisa Jr, MD; Andrew A. Sama, MD; Alexander P. Hughes, MD; Russel C. Huang, MD; Federico P. Girardi, MD; Albert P. Einstein Jr, MD; Sama, PhD; Cho, MD; P. Einstein Jr, MD; Hughes, MD; Girardi, MD; Albert Einstein College of Medicine

**INTRODUCTION:** The purpose of this study is to report the amount of deformity correction and maintenance by LLIF and its effecting factors.

**METHODS:** Out of 512 LLIF cases, 100 stand-alone LLIF cases for degenerative lumbar scoliosis were identified after excluding previous fusion, posterior fixation, and cases without scoliosis. Radiographic and clinical data were analyzed retrospectively. In each patient, overall and segmental deformity correction (difference between postop and preop) and maintenance (difference between final and postop) were measured, and the amount of segmental correction and maintenance was compared in terms of approach side (convex vs. concave). Also, correction was compared between groups with or without end plate fracture, and maintenance was compared between the groups with or without subsidence.

**RESULTS:** Total 34 patients with follow up were included, and a total of 86 levels were treated. The amount of overall and segmental correction and maintenance is illustrated in Table. Overall and segmental scoliosis correction was more predictable than lordosis creation. There was no difference in the amount of segmental correction and maintenance in between convex and concave side. The group without the endplate fracture showed more segmental scoliosis correction significantly, the group without the subsidence showed more segmental scoliosis and lordosis maintenance significantly.

<table>
<thead>
<tr>
<th>Level</th>
<th>Number</th>
</tr>
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<tbody>
<tr>
<td>T9-10</td>
<td>1</td>
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<tr>
<td>T10-11</td>
<td>2</td>
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<tr>
<td>L3-4</td>
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<tr>
<td>L4-5</td>
<td>262</td>
</tr>
<tr>
<td>L5-S1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>857</td>
</tr>
</tbody>
</table>
DISCUSSION: We report the amount of overall and segmental deformity correction and maintenance by LLIF procedure. Segmental scoliosis correction is very predictable unless endplate breakage occurs during surgery. Segmental deformity correction maintained well until final follow up unless subsidence occurs. Overall or Segmental lordosis creation is less predictable as we proposed it is dictated by the position of the cage. There was no difference in the amount of segmental correction and maintenance in between convex and concave side.

GP140
CLINICAL RESULTS OF INSTRUMENTED LUMBAR SPINAL SURGERY IN ELDERLY PATIENTS
Sakuma, Yoshihiro1; Aramomi, Masaaki2; Masaki, Yutaka2; Ohtori, Seiji1; Inoue, Gen3; Yamauchi, Kazuyo1; Orita, Sumihisa1; Kamoda, Hiroto1; Miyagi, Masayuki1; Ishikawa, Tetsuhiro1; Arai, Gen1; Suzuki, Miyako1; Oikawa, Yasuhiro1; Kubota, Go1; Inage, Kazuhi; Dept. of Orthopaedic Surgery, Graduate School of Medicine, Chiba University1 Dept. of Orthopaedic Surgery, Sammu Medical Center2 Dept. of Orthopaedic Surgery, Kitasato University, School of Medicine3

INTRODUCTION: Few reports have quantified the limits of invasive surgery in elderly patients. Sano et al. reported their original age-specific sliding scale in Japanese to evaluate the limit of invasive surgery based on surgery time and blood loss. Our aim was to evaluate the clinical results of lumbar spinal surgery in elderly patients using this sliding scale retrospectively.

METHODS: We included 32 patients (10 men, 22 women) aged 75 years or older (mean age, 80.6 years) who had undergone instrumented lumbar spinal surgery. We used the sliding scale to investigate the influence of surgery time and blood loss on the incidence of general postoperative complications. Clinical outcome was also assessed with the Japanese Orthopaedic Association (JOA) score.

RESULTS: The average surgery time and blood loss were 5 hours 46 minutes and 748 mL, respectively, in patients aged 85-89 years; 5 hours 20 minutes and 625 mL, respectively, in patients aged 80-84 years; and 4 hours 53 minutes and 588 mL, respectively, in patients aged 75-79 years. General postoperative complications occurred in 5 cases (15.6%); surgery time exceeded the sliding scale in all 5 cases. In patients over 80 years of age, the incidence of complications was 25% in cases with excessive blood loss and 33.3% in cases with excessive surgery time. In cases with both excessive blood loss and surgery time, the incidence of complications was 14.3% in all patients and 33.3% in patients over 80 years of age. The mean JOA score improved from 12 before surgery to 23 after surgery in patients aged 75-79 years and from 11 before surgery to 21 after surgery in patients aged 80-84 years, without any significant differences in age.

DISCUSSION: Our results demonstrate the utility of the sliding scale. It suggested the
limits of invasive surgery according to age and could be useful tools in surgical planning.

**GP141**

**DOES SITE OF SYMPTOMS INFLUENCE THE SURGICAL RESULTS FOR DISCOGENIC LOW BACK PAIN TREATMENT?**


**PURPOSE:** Surgical results for discogenic low back pain (DLBP) treatment remain controversial. The method of diagnosis of DLBP generally used is MRI and discography. However, this imaging sometime fails to diagnose DLBP. Symptoms from DLBP are varied and include back pain alone, referred leg pain, and referred inguinal pain. In the current study, we aimed to evaluate whether the site of symptoms influences surgical results for DLBP treatment.

**METHOD:** The site of symptoms before surgery and the surgical result were retrospectively evaluated in 62 DLBP patients. Symptom sites before surgery were divided into (1) back pain alone, (2) back pain + referred inguinal pain, (3) back pain + referred thigh pain, and (4) back pain + referred lower leg pain. The patients showed disc degeneration only at one level (L4-5 or L5-S1) on MRI, pain provocation on discography, and underwent anterior interbody fusion. Visual analog scale (VAS) of back pain and the Roland-Morris Disability Questionnaire (RDQ) were evaluated before and 2 years after surgery.

**RESULTS:** VAS and RDQ were not significantly different between the 4 groups before surgery, but were significantly improved in all 4 groups 2 years after surgery (P < 0.05). The greatest improvement of back pain was found in the group with back pain + referred inguinal pain compared with the other 3 groups (P < 0.05). Less improvement of back pain in the back pain alone group was seen compared with the back pain + referred thigh and back pain + referred lower leg pain groups (P < 0.05).

**DISCUSSION:** If DLBP is strictly diagnosed using several imaging modes, surgical results were superior in patients with both back pain and either referred inguinal or leg pain compared with those having back pain alone.

**GP142**

**BIOMECHANICAL FUNCTIONAL EVALUATION OF A NOVEL ARTIFICIAL NUCLEUS SYSTEM FOR DISC NUCLEUS REPLACEMENT**

Tae-Kyung Lee, Jung-Hwa Hong, Tae-Hong Lim*; Department of Control and Instrumentation, Korea University, South Korea

*Department of Biomedical Engineering, University of Iowa, Iowa, USA

**INTRODUCTION:** Disc nucleus replacement (DNR) is one of the viable options for degenerative disc disease (DDD) treatment without fusion. The objective of this was the development of new artificial nucleus system (ANS) and its biomechanical functional evaluation.

**METHODS:** ANS consisting of a balloon and a fluid injection device (FID) was developed for DNR in minimally invasive manner. The balloon has a valve specially designed for in-situ fluid injection, fluid leakage prevention and in-situ filling of the hole made in annulus for total nucleotomy. FID is designed to control the injected fluid volume. The implantation procedure is: 1) total nucleotomy via 3mm hole made through the annulus; 2) insertion of folded balloon; 3) fluid injection into the balloon using until the fluid pressure reaches to a desired level. Biomechanical functions of ANS were tested in terms of axial stiffness and rotational flexibility of the segment before and after DNR with our ANS system.
RESULTS: Total nucleotomy increased segmental axial and rotational displacements significantly from the intact case. DNR with ANS (0.6MPa fluid pressure) was found to restore both axial and rotational stiffness back to those of the intact case. CT images taken after biomechanical tests showed the height of the disc with ANS similar to that of the intact segment.

DISCUSSION: It was feasible to perform DNR with ANS through 3 mm hole in annulus, which indicates a minimum incidence of implant back-out through the annulus incision. The test results also demonstrated that segmental biomechanical behaviors are similar before and after DNR with ANS. The balloon of ANS was filled with sailine in this study but can be filled with any fluid or more preferably temperature responsive injectable hydrogel. These indicate a great potential for successful clinical use of ANS although further biomechanical tests on fatigue strength of ANS should be performed.

GP143
VERTEBRAL COLLAPSE AFTER LUMBAR SEGMENTAL FUSION

INTRODUCTION: Lumbar arthrodesis has been used for large cohorts with successful results. We nonetheless experienced cases of postoperative vertebral collapse (VC) resulting in lumbar kyphosis. We assumed that the cause of VC is not only long fusion but also segmental fusion. This study aims to reveal risk factors of VC after lumbar segmental fusions.

METHODS: A total of 69 patients (22 males and 32 females, mean age of 61 years) were selected. Procedures performed included segmental posterior lumbar fusion at L4/S and at L5/S (54 and 15 cases, respectively) (6 PLIF, 17 PLF and 46 TLIF). Exclusion criteria were decompression at different levels and/or previous VC. The average follow-up was 4 years. Change in Cobb angle, pelvic incidence (PI), lumbar lordosis (LL) and sacral slope (SS) were radiographically assessed. We evaluated disc degeneration of adjacent levels (L1/2 to L5/S) at each follow-up period. Relations between VC and each factor were assessed by stepwise logistic regression analysis. Relations between VC and back pain.

RESULTS AND DISCUSSIONS: VC occurred in 8 patients after fusions (5 patients at Th12, 3 at L1 and 2 at L2). Stepwise analysis revealed that risk factors were advanced age, preoperative low LL and change in Cobb angle by surgical procedures (ROC=0.88). Change in Cobb angle was significantly related to the presence of VC in particular (Odds ratio=1.3/1 degree). VC occurred in 7 patients (88%) within 2 years, which suggested close relations of VC to lumbar surgery. VC also led to significantly high scores of VAS (back pain), suggesting that excessive change in Cobb angle negatively affects surrounding tissues. Meanwhile, lower LL also put an axial load on the upper segments.

CONCLUSION: Risk factors of VC after lower segment arthrodesis are excessive segmental correction and original flat back. Furthermore, VC is a risk factor of unsatisfactory surgical results.

GP144
LOW BACK PAIN INTENSITY IN LUMBAR SPINAL STENOSIS MEASURED BY USING THE JAPANESE ORTHOPAEDIC ASSOCIATION SCORE AND THE VISUAL ANALOGUE SCALE -DISTRIBUTION, RESPONSIVENESS TO THE SURGERY AND CORRELATION BETWEEN THE TWO MEASUREMENTS
Hiroshi Hashizume (1), Hiroshi Yamada (1), Hiroyuki Oka (2), Akihito Minamide (1), Yukihiro Nakagawa (1), Hideto Nishi (1),
INTRODUCTION: The Japanese Orthopaedic Association (JOA) score includes a subjective index for low back pain (LBP) (3, none; 2, occasional mild pain; 1, continuous pain or occasional severe pain; 0, continuous severe pain). In the present study, we aimed to investigate the prevalence of concomitant LBP and lumbar spinal stenosis (LSS), and to examine the correlation between LBP intensity measured by using the JOA score and the Visual Analogue Scale (VAS) in patients with LSS.

METHODS: A total of 420 patients with LSS (230 men and 190 women; mean age, 69.2 ± 8.7 years) who were surgically treated was recruited. LBP intensity was measured by using the JOA scores (3–0 points) and VAS values (0–100 mm) before and 1 year after surgery. Concomitant LBP was considered to be “present” when the JOA score was 1 or 0. The prevalence of LBP, distribution of the JOA scores and VAS values, and the correlation between the JOA scores and VAS values were examined.

RESULTS: The preoperative JOA score was 0 in 22, 1 in 237, 2 in 142, and 3 in 19 patients. The postoperative JOA score was 0 in 5, 1 in 97, 2 in 210, and 3 in 108 patients. The pre-surgical prevalence of LBP was 61%, which decreased to 24% after surgery. Similarly, the pre-surgical median VAS value was 61 (Q1–Q3: 34–79), which decreased to 21 (0–52) after surgery. The average VAS values corresponding to the JOA scores of 0, 1, 2, and 3 were 86 (95% confidence interval, 77–95), 68 (65–71), 38 (35–42), and 14 (4–24) before surgery, and 89 (70–100), 60 (55–64), 27 (25–30), and 4 (0–8) after surgery, respectively. The Spearman’s rank correlation coefficient between the JOA scores and VAS values was -0.61 before surgery and -0.74 after surgery (p < 0.0001). The correlation coefficient between the 2 measurements for the perioperative change in pain intensity was 0.58 (p < 0.0001).

DISCUSSION: This study verified the validity of JOA score and indicated the usefulness of the measurement for evaluating LBP intensity in the LSS.

GP145

THE INFLUENCE OF PAIN SENSITIVITY ON THE TREATMENT OUTCOME OF TRANSFORAMINAL EPIDURAL STEROID INJECTION IN PATIENTS WITH LUMBAR SPINAL STENOSIS

Ho-Joong Kim, Jin S. Yeom, Joon Woo Lee, Bong-Soon Chang, Choon-Ki Lee; Spine Center and Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital

INTRODUCTION: Pain sensitivity could be one of the determining factors for symptom severity in the degenerative lumbar spinal stenosis (LSS). The aim of this study was to investigate the effect of individual pain sensitivity on the results of transforaminal epidural steroid injection (TFESI) for the patients with LSS.

METHODS: Seventy-seven patients with LSS were included in the present study. Prospective planned evaluations were performed twice consecutively before and 2 months after TFESI. These included a detailed medical history, a physical examination, and completion of a series of questionnaires, including pain sensitivity questionnaire (PSQ), Oswestry disability index (ODI), visual analog scale (VAS) for back and leg pain. The correlations were analyzed among variables between total PSQ/PSQ-moderate/PSQ-minor and pain and disability level measured by VAS for back/leg pain.
and ODI both before and 2 months after TFESI.

**RESULTS:** Two months after TFESI, there were significant decreases of VAS for back/leg pain and ODI compared to those before injection. Before injection, VAS for back pain and leg pain was highly associated with the PSQ-scores including total PSQ and PSQ sub-scores after adjustment for age, BMI, and grade of canal stenosis. However, any sub-scores of PSQ and total PSQ scores were not correlated with either VAS for back pain/leg pain or ODI two months after TFESI with adjustment made to age, BMI, gender, and grade of canal stenosis.

**DISCUSSION:** The current study highlights that individual pain sensitivity does not influence the outcomes of TFESI treatment in patients with LSS even though pain sensitivity has a significant negative correlation with symptom severity of LSS.

**GP146**

**EVALUATION OF BEHAVIOR AND EXPRESSION OF RANKL IN DORSAL ROOT GANGLIA AFTER SCIATIC NERVE COMPRESSION AND APPLICATION OF NUCLEUS PULPOSUS IN RATS.**

Yoshiyuki Matsuyama, MD, Yoshihiro Sakuma, MD, Miyako Suzuki, MD, PhD, Sumihisa Orita, MD, PhD, Kazuyo Yamauchi, MD, PhD, Gen Inoue, MD, PhD, Yasuchika Aoki, MD, PhD, Tetsuhiro Ishikawa, MD, PhD, Masayuki Miyagi, MD, PhD, Hiroto Kamoda, MD, PhD, Gou Kubot; Department of Orthopaedic Surgery, Graduate School of Medicine Chiba University

**INTRODUCTION:** Radicular pain is a common symptom of lumbar disc herniation, which is caused by mechanical compression and inflammation of nerve roots in animals and humans. Cytokines are generated at mechanical compression and inflammation site. However, pathomechanisms of pain from lumbar disc herniation have not been fully elucidated. Cytokines generated at the inflammatory site produce associated pain, but non-steroidal anti-inflammatory drugs and steroid are sometimes insufficient in patients. Nuclear factor-kappa B (NF-kappaB), receptor activator of NFkB (RANK), its ligand (RANKL) is a gene transcriptional regulator of inflammatory cytokines. The purpose of current study was to evaluate painful behavior and expression of RANKL in dorsal root ganglia (DRGs) after sciatic nerve compression and application of nucleus pulposus (NP) in rats.

**METHODS:** In the model, the sciatic nerve was compressed with NP for 2 seconds using forceps (n = 20). We used sham-operated animals (n = 20) and control without any procedure (n=20). Mechanical hyperalgesia were measured every second day for 3 weeks using von Frey filaments. RANKL expression in L5 DRGs was examined at 5 and 10 days after surgery using immunohistochemistry. Extent of mechanical hyperalgesia and the number of RANKL immunoreactive DRG neurons was compared among the 3 groups.

**RESULTS:** Mechanical was found in the nerve compression plus application of NP group rats during 12 days, but not in the control and sham-operated animals (p < 0.05). RANKL was immunostained in nuclei in L5 DRG neurons, and the expression was up-regulated in the nerve compression plus application of NP group rats compared with the control and sham-operated rats (p < 0.01).

**DISCUSSION:** Our results indicate that nerve compression plus application of NP produced pain-related behavior and up-regulation of RANKL in DRG neurons. RANKL may play important role to mediate pain from a sciatic nerve which be compressed and applied of NP.
GP147
NUCLEOPLASTY WITH NUCORE® INJECTABLE NUCLEUS REPLACEMENT FOR HERNIATED LUMBAR DISC: A MULTICENTER STUDY WITH A MINIMUM FIVE-YEAR FOLLOW-UP
U. Berlemann MD1, O. Schwarzenbach MD1, A. Diwan MD PhD2, S. Kitchel MD3, D. Coric MD4; 1The Spine Center, Thun, Switzerland; 2St.Georg Hospital, Sydney, Australia; 3Orthopedic Spine Associates, Eugene OR, USA; 4Carolinias NeuroSurgery and Spine Associates, Charlotte NC, USA

INTRODUCTION: Microdiscectomy has been shown to be highly effective in relieving pain due to lumbar disc herniation. However, significant loss of disc height with corresponding recurrent back and/or leg pain may occur over time. This is a report of a minimum five-year follow-up data from a clinical multicenter study using an in-situ curing injectable hydrogel (NuCore® Injectable Nucleus, Spine Wave, Inc.) as a nucleus replacement following microdiscectomy. The material is a protein polymer which is injected through the annular defect, replacing nucleus tissue lost to herniation and discectomy.

METHODS: Thirty patients (age 18-60 years) at 4 centers were eligible. All patients underwent a standard lumbar microdiscectomy followed by the injection of NuCore® Injectable Nucleus material. Outcomes included leg pain and back pain measured on a Visual Analogue Scale (VAS), functioning assessed with the Oswestry Disability Index (ODI), quality-of-life assessed with the SF-36, and disc height on plain radiographs. MRIs taken at different time points were analyzed by an independent reviewer.

RESULTS: Twenty-five patients completed the five-year follow-up with an average follow-up period of 77 months. Three patients required revision surgery with fusion. Overall, four patients had to be revised due to reherniation of the nucleus. VAS leg pain decreased from 6.4 (SD ± 2.4) pre-op to 1.1 (±1.5) at latest follow-up. VAS back pain decreased from 4.2 (±2.9) to 1.8 (±2.0) and ODI from 42 (±17) to 10 (±8). Disc height loss was 15.9% at latest follow-up compared to pre-op. On MRI analysis no relevant reactions of the endplate nor new or worsening of pre-existing Modic changes were seen.

DISCUSSION: Long-term data of patients with nucleus augmentation with NuCore® Injectable Nucleus following lumbar microdiscectomy is favourable and in line with the literature. However, potential advantages over microdiscectomy alone have to be verified in randomized, controlled trials.

GP148
DETECTION OF SPINAL IMPLANT MATERIALS IN SCOLIOSIS PATIENTS WITH LONG-TERM FOLLOW UP: A QUESTIONNAIRE STUDY
Toshiaki Kotani1, Tsutomu Akazawa1, Tsuyoshi Sakuma1, Tetsuharu Nemoto1, Kento Nawata1, Atsuro Yamazaki1, Kazuhisa Takahashi2, Shohei Minami1; 1. Dept. of Orthopaedic Surgery, Seirei Sakura Citizen Hospital, Chiba, Japan, 2. Dept. of Orthopaedic Surgery, Chiba University, Chiba, Japan

INTRODUCTION: A common concern of scoliosis patients with spinal implants is that their metal implants will activate airport metal detectors. The purpose of the present study was to determine the long-term detection rate of airport metal detectors to scoliosis patients with implants by mail-based questionnaire.

METHODS: We mailed questionnaires to 299 idiopathic scoliosis patients who had undergone corrective surgery from 1968 to 1988 that asked about the responses of airport metal detectors to their implants. A total of 46 patients who had travelled by airplane after surgery completed the ques-
GP149
RISK FACTORS FOR BONE NON-UNION AFTER LUMBAR INTERBODY FUSION
Ko Ishida, Tomotaka Akamatsu, Yohei Ito, Tomoyuki Katsuhata, Naoto Mitsugi; Yokohama City University Medical Center, Orthopaedic Surgery

INTRODUCTION: Although posterior lumbar interbody fusion for lumbar stenosis leded mostly good clinical results, sometimes bone non-union occurred. The purpose of this study is to clarify bone union rate and risk factors for bone non-union after lumbar interbody fusion.

RESULTS: The average age at surgery was 16.1 ± 4.0 (range: 8-29) years. The average follow-up period was 35.2 ± 3.2 (range: 28.8-41.1) years. The average number of flights per patient was 13.7 ± 16.7. Overall, 6 patients (13.0%) responded that their implants activated metal detectors. No significant difference in detection rates was observed between patients who received anterior versus posterior implants.

DISCUSSION: The archway metal detectors used in primary screening have been reported to not detect modern spinal implants, while the handheld metal detectors used in secondary screening do detect all modern posterior spinal implants. A possible explanation for the detection rate in the present study is that patients may have activated handheld metal detectors during secondary screening. Surgeons should educate their patients about not carrying other metallic objects, such as mobile phones and keys, before passing through archway detectors, so as to not be required to undergo handheld metal detector screening. This information can help the passenger avoid uncomfortable body searching screening procedures, thereby easing air travel anxiety in postoperative scoliosis patients.

METHODS: One hundred cases who had lumbar stenosis with instability segment, degenerative spondylolisthesis, isthmic spondylolisthesis, or degenerative scoliosis were operated by PLIF or TLIF using pedicle screws and interbody cage with local or iliac bone and followed more than one year from September 2004 to June 2010 in our hospital. Average age was sixty six. Forty two were male and fifty eight were female. Follow up period was 52.6 months and number of fused segments was 1.6. Bone union was defined by bone bridging or bone continuity through interbody cage in CT and less than five degrees in fused segments for flexion and extension X-rays. Divided into two groups by bone union and non-union group, several parameters and clinical results were compared statistically.

RESULTS AND DISCUSSION: Eighty four cases acquired bone union and bone union rate was 84%. Bone union rate was 86.1% in L1/2 to 4/5 and 68.8% in L5/S, and union rate was significantly lower in L5/S than other areas. Divided into two groups, age was 65.0 years old in union group and 69.8 in non-union group and significantly high in non-union group. BMI, Diabetes, smoking, drinking, bone mineral density in lumbar and femoral neck, presence of crosslink, bone filled area, follow up period, JOA scores and VAS were not significantly different. Number of fused segments was 1.5 in union group and 2.1 in non-union group and significantly high in non-union group.

CONCLUSION: Bone union rate was 84% for lumbar interbody fusion in our hospital. Risk factors for bone non-union were high age, multilevel fusion, and L5/S fusion. Relationship between clinical results and bone union was not significant.
GENERAL POSTERS

GP150
ABLATION OF THE BASIVERTEBRAL NERVE: PILOT STUDY RESULTS, CONTINUOUS EXPERIENCE AND LONG – TERM RESULTS OF AN INNOVATIVE TREATMENT OF BACK PAIN
Becker, Stephan; Institute for Musculoskeletal Analysis, Research and Therapy IM-SART. Ludwig Boltzmann Institute for Experimental and Clinical Traumatology, Austrian Cluster for Tissue Regeneration Vienna Austria

INTRODUCTION: The basivertebral nerve has been described as one of the major factors of back pain. This abstract summarizes the basic research around the basivertebral nerve and the outcome of two case series. The Intracpet System is a new, needle-based device developed to ablate the BVN within the vertebral body with RF energy.

METHODS: Prospective multicenter study, long – term monocenter follow - up.
16 patients prospectively treated between 2008 and 2009 in a multicenter trial. Long – term (max. 5.5y) f/u of nine patients in a single center (max. 5.5y). All patients presenting for surgical therapy (fusion or TDR) after failed conservative management with erosive osteoarthritis (Modic 1 /2) of two to three adjacent vertebrae. The second case series with ten patients (max. F/U 2.5 y). includes patients with spondylolisthesis grade one, black disc grade 2 and 3 after Pfirrmann. A total of 36 levels were treated. F/U with ODI, VAS and SF36.

RESULTS: The initial 16 patients showed a significant decrease of ODI scores (31 points) within the first year (p=0.001). The mean follow – up (3 – 5.5 years) showed still improved parameters (VAS pre 6.3, max F/U 1.1; SF36 PCA pre 36.8, max F/U 47.4; MCA pre 47.4, max F/U 50.2; ODI pre 53.1, max F/U 18.8. The post- initial study patients showed also positive results (VAS max F/U 1, SF36 PCA max F/U 50.5; MCA max F/U 56.1, ODI max F/U 2.7. Sure hit of target in 31 levels, 2 miss, 1 patient lost to F/U at 6w. Overall all of the on – target patients showed continuing significant improvement, the missed target patients showed no clinical improvement which led to fusion procedures.

DISCUSSION: The ablation of the BVN has no negative effect on spine stability. Fusion or TDR could be avoided in all on – target patients. Therefore basivertebral nerve ablation emerges as a very important minimal – invasive tool to treat back pain and avoid larger surgery and should be adapted in anatomical and surgical educational programs.

GP151
PROGNOSTIC FACTORS OF SURGICAL OUTCOME AFTER SPINOUS PROCESS-SPLITTING LAMINECTOMY FOR LUMBAR SPINAL STENOSIS
Keishi Maruo, Tokuhide Moriyama, Toshiya Tachibana, Shinichi Inoue, Shinichi Yoshiha; Department of Orthopaedic Surgery, Hyogo College of Medicine

INTRODUCTION: Expansive laminectomy is the most widely used procedure for degenerative lumbar spinal stenosis (LSS). Lumbar spinous process-splitting laminectomy (LSPSL) has been reported to reduce muscle atrophy and postoperative wound pain. The purpose of this study was to assess the clinical and radiographic outcome and to identify the predictive factors associated with a poor clinical outcome after LSPSL.

METHODS: This study was a consecutive single center retrospective case review of patients undergoing LSPSL for LSS with a minimum 2-year follow-up. Degenerative lumbar scoliosis (DLS) less than 30 degrees and degenerative spondylolisthesis (DS) less than 20% were included. The Japanese Orthopedic Association score (JOA score), recovery rate, reoperation, and complications were reviewed to evaluate the clinical out-
come. The poor clinical outcome group was defined as a recovery rate less than 50%.

**RESULTS:** A total of 52 consecutive patients (mean age: 72.1 years) met the inclusion criteria with a mean follow-up of 2.6 years (range: 2-4.5). The preoperative diagnosis consisted of LSS in 19 cases, DS in 19 cases, DLS in 9 cases, and DS with DLS in 5 cases. The mean JOA score significantly increased from 14.6 points to 23.2 points at the final follow-up. The mean recovery rate was 60.1%. Thirteen patients (25%) had a recovery rate of less than 50%. A higher rate of DLS was observed in the poor surgical group (Good 15%, Poor 62%, P = 0.003). Progression of slippage was found in 8 of the 24 (33%) patients with DS. Progression of scoliosis was found in 5 of the 14 (36%) patients with DLS. Progression of scoliosis and slippage did not have an impact on the clinical outcome.

**DISCUSSION:** The clinical and radiographic outcomes of LSPSL for LSS and DS were favorable, and the progression of slippage and scoliosis were similar to its natural history. However, the presence of DLS is significant risk factor associated with poor clinical outcome.

**GP152**

**EFFECTS OF LORDOTIC ANGLE OF A CAGE ON SAGITTAL ALIGNMENT AND CLINICAL OUTCOME IN ONE LEVEL POSTERIOR LUMBAR INTERBODY FUSION WITH PEDICLE SCREW FIXATION**

Jae Hyup Lee, MD,1 Dong-Oh Lee, MD 1 Ji-Ho Lee, MD,1 Hyeong-Seok Lee, MD,2 Choon-Ki Lee, MD,1 Bong-Soon Chang, MD,1; 1Department of Orthopedic Surgery, College of Medicine, Seoul National University, Seoul, 156-707, Korea 2Department of Orthopedic Surgery, Marynoll Medical Center, Busan, 600-730, Korea

**INTRODUCTION:** Polyetheretherketone (PEEK) cage increases the fusion rate and maintains lumbar lordosis by securing stability in the initial stage in PLIF. However, few clinical studies have been reported the relationship between the lumbar lordosis and the lordotic angles of the cage. This study aims to assess the differences in the radiological and clinical results including segmental lordosis, total lumbar lordosis depending on the lordotic angles of the cage in posterior lumbar interbody fusion (PLIF).

**METHODS:** We reviewed 185 segments which underwent PLIF using two different lordotic angles of 4º (115 segments) and 8º (70 segments) of a PEEK cage on a degenerative lumbar spine. The segmental lordosis and total lumbar lordosis of the 4º and 8º cage groups were compared preoperatively, on the immediate postoperatively, on the 6th and 12th postoperative months. Clinical assessment was performed using the Oswestry Disability Index (ODI) and the visual analogue scale (VAS) of low back pain.

**RESULTS:** There were no differences in terms of age, sex, preoperative diagnosis, or surgical segments in both groups. The preoperative and immediate postoperative segmental lordosis angles were 12.9º and 12.6º in the 4º group, and 12º and 12.0º in the 8º group. Both groups exhibited no significant different segmental lordosis angle and total lumbar lordosis over period and time. However, the total lumbar lordosis significantly increased from six months postoperatively compared with the immediate postoperative day in the 8º group. The ODI and the VAS in both groups had significantly improved postoperatively compared to the preoperative states. However, there were no differences between the two groups.

**DISCUSSION:** Cages with different lordotic angles of 4º and 8º showed insignificant results clinically and radiologically in short-level PLIF surgery. Clinical improvements and sagittal alignment recovery were significantly observed in both groups.
GP153
IS DISCECTOMY WITH LUMBAR DISC HERNIATION EFFECTIVE IN DEGENERATIVE LUMBAR SPONDYLOLISTHESIS?
Takato Aihara, Kenji Hatakeyama, Makoto Urushibara, and Junarto Ouchi; Dept. of Orthopedic Surgery, Funabashi Orthopedic Hospital, Funabashi-city, Japan

INTRODUCTION: The purpose of the present prospective study was to assess the effect of discectomy with lumbar disc herniation (DH) on degenerative lumbar spondylolisthesis (DS).

METHODS: Thirty-three consecutive patients with DS were enrolled in this study to compare outcomes of 2 surgical methods. The patients were divided into the following 2 groups: group H (14 DS patients treated by microendoscopic decompression [MED] and discectomy with DH) and group C (19 DS patients treated by MED without DH). All patients were prospectively followed, and the degrees of improvement (DOIs) were calculated by the following formula: postoperative score - preoperative score of the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire. Lateral radiographs in maximal flexion and extension, and in neutral position were obtained before and after surgery to measure the intervertebral angle and percentage of slipping, and intervertebral disc height at the level of the slip. The mean duration of follow-up was 29 months in groups H and C. The preoperative and postoperative scores, and all DOIs were statistically compared between groups H and C. All radiological measurements were statistically compared between before and after surgery.

RESULTS: All the preoperative scores in group H were lower than those in group C (Fig.).

There were no statistically significant differences in the postoperative scores and all DOIs between groups H and C. The intervertebral disc height in group H was significantly lower after surgery than before surgery. The intervertebral range of motion and percentage of slipping were decreased after surgery in group H (Fig.).

DISCUSSION: The preoperative scores were lower in group H, however, the surgical outcome in both groups were similar. We think this is because the intervertebral motions at the level of the slip were stabilized after discectomy in group H. Therefore, discectomy with DH may lead to good clinical outcome in DS.
BACKGROUND: Lumbar fusion has been widely used and mostly resulted well. However, we experienced cases of adjacent segment disorders resulting in unsatisfactory outcomes with unclear risk factors, which led to repeat surgery. This study aims to reveal the risk factors of adjacent segment disorder after segmental fusion.

METHODS: A total of 54 patients (22 males and 32 females, mean age of 61 years) with L4/5 fusion (5 PLIF, 15 PLF and 34 TLIF) and 15 (5 males and 10 females, mean age of 51 years) with L5/S fusion as a control were selected. Patients with decompression at different levels were excluded. The average follow-up was 4 years (range: 2.7-6.0 years). Angle changes of L4/5, pelvic incidence (PI), lumbar lordosis (LL) and sacral slope (SS) were radiographically assessed. We defined adjacent disc degeneration (AD) as decrease in disc height, osteosclerosis surrounding endplates (XP) and/or intensity change in discs (L1/2 to L5/S) (MRI), and assessed them at each follow-up period. The Kaplan-Meier method was used to assess the failure rate of AD. Radiographic parameters, procedures, sex, ages were statistically analyzed with the COX hazard model.

RESULTS AND DISCUSSIONS: Three patients underwent repeat surgery due to AD (caused by degeneration at L3/4). The Kaplan-Meier method revealed that AD at L1/2, L2/3 and L5/S occurs before AD at L3/4. No difference was noted between L4/5 and L5/S in the onset timing. The hazard model revealed that risk factors of AD at L3/4 were angle change by procedures and AD at L2/3, whereas those of AD at L2/3 were advanced age and change in SS. Risk factors of AD at L5/S were unclear, which suggested that AD at L5/S is specific for AD at L4/5.

CONCLUSION: Adjacent segment disorder at L3/4 is attributable to excessive correction of lordosis and is usually preceded by AD at L2/3. For prevention of adjacent segment disorder, preoperative maintenance of alignment is necessary.

GP155
IMMUNOHISTOCHEMICAL ANALYSIS OF THE RADIOLUCENT ZONE AROUND PEDICLE SCREWS AFTER SPINAL FUSION SURGERY
Koji Akeda, Koichiro Murata, Norihiko Takegami, Akihiro Sudo; Department of Orthopaedic Surgery, Mie University Graduate School of Medicine

INTRODUCTION: The use of spinal instrumentation with a pedicle screw (PS) system is increasingly common. PS loosening, evaluated by the presence of a radiolucent zone on radiogram or CT image, has been reported to be associated with pain and/or pseudarthrosis. Although the radiolucent zone around PSs has been reported to be composed of fibrous tissue, a detailed histopathology of the radiolucent zone has not been performed. The purpose of this study was to immunohistochemically evaluate the tissue of the radiolucent zone surrounding PSs.

METHODS: Five cases of re-operation after spinal surgery because of loosening of PSs were studied (men: 3; women: 2; mean age: 70.4 yrs). The mean duration from the initial surgery to re-operation was 8 months. During surgery, fibrous tissues were removed from the screw holes after removal of loosened PSs. The tissues were fixd in 4% paraformaldehyde and processed for histological analysis. Anti-TRAP (tartrate-resistant acid phosphatase), RANKL (receptor activator of nuclear factor kappa-B ligand), RANK, CD68, p65 (activated NF-.B) and TNF-. antibodies were used for immunohistological analyses.

RESULTS: Histologically, the radiolucent zone around PSs was composed of fibrous tissue with active proliferation of fibroblasts, but also contained an area of microvessel formation. CD68-positive macrophages were found around the area of mi-
crovessel formation, where RANKL-expressing cells were also identified. At the bone-tissue boundary, many TRAP-positive multinucleated giant cells, which also expressed RANK, were identified. Most of constituent cells within the tissue expressed p65. Immunoreactivity for TNF- was also clearly identified (strong: 3 cases, moderate: 2 cases).

**DISCUSSION:** Migration of macrophages, activation of NF- and expression of TNF-, were found in fibrous tissues around loosened PSs. The expression of pro-inflammatory cytokines may be responsible for the osteolysis and pain around loosened PSs.

**GP156**

**EVALUATION OF THE EFFECT OF PARATHYROID HORMONE TREATMENT ON CHANGES IN PEDICLE SCREW FIXITY BY COMPUTED TOMOGRAPHY-BASED FINITE ELEMENT ANALYSIS**

Kazuhide Inage(1), Yukio Nakata(1), Sumi hisa Orita(1), Kazuyu Yamauchi(1), Miyako Suzuki(1), Yoshihiro Sakuma(1), Go Kubota(1), Yasuhiro Oikawa(1), Takeshi Sainoh(1), Jun Sato(1), Kazuki Fujimoto(1), Sadao Arai(2), Kazuhisa Takahashi(1), Seiji Ohtori(1); (1) Dept. of Orthopaedic Surgery, Graduate School of Medicine, Chiba University (2)Arai Orthopaedic Clinic

**INTRODUCTION:** After spinal instrumentation use, reduced pedicle screw (PS) fixity due to osteoporosis and decreased bone strength leads to serious complications such as PS implant failure (loosening, etc.). Although the human parathyroid hormone (PTH) medication, teriparatide, reportedly increases bone density, it is unclear whether PTH treatment has a positive effect on PS fixity. Here, we aimed to evaluate the effect of PTH treatment on PS fixity using a computational finite element method.

**METHODS:** Five osteoporosis patients (5 women; age, 73–75 years; mean age, 74 years) underwent lumbar spinal computed tomography (CT) before and after PTH treatment (treatment duration, 13–18 months; mean, 14 months). We excluded patients with significantly deformed vertebral bodies due to implant or compression fracture. A three-dimensional computational model of the vertebral body was created using acquired CT data. We virtually performed the PS insertion and pull-out test in the longitudinal axis direction with caudal endplate restriction, using finite element analysis software (Mechanical Finder®). The yield points of the vertebral body were computed from elastic and plastic deformation stresses, and changes in the yield points were compared before and after PTH treatment.

**RESULTS:** After PTH treatment, the pedicle elastic modulus increased from 5358 ± 396.8 kPa to 6843 ± 481.5 kPa (p = 0.0001), and the yield point increased from 1000.7 ± 45.2 kPa to 1147.8 ± 51.5 kPa (p = 0.0017).

**DISCUSSION:** The estimated pedicle stiffness and PS pull-out load were increased by 25% and 15%, respectively. A previous study indicated that the reduction of PS pull-out load by using a hook was -70 to -80 N, whereas the present study indicated that PS fixity was increased by 150 N, suggesting that PTH treatment is effective for increasing PS fixity. Thus, PTH treatment can prevent or reduce PS implant failure by increasing the PS pull-out strength.

**GP157**

**TWO-YEAR FOLLOW UP OUTCOMES OF DYNAMIZATION-PLIF FOR DESTRUCTIVE SPONDYLO-ARTHRPATHY ~IS DYNAMIZATION PLIF FOR DSA USEFUL METHOD TO REDUCE THE RISK OF INSTRUMENTATION FAILURE?~**

Naoki Okamoto, Jun-ichi Kunogi, Naohiro Kawamura, Shigeru Masuyama, Kazuhiro Masuda, Yujiro Hirao, Kengo Fujii; Department of Spine and Orthopedic Surgery, Jap-
**anese Red Cross Medical Center**

**INTRODUCTION:** There are many problems in PLIF for destructive spondylo-arthropathy (DSA) of patients with hemodialysis such as instrumentation failure, intervertebral non-union, progression of kyphosis, and poor post-operative clinical outcome. The purpose of this study is to evaluate the efficiency of Dynamization-PLIF (D-PLIF).

**METHODS:** Between August 2009 and October 2011, 31 patients with lumbar DSA underwent D-PLIF in our institution. Of these, 16 patients with over 2 year-follow up were included in this study. Research objects were radiographic findings and clinical outcome (ZCQ and VAS).

**RESULT:** The 16 cases consisted of 7 male and 9 female, mean age was 64.0, mean hemodialysis period was 24.0 years, and mean follow up period was 33.2 months. Operated levels was as follows; 1 level, 8 cases; 2 levels, 7 cases; 3 level, 1 case. In most of the cases shortening of PLIF segment stopped within 6 months with average of 3.6mm. Generally, the fusion level and lumbar lordosis kept good alignment. 15 cases got intervertebral bony union. Only two cases required re-operation for loosening of pedicle screw and adjacent level impairment. In clinical outcome, ZCQ and VAS improved significantly at the last observation compared with before operation. In ZCQ, symptom severity score improved 4.0±1.0 to 2.6±0.8, and physical function score improved 3.3±0.6 to 2.1±0.3. VAS(back pain & leg pain) improved 8.3±1.9 to 4.6±2.8.

**DISCUSSION:** The endplate and vertebrae of DSA patients are fragile because of low bone quality, which leads to high frequency of instrumentation failure. In our D-PLIF, pedicle screws can slide along the rods, and this allows sinking of cages synchronizing the shortening of anterior element. Consequently, loosening of pedicle screw was rare and bone union may have been promoted by intervertebral compression. In conclusion, D-PLIF is useful method for DAS, in point of reducing instrumentation failure, keeping good alignment, and getting good clinical outcome.

**GP158**

**CLINICAL OUTCOMES OF ENDOSCOPE-ASSISTED SPINAL DECOMPRESSION SURGERY FOR DEGENERATIVE LUMBAR SPONDYLOLISTHESIS WITH SPINAL INSTABILITY**

Minamide A, Yoshida M, Yamada H, Hashizume H, Nakagawa Y, Nishi H, Iwasaki H, Tsutsui S, Okada S; Department of Orthopaedic Surgery, Wakayama Medical University, Wakayama, Japan

**INTRODUCTION:** The authors have developed a minimally invasive laminotomy using spinal endoscope to lumbar spinal disorders since 1998. The novel microendoscopic laminotomy (MEL) technique helps to preserve the facet joints, posterior ligament complex and soft tissues as much as possible. The MEL may not cause postoperative spinal instability. The purpose of this study was to investigate the clinical outcomes of MEL surgery for degenerative lumbar spondylolisthesis (DS) with or without spinal instability.

**METHODS:** From 2003 to 2010, all patients, who developed a surgical treatment for DS on L3/4 or L4/5 single level, underwent MEL surgery at the authors’ institute. A total of 302 patients (126 males, 176 females; mean age: 68.9 years) were reviewed prospectively. They were divided into two groups by with (SI group) or without (Non-SI group) spinal instability. The spinal instability was defined as %slip > 20% and either slippage > 5% or posterior opening > 5o on lateral stress radiographs. The following items were evaluated preoperatively and 2-years postoperatively: Japanese Orthopaedic Association scoring system (JOA score), the recovery rate, VAS for low back pain, and
clinical affected factors. All parameter were analyzed statistically (p<0.05).

RESULTS: Finally, 245 patients (SI: 86pts, Non-SI: 159pts) were reviewed. There were no significant differences in age and preoperative JOA score between two groups. The JOA recovery rate in SI and Non-SI groups was respectively 61.7±27.2% and 66.5±22.7% (p>0.05). The mean %slip of all patients was 17.1% preoperatively and 17.7% 2-years postoperatively (p>0.05). In the SI group, there was no postoperative enhancement of spinal instability (p>0.05). Moreover, the spinal stabilization with disc height decrease was postoperatively found in 37% of SI group.

CONCLUSIONS: This observation suggests that MEL offered good clinical outcomes of DS with SI, and the postoperative spinal stabilization.

GP159
INCIDENTAL DUROTOMY IN POSTERIOR LUMBAR SURGERY AND ITS PREVENTION USING THE YELLOW LIGAMENT FLOATING METHOD
T.Yamazaki, N.Hara, S.Terayama, K.Hayakawa; Department of Orthopedic Surgery, Musashino Red Cross Hospital

Introduction: Incidental durotomy (ID) is a common complication in posterior lumbar surgery and sometimes leads to serious conditions, such as nerve damage or brain hemorrhage. It is important to know how ID occurs and the prevention measures.

Methods: ID from 2004 to 2012 was prospectively recorded. We investigated the surgical procedure in which ID occurred and the preventive effect of the yellow ligament floating method.

Results and discussion: Fifty IDs including 6 nerve injuries occurred in 1553 posterior lumbar surgeries. ID occurred during laminectomy in 25 cases; while retracting the nerve root to remove disc herniation in 7; while separating scar tissue or yellow ligament in 5; while removing herniation with forceps in 3; while inserting PLIF cage in 2; and in 1 case each during pedicle screw insertion, while removing soft tissue with forceps during approach, while retracting a nerve root to insert a PLIF cage, while during decortication for bone graft using an osteotome, and injecting epinephrine before incision. ID was not always found when it occurred, but was discovered just before closure in 3 cases, and was recognized by spinal fluid in the drain tube in 1 case. Conventional laminectomy was performed for spinal canal stenosis when disectomy or fusion was unnecessary in 86 cases and ID occurred in 7 cases. After 2006, the yellow ligament floating method was performed for the same condition in 288 cases and ID occurred in 2. The yellow ligament floating method was significantly effective for ID prevention (P=0.0015 chi-square test) as a decompression procedure.

ID can occur during various procedures, and the most frequent surgical procedure was laminectomy. The Japanese Society for Spine Surgery and Related Research reported that full recovery from ID was 84.5%. Heinrich’s law states that preventing a minor accident may prevent a more serious accident. The yellow ligament floating method is useful for preventing serious accidents by reducing ID.

GP160
EFFECT OF CERVICAL LAMINOPLASTY ON LOWER BACK PAIN
Yuuji Hiroa, M.D.; Katsushi Takeshita, M.D., Ph.D.; Hiroyuki Oka, M.D.; Yasushi Oshima, M.D., Ph.D.; Takashi Ono, M.D.; Junichi Ohya, M.D.; Kazuhito Soma, M.D.; Hirotaka Chikuda, M.D., Ph.D.; the Department of Orthopaedic Surgery, the University of Tokyo, Japan

INTRODUCTION: Axial neck pain after cervical posterior surgery is a well-known problem. However, there are few reports on
local pain outside the neck and upper extremities. The purpose of this study was to identify the effect of laminoplasty on pain in areas including the lower back.

**METHODS:** We studied 94 patients (61 men, 33 women) with cervical stenotic myelopathy who underwent laminoplasty in our hospital. Mean age at surgery was 64.7 years, and the mean follow-up period was 25 months. Numerical Rating Scales (NRS; 0 to 10 points, 0 indicates no pain) for pain in the lower back and other regions were obtained preoperatively and at last follow-up. We defined pain relief as decrease of NRS by 2 points or more, and pain deterioration as an increase of 2 points or more. We identified 15 patients who also suffered from thoracic/lumbar disorders, and excluded them from the analysis. To determine whether any radiographic characteristics or psychological factors are related to lower back pain, we evaluated sagittal alignment parameters, the severity of thoracic/lumbar spondylosis by the Kellgren-Lawrence (K-L) grade, and the self-rating scale of Profile of Mood Stated (POMS), calculating Spearman correlation coefficients.

**RESULTS:** Median of lower back pain was 2 points preoperatively, and 3 points at last follow-up. Though 24% of patients reported pain relief in the lower back, 17% reported pain deterioration. Lower back pain at final follow-up had no significant relationship with sagittal alignment or K-L grade. On the other hand, we identified relationships between lower back pain at final follow-up and most of the POMS subscales.

**DISCUSSION:** Lower back pain deteriorated in some patients and had little relationship with radiographic characteristics. This study clarified the frequency of post-laminoplasty axial pain not only in the neck but also in the back to lower back, and a possible relationship between lower back pain and psychological factors.

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**GP161**

**PATIENT CHARACTERISTICS AFFECTING DISCHARGE DISPOSITION AFTER LUMBAR FUSION**

Alejandro Marquez-Lara MD, Sreecharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

**INTRODUCTION:** Lumbar fusion (LF) is commonly utilized to treat degenerative disorders. The purpose of this study was to analyze patient characteristics, comorbidities, and outcomes that influence the discharge disposition following a LF.

**METHODS:** The Nationwide Inpatient Sample (NIS) was queried from 2002-2011. Patients undergoing elective LF for degenerative pathology were identified and separated into three cohorts based upon the discharge disposition (home vs home with healthcare vs outside facility). Patient demographics, comorbidity burden (CCI), length of stay (LOS) and costs were assessed. Regression analysis with a 95% confidence interval was utilized to identify independent predictors for discharge to another facility. SPSS v.20 was utilized for statistical analysis and a p-value of <0.001 denoted statistical significance.

**RESULTS:** A total of 263,873 LF’s were identified of which, 190,330 (72.1%) were discharged home, 36,327 (13.8%) were discharged home with healthcare and 37,216 (14.1%) were discharged to an outside facility. The outside facility cohort was significantly older and demonstrated a greater comorbidity burden. In addition, patients discharged to an outside facility were associated with a greater number of fusion levels and incurred a significantly greater LOS, costs, and postoperative complications. Regression analysis demonstrated that common chronic conditions (hypertension, diabetes, depression, congestive heart failure, etc), psycho-neurological conditions,
and drug abuse were independent risk factors for discharge to an outside facility.

**CONCLUSION:** After a lumbar fusion, 14.1% of patients were discharged to an outside facility. This study identified the perioperative parameters that increase the risk for discharge to an outside facility. Further research is warranted to demonstrate if preoperative optimization of these risk factors may reduce the need for additional postoperative care following a lumbar spinal fusion.

**GP162**

**EFFECT OF HYPERTENSION IN SURGICAL OUTCOMES AFTER LUMBAR SPINE SURGERY**

Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

**INTRODUCTION:** Hypertension (HTN) is common in patients undergoing lumbar spine surgery (LSS). However, the impact of high blood pressure with regards to patient outcomes and hospital resource utilization after LSS is not well characterized.

**METHODS:** The Nationwide Inpatient Sample (NIS) database was queried from 2002-2011. Patients who underwent an elective lumbar decompression (LD) or lumbar fusion (LF) were selected. Patients with HTN were then identified within each surgical cohort. Demographics, comorbidity burden (CCI), length of stay (LOS) and costs were assessed. Regression analysis with a 95% confidence interval was utilized to determine if HTN was an independent predictor of postoperative complications. SPSS v.20 was utilized for statistical analysis and a p-value of <0.001 denoted statistical significance.

**RESULTS:** A total of 292,835 LDs and 264,944 LFs were identified between 2002-2011. There were 128,827 (43.9%) and 119,550 (45.1%) hypertensive patients in the LD and LF cohorts respectively. Hypertensive patients were significantly older and demonstrated a greater CCI than normotensive patients. HTN was associated with a greater LOS, hospital costs and postoperative complication. However, there were no significant differences in mortality between hypertensive and normotensive patients. Regression analysis demonstrated that HTN was an independent predictor of postoperative hemorrhagic anemia and urinary tract infection.

**CONCLUSION:** Hypertensive patients were older, demonstrated a greater comorbidity burden, and incurred a greater number of postoperative complications, which likely contributed to the greater LOS and total hospital costs in this patient population. Interestingly, HTN was not associated with a greater mortality rate. In light of these findings, further studies are warranted to determine if adequate peri-operative blood pressure control can reduce the rate of postoperative complications and the utilization of hospital resources.

**GP163**

**CLINICAL DEPRESSION IS ASSOCIATED WITH HIGHER OVERALL MEDICAL COSTS IN WORKER’S COMPENSATION SUBJECTS AT 3 YEARS AFTER SINGLE LEVEL LUMBAR FUSION SURGERY**

Joshua T. Anderson, BS (1,2), Ryan J. Duff (3), Uri M. Ahn, MD (4), Nicholas U. Ahn, MD (1); 1 University Hospitals Case Medical Center Department of Orthopaedic Surgery 2 Case Western Reserve University School of Medicine 3 University of Minnesota Twin Cities 4 New Hampshire Spine Institute

**INTRODUCTION:** Worker’s compensation (WC) subjects consistently have worse outcomes following lumbar fusion than non-WC subjects. Few studies have evaluated predictors of poor fusion outcomes in WC subjects.
METHODS: We used ICD-9 and CPT codes to identified 4107 subjects from the Ohio Bureau of Worker's Compensation that underwent single level lumbar fusion as their index fusion after injury. 720 subjects underwent fusion for the indication of spondylololisthesis, 37 of which had depression before fusion. 1166 subjects underwent fusion for degenerative disc disease (DDD), 78 of which had depression before fusion. Subjects with a smoking history or failed back syndrome were not considered. We measured each subject's total medical costs at 3 years after fusion. We analyzed the impact of depression on medical costs in each group with separate linear regression analyses.

RESULTS: Net medical costs were significantly higher in subjects diagnosed with depression before fusion in both the spondylolisthesis group (p<0.00) and the DDD group (p<0.00). Among the spondylolisthesis group, subjects without depression at 3 years after fusion had a mean net medical cost of $41,185 (CI+/-$2783). Those with depression had a mean net medical cost of $66,492 (CI+/-$21,321). Within this group, personal income also significantly impacted total medical costs (p<0.00). Among the DDD group, subjects without depression at 3 years after fusion had a mean net medical cost of $45,456 (CI+/-$2472). Those with depression had a mean net medical cost of $61,136 (CI+/-$10,643). Income did not significantly impact the DDD group. Among both groups, the influences of obesity, gender, and age did not significantly impact medical costs.

DISCUSSION: Among worker's compensation subjects diagnosed with clinical depression, single level fusion surgery for the indication of either degenerative disc disease or spondylolisthesis is associated with significantly higher medical costs at 3 years follow-up.

GP164
TWO-YEAR RESULTS OF X-STOP INTERSPINOUS IMPLANTS WITH LUMBAR SPINAL STENOSIS
Kazuhiro Masuda, Jun-ichi Kunogi, Naohiro Kawamura, Shigeru Masuyama, Yujiro Hirao, Kengo Fujii, Gaku Niitsuma, Naoki Okamoto, Naoki Takahashi; Department of Spine and Orthopedic Surgery, Japanese Red Cross Medical Center

INTRODUCTION: Surgical decompression is the most common procedure to symptomatic lumbar spinal stenosis (LSS) and indirectly decompression such as the dynamic stabilization device is not popular in Japan, because spinal canal of Japanese population is significantly narrow compared with those of Westerners. The aims of the present study were to retrospectively assess the clinical outcomes in Japanese population with symptomatic LSS before and at periodic intervals following X-STOP implantation and compared these outcomes with those of decompression surgery.

METHODS: We retrospectively analyzed 50 consecutive patients treated with X-STOP implantation from January 2011. All patients were treated at the stenotic segment, which was at one or two levels in each patient. The Zurich Claudication Questionnaire (ZCQ) were used for clinically evaluating the patients at the preoperative, 1-year and 2-year. The outcomes in patients treated with X-STOP implantation were compared to those in 50 patients treated with decompressive procedures without fusion at one or two levels of stenotic segment.

RESULTS: Of the 50 patients enrolled, 46 completed all questionnaires at 1-year and 42 patients at 2-years. Clinically significant improvement was attained by 66.7% at 1-year and 56.7% at 2-years, compared with 71.3% at 1-year and 60.7% at 2-years. More than 60% patients expressed satisfaction (ZCQ patient satisfaction score <2) with
both procedures. The complication rate was with X-STOP was 9.5% (4/42).

**RESULTS:** Cervical computed tomography (CT) showed remarkable crown-shaped calcium deposits surrounding the odontoid process. The patient was diagnosed with the CDS. The patient’s condition relieved by nonsteroidal anti-inflammation drugs and corticosteroids within one week.

**DISCUSSION:** Some limitations of our study must be acknowledged. The present study was based on retrospective observational study. Thus, the patient allocation was non-randomized. However, our study produced novel findings, that improved clinical outcomes are maintained at 2-years after X-STOP implantation in Japanese populations with symptomatic LSS and there were no significant differences between the clinical outcomes of X-STOP implantation and those of decompression surgery.

**GP165**

**CROWNED DENS SYNDROME AFTER LUMBAR SPINAL SURGERY**

Kazuhiro Masuda, Jun-ichi Kunogi, Naohiro Kawamura, Shigeru Masuyama, Yujiro Hirao, Kengo Fujii, Gaku Niitsuma, Naoki Okamoto, Naoki Takahashi; Department of Spine and Orthopaedic Surgery, Japanese Red Cross Medical Center

**INTRODUCTION:** Crowned dens syndrome (CDS) is a rare but underrecognized cause of acute cervical pain and calcifications in the periodontoid space. We describe a case of CDS mimicking acute meningitis after lumbar spinal surgery.

**METHODS:** A 81-year-old woman with lumbar spinal canal stenosis secondary to a degenerative spondylolisthesis underwent decompression and fusion with instrumentation from T12 to L4. Surgical procedure was uncomplicated. Three weeks later, She became systemically unwell with headache, restriction of neck motion, and fever 39°. A laboratory examination revealed a markedly increased C-reactive protein level (22.5 mg/dl), serum amyloid A (2313μg/ml), and a slightly increased white blood-cell count (9,000/μl). We performed a rachicentesis on the suspicion of acute meningitis, but no relevant cerebrospinal fluid abnormalities were detected.

**DISCUSSION:** CDS is diagnosed on clinical and radiological grounds. Sometimes symptoms of CDS are misleading and may be misdiagnosed as meningitis, especially happened after spinal surgery in our case. CT scanning is necessary for diagnosis. Spinal surgeon should be consider CDS as a differentiated diagnosis of a possible etiology for fever, headache and cervical pain of unknown origin, and prevent invasive, expensive and useless investigations.

**GP166**

**ADJACENT SEGMENT PATHOLOGY AFTER SINGLE LEVEL MINIMALLY INVASIVE TRANSFORAMINAL LUMBAR INTERBODY FUSION WITH PERCUTANEOUS SCREW INSTRUMENTATION A MINIMUM THREE YEARS FOLLOW-UP**

Moon Chan Kim, Jung Wook Park, Woo Chul Kim, Hong Suk Lee, Do Keun Kim, Hung Tae Chung; Department of orthopaedic surgery of Busan Bumin Hospital

**INTRODUCTION:** The purpose of this study was to investigate the ASP, especially disc degeneration and Modic change after MI-
TLIF with percutaneous screw instrumentation.

**METHODS:** Forty-four patients treated with single level MI-TLIF who had taken MRI at preoperative periods and at least 3-years follow-up were included between Dec.2008 and Aug.2010. Disc degeneration grading through MRI was based on a modified Pfirrmann grade by observing the T2-weighted midsagittal image. Vertebral body endplate and bone marrow change grading through MRI was based on Modic change by observing the T1 and T2 weighted midsagittal image. The progressive pattern of Pfirrmann grade and Modic change three years after surgery was analysed in adjacent level of fusion segment.

**RESULTS:** All patients had progressive pattern of disc degeneration. Although caudal level of fusion segment except L5-S1 fusion was observed in 27(90.0%) cases. The progressive adjacent disc degeneration of cranial level was found in all level. The progressive disc degeneration of caudal level was 4(80%) in L3/4 fusion, 23(92%) in L4/5 fusion. The progressive pattern of disc degeneration was occurred more frequently in cranial level of fusion segment. Also, 40(90.9%) patients had progressive pattern of Modic change. The progressive adjacent Modic change of cranial level was found in 3(60%) of L3-4 fusion, 18(72%) of L4-5 fusion, 12(85.7%) of L5-S1 fusion. The progressive pattern of Modic change of caudal level was found in 4(80%) of L3-4 fusion, 22(88%) of L4-5 fusion. The progressive pattern of Modic change was more frequent in caudal level of fusion segment.

**DISCUSSION:** We found different progressive patterns of disc degeneration & modic change according to adjacent segment of MI-TLIF. This method can be presume the occurrence of ASP to be delayed compared to other posterior fusion methods. However in this study we have verified the progression of ASP so studies comparing other posterior fusion methods will be needed.

**GP167**

**THE INFLUENCE OF SPINAL SAGITTAL BALANCE ON CLINICAL OUTCOMES AFTER MICROENDOSCOPIC LAMINOTOMY FOR PATIENTS WITH LUMBAR SPINAL CANAL STENOSIS.**

Dohzono S, Toyoda H, Terai H, Suzuki A, Yasuda H, Shinohara Y, Tamai K, Nakamura H; Department of Orthopaedic Surgery, Osaka City University Graduate School of Medicine

**INTRODUCTION:** Little is known about the relation between anterior translation of the C7 plumb line and clinical outcomes after decompression surgery for patients with lumbar spinal canal stenosis (LSS). The purpose of this study was to evaluate whether spinal sagittal balance affects low back pain (LBP) and clinical outcomes after microendoscopic laminotomy.

**METHODS:** The study subjects were 88 patients (47 male and 41 female; mean age, 68.7 years) who were diagnosed with LSS. All patients underwent microendoscopic laminotomy at our institution. Patients were observed for an average of 16.0 months (6-48 months). All patients evaluated the JOA score and VAS for LBP, leg pain and leg numbness before and after surgery. The distance between C7 plumb line and the posterior corner of the sacrum (sagittal vertical axis, SVA) and L1S1 angle before surgery were measured using lateral standing films of the entire spine. Patients were divided into two groups according to SVA: Forward bending trunk group (F group) showed a value of SVA was more than 50mm; and Control group showed less than 50mm. Radiologic factors and clinical outcomes were compared between two groups.

**RESULTS AND DISCUSSION:** 35 patients were allocated to F group, and 53 to Control group. The average SVA was 81.0mm in F group and 22.0mm in Control group. L1S1
angle of the F group (22.9degree) was significantly lower than that of Control group (32.8 degree). There was no significant difference between two groups in the improvement ratio of JOA scores and VAS for leg numbness at the final follow-up. VAS for LBP and leg pain of the F group at the final follow-up (21.1/18.9mm) was significantly higher than that of Control group (11.0/9.4mm), though there was no significant difference between groups preoperatively.

**CONCLUSION:** Microendoscopic surgery itself is minimally invasive to the paraspinal muscles. However preoperative abnormal translation of SVA related to residual low back pain after this procedure.

**GP168**
**EVALUATION OF LOW DOSE RH BMP-2 AND BONE-MARROW DERIVED MESENCHYMAL STEM CELLS IN POSTEROLATERAL SPINAL FUSION-DIFFERENCES WITH AND WITHOUT OSTEOSTERGIC DIFFERENTIATION**

Tao Hu 1, Soo Yein Toh 1, Raymond Wing Moon Lam 1, Ming Wang 1, Sunny Akogwu Abbah 1, James Cho-Hong Goh 2, Jun Li 2, Kishore Bhakoo 1,3, Simon Cool 1,4, Hee-Kit Wong 1*; 1 Department of Orthopaedic Surgery, Yong Loo Lin School of Medicine, National University of Singapore, Singapore. 2 Department of Biomedical Engineering, Faculty of Engineering, National University of Singapore, Singapore. 3 Singapore Bioimaging Consortium, Agency for Science, Technology and Research, Singapore. 4 Institute of Medical Biology, Agency for Science, Technology and Research, Singapore. *Corresponding author.

**INTRODUCTION:** High dose rhBMP-2 has been reported to result in complications, such as seroma formation, etc. Dose reduction can reduce complications, but this influences fusion rate in a dose dependent manner. Both osteogenic differentiated and undifferentiated bone-marrow derived mesenchymal stem cells (BMSCs) have been reported to enhance bone regeneration. We proposed that low dose rhBMP-2 combined with osteogenic differentiated/undifferentiated BMSCs may induce posterolateral spinal fusion.

**METHODS:** Forty-four syngeneic Fischer rat were divided into 6 groups: 1)10µg rhBMP-2 with undifferentiated BMSCs, 2)2.5µg rhBMP-2 with undifferentiated BMSCs, 3)0.5µg rhBMP-2 with undifferentiated BMSCs, 4)10µg rhBMP-2 with osteogenic-differentiated BMSCs, 5)2.5µg rhBMP-2 with osteogenic-differentiated BMSCs, 6)0.5µg rhBMP-2 with osteogeni-differentiated BMSCs. Each rat underwent posterolateral spinal fusion between L4 and L5 transverse processes on the both sides following implantation of 1M cells. The lumbar spines were harvested and evaluated by manual palpation test, microCT and histological analysis at 6 weeks postoperatively.

**RESULTS:** Through manual palpation of the harvested spine, both differentiated and undifferentiated BMSCs groups with 10µg rhBMP-2 achieved 100% (6/6) solid fusion. In 2.5µg rhBMP-2 groups, 4 of 8 rats (50%) in the undifferentiated BMSCs group, and 1 of 8 rats (12.5%) in the differentiated BMSCs group achieved fusion. In 0.5µg rhBMP-2 groups, no solid fusion was achieved (0%). MicroCT and histology results confirmed the findings of the manual palpation.
DISCUSSIONS: The results support the view that high dosage rhBMP-2 could mask the effect of BMSCs, where both groups showed solid fusion irrespective of differentiation condition. In the lower dose rhBMP-2 condition, undifferentiated BMSCs performed better in terms of bone formation and matrix integration as compared to the differentiated BMSCs in the rodent posterolateral spinal fusion model.

GP169
FUSION PERFORMANCE OF BONE MARROW-DERIVED MESENCHYMAL STEM CELL AND LOW DOSE RECOMBINANT HUMAN BONE MORPHOGENETIC PROTEIN 2 DELIVERED BY POLYELECTROLYTE COMPLEX MICROBEADS IN A PORCINE ANTERIOR LUMBAR INTERBODY FUSION MODEL
Tao Hu 1, Soo Yein Toh 1, Raymond Wing Moon Lam 1, Ming Wang 1, Sunny Akogwu Abbah 1, James Cho-Hong Goh 2, Jun Li 2, Kishore Bhakoo 1,3, Simon Cool 1,4, Hee-Kit Wong 1*; 1 Department of Orthopaedic Surgery, Yong Loo Lin School of Medicine, National University of Singapore, Singapore. 2 Department of Biomedical Engineering, Faculty of Engineering, National University of Singapore, Singapore. 3 Singapore Bioimaging Consortium, Agency for Science, Technology and Research, Singapore. 4 Institute of Medical Biology, Agency for Science, Technology and Research, Singapore. *Corresponding author.

INTRODUCTION: High dose rhBMP-2 has been reported to result in complications such as seroma formation, osteolysis, etc. Previously, we have reported a polyelectrolyte complex (PEC) microbeads carrier system that can reduce the effective dose of rhBMP-2 in rodent spinal fusion model. The aim of this study is to evaluate the safety and efficacy of combination of bone marrow-derived mesenchymal stem cell, and low-dose rhBMP-2 incorporated PEC system, in a three-level large animal model of anterior lumbar interbody spinal fusion application.

METHODS: Six Yorkshire pigs underwent a tri-segmental (L2/L3; L3/L4; L4/L5) anterior lumbar interbody fusion (ALIF) in four groups, namely: (1) BMSCs + 25µg rhBMP-2 delivered by PEC; (N=3, n=9) (2) 25µg rhBMP-2 delivered by PEC; (N=1, n=3) (3) BMSCs + 5µg rhBMP-2 delivered by PEC; (N=1, n=3) and (4) 50µg rhBMP-2 delivered by absorbable collagen sponge (negative control, N=1, n=3). The lumbar spines were harvested and evaluated by microCT, biomechanical testing and histological analysis at 12 weeks postoperatively.

RESULTS: The mean radiographic scores at 12 weeks were 2.7, 2.0, 1.0, and 1.0 for groups 1 to 4, respectively. The micro-computed tomographic scanning, biomechanical evaluation and histological analysis demonstrated solid fusion in group 1, while group 2 showed inferior quality of fusion and groups 3 and 4 failed to fuse the interbody spaces. There was no evidence of seroma formation, implant rejection or any other complications.
DISCUSSIONS: The results of this study suggest that combination of the BMSCs and low dose rhBMP-2 delivered by PEC could be used as a bone graft substitute in this large animal ALIF model, and may be a viable alternative to conventional autograft bone.

GP170
COMPARISON OF RADIOLOGICAL AND CLINICAL RESULTS OF BALLOON KYPHOPLASTY ACCORDING TO ANTERIOR HEIGHT LOSS IN THE OSTEOPOROTIC VERTEBRAL FRACTURE
Jae Hyup Lee, MD,1 Dong-Oh Lee, MD,1 Ji-Ho Lee, MD,1 Hyeong-Seok Lee, MD,2 Bong-Soon Chang, MD,1 Choon-Ki Lee, MD,1; 1Department of Orthopedic Surgery, College of Medicine, Seoul National University, Seoul, 156-707, Korea 2Department of Orthopedic Surgery, Marynoll Medical Center, Busan, 600-730, Korea

INTRODUCTION: The purpose of this study was to compare the vertebral height reduction rate, kyphotic angle and clinical results according to the degree of anterior vertebral height loss, and to determine the feasibility and effects of kyphoplasty on severely collapsed osteoporotic vertebral fracture.

METHODS: A total of 129 patients (145 vertebrae) who had kyphoplasty due to osteoporotic vertebral fracture and were followed up for more than 1 year were recruited for analysis. The patients’ kyphotic angle, anterior vertebral height and anterior height reduction ratio 1 year after surgery were compared. Pain around the fractured vertebral body and the radiological and clinical results according to bone mineral density were also compared. Patients were divided into three groups according to the ratio of vertebral compression rate; compression rate exceeding 70% were placed in Group I, compression rate of 50~70% in Group II, and compression rate of 30~50% or less in Group III.

RESULTS: Group I had a higher vertebral height reduction rate immediately after surgery compared to the other groups, but the reduction rate of vertebral height in Group I noticeably decreased with time. All three groups showed a significant reduction in the anterior height between pre- and post-operation. The anterior height 1 year after surgery did not differ between Group I and II, but Group III showed a significantly higher anterior height compared to the other groups. Pain around the fractured vertebra at 1 year after surgery did not differ significantly between groups.

DISCUSSION: Kyphoplasty on patients with an anterior vertebral compression rate exceeding 70% due to osteoporotic vertebral fracture significantly improved the degree of pain, anterior vertebral height reduction and kyphotic angle correction, with no differences in these parameters being found compared with other groups. Therefore, kyphoplasty can be a useful approach in patients with an anterior vertebral compression rate exceeding 70%.

GP171
MRI EVALUATION OF DURAL SAC ENLARGEMENT BY INTERSPINOUS SPACERS (X-STOP): DOES LIMITING THE SPINAL EXTENSION CHANGE THE GLOBAL SAGITTAL ALIGNMENT?
Akazawa T., Kotani T., Sakuma T., Nemoto T., Nawata K., Yamazaki A., Minami S., Ohtori S., Takahashi K.; Dept. Orthopedic Surgery, Seirei Sakura Citizen Hospital, Sakura; Dept. Orthopedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Japan.

INTRODUCTION: This study aimed to answer the following question regarding surgery using interspinous spacers (X-STOP).
1. Does the dural sac enlarge?
2. Does flexing the affected spine have an effect on the global alignment?
3. Do clinical symptoms improve?
**METHODS:** The subjects were 11 patients who had lumbar spinal stenosis and had undergone surgery using interspinous spacers. There were 6 men and 5 women and their mean age was 72.6 years (range: 63-82 years). The evaluation of pre- and postoperative imaging involved MRI, plain x-rays. The VAS scores were examined. Three-dimensional MRI was used for evaluation, and the area of the dural sac was measured using a cross-sectional image of the superior endplate of the lower vertebral body of the affected spine. The plain x-ray of the whole spine was to measure thoracic kyphosis (TK), lumbar lordosis (LL), pelvic parameters, affected intervertebral angle, disc height, and percentage of slip.

**RESULTS:** MRI showed that the pre- and postoperative areas of the dural sac were 54.3±23.6 mm² and 79.2±26.7 mm², respectively, indicating a significant enlargement (p<0.001). There was no significant difference between the pre- and postoperative flexion disc angles, but the extension disc angles were 9.4° and 6.2°, respectively (p=0.002). There was no significant difference in pre- and postoperative TK, LL, PT, SS, or SVA. The pre- and postoperative intervertebral angles were 4.7° and 3.3°, respectively, indicating a decrease (p=0.219). The VAS scores were significantly improved postoperatively: low back pain (preoperative: 4.6 and postoperative: 2.2, p=0.024), buttock and lower leg pain (7.3 and 1.7, p<0.001), and buttock and lower leg numbness (5.4 and 1.8, p=0.043).

**DISCUSSION:** MRI showed that the dural tube enlarged 1.46 fold, and indirect decompression was achieved using the interspinous spacer. The disc angle in a standing position was slightly decreased postoperatively, but the global sagittal alignment was not affected.

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**GP172**

**THE CLINICAL OUTCOMES AND FEATURES AFTER MICROENDOSCOPIC LAMINOTOMY FOR ELDER PATIENTS WITH LUMBAR SPINAL STENOSIS.**

Hiroyuki Yasuda, Hiromitsu Toyoda, Sho Dohzono, Tomiya Matsumoto, Hidetomi Terai, Akinobu Suzuki, Kazuhiro Shinohara, Kohji Tamai, Hiroaki Nakamura; Department of Orthopedic Surgery, Osaka City University Graduate School of Medicine

**INTRODUCTION:** With increased aging of the population, spine surgeons have more opportunity to treat elder patients for lumbar spinal stenosis (LSS). The purpose of this study was to clarify the clinical features and to evaluate clinical outcomes after microendoscopic laminotomy (MEL) with LSS in the elder patients aged 75 years or older.

**MATERIALS AND METHODS:** We retrospectively reviewed 93 consecutive patients with LSS who underwent MEL. We excluded patients with other conditions that could affect functional status and finally 81 patients (47 male and 41 female), aged 68.5 ± 10.2 years, were analyzed in this study. The number of single level decompression was 72, two levels was 8 and three levels was 1. Follow up period was 18.8 ± 8.8 months. JOA score (0-29), visual analog scale (VAS) for low back pain/leg pain/leg numbness were evaluated before surgery and at 3, 6, 12 months after the surgery and the final follow up. Patients were divided into three groups according to age at the time of surgery; group A : less than 65 years, group B : from 65 years to 74 years, group C : 75 years or more. The data was analyzed and compared among three groups.

**RESULTS:** JOA score at 3 and 6 months after surgery in group B and C were significantly lower than that in group A (at 3M: 26.5/24.2 /23.2, at 6M: 27.2/25.0/25.5,) and the clinical courses of VAS for low back pain/leg pain were similar. There were no significant differences in VAS for leg numb-
GP173
SPINAL OSTEOTOMY AND CORRECTION USING SUK DVR SYSTEM FOR ADULT SAGITTAL PLANE DEFORMITY
Masahiro Kanayama, MD* Motoya Ikawa, MD** Tomoyuki Hashimoto, MD* Keiichi Shigenobu, MD* Fumihiro Oha, MD* Akira Iwata, MD* Shingo Onda, MD* Masaru Tanaka, MD* Hiromi TsumeKawa, MD**: *Spine Center, Hakodate Central General Hospital, Hakodate, Japan **Dept. of Orthopaedic Surgery, Toyooka Central Hospital, Asahikawa, Japan

INTRODUCTION: SUK DVR system was developed for vertebral derotation maneuver in scoliosis surgery. We applied this device for sagittal-plane correction in adult spinal deformity. This study aims to introduce surgical techniques and report radiographic and clinical results.

METHODS: Thirteen patients who underwent spinal osteotomy (PSO in 11; PVCR in 2) using SUK DVR system for adult sagittal plane deformity were reviewed. Surgical procedures included (1) preparing secure proximal and distal vertebral anchors using multisegmental pedicle screw-rod fixation, (2) decancelling only posterior two-thirds of vertebral body and leaving anterior one-third for anterior column support, and (3) closing the osteotomy by approximation of SUK tubes secured to the proximal- and distal-endmost screws. Radiographic parameters included anterior deviation of C7 plumb line and kyphosis correction. Clinical outcomes were evaluated by VAS of back pain and RDQ. Mean follow-up period was 14 months (5-24 months).

RESULTS: Distal fixation ended at L4 in six, L5 in six, and L6 in one patient; no patients required fixation to the sacrum and/or pelvis. Kyphosis angle improved from +24 degrees to -21 degrees; mean correction was 45 degrees. Anterior deviation of C7 plumb line was 12.1 cm before surgery, 4.1 cm after surgery, and 5.8 cm at the final follow-up. VAS of back pain improves from 68/100 to 21/100. RDQ were 17.3 before surgery, and improved to 9.3 at the final follow-up.

DISCUSSION: The current procedures have biomechanical advantages and resulted in favorable clinical outcomes. SUK DVR system can provide and control a powerful correction force as intended. Multisegmental pedicle screw anchoring can maximize the correction force in patients with osteoporosis and poor bone stock.

GP174
COMPARISON OF PERI-OPERATIVE OUTCOMES OF LUMBAR FUSION: ORTHOPAEDIC SURGERY VERSUS NEUROSURGERY
Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

INTRODUCTION: The influence of the training specialty on the outcomes associated with spine surgery is not well characterized. The purpose of this study was to compare the peri-operative outcomes in lumbar fusions (LF) between Orthopaedic surgeons and Neurosurgeons.

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was searched to identify patients undergoing a LF for degenerative pathologies be-
between 2006 and 2011. The selected cohort was divided based upon the primary surgeon’s specialty (Orthopaedic surgery or Neurosurgery). Preoperative patient characteristics and peri-operative outcomes were assessed. SPSS v.20 was utilized for statistical analysis with a p-value of = 0.05 to denote significance.

RESULTS: A total of 7,909 LF were identified from 2006-2011, of which 3,887 (49.1%) were performed by Orthopaedic surgeons and 4,022 (50.9%) by Neurosurgeons. There were significant differences in patient comorbidities between Orthopaedic and Neurosurgery patients. The Neurosurgery cohort more often underwent ambulatory procedures and demonstrated a longer operative time. However, Orthopaedic patients incurred a longer hospital stay than Neurosurgery patients. In addition, there were significant differences in the incidence and type of postoperative complications between specialties. However, the mortality rate did not significantly differ between groups.

DISCUSSION: The results in this study demonstrate distinct patient profiles and peri-operative events associated with each spine surgery specialty. Despite these differences, the mortality rate did not differ between the surgical cohorts. In light of these findings, further studies are warranted to better characterize the risk factors associated with each specialty and their impact in patient outcomes and hospital resource utilization after LF procedures.

GP175
IMPACT OF RESIDENT INVOLVEMENT ON COMPLICATIONS FOLLOWING LUMBAR DECOMPRESSION SURGERY
Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Bryan D. Haughom MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

INTRODUCTION: Although fundamental to the practice of medicine, the need to train the next generation of surgeons may compromise the quality of care delivered to patients. The goal of this study was to characterize the impact of resident involvement on the rates of complications following lumbar decompression (LD) surgery.

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was searched to identify patients undergoing a LD for degenerative conditions between 2006 and 2011. Patients were divided into two cohorts based upon resident participation during the surgical procedure. Preoperative patient characteristics and peri-operative outcomes were assessed. SPSS v.20 was utilized for statistical analysis with a p-value of = 0.05 to denote significance.

RESULTS: A total of 11,055 LDs were identified between 2006 and 2011, including 3,339 (30%) cases with resident involvement. The resident cohort demonstrated a lower BMI and a higher incidence of alcohol abuse than those cases without resident involvement. There was a higher rate of
clean-contaminated and contaminated surgical wounds in those cases with resident involvement. Cases with resident involvement were associated with a longer operative time and hospitalization, a greater incidence of postoperative complications, and greater re-operation rates. There were no differences in mortality between the two cohorts.

**DISCUSSION:** Thirty-day outcomes data indicated higher rates of re-operation, and postoperative complications in those cases with resident involvement. Differences in preoperative wound class and a longer operative time may help explain these differences. Despite these findings, there were no differences in mortality between the two cohorts. In light of these findings, further analysis is warranted in order to determine preoperative measures that should be undertaken to help mitigate the peri-operative complications associated with resident involvement during a LD procedure.

### GENERAL POSTERS

**GP176**

**INCIDENCE, PREDICTORS AND OUTCOMES OF PNEUMONIA AFTER LUMBAR SPINE SURGERY**

Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

**INTRODUCTION:** Postoperative pneumonia (PNA) is a frequent complication following orthopaedic procedures. However, there is limited data in the published literature regarding the peri-operative risk factors associated with PNA after lumbar spine surgery (LSS).

**METHODS:** Patients who underwent LSS were identified in the National Surgical Quality Improvement Program (NSQIP) database. Patients with postoperative PNA were identified and compared to unaffected patients. Patient characteristics, lab values, and perioperative outcomes were assessed. Regression analysis was performed to identify predictors for postoperative PNA with a 95% confidence interval. SPSS v.20 was utilized for statistical analysis with a p-value of = 0.05 to denote significance.

**RESULTS:** A total of 22,676 LSS were identified between 2006-2011, of which 85 (0.4%) incurred postoperative PNA. Affected patients were significantly older, and demonstrated a higher BMI and a greater number of comorbidities. The PNA cohort underwent a greater proportion of non-ambulatory surgeries and demonstrated an increased number of blood transfusions and a longer operative time. In addition, affected patients demonstrated a longer hospitalization, greater readmission and reoperation rates, and a higher incidence of postoperative complications. Risk factors associated with postoperative PNA included obesity, chronic obstructive pulmonary disease (COPD), peripheral vascular disease (PVD), and a longer operative time.

![Table 1](image1.png)

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<th>Variable</th>
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<th>p-value</th>
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<td>Diabetes mellitus (%)</td>
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<td>Smoking</td>
<td>24.0%</td>
<td>24.7%</td>
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<td>Alcohol</td>
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<td>100.0</td>
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<td>Heart rate (beats/min)</td>
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<td>76.0</td>
<td>0.62</td>
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<td>Body mass index (kg/m^2)</td>
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<td>BMI (kg/m^2), mean (SD)</td>
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<td>30.14 (6.14)</td>
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<td>Preoperative Health and Comorbidities</td>
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<tr>
<td>Chronic obstructive pulmonary disease (%</td>
<td>4.2%</td>
<td>4.2%</td>
<td>0.79</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease (PNA)</td>
<td>3.4%</td>
<td>3.2%</td>
<td>0.47</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease (LSS)</td>
<td>6.2%</td>
<td>5.9%</td>
<td>0.39</td>
</tr>
<tr>
<td>Hypertension</td>
<td>46.6%</td>
<td>47.8%</td>
<td>0.74</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>0.8%</td>
<td>1.2%</td>
<td>0.06</td>
</tr>
</tbody>
</table>

**Table 2:** Comparison of Statistical and Post-Operative Outcomes of Lumbar Decompression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Resident Present</th>
<th>Attending Alone</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambulatory Surgery (%)</td>
<td>21.8%</td>
<td>30.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Wound Class (%)</td>
<td>90.4%</td>
<td>99.2%</td>
<td>0.004</td>
</tr>
<tr>
<td>Clean</td>
<td>90.4%</td>
<td>99.2%</td>
<td>0.004</td>
</tr>
<tr>
<td>Contaminated</td>
<td>0.2%</td>
<td>0.4%</td>
<td>0.25</td>
</tr>
<tr>
<td>Dirty</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.25</td>
</tr>
<tr>
<td>Operative time (mean, SD)</td>
<td>150.1 (14.5)</td>
<td>150.3 (14.6)</td>
<td>0.099</td>
</tr>
<tr>
<td>% of Blood transfusion, mean (SD)</td>
<td>0.097 (0.32)</td>
<td>0.072 (0.24)</td>
<td>0.09</td>
</tr>
</tbody>
</table>

**Table 3:** Comparison of Statistical and Post-Operative Outcomes of Lumbar Decompression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Resident Present</th>
<th>Attending Alone</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respirations (%)</td>
<td>1.6%</td>
<td>1.9%</td>
<td>0.008</td>
</tr>
<tr>
<td>Any complication (%)</td>
<td>2.1%</td>
<td>3.1%</td>
<td>0.001</td>
</tr>
<tr>
<td>Superficial wound infection (%)</td>
<td>1.1%</td>
<td>0.9%</td>
<td>0.01</td>
</tr>
<tr>
<td>Urostomy (%)</td>
<td>0.3%</td>
<td>0.0%</td>
<td>0.001</td>
</tr>
<tr>
<td>Pneumonia %</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.05</td>
</tr>
<tr>
<td>Pulmonary embolus (%)</td>
<td>0.3%</td>
<td>0.0%</td>
<td>0.001</td>
</tr>
<tr>
<td>Cardiac event (%)</td>
<td>0.1%</td>
<td>0.6%</td>
<td>0.001</td>
</tr>
<tr>
<td>Deep vein thrombosis (%)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.001</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.001</td>
</tr>
</tbody>
</table>
GENERAL POSTERS

DISCUSSION: In this study postoperative PNA was associated with a greater incidence of perioperative complications, and longer hospitalization. In addition, multiple risk factors including obesity, COPD, PVD and a longer operative time were associated with an increased risk of postoperative PNA. In light of these findings, further research is warranted to determine if optimization of these perioperative risk factors can mitigate the impact of PNA on hospital resource utilization and postoperative outcomes.

GP177
INCIDENCE, PREDICTORS AND OUTCOMES OF PULMONARY EMBOLISM AFTER LUMBAR SPINE SURGERY
Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

INTRODUCTION: Postoperative pulmonary embolism (PE) is a well-known life-threatening complication following orthopaedic procedures. However, there is limited data on the incidence, risk factors, and peri-operative outcomes for PE following lumbar spine surgery (LSS).

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was utilized to identify patients who underwent elective LSS. Patients with a PE were compared to unaffected patients. Preoperative patient characteristics, lab values, and peri-operative outcomes were assessed. Regression analysis was performed to identify predictors for a postoperative PE with a 95% confidence interval. SPSS v.20 was utilized for statistical analysis with a p-value of = 0.05 to denote significance.

RESULTS: A total of 22,610 LSS were identified between 2006-2011, of which 79 (0.3%) demonstrated a postoperative PE. The affected cohort was older, and demonstrated a higher BMI and a greater number of comorbidities. PE patients underwent a greater proportion of non-ambulatory surgeries and incurred a longer operative time than non-PE patients. In addition, affected patients incurred a longer hospitalization, greater readmission rates, and a higher incidence of postoperative deep vein thrombosis.
basis and mortality than unaffected patients. Risk factors associated with a postoperative PE included obesity, elevated white blood cell count (WBC), and prolonged operative time. Interestingly, smoking was associated with a reduced risk for a postoperative PE.

DISCUSSION: This study demonstrated that patients with a postoperative PE incurred a longer hospitalization, a higher readmission rate, and greater mortality than unaffected patients. Furthermore, risk factors associated with a postoperative PE included obesity, elevated WBC and a longer operative time. Understanding the incidence and risk factors associated with a PE may assist in the prevention, diagnosis, and treatment of this potentially fatal complication.

GP178
OUTCOMES AFTER LUMBAR DECOMPRESION OR FUSION IN PATIENTS WITH AN ELEVATED WHITE BLOOD CELL COUNT (>10K)
Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

INTRODUCTION: Patients undergoing lumbar spine surgery (LSS) may present with an elevated white blood cell (WBC) count. However, little has been reported on the effects of this abnormal lab value in patients undergoing elective LSS.

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was queried to select patients who underwent LSS between 2006-2011. Patients with an elevated WBC count (>10,000 cell/μL) were identified. Preoperative patient characteristics and peri-operative outcomes were assessed. Regression analysis, with a 95% confidence interval, was performed to determine the association between an elevated WBC and postoperative complications after controlling for demographics and comorbidities. SPSS v.20 was utilized for statistical analysis with a p-value of = 0.001 to denote significance.

RESULTS: A total of 20,188 LSS were identified of which 2,684 (13.3%) demonstrated an elevated WBC count. Patients with leukocytosis were older and demonstrated a greater number of comorbidities. Patients with an elevated WBC count more often underwent outpatient procedures, and demonstrated fewer intraoperative blood transfusions and shorter operative times. There were no significant differences in the hospital length of stay or postoperative complications between the two cohorts. Regression analysis demonstrated that an elevated WBC count was not associated with a greater risk of complication or mortality.

| Table 1: Characteristics of Patients with Elevated WBC (WBC >10K) |
|---------------------------------|----------------|----------------|-----------------|----------------|
| Variable                        | Normal WBC   | Elevated WBC  | P-value         |
| Count (%)                       | 17.50±(16.7%)| 20.84±(13.3%)| >0.001          |
| Age (years), mean (SD)          | 57.5±(15.4)  | 53.8±(13.1%)  |                |
| Preoperative Risk and Comorbidities |               |                |                |
| BMI (kg/m²), mean (SD)          | 28.85±(6.3)  | 31.05±(8.6)   | >0.001          |
| Diabetes Mellitus (%)           | 14.8         | 17.6          | >0.001          |
| Smoking (%)                     | 33.1         | 41.6          | >0.001          |
| Alcohol (%)                     | 33.1         | 41.6          | >0.001          |
| COPD (%)                        | 3.7          | 5.8           | >0.001          |
| Corticosteroids (%)             | 3.8          | 5.6           | >0.001          |
| Hypertension (%)                | 11.4         | 40.7          | >0.001          |
| Preoperative vascular disease (%)| 1.2          | 5.4           | >0.001          |
| BMI >30 (%)                     | 9.2          | 21.3          | >0.001          |
| WBC (cell/μL)                   | 11,300±2,684 | 18,420±15,421| >0.001          |

DISCUSSION: Despite an older and more comorbid patient population in patients with leukocytosis, the peri-operative outcomes did not significantly differ between the two cohorts. In fact, an elevated WBC count demonstrated favorable intraoperative parameters. The results in this study suggest that an elevated WBC does not significantly affect outcomes after LSS and

| Table 2: Surgical Characteristics of Patients with Elevated WBC |
|---------------------------------------------------------------|----------------|----------------|
| Variable                        | Normal WBC   | Elevated WBC  |
| Ambulatory Surgery (%)         | 32.2          | 21.3          |
| Operative time, mean (SD)      | 149.0±(7.8)   | 136.9±(8.1)   |
| % of Blood transfusion, mean (SD)| 0.16±(0.04) | 0.07±(0.04)   |
| Major Outcomes and Morbidity |               |                |
| Length of stay (days), mean (SD) | 2.0±(2.9) | 2.2±(2.4) |
| Readmission (%)                | 5.3          | 8.2           |
| Reoperations (%)               | 2.6          | 3.5           |
| Any Complication (%)           | 31.6         | 40.4          |
| Superficial wound infection (%)| 1.1±(1.1)    | 1.3±(1.3)     |
| Infection (%)                  | 0.5          | 1.3           |
| Unplanned admission (%)        | 0.26±(0.3)   | 0.31±(0.4)    |
| Pneumonia (%)                  | 0.06±(0.1)   | 0.08±(0.1)    |
| Ventricle - 48 hours (%)       | 0.17±(0.1)   | 0.13±(0.1)    |
| Acute renal failure (%)        | 0.06±(0.1)   | 0.04±(0.1)    |
| UTI (%)                        | 0.39±(0.1)   | 0.34±(0.1)    |
| Stroke (%)                     | 0.10±(0.1)   | 0.04±(0.1)    |
| Cardiovascular (%)             | 0.23±(0.1)   | 0.31±(0.1)    |
| Blood transfusion (%)           | 0.7±(0.2)    | 0.37±(0.2)    |
| DVT (%)                        | 0.06±(0.1)   | 0.11±(0.1)    |
| Mortality (%)                  | 0.11±(0.04)  | 0.03±(0.04)   |

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may even contribute to a faster operative time and recovery. Further research is warranted to better characterize the impact of an elevated WBC count in LSS.

GP179
OUTCOMES AFTER LUMBAR SPINE SURGERY IN PATIENTS WITH AN ELEVATED CREATININE
Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

INTRODUCTION: Routine preoperative blood testing may reveal an elevated creatinine (Cr) level. However, the impact of this abnormal lab value on peri-operative outcomes in lumbar spine surgery (LSS) is not well characterized.

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was queried between 2006-2011. Patients undergoing LSS were identified and divided based upon the preoperative Cr level (Males >1.3mg/dL, Females >1.1mg/dL). Preoperative patient characteristics and peri-operative outcomes were assessed. Regression analysis, with a 95% confidence interval, was performed to determine the association between an elevated Cr and postoperative complications after controlling for demographics and comorbidities. SPSS v.20 was utilized for statistical analysis with a p-value of = 0.001 to denote significance.

RESULTS: A total of 18,647 LSS were identified from 2006-2011, of which 1,656 (8.9%) demonstrated an elevated Cr. These patients were significantly older and demonstrated a greater number of comorbidities than the control group. In addition, patients with an elevated Cr underwent fewer outpatient procedures, demonstrated a greater number of blood transfusions, and incurred a longer operative time. In addition, a high Cr was associated with a longer hospitalization and a greater incidence of postoperative complications. However, regression analysis demonstrated that an elevated Cr was not associated with a greater risk of postoperative complications.

DISCUSSION: Patients with an elevated Cr demonstrated a greater incidence of postoperative complications and incurred a longer hospitalization. However, after controlling for demographics and comorbidities, an elevated Cr was not associated with a greater risk of postoperative complications. In view of these results, further investigation is warranted to clarify the impact of an elevated Cr level on peri-operative outcomes in LSS.
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INTRODUCTION: Anemia is thought to increase the risk for postoperative complications after spine surgery. However, there is limited published data describing the impact of a low hematocrit (Hct) in patients undergoing lumbar spine surgery (LSS).

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was queried between 2006-2011. Patients who underwent LSS were selected and divided into cohorts based upon the preoperative Hct level (Males: Hct <40.6g/dL, Females: <36.1g/dL). Patient characteristics and peri-operative outcomes were assessed. Regression analysis, with a 95% confidence interval, was performed to determine the association between anemia and postoperative complications after controlling for demographics and comorbidities. SPSS v.20 was utilized for statistical analysis with a p-value of = 0.001 to denote significance.

RESULTS: A total of 20,280 LSS cases were identified between 2006-2011 of which 4,522 (22.3%) demonstrated a low Hct. Anemic patients were significantly older and demonstrated a greater number of comorbidities. In addition, patients with anemia underwent fewer outpatient procedures, and demonstrated a greater number of blood transfusions, and a longer operative time. Anemic patient incurred greater postoperative complications, readmission rates and incurred a longer hospitalization. Regression analysis demonstrated that a preoperative anemia was associated with a greater risk for postoperative blood transfusions.

DISCUSSION: Anemic patients undergoing LSS demonstrated a greater comorbidity burden, longer operative time, and greater intraoperative blood transfusions, which likely influenced the greater postoperative complication rates and longer hospitalization. The results of this study demonstrate a logical association between preoperative anemia and peri-operative blood transfusions. However, further research is warranted to better characterize the association between anemia and the peri-operative outcomes in LSS.

GP181
OUTCOMES AFTER SINGLE-LEVEL LUMBAR DECOMPRESSION OR FUSION IN PATIENTS WITH HYPERTENSION
Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

INTRODUCTION: Hypertension (HTN) is common among patients undergoing lumbar spine surgery (LSS). However, there is limited data in the literature describing the impact of HTN on the peri-operative outcomes following elective LSS.

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was queried between 2006-2011. Patients who underwent a single-level lumbar fusion (LF) or lumbar decompression (LD) were identified. Patients with a history of HTN
were compared to normotensive patients. Preoperative patient characteristics, lab values, and perioperative outcomes were assessed. Regression analysis was performed, with a 95% confidence interval, to identify the association between HTN and postoperative complications after controlling for demographics and comorbidities. SPSS v.20 was utilized for statistical analysis with a p-value of = 0.001 to denote significance.

RESULTS: A total of 17,283 single-level LD and LF cases were identified of which 45.9% had HTN. These patients were significantly older and demonstrated a higher number of comorbidities than normotensive patients. Hypertensive patients underwent fewer outpatient procedures, and demonstrated greater intraoperative blood transfusions and longer operative times. In addition HTN was associated with longer hospital stay and a greater incidence of postoperative complications. Regression analysis demonstrated a strong association between HTN and organ space infections.

DISCUSSION: This study demonstrated that HTN was associated with a greater number of comorbidities and longer operative times, which likely influenced the longer hospitalization and greater incidence of postoperative complications. The results in this study suggest that HTN significantly impacts postoperative outcomes after LSS. However, the various associated comorbidities in patients with HTN warrants further studies to minimize possible confounding factors with aims to reduce complications and improve outcomes in LSS.

GP182

RISK FACTORS ASSOCIATED WITH SURGICAL SITE INFECTIONS FOLLOWING LUMBAR SPINE SURGERY FOR DEGENERATIVE PATHOLOGIES

Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: A surgical site infection (SSI) is one of the most common complications after orthopaedic procedures. However, the incidence as well as the risk factors associated with a SSI after lumbar spine surgery (LSS) has been poorly reported.

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was queried to identify patients who underwent elective LSS between 2006-2011. The resulting cohort was divided between patients who had a SSI and those who did not. Preoperative patient characteristics and peri-operative outcomes were assessed. Regression analysis, with a 95% confidence interval, was performed to determine the risks associated with SSI. Statistical analysis was performed with SPSS v.20 and a p-value of <0.001 denoted significance.

RESULTS: A total of 22,676 lumbar spine surgeries were identified from 2006-2011, of which 462 (2.0%) developed a postoperative SSI. There were no significant differences in patient age between cohorts, however infected patients demonstrated a greater comorbidity burden. Wound com-
Complications were also associated with longer operative times, greater resident involvement and greater intraoperative blood transfusions. In addition, the affected cohort demonstrated a longer hospitalization and incurred greater rates of readmissions, reoperations and sepsis. Regression analysis demonstrated that obesity, diabetes, dialysis, steroid use, bleeding disorders, resident involvement, and increased operative times were associated with an increased risk of SSI.

**DISCUSSION:** This study demonstrated that SSI are associated with greater perioperative complications and hospital resource utilization. In addition a number of risk factors were identified to be strongly associated with a SSI. The development of peri-operative protocols based upon these identified risk factors may help mitigate the incidence of SSI and the impact of this occurrence on peri-operative outcomes and hospital resource utilization.

**GP183**

**SENTINEL EVENTS IN LUMBAR SPINE SURGERY**

Alejandro Marquez-Lara MD, Sreeharsha V. Nandyala BA, Hamid Hassanzadeh, MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

**INTRODUCTION:** Sentinel events in lumbar spine surgery can have significant medical, social, economic, and legal implications. The incidence and peri-operative outcomes associated with these complications have not been well characterized in the published spine literature.

**METHODS:** The Nationwide Inpatient Sample was queried from 2002-2011. Patients who underwent elective lumbar spinal surgery were identified. Sentinel events including bowel or peritoneal injury, vascular injury, nerve injury, retention of foreign objects, and wrong-site surgery were identified. Patient demographics, comorbidities (CCI), number of fusion levels, length of stay, total costs, and postoperative outcomes were assessed. The risk for in-hospital mortality associated with each complication was calculated utilizing a 95% confidence interval (CI). Statistical analysis was performed with SPSS v.20 and a p-value of <0.001 denoted significance.

**RESULTS:** A total of 543,146 lumbar spine surgeries were recorded from 2002-2011 of which 414 (0.8 per 1,000 cases) incurred sentinel events. There were no significant differences in the mean age or CCI between the two cohorts. However, affected patients more often underwent 3+ level fusion procedures. The sentinel events cohort incurred a longer hospitalization, greater costs, and a greater incidence of in-hospital complications. Patients with a bowel or peritoneal injury, vascular injury, and wrong-site surgery demonstrated a greater risk of
INTRODUCTION: We investigated the rate of perioperative complications in decompression surgery versus instrumented fusion over-85-year population.

METHODS: Of 907 patients who underwent lumbar spine surgery for degenerative disorders from January 2006 to June 2012, 33 patients (3.6% of the entire population) were over 85 years (85 to 94 years). Surgical indications were determined solely based on the pathology regardless of age. Spinal stenosis without instability was treated by laminoplasty; instrumented fusion was indicated in the case of neuroforaminal decompression and/or spinal instability. With respect to the type of surgery, we investigated co-morbidities, ASA classification, perioperative complications, and JOA score.

RESULTS: 19 patients underwent posterior decompression without fusion. Instrumented fusion was performed in 14 patients (PLIF in 6, TLIF in 4 and PLF in 4). Co-morbidities were hypertension in 52%, diabetes in 39%, heart disease in 36%, old cerebral infarction in 15%, and history of malignant tumor in 12%. All the patients were classified as ASA 2 or less. Overall perioperative complication rate was 24%: the rate was 21% in decompression group (deep infection, dural tear, GI tract complication, death due to cerebral infarction in one each) and 28.5% in the fusion group (deep infection in 1, implant dislodgement in 2, GI tract complication in 1). The rates of perioperative complications were not statistically different between the two groups. Both group showed significant improvement in JOA score.

DISCUSSION: In the treatment of lumbar degenerative disorders in elderly patients, surgeons favor less invasive decompression over instrumentation surgery. The current study showed that the rate of perioperative complication was comparable between decompression alone and instrumented fusion. If the pathology requires spinal fusion, surgeons should not hesitate to perform...
GENERAL POSTERS

instrumentation even in the patients over 85 years.

GP185
SURGICAL DEBRIDEMENT WITH RETENTION OF SPINAL INSTRUMENTATION AND LONG-TERM ANTIMICROBIAL THERAPY FOR MULTIDRUG RESISTANT SURGICAL SITE INFECTIONS AFTER SPINAL SURGERY: A CASE SERIES
Miyazaki, S; Kakutani, K; Maeno, K; Takada, T; Hirata, H; Kurakawa, T; Terashima, Y; Kurosaka, M; Nishida, K; Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan

INTRODUCTION: Multidrug resistant surgical site infection (SSI) is one of the most significant complication after instrumented spinal surgery. However, there is no consensus on treatment strategies, in particular, surgical procedures, whether retention or removal of instrumentation, are still controversial. In this study, we present our experience with the debridement with retention of instrumentation and long-term antimicrobial therapy (more than 3 months) for multidrug resistant SSI.

METHODS: This is a retrospective case series of the clinical results of 12 cases (8 men and 4 women, 69.6 years) with multidrug resistant SSI occurred in 409 consecutive cases in which spinal instrumentation was used between 2007 and 2013. The microbial pathogen included 8 cases of methicillin-resistant staphylococcus aureus, 2 cases of multiple-drug resistant corynebacterium, 1 case of methicillin-resistant coagulase negative staphylococcus aureus, and 1 case of methicillin-resistant staphylococcus epidermidis.

RESULTS: Eleven patients with SSI were diagnosed within 90 days postoperatively and 1 patient on day 171. The mean time from the diagnosis to surgery was 2.9 days (range1-6). Ten patients underwent surgical debridement with implant retention and 2 patients didn’t need any surgery. Furthermore, no patients required multiple operations. All patients were given antimicrobial treatment. Intravenous antimicrobials (VCM, VCM+TAZ, or GM) were administrated for average 64.2 days (12-352) and oral antimicrobials (RFP+SMX/TMP, SMX/TMP, or MINO) for average 318 days (89-1673). The mean time to recover clinical presentation, such as pain relief, wound-healing, and decline of fever, was 29.3 days (7-55) and the mean time until C-reactive protein levels returned to normal was 56.7 days (7-105). All SSI were controlled and never recur during follow up.

DISCUSSION: Multidrug resistant SSI is successfully treated with the debridement with implant retention and long-term antimicrobial therapy.

GP186
PROGNOSTIC FACTORS IN MICROENDOSCOPIC LAMINOTOMY FOR PATIENTS WITH LUMBAR SPINAL STENOSIS
Toyoda H, Dozhono S, Matsumoto T, Terai H, Suzuki S, Yasuda H, Nakamura H; Dept. Orthopaedic Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan

INTRODUCTION: Decompressive surgery for lumbar spinal stenosis is the most frequently performed spine operation, but there have been few studies on factors that may predict outcome. We tried to find predictors of outcome in microendoscopic laminotomy (MEL) for lumbar spinal stenosis (LSS).

MATERIALS AND METHODS: We retrospectively reviewed 93 consecutive patients with LSS who underwent MEL. We excluded patients with other conditions that could affect functional status and finally 88 patients (aged 68.5 ± 10.2 years) were analyzed. Mean follow up period was 18.8 ± 8.8 months. We investigated factors predicting inferior function (JOA score was less than 25 points) and residual back and leg pain
(VAS scores was more than 30mm) after MEL using multivariate regression analysis.

**RESULTS:** The mean JOA score was 14.0±4.2 points preoperatively and improved to 25.2±3.5 points at the latest follow up. The mean VAS for leg pain was 59.1±28.9 preoperatively and improved to 13.2±22.6 at the latest follow up. The mean VAS for low back pain was 45.4±30.9 preoperatively and improved to 15.1±20.6 at the latest follow up. In multivariate analysis, sex (OR1.2), ASA physical classification system (OR2.1), posterior angulation(OR2.1)were significantly associated with inferior function. Duration of symptoms (OR1.9), sagittal vertical axis (SVA)(OR1.4)were significantly associated with residual low back pain. SVA(OR1.4)were significantly associated with residual leg pain.

**CONCLUSION:** Multiple factors predict outcome in MEL, most importantly ASA, posterior angulation and SVA.

**GP187**

**GOOD CLINICAL OUTCOMES AND FUSION RATE OF LESS INVASIVE FACET FUSION WITH A PERCUTANEOUS PEDICLE SCREW SYSTEM FOR DEGENERATIVE LUMBAR SPONDYLOLISTHESIS**

Tomohiro Miyashita *1, Hiromi Ataka *2, Kei Kato *1, Takaaki Tanno *2; *1: Spine Center, Matsudo City Hospital, Matsudo, Japan *2: Spine Center, Matsudo Orthopaedic Hospital, Matsudo, Japan

**INTRODUCTION:** Based on our long-term clinical and radiological follow-up study of posterolateral fusion (PLF) for degenerative lumbar spondylolisthesis (DLS), we recognized that facet fusion (FF) alone would be sufficient for spinal fusion. We devised a new, simple, less invasive FF using a percutaneous pedicle screw (PPS) system for DLS. In this study, we assessed the fusion rate and clinical outcomes of this procedure.

**METHODS:** Eighty-two patients (51 women, 31 men; average age, 68.1 years), who underwent FF for single-level DLS, were retrospectively reviewed after a minimum 1-year follow-up. The surgical method involved, making a 5cm skin incision, bilateral laminar fenestration, and FF with autologous bone harvested from the spinous process. PPS were then inserted. We evaluated the FF rate using CT, the range of motion (ROM) at the fused level on a flexion-extension lateral X-ray, preoperatively and at the final follow-up, and the therapeutic effectiveness of FF using the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ).

**RESULTS:** The FF rate was 85.4%. The ROM at the fused level was less than 2 degrees at the final follow-up in all the patients with adequate FF on CT. In those (11 patients) with inadequate FF, the average ROM significantly decreased from preoperative 13.4 degrees to postoperative 3.9 degrees. Therapeutic effectiveness on the JOABPEQ was demonstrated in the Walking ability score by 92.3% of the patients and in the Low back pain score by 71.9%.

**DISCUSSION:** Park et al reported that FF alone is an effective surgical option for DLS. However, in their method, a bone graft was harvested from the iliac crest and a conventional pedicle screw system was used. We devised a less invasive FF using a local bone graft and a PPS system. The clinical outcomes and the fusion rate of FF with the PPS system were comparable to those with conventional PLF. Thus, FF with a PPS system is a useful technique for the management of DLS.

**GP188**

**SSI SURVEILLANCE FOLLOWED BY VANCOMYCIN POWDER PROPHYLAXIS OF HIGH-RISK CASES TO REDUCE SSI RATES AFTER SPINAL SURGERY.**

Kentaro Takagi, Satoshi Oghara, Masuda Kimio, Iwasawa Mitsuyasu, Takamure Kouji, Uchida Yoshio, Tabira Yoshihiko, Hirai Shima, Makabe Kenta, Mori Toshihito; De-
INTRODUCTION: Prevention of surgical site infection (SSI) is particularly important in spinal surgery. Vancomycin powder (VP) is effective in preventing SSI before closing surgical wounds. However, VP is not preferred as a prophylactic in all cases because vancomycin is an MRSA therapeutic drug. In our hospital, we conducted prospective SSI surveillance following spinal surgery. After identifying the high-risk group, we used VP for SSI prophylaxis in these patients.

METHODS: Phase 1: SSI surveillance of spinal surgery began in April 2011. Factors recorded included sex, age, BMI, primary disease, ASA classification, diabetes, smoking, rheumatoid arthritis (RA), steroids, operative time, spinal instrumentation, amount of bleeding, and dural tear. Phase 2: based on phase 1 results, from September 2012 we defined a high-risk group as patients with RA undergoing instrumentation fusion surgery, and started selective VP use in this group. VP was used with 1000mg/operation dosage after hospital IRB approval. SSI rate was studied prospectively and a significant difference was observed in the VP treated group (P<0.05).

RESULTS: Phase 1: 152 cases of spinal surgery (59, cervical spine; 93, thoracolumbar spine; 102 decompression; 50 fusion) were registered with occurrence of deep SSI observed in 4 (2.7%). Phase 2: 108 cases of spinal surgery (35, cervical spine; 73, thoracolumbar spine; 76, decompression; 32, fusion) were registered with only 1 (lumbar decompression with no previous history: 0.9%) developing SSI. In phase 2, no SSI developed out of 12 spinal fusion cases in RA patients. SSI incidence was reduced significantly (P = 0.036, Chi-square test) in the phase 2.

DISCUSSION: Surveillance of SSI is reported to be useful in the investigation and prevention of SSI. In our hospital, it was also useful for identifying high-risk cases, leading to SSI reduction. After identifying the SSI high-risk group, selective prophylactic VP usage may help prevent SSI.

GP189
ANALYSIS OF REOPERATIONS AFTER MICROENDOSCOPIC LUMBAR DECOMPRESSION
Yuzawa Yohei; Spine Center Tokyo-West Tokushukai Hospital 3-1-1 Matsubara-cho Akishima, Tokyo, 196-0003 Ja

INTRODUCTION: This study analyzed reoperation cases after microendoscopic lumbar decompression (MED).

METHODS: We studied all patients who had undergone MED more than 6 months previously. The number of patients was 250, the mean age was 45.0, with 170 males and 80 females. Preoperative diagnoses were 225 intra-canal disc herniations, 23 spinal stenoses, 2 lateral disc herniations. Reoperation ratio, duration from primal surgery, site of reoperation and reoperation procedure were investigated. Operation outcome was measured by improvement in the JOA score using Hirabayashi’s formula.

RESULTS AND DISCUSSION: The number of reoperation cases among the MED patients was 7 (4 males, 3 females), which accounted for 2.8% of all the MED patients. The mean age was 40.9. The mean duration from primal surgery was 20.5 (14 to 469) days. All pre-reoperative diagnoses were recurrence of disc herniation. Regarding the sites of reoperation, 6 cases were of the same level and same side and one case was of a different level. Reoperation procedures were 5 MEDs, 1 laminotomy and 1 fusion. Laminotomy was performed for the case with spinal stenosis and fusion was performed for the case whose job involved very heavy manual labor. The improvement rate of all MED patients was 77.2% with reoperation patients accounting for 69.1%. The reported reoperation rate of standard
open or microsurgical methods was 2% to 5%. In our study the reoperation rate was 2.8%. In some literatures, the clinical success ratios of reoperation surgery were inferior to primary discectomy. In our study, the improvement rate of primal MED was 77% and the improvement rate of reoperation was 69%. Regarding the selection of the surgical methods for recurrent disc herniation, many authors do not recommend fusion after a first-time recurrent disc herniation. Reoperation can be performed with the same microendoscopic procedure.

GP190
CAN POVIDONE-IODINE SOLUTION PREVENT SURGICAL SITE INFECTION IN SPINE SURGERY?
Naoki Takahashi, Jun-ichi Kunogi, Naohiro Kawamura, Shigeru Masuyama, Kazuhiro Masuda, Yujiro Hirao, Kengo Fujii, Gaku Niitsuma, Naoki Okamoto; Japanese Red Cross Medical Center, Department of Spine and Orthopedic surgery

INTRODUCTION: Surgical site infection (SSI) is one of the most devastating perioperative complications, prevention is important as well as treatment. The purpose of this study is to examine the effectiveness of intraoperative irrigation with povidone-iodine solution.

METHODS: We irrigated the surgical wounds of patients undergoing spine surgery with the solution composed of 10cc povidone-iodine 10% + 50cc physiological sodium chloride solution from January 2012. The irrigation was performed before wound closure. The surgical site was filled with the solution for one minute, and then the substance was washed out by copious irrigation with physiological sodium chloride solution. We prospectively recorded the clinical data of patients who underwent spine surgery between January 2011 and December 2012, and compared the rate of SSI. Then, the effect of povidone-iodine disinfection was accessed by chi-square test.

RESULTS: We performed 443 and 575 spine surgeries during 2011 and 2012 respectively. There were no significant difference in the patient’s background (age, sex, diabetes mellitus, and hemodialysis), operation time, intraoperative bleeding, and the variety of operative procedures performed. Five SSI were observed in patients operated during 2011 (1.13%). In contrast, four SSI were observed during 2012 (0.70%). But, we found no significant difference in the rate of SSI between two groups.

DISCUSSION: Although several studies indicated the effectiveness of povidone-iodine irrigation in spine surgery, our results failed to confirm them. It may be attributed to the difference of the way of administration. Future study may confirm the efficacy by modifying the way of administration.

GP191
ENTRAPMENT OF THE SUPERIOR CLUNEAL NERVE CAN CAUSE LEG PAIN AND/OR TINGLING MIMICKING LUMBO-SACRAL SPINAL DISORDERS. REPORT OF 19 SURGICAL CASES.
Yoichi Aota, Takuya Kawai, Hiroshi Kuniya, Tomoyuki Konno, Tomoyuki Saito; Yokohama stoke and brain center, Yokohama, Kanagawa, Japan and Department of Orthopaedic Surgery, Yokohama City University Graduate School of Medicine, Yokohama, Kanagawa, Japan

INTRODUCTION: Entrapment of superior cluneal nerve (SCN) can become spontaneously entrapped over the iliac crest. Previous reports were few and limited to subjects with low back or buttock pain. We report clinical symptoms, surgical findings and outcome on consecutive patients who required surgical exploration because of intractable pain.

METHODS: Diagnosis of SCN entrapment was made by palpation of the iliac crest
resulting markedly tender and replicated leg pain and by pain relief after local anaesthetic injection. A total of 19 patients (F/M=9/10) with a mean age of 66 (41 - 83) was surgically treated.

RESULTS: Of 19, 12 had leg pain or tingling spreading below the knee, mimicking a lumbar radiculopathy. Six had been misdiagnosed as lumbar spine disorders and had prior unnecessary spine surgeries. Range of lumbar motion was limited in flexion (n=7), extension (n=3), or both (n=9). Forward bending with rotation contralateral to the lesion induced pain in 11 patients. Release was done unilaterally (n=9) or bilaterally (n=10). At least, two branches were explored at the tender point. Under microscopic observation, entrapment was noted under the thoracolumbar and/or gluteus maximus fascia often with adhesion. Satisfactory outcome was obtained in all patients. Seven experienced complete disappearance of symptoms. The mean VAS scores were 71 ± 23 mm before and 13 ±15 at 3 months after surgery. Revision was done in 2 patients at 1 month and 3 years after surgery with satisfactory outcome.

DISCUSSION: This clinical entity is underdiagnosed and should be considered as a potential cause of severe low-back or leg pain. Combination of limited lumbar motion with radiating leg symptoms mimics lumbo-sacral radiculopathy. A specific physical sign for entrapment of SCN does not exist. However, forward bending with rotation contralateral to the lesion may replicate pain. Spine surgeons should be aware of this clinical entity and preclude unnecessary spine surgeries.

GP192
CLOSED SUBARACHNOID DRAINAGE FOR MANAGEMENT OF CEREBROSPINAL FLUID LEAKAGE - THE EFFICACY OF THE PUMP- REGULATED LUMBAR SUBARACHNOID DRAINAGE-
Nobuyuki Suzuki, Muneyoshi Fukuoka, Jun Mizutani, Seiji Otsuka, Takanobu Otsuka; Department of Orthopaedic Surgery, Nago-ya City University Graduate School of Medical Sciences

INTRODUCTION: The frequency of cerebrospinal fluid(CSF) leakage in spine surgery is 1-3.1%. At the second surgery the rate becomes 8.1 %. The spinal drainage is one of the most effective treatments for CSF leakage. But the pressure regulated drainage forced the patients to be bed rest and very limited activities, because it's drainage amount is highly sensitive to patient positioning. To allow the patients more active and avoid over drainage, we present a safe and effective method of pump-controlled lumbar subarachnoid drainage.

METHODS: From July 2010 to September 2012, the patients who were underwent spinal surgery and needed to be treated by spinal drainage because of CSF leakage were involved in this study. Pump-controlled lumbar subarachnoid drainage were used for all those cases. The drainage system consists of SILASCON® spinal drainage kit, infusion pump, extension tube designed for infusion pump, three-way stop-cock and IVH bag. All those instruments are daily prepared in a hospital.

RESULTS: During that period 6 patients were treated with a pump-controlled lumbar subarachnoid drainage. Patient population consisted of 3 men and 3 women, ranging in age from 18 to 75 years. The average duration of lumbar drainage was 8 days (range, 5-13days). In this series, 2 patients developed a CSF fistula after tumor resection and the remaining 4 patients developed iatrogenic CSF fistulae after surgery.
GENERAL POSTERS

for decompression. All those leakages were successfully closed. No patient in this study developed headache, infection or deep venous thrombosis.

**DISCUSSION:** This system addresses the issue of over- and under-drainage because changes in position of the drain chamber or patient position have no effect on the rate or amount of CSF is withdrawn. That decreased complications i.e. headache, infection, tension pneumocephalus and patient satisfaction was improved. So we recommend this method for the patients who need drainage after CSF fistula.

**GP193**

**USE OF AMNIOTIC MEMBRANE ANTI-ADHESION BARRIER FOR LUMBAR DISCECTOMY**


**INTRODUCTION:** Animal studies found that anti-adhesion barriers reduced scar after surgery. Human amniotic membranes have been used to prevent peridural fibrosis but clinical utility has been debated. There is also concern if these materials increase complications of dural tears, hematoma, or early recurrent disc herniation. The purpose of this study was to compare early complications and clinical outcomes in discectomy patients who received amniotic membrane barrier to those who did not.

**METHODS:** A consecutive series of 282 patients undergoing single-level lumbar discectomy was identified with 114 patients receiving amniotic membrane compared with 112 who did not (56 patients excluded for use of fat graft, gel foam, or other material (n=42), not clear if barrier material used (n=9), or charts could not be located (n=5)). Data collected included: complications, re-operations, pre- and post-operative Oswestry Disability Index (ODI), and visual analog scores assessing back pain leg pain recorded for early follow-up (2-4 weeks) and most recent office visit.

**RESULTS:** There was no significant difference in re-operation rates for disc re-herniation among patients receiving amniotic membrane barrier and those not (3.5% vs. 6.3%; p>0.30). There was also no significant difference in post-operative hematoma or other surgery-related complication rates. In both groups, back pain, leg pain, and ODI scores improved significantly at early and last follow-up (p<0.01) with no significant differences between groups (p>0.15).

**CONCLUSION:** Patients treated with amniotic membrane anti-adhesion barrier did not have increased adverse effects, nor did they have a better outcome. Only 4 of 114 patients receiving the membrane underwent re-operation for recurrent herniation; too few to make a meaningful evaluation of the ease of approach for subsequent intervention. There does not appear to be any significant difference with/without using amniotic membrane for single-level discectomy.

**GP194**

**IMPLEMENTATION OF A SPINE SURGERY QUALITY ASSURANCE PROGRAM IN A MULTI-SITE PRIVATE PRACTICE**


**INTRODUCTION:** There are growing demands for quality assessment in spine care including comparisons between providers. The purpose of this study was to describe implementation of a spine surgery quality
assurance (QA) program within a multi-site spine practice.

**METHODS:** Data included procedure type, surgeon, assistant, hospital, intra-operative complications/events (designated “other” such as change in surgical plan, unanticipated challenges, etc.), post-operative complications/events, and re-operations. At each post-operative visit, clinical staff completed a form on complications/events. Quarterly, a summary report was generated for the peer review committee and each surgeon with the number of cases performed for the practice and individual, number and incidence of dural tears, infections, re-operations, and “other” to allow comparisons of individuals to overall practice and each other. Cumulative reports were prepared annually for the period beginning with the program’s inception in January 2009.

**RESULTS:** QA reports were successfully generated and reviewed by peer review committee and individual surgeons. Any outlying value was investigated in greater detail and reviewed with the individual. An example of data generated from cumulative annual reporting was an infection rate for the practice of 1.7%, ranging from 0.0% to 4.7% among surgeons.

**DISCUSSION:** The QA program was successfully implemented and remains active. Benchmarking surgeon performance is possible within the practice. Trending individual surgeon’s performance allows for peer analysis, and remedial measures for consistent outliers. External benchmarking can be performed using published complication rates for dural tears and infections; however, differences in definitions applied and procedures limit exact comparisons. This program may serve as a step toward comprehensive QA monitoring for spine surgery on a larger scale.

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**GP195**

**THE IDEAL TRAJECTORY FOR BALLOON KYPHOPLASTY USING RAY-SUM 3D IMAGING**

Atsuro Yamazaki1, Toshiaki Kotani1, Tsutomu Akazawa1, Tsuyoshi Sakuma1, Tetsuharu Nemoto1, Kento Nawata1, Kazuhisa Takahashi2, Shohei Minami1; 1. Dept. of Orthopaedic Surgery, Seirei Sakura Citizen Hospital, Chiba, Japan, 2. Dept. of Orthopaedic Surgery, Chiba University, Chiba, Japan

**INTRODUCTION:** Balloon kyphoplasty (BKP) is a common procedure for spinal compression fractures; however, few studies have investigated the anatomical trajectory of BKP. The purpose of the present study was to investigate the ideal entry points and inclination angles for BKP using ray-sum images by postprocessing CT data sets.

**METHODS:** We identified 58 patients with a vertebral compression fracture in T12, L1, or L2 who underwent BKP. We excluded 28 patients for severe collapsed fracture or fractures involving the posterior wall and pedicles. Of the 58 patients, 90 vertebrae (T12, L1, L2) of 30 patients were included in the study. Axial planes that passed the center of both pedicles and one of the anterior walls of vertebral bodies at T12, L1, or L2 were reconstructed. On the reconstructed images, we defined paths between the center of the anterior wall of the vertebral body and center of the pedicle as the ideal trajectory for BKP. Intersection of the ideal trajectories and posterior cortices of the vertebra were plotted on reconstructed images, and indicated the entry points for BKP. These intersections of the entry points were displayed on 3D ray-sum imaging, which has an appearance similar to that of conventional fluoroscopy. Insertion angles on the axial plane were also evaluated on the reconstructed CT.

**RESULTS:** The left and right entry points were located 2.8 ± 1.4 and 2.3 ± 1.2 mm lateral and 4.0 ± 2.5 and 4.1 ± 2.3 mm cra-
nial from the outer and superior edge of the pedicles, respectively. There was no significant difference in the distance from the outer edge of the pedicle between the levels of vertebrae. The distance between the entry points and the outer edge of the pedicle was 37.2 ± 23.3% of the transverse diameter of the pedicle. The insertion angle was 22.9 ± 1.7 degrees without any significant difference between vertebrae.

**DISCUSSION:** Ray-sum 3D imaging can be useful to surgeons for preoperative planning for BKP.

**GP196**  
**PREGNANCY AFTER LUMBAR TOTAL DISC REPLACEMENT**  
Anthony Owusu, M.D., Jack E. Zigler, M.D., Richard D. Guyer, M.D., Scott L. Blumenthal, M.D., Donna D. Ohnmeiss, Dr.Med.,; Texas Back Institute Research Foundation and the Texas Back Institute, Plano, TX

**INTRODUCTION:** The age of patients indicated for lumbar total disc replacement (TDR) for the treatment of painful disc degeneration begins with 18 years and in most clinical TDR studies the mean age ranges from 40 to 45 years. This suggests that there are females of child bearing age who may receive, or be interested in receiving, TDR. There is much literature on back pain during pregnancy, but a paucity of information for patients contemplating surgery who may wish to become pregnant later. Most TDRs are designed for implantation using an anterior lumbar spine approach which may increase patient concerns about future pregnancy. The purpose of this study was to evaluate the course of back pain and safety of pregnancy after lumbar TDR.

**METHODS:** From a single center, 10 patients were identified who became pregnant after lumbar TDR surgery. Data were recorded from study records to determine if the patients experienced increased pain or had any complications with their pregnancy or delivery. The mean age of the patients was 29.9 years, ranging from 25 to 38 years.

**RESULTS:** TDR procedures were performed at a single level, with 9 at L5-S1 level and 1 at L4-5. Half of the patients had delivery via Cesarean section and the others underwent vaginal delivery. There were no pregnancy-related complications. One patient reported moderately increased back pain during pregnancy which resolved after delivery.

**DISCUSSION:** Although based on a small patient sample, pregnancy after lumbar TDR followed a typical course. One patient reported moderate back pain during pregnancy which resolved post-delivery. Planning to become pregnant was an exclusion criterion in FDA IDE trials for TDRs, primarily to maintain study group homogeneity and avoiding issues related to not being able to radiograph pregnant patients. It is hoped that this study may provide reassurance to women who become pregnant after TDR surgery that there should not be undue concern about safety of pregnancy and delivery.

**GP197**  
**SPINAL ALIGNMENT AND LOW BACK PAIN AFTER TOTAL HIP REPLACEMENT ARTHROPLASTY IN PATIENTS WITH SEVERE HIP OSTEOARTHRITIS**  
Yawara Eguchi1, Satoshi Iida2, Chiho Suzuki2, Yoshiyuki Shinada2, Seiji Ohtori2, Kazuhisa Takahashi3; 1Department of Orthopedic surgery, Shimoshizu National
GENERAL POSTERS

Hospital, Chiba, Japan 2 Department of Orthopaedic surgery, Matsudo City Hospital, Chiba, Japan 3 Department of Orthopaedic Surgery, Graduate School of Medicine, Chiba University, Chiba, Japan

INTRODUCTION: The influence of hip osteoarthritis on spinal sagittal alignment and the low back pain (LBP) was first recognized as hip-spine syndrome by Offerski and MacNab in 1983. The purpose of this study was to evaluate the effect of total hip replacement arthroplasty (THA) on the spinopelvic alignment and the low back pain (LBP) in patients with severe hip osteoarthritis.

METHODS: 30 patients (29 females, one male; median age, 63.5 years) with severe hip osteoarthritis who were performed with THA were studied in this study. Exclusion criteria were previous lumbar surgery and current medical treatment for LBP. Sagittal spinopelvic alignments such as sacral slope (SS), lumbar lordosis (LL), pelvic tilt (PT), and pelvic incidence (PI) and coronal alignments such as lumbar scoliosis were assessed before surgery and one and 6 months after THA. In addition, visual analogue scales (VAS) score of low back pain and the coxalgia and Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JO-ABPEQ) were also investigated.

RESULTS AND DISCUSSION: Lumbar scoliosis significantly decreased from 6.56 to 3.87 degrees and SS also significantly decreased from 35.6 to 33.2 degrees after THA. On the other hand, there were no significant differences in LL, PT and PI. The incidence of LBP before THA was 66% (20 of 30 patients). Following THA, VAS score of LBP and coxalgia and JOABPEQ significantly improved after THA. It was previously reported that the THA improved LBP but not spinal sagittal alignment in patients with degenerative hip joint syndrome. In this study, both LBP and spinal alignment such as lumbar scoliosis and sacral slope were improved by THA, demonstrating that abnormal lumbosacral alignment affected LBP.

GP198
PROSPECTIVE COHORT STUDY OF QUALITY OF LIFE IN PATIENTS WITH METASTATIC SPINE TUMORS
Kakutani K1; Sakai Y2, Maeno K1 Yurube T1; Hirata H1; Kurakawa T1; Miyazaki S1; Terashima Y1, Takada T1; Iguchi T3 Kurosaka M1; Nishida K1. 1. Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine 2. Division of Rehabilitation Medicine, Kobe University Graduate School of Medicine 3. Department of Rehabilitation Science, Kobe University Graduate School of Medicine in Hyogo Rehabilitation Center

INTRODUCTION: Metastatic spinal tumor declined quality of life (QOL), the effect of spinal surgery on deteriorated QOL is still obscure. The aim of this study is to clarify the comprehensive effect of spinal surgery for metastatic spinal tumor.

METHODS: Consecutive 55 patients with progressive paralysis due to metastatic spinal tumors were prospectively followed. 39 patients received spine surgery (Group S); 16 patients chose conservative treatment (Group C). Survival analysis was performed by Kaplan-Meier method. At the day of surgical indication, 1,3 and 6 month later, general condition and ADL were evaluated by the Eastern Cooperative Oncology Group Performance Status (PS) and Barthel index (BI). Neurological status was assessed by the Frankel classification.

RESULTS: Median survival time of Group S and C was 288 and 120 days respectively, Group S is significantly longer than Group C. Group S patients reduced PS with time (mean: 3.5.1.9.1.7.1.6) but Group C patients deteriorated PS (mean:3.5.3.8.3.7.3.5). In addition, BI was increased in the Group S (mean:40.0.71.1.71.84.5) and reduced in the Group C (mean:40.6.25.4.26.6.34.5). At
every time point after surgery, Group S significantly improved PS and BI compared to Group C. Whereas 15% of improved patients re-deteriorated during the follow up. 85% of Group S patients improved 1= scores for the Frankel classification but 9% re-deteriorated, while no patient in the Group C improved Frankel classification. In addition, the patients with high grade cancer (lung and esophageal cancer) demonstrated the improvement as well as low grade cancer patients.

**DISCUSSION:** Surgery for metastatic spinal tumors maintained true survival, furthermore it elevated and maintained PS and BI in more than 80% patients. This study suggests that surgical treatment can improve QOL as well as neurological deficit in patients with metastatic spinal tumors.

**GP199**

**BOWEL/BLADDER DYSFUNCTION AND NUMBNESS IN THE SOLE OF THE BOTH FEET IN LUMBAR SPINAL STENOSIS - A MULTICENTER CROSS-SECTIONAL STUDY (DISTO-PROJECT) –**

Kazuyuki Watanabe1, Miho Sekiguchi1, Koji Yonemoto2, Takuya Nikaido1, Kinshi Kato1, Koji Otani1, Shoji Yabuki1, Tatsuyuki Kaku2, Shin-ichi Kikuchi1, Shin-ichi Konno1 ,DISTO-project working group; 1Department of Orthopaedic Surgery, Fukushima Medical University School of Medicine 2Biostatistics Center, Kurume University

**INTRODUCTION:** In LSS, numbness in the sole of the both feet or bowel/bladder dysfunction appear at rest especially for cauda equine lesion. The purpose of this study was to clarify the relationship between symptoms at rest and severity of lumbar spinal stenosis (LSS).

**METHODS:** The research group consisted of Lumbar Spinal Stenosis Diagnosis Support Tool (DISTO)-project members. The survey was conducted in 564 hospital and general practices nationwide from December 1, 2011 to December 31, 2012. The patients who visited to clinic or hospital because of their low back pain were included in this study. Patients were diagnosed with LSS by using LSS-diagnostic support tool (LSS-DST)(table1). Japanese Orthopaedid association back pain evaluation questionnaire (JOABPEQ) was examined. Presence of both sole numbness and bowel/bladder dysfunction were evaluated by medical interview. The subjects were divided into 4 groups according to their symptoms; the group of both sole numbness and bowel/bladder dysfunction (SN+BD group), the group of only sole numbness (SN group), the group of only bowel/bladder dysfunction (BD group), and the group of no symptoms at rest (Non group). JOABPEQ were compared among 4 groups

**RESULTS:** 3647 patients were predicted to have LSS according to the results of LSS-DST. 1159 of 3647 patients (69.9%) indicated to have the symptoms at rest; 411 patients had numbness of the both soles, 180 patients had bowel/bladder dysfunction. There were significant differences in each domains of JOABEQ among 4 groups. The SN group showed lower JOABPEQ score compared with the Non group. The BD group showed slightly low score compared with the Non group. The SN+BD group showed the lowest score in each domains of JOABPEQ compared with other three groups (p<0.05).

**DISCUSSION:** LSS patients having sole numbness and bowel/bladder dysfunction at rest showed significantly lower QOL and activities of daily living. These symptoms might be related with severity of LSS.
GP200
PROSPECTIVE MULTICENTER SURVEIL-
LANCE AND RISK FACTOR ANALYSIS OF
DEEP SURGICAL SITE INFECTION AFTER
POSTERIOR THORACIC AND/OR LUMBAR
SPINAL SURGERY IN ADULTS
Satoshi Ogihara, MD1, Takashi Yamazaki,
MD2, Hiroyuki Oka, MD3, Kota Miyoshi,
MD4, Seiichi Azuma, MD5, Takashi Yamada,
MD6, Motoaki Murakami, MD7, Naohiro
Kawamura, MD8, Nobuhiro Hara, MD9, Sei
Terayama, MD2, Jiro Morii, MD10, So Kato,
MD11, and Toru Maruy; 1Department of
Orthopaedic Surgery, Spine Center, Sagami-
hara National Hospital 2Department of
Orthopaedic Surgery, Musashino Red Cross
Hospital 3Department of Joint Disease Res-
search, 22nd Century Medical and Research
Center, the University of Tokyo 4Department of
Orthopaedic Surgery, Yokohama Rosai Hospital 5Department of
Orthopaedic Surgery, Saitama Red Cross Hospital 6Department of Orthopaedic Surgery,
NTT Kanto Hospital 7Department of Ortho-
paedic Surgery, Toranomon Hospital 8Department of Spine and Orthopaedic Sur-
gery, Japanese Red Cross Medical Center 9Department of Orthopaedic Surgery, Facul-
ty of Medicine, University of Tokyo 10Department of Orthopaedic Surgery, Sanraku Hospital 11Department of Ortho-
paedic Surgery and Musculoskeletal Oncol-
gy, Tokyo Metropolitan Komagome Hospi-
tal 12Department of Orthopaedic Surgery,
Saitama Medical Center, Saitama Medical
University

INTRODUCTION: SSI is one of the most seri-
ous and significant complications after spi-
nal surgery that is associated with high
morbidity rates, high healthcare costs, and
poor patient outcomes. The accurate identi-
fication of risk factors is essential in devel-
oping strategies to prevent potentially dev-
astating infections. The purpose of this
study was to identify independent risk fac-
tors for adult patients who develop deep
SSI after posterior thoracic and/or lumbar
spinal surgery using a prospective multicen-
ter surveillance research method.

METHODS: From July 2011 to June 2012,
we performed a prospective surveillance
study in adult patients who had developed
SSI after undergoing thoracic and/or lumbar
posterior spinal surgery at participating 11
hospitals. Detailed data on preoperative
and operative patient characteristics were
recorded prospectively using a standardized
data collection format. In all the participat-
ing hospitals, a patient was considered to
have SSI based on the definition set forth by
the Centers for Disease Control.

RESULTS: A total of 2,736 consecutive adult
patients undergoing posterior thoracic and/or lumbar spinal surgeries were en-
rolled, among whom 24 (0.9%) developed
postoperative deep SSI. Multivariate regres-
sion analysis indicated 4 independent risk
factors: Preoperative steroid therapy (P =
0.001), spinal trauma (P = 0.048), and male
gender (P = 0.02) were statistically signifi-
cant independent patient-related risk fac-
tors, whereas operating time > 3 hours (P <
0.001) was a surgery-related independent
risk factor.

DISCUSSION: Preoperative steroid therapy,
spinal trauma, male gender, and operating
time > 3 hours were 4 independent risk fac-
tors for deep SSI after thoracic and/or lum-
bar spinal surgeries in adult patients. Identifi-
cation of these risk factors should serve as
a basis for developing protocols for decreas-
ing the risk of SSI in future patients.

GP201
LOWER URINARY TRACT SYMPTOM IN PA-
IENTS WITH LUMBAR CANAL STENOSIS
WHO HAVE UNDERGONE DECOMPRESSION
SURGERY
Naohiro Kawamura, Jun-ichi Kunogi, Shigeru
Masuyama, Kazuhiro Masuda, Yujiro Hirao,
Kengo Fujii, Zaika Tei, Masakazu Kanetaka,
Gaku Niitsuma, Naoki Okamoto, Naoki Takahashi; Department of Spine and Ortho-
pedic Surgery, Japanese Red Cross Medical Center

INTRODUCTION: Patients with lumbar spinal canal stenosis (LCS) not only experience leg neuropathy but also lower urinary tract symptoms (LUTS). But there are few reports concerning the prevalence and severity of bladder symptoms especially on patient-based outcome which is easy to obtain in daily practice.

METHODS: From January to June 2013, among the patients who underwent posterior decompression surgery with/without fusion for LCS, a total of 40 male patients aged 40-85 (mean 68.1) years, and 33 female patients aged 50-84 (mean 70.2) years completed the following questionnaires; the Zurich Claudication Questionnaire (ZCQ), International Prostate Symptom Score (IPSS), overactive bladder symptom score (OABSS), International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF). Spearman’s rank-correlation coefficient was used to examine the correlation.

RESULTS: The mean number of levels decompressed was 2.3 in male and 2.0 in female. Spinal fusion with instrumentation was applied to 10 male (25%) and 22 female (69%). Notably, 22 male patients (55%) showed moderate-to-severe symptoms by IPSS, although 14 of them had no history of prostatic hypertrophy. In OABSS 14 males (35%) and 8 females (25%) had moderate-to-severe symptoms. In male patients, IPSS had weak correlation with ZCQ (r, 0.381) and the number of levels decompressed.

DISCUSSION: It was suggested from the results that the severity of symptom for LCS may correlate with LUTS. The present patient-based outcome scales for LCS lacks the assessment for LUTS although patient have them in relatively high frequency. In the future study the response for the treatment and the postoperative course are to be examined. Further study is necessary to elucidate the etiology of LUST in LCS and to identify proper instruments to access it.

GP202

COMPARISON OF COMORBIDITY AND SURGICAL OUTCOMES IN LUMBAR FUSION SURGERY

Sreesharsha V. Nandyala BA, Alejandro Marquez-Lara MD, Hamid Hassanzadeh MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: Few studies have elucidated the impact of the patient’s comorbidity burden on the surgical characteristics, costs, and length of stay with regards to lumbar arthrodesis.

METHODS: Data from the Nationwide Inpatient Sample was queried from 2002-2011. Patients undergoing an index anterior (ALIF), posterior (PLIF), or anterior/posterior (APLF) lumbar fusion for degenerative conditions were identified and stratified. A modified Charlson Comorbidity Index (CCI) was calculated for each patient and the patients were grouped according to their score. Patient demographics, length of stay (LOS), costs, surgical complexity (levels of fusion), and rhBMP-2 utilization were assessed within each CCI cohort. SPSS v.20 was utilized for statistical analysis with a Pearson Correlation Co-efficient with an alpha-level of <0.01.

RESULTS: A total of 315,597 lumbar fusion procedures were identified from 2002-2011 of which 71.2%, 46.7%, and 64.2% of cases were performed in patients with a CCI of ≥2 in the ALIF, PLIF, and APLF cohorts, respectively. With an increasing co-morbidity, patients incurred a greater hospitalization and total hospital costs. In contrast, BMP utilization significantly decreased with rising comorbidity in the ALIF cohort. Lastly, with greater comorbidity, the proportion of 3+ level fusion procedures significantly increased in all surgical cohorts.
DISCUSSION: This analysis of the NIS database demonstrates that the majority of lumbar arthrodesis procedures are performed in relatively healthy patients with a CCI of $=2$. With greater comorbidity, the surgical complexity increased as evidenced with the rise of 3+ level fusions. The greater surgical complexity and hospitalization may, in part, explain the increased total hospital costs associated with rising comorbidity across the spectrum of lumbar arthrodesis. However, further investigation is warranted to explain the trends of BMP utilization as a function of patient comorbidity.

GP203
COMPARISON OF COMORBIDITY AND THE RELATIVE RISK INCREASE FOR IN-HOSPITAL MORTALITY AND COMPLICATIONS FOLLOWING LUMBAR SPINE SURGERY
Sreesharsha V. Nandyala BA, Alejandro Marquez-Lara MD, Hamid Hassanzadeh MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: The published literature lacks data evaluating the association between a rising level of comorbidity and the relative risk for postoperative complications and mortality following a lumbar fusion.

METHODS: Data from the Nationwide Inpatient Sample was queried from 2002-2011. Patients who underwent an index lumbar fusion were identified and stratified based upon each patient’s modified Charlson Comorbidity Index (CCI). Postoperative inpatient mortality, thromboembolism, wound infection, cardiac event, renal failure, and ileus were assessed. The relative risks in each CCI cohort were calculated in reference to the previous respective CCI group in order to investigate the risk increase with a rising comorbidity burden. SPSS v.20 was utilized for statistical analysis with a 95% confidence interval for relative risk.

RESULTS: A total of 315,597 lumbar arthrodesis procedures were recorded from 2002-2011. The initial relative risk increase for inpatient mortality, pulmonary embolism (PE), wound infection, cardiac events, and renal failure was significant beginning with a CCI score of 2 and compounded for the subsequent CCI cohorts. The risk increase for mortality was most dramatic for patients with a CCI score $>5$. The initial significant increase in relative risk for deep vein thrombosis (DVT) was demonstrated in less comorbid patients with the CCI of 1, and was consistently significant for the subsequent CCI groups.

DISCUSSION: This analysis of the NIS database demonstrates that the CCI can be utilized to estimate the relative risk increase for in-hospital mortality and complications following lumbar arthrodesis. This study suggests that the risk increase for in-hospital mortality and catastrophic complications initiates in less comorbid patients with a CCI of 1 and 2.

Further studies are warranted to investigate the etiologies for this risk increase of complications following lumbar arthrodesis.
GENERAL POSTERS

GP204
COMPARISON OF PATIENT DEMOGRAPHICS AND SURGICAL CHARACTERISTICS BETWEEN AGE GROUPS IN LUMBAR FUSION SURGERY
Sreeharsha V. Nandyala BA, Hamid Hassanzadeh MD, Alejandro Marquez-Lara MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: Despite the rapid expansion and popularity of lumbar fusion procedures, few studies have characterized the changing patient demographics and surgical characteristics between age groups.

METHODS: Data from the Nationwide Inpatient Sample was queried from 2002-2011. Patients undergoing an index anterior (ALIF), posterior (PLIF), or anterior/posterior (APLF) lumbar fusion were identified and separated into cohorts. Patients in each surgical cohort was stratified into age groups as follows: 18-39, 40-49, 50-59, 60-69, 70-79, and 80+. Patient demographics, comorbidities (CCI), length of stay (LOS), costs, surgical complexity (levels of fusion), and rhBMP-2 utilization were assessed within each age cohort. SPSS v.20 was utilized for statistical analysis with a Pearson Correlation Co-efficient with an alpha-level of <0.01.

RESULTS: A total of 315,597 lumbar arthrodesis procedures were recorded from 2002-2011 of which 80%, 55.8%, and 73.3% of cases were performed prior to the sixth decade in the ALIF, PLIF, and APLF cohorts, respectively. In all approaches, a greater proportion of females underwent lumbar fusion with increasing age. In addition, with greater age, the patient’s CCI, mean hospital LOS, and total costs increased significantly. Furthermore, with greater age, the proportion of 3+ level fusion procedures significantly increased. Lastly, BMP utilization decreased with age in the ALIF cohort, but increased slightly in the PLIF approach.

Discussion: This analysis of the NIS database demonstrates that with greater age, the proportion of females undergoing lumbar fusion, the comorbidity burden and the surgical complexity significantly increased. The greater comorbidity burden and surgical complexity may, in part, explain the greater hospital stay and the total costs across the spectrum of lumbar arthrodesis. However, the dichotomy in BMP utilization as a function of age between the ALIF and PLIF cohorts remains subject to further investigation.

GP205
EPIDEMIOLOGICAL TRENDS IN INTERSPINOUS PROCESS, PEDICLE-BASED DYNAMIC STABILIZATION AND FACET REPLACEMENT DEVICES BETWEEN 2007-2011
Sreeharsha V. Nandyala BA, Alejandro Marquez-Lara MD, Steven J. Fineberg MD, Miguel A. Pelton BS, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: Interspinous process spacers (ISP), pedicle based dynamic stabilization devices (PBDS), and facet replacement (FR) devices were introduced as minimally invasive and motion-sparing alternatives to treat lumbar degenerative pathologies. The purpose of this study was to characterize the national trends of these procedures in regards to the incidence, demographics, comorbidities, costs, and mortality.

METHODS: Data from the National Inpatient Sample was queried from 2007-2011. Patients undergoing an insertion of an ISP, PBDS, or a FR for degenerative conditions
were identified. The patient demographics, comorbidity burden (CCI) hospital length of stay (LOS), costs, and mortality were assessed in each cohort during this period. SPSS v.20 was utilized for statistical analysis with a Pearson Correlation Co-efficient with an alpha-level of < 0.05.

RESULTS: The national weighted estimate of dynamic stabilization cases peaked in 2008 (4,695) and steadily declined to 1,212 in 2011. The ISP and PBDS cohorts demonstrated the greatest decrease in incidence. In addition, the mean age at surgery in the ISP and FR cohorts demonstrated a significant downtrend. In all cohorts from 2007-2011, the mean CCI, LOS, and total hospital costs significantly increased. Lastly, there were no significant changes in mortality during this period.

DISCUSSION: From 2007-2011, the utilization of interspinous spacers, pedicle based dynamic stabilization systems, and facet replacement devices has declined since their peak in 2008. Patients undergoing these procedures during this period were associated with a mounting comorbidity burden and demonstrated a significant up-trend in the mean LOS and total hospital costs. None of the surgical cohorts were associated with significant changes in mortality. Further studies are warranted to characterize the decline of these procedures and the associated long-term outcomes compared to traditional lumbar decompression and fusion techniques.

GP206
THE INFLUENCE OF TIMING AND CONTEXT ON PAIN ASSESSMENT IN PATIENTS WITH LUMBAR SPINAL STENOSIS
Matthew Smuck, MD(1), Patricia Z. Zheng, MD(1), Ming-Chih J. Kao, PhD, MD(2), Richard W. Hu, MD(3), Christy Tomkins-Lane, PhD(4); (1) PM&R Section, Department of Orthopaedic Surgery, Stanford University, Redwood City, CA, USA (2) Pain Medicine Division, Department of Anesthesiology, Stanford University, Redwood City, CA, USA (3) Division of Orthopaedics, Department of Surgery, University of Calgary, Calgary, Alberta, Canada (4) Department of Physical Education and Recreation, Mount Royal University, Calgary, Alberta, Canada

INTRODUCTION: Standardized pain assessment is vital for outcomes research, but is difficult in conditions like lumbar spinal stenosis (LSS) where pain variability is a hallmark symptom. Here we investigate the impact of context and timing on pain outcomes in LSS.

METHODS: 21 consecutive LSS patients were tested 1 week pre- and 6 months post-decompression with the SF36, SSSQ, ODI, and the Self-Paced Walking Test (SPWT). During the SPWT, current back and leg pain were assessed before starting (pain at rest) and at maximum tolerated walk (provoked pain). Percent change after surgery was calculated for all current pain measures, and for recent historical pain including prior 7-day pain (ODI pain question) and prior month pain (SF36 and SSSQ pain subscales). Significance of postop changes in pain were determined using Welch Two Sample t-test; and correlations of change between the different pain measures were calculated using Spearman’s Roh.

RESULTS: Significant pre- to postop improvements were observed in all pain measures. Greatest reductions were observed for the SF36 pain subscale and pro-

Figure 1
National Weighted Estimate of Lumbar Dynamic Stabilization Procedures from 2007-2011

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voked leg pain (both >70%). Least change occurred for the ODI pain question and back pain at rest (both <30%). No correlations were detected between the current pain measures (leg or back, at rest or provoked) and the recent historical pain (month or 7-day). Among the recent historical pain measures, only weak correlation existed between the ODI pain question and the SF36 pain subscale (r=0.47).

**DISCUSSION:** In patients with LSS, the context and timing of pain assessment strongly influences pain severity and proportion of change following surgery. Despite collection of all measures in the same setting, only scant and weak correlations were observed between pain measures involving different timing and contexts. While the subjectivity of pain likely plays a role in this variability, changes in the timing and context of pain assessments may reflect different disease constructs in LSS.

**GP207**

**USE OF THE SPINE ADVERSE EVENTS SEVERITY (SAVES) SYSTEM TO CATEGORIZE AND REPORT ADVERSE EVENTS IN SPINE SURGERY**

Wagner PJ1, Ailon T2, Zhou H1, Pascal S1, Harrigan MB1, Stauff M1, Lapinsky A1, Connolly PJ1, DiPaola CP1; 1 UMass Memorial Healthcare, University of Massachusetts Medical School, Worcester MA 2 Harvard School of Public Health, Boston MA

**INTRODUCTION:** Analysis of adverse events (AEs) in spine surgery has historically been retrospective, utilizing hospital administrative data. Our objective was to determine the incidence, severity and effect on hospital length of stay (LOS) for AEs in spine surgery using the Spine AdVerse Events Severity (SAVES V2) system.

**METHODS:** AEs for all surgical spine patients at our institution were prospectively collected for 18 months and correlated with retrospective data from operative reports and H&Ps. Statistical analyses compared patient demographics, diagnoses, and surgical characteristics to hospital length of stay and likelihood of adverse events.

**RESULTS:** This system captured 75% (765/977) of surgical cases for all indications over the study period. 73% (541/743) of patients experienced at least one AE, with an average of 1.2 AEs per patient (range 0-5). The most common AEs were pain control (31%), urinary retention (9.7%), wound infection (6.3%), and incidental durotomy (5.8%). For patients experiencing at least one AE, 30% had no effect on LOS, 48% increased LOS by 1-2 days, 15% increased LOS by 3-7 days, and 7% had prolonged LOS greater than 8 days. Our system captured 25.4% more adverse events (60.0% vs. 34.6%) than hospital administrative data. Univariate analysis revealed patient age, emergent surgery, diagnostic and surgical categories, and spine region to be predictors of both AEs and LOS. Instrumentation was predictive of increased LOS but not AEs. The type of AE was strongly associated with LOS. Multivariable analysis of AE likelihood demonstrated emergent surgery to be the strongest independent predictor with an adjusted odds ratio of 8.5 versus elective surgery.

**DISCUSSION:** Spine surgery is associated with a high incidence of adverse events, which often prolong hospital length of stay. Better characterization of adverse events and their predictors could lead to improved management strategies that reduce patient morbidity and mortality.

**GP208**

**THE DISC DEGENERATION HAS LITTLE IMPACT ON SURGICAL OUTCOMES FOR LUMBAR SPONDYLOLYSIS.**

Kazuki Fujimoto1, Masatsune Yamagata1, Ko Shimizu1, Yoshikazu Ikeda1, Fumitake Nakajima1, Mitsuhiro Hashimoto1, Takuro Moriya1, Koji Akimoto1, Yuya Ogawa1, Seiji Ohtori2, Kazuhisa Takahashi2; 1 Chiba Ro-
**INTRODUCTION:** In case of spondylolysis with disc degeneration, the surgical choice of interbody fusion procedure or repair of defect is controversial.

**METHODS:** 13 patients were included to this study, 12 male and 1 female, with a mean age of 23.5 years, ranging from 13 to 55 years. Among these, 10 cases engaged in sports activities, including 5 baseball players, 3 soccer players, 1 tennis player, and 1 high jumper, and the others were light labor workers. 7 cases had a segmental screw and wire fixation, 4 cases had a Buck’s fusion, 2 cases had a segmental screw and hook fixation. JOA score and VAS were evaluated before and six months after surgery, and the period of return to sports activity or work was also evaluated. Rate of bony union and preoperative disc degeneration was investigated. The relation between preoperative disc degeneration and surgical outcome was assessed.

**RESULTS:** The mean preoperative JOA score was 21.5 points and the mean JOA score at 6 months after surgery was 28.6 points. The mean preoperative VAS indicating 8.3 points significantly improved to 1.9 points at 6 months after surgery. All cases returned to their previous sports activities or works after surgery. The average period of return to sports activities or works was 4.2 months, ranging from 3 to 7 months. 9 of 13 cases (69%) achieved solid bony union. The number of patients with disc degeneration in preoperative MRI was five. There was no significant difference between those with and without preoperative disc degeneration in terms of surgical outcome. There were no significant changes in disc height and spinal instability between preoperative and postoperative radiograms.

**CONCLUSIONS:** This study showed favorable clinical outcome after surgical treatment for lumbar spondylolysis. In choosing surgical treatment for lumbar spondylolysis, preoperative disc degeneration has little impact on postoperative surgical outcome.

**GP209**

**DOES THE TYPE OF SURGERY INFLUENCE THE SURGICAL RESULTS FOR METASTATIC SPINE DISEASE?**

Kee-Yong Ha, MD, PhD, Jan Noel Molon, MD, Young-Hoon Kim, MD, PhD, Joo-Hyun Ahn, MD, and Nak-Min Hyun MD; Department of Orthopedic Surgery, Seoul St. Mary’s Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea.

**INTRODUCTION:** Surgical treatment has been getting a more prominent role in the treatment options for metastatic spine disease. We evaluated whether the type of surgery may influence surgical results. By comparing surgical results of different surgical options, we want to know whether the type of surgery may influence surgical results for metastatic spine disease.

**METHODS:** 48 patients with metastatic spinal disease who had undergone palliative surgery were enrolled. Posterior decompression with fusion (n= 34), and anterior-posterior reconstruction (n=14) were performed. Visual analogue scale, Karnofsky performance score, American spinal cord association (ASIA) scale, and Spinal Instability Neoplastic Score(SINS) were compared. The survival period and related hazard factors were also assessed. Separately, lung and hepatocellular cancer were investigated to reduce bias.

**RESULTS:** Most patients experienced improvement in pain and performance status (18.5 ± 16.5 %) 3 months post-operatively. 12 patients (25%) graded ASIA D experienced neurological improvement to ASIA E. There were no significant difference in patient demographics, 6 months-cumulative survival rates (P >0.05). Survival was not
affected by the preoperative pain scale, Tokuhashi score, neurologic status and operation type. Improvement of performance status (hazard ratio 0.84, 95% CI 0.77-0.92) and SINS (hazard ratio 1.9, 95% CI 1.2-2.9) significantly affected survival after operation in metastatic spine disease of lung and hepatocellular cancer.

**DISCUSSION:** There was no significant difference in survival rates between posterior and antero-posterior surgery for metastatic lesions resulting from lung and hepatocellular cancer. Improvement of performance status and SINS had a significant impact on the survival rate following surgical treatment for these metastatic spine lesions.

**GP210**

**LUMBAR SPINAL CANAL STENOSIS ASSOCIATED WITH COMPRESSION FRACTURE OF LOWER LUMBAR SPINE**


**BACKGROUND:** Lumbar spinal canal stenosis associated with compression fracture of the lower lumbar spine (CFLSS) is relatively rare, and the optimal surgical treatment for CFLSS remains to be elucidated. The purpose of this study was to evaluate the surgical results of CFLSS with illustration of its clinical features.

**MATERIALS AND METHODS:** 68 patients who underwent surgical treatment for CFLSS were included in this study. L3, 4, or 5 vertebrae were involved in all CFLSS patients. The mean age at the time of surgery was 74.5 years. Characteristic of the radiographic findings and the surgical results were retrospective reviewed. 55 patients who underwent decompression surgery for degenerative spondylolisthesis without compression fractures were also evaluated as a control group for this study.

**RESULTS:** A single vertebra was involved in 31 patients (46%) and multiple vertebrae in 37 (54%). Anterior and/or lateral listhesis more than 10% at the affected levels was observed in 51 patients (75%). The slippage occurred at intervertebral level above the fractured vertebra in 38 patients (56%) and at level below the fractured vertebra in 13 (19%). 43 patients underwent decompression surgery alone (LAM), 17 posterior intervertebral fusion (PLIF) and 8 posterolateral fusion with spinal implants (PLF). At 2 years after surgery, the mean recovery rate of LAM was 56±29% in Japanese orthopedic association score, 58% in PLIF, 36% in PLF, and 75% in the control group. Complications occurred in 27 patients (40%), 12 in LAM, 11 in PLIF and 5 in PLF. A majority of the complications were related to bone fragility. While in the control group, the complications occurred 17% of the patients.

**DISCUSSIONS:** Since 75% of CFLSS developed spondylolisthesis at the upper or lower intervertebral levels, the onset of symptoms may be mainly caused by the instability of the affected segments. The clinical results were not favorable either in decompression alone or fixation with spinal implants.
**GP211**

**ASSESSMENT OF RISK FACTOR OF ROD FRACTURE AFTER POSTERIOR SPINAL FUSION FOR ADULT SPINAL DEFORMITY**

Naobumi Hosogane1,2, Kota Watanabe3, Hitoshi Kono4, Mitsuru Yagi5, Hideaki Imabayashi1, Masashi Saito4, Yoshiaki Togama2, Morio Matsumoto2; 1 Department of Orthopedic Surgery, National Defense Medical College 2 Department of Orthopedic Surgery, Keio University 3 Department of Advanced Therapy for Spine and Spinal Cord Disorders, Keio University 4 Keiyu Spine Center 5 Orthopedic Surgery, National Hospital Organization, Murayama Medical Center

**INTRODUCTION:** Surgical outcomes of correction surgery in adult spinal deformity (ASD) has been improved, however postoperative complications such as rod fracture (RF) remain unresolved. The purpose of this study was to clarify the risk factors of RF after posterior spinal fusion (PSF) for ASD.

**METHODS:** One-hundred-twenty-one ASD patients (14 males 107 females, mean 65.3 years) who underwent PSF > 5 levels and followed > 1 year (mean 2.6 years) were included in the study. Spinal osteotomy was performed in 26 patients (22 PSO, 3 VCR, 1 wedge osteotomy). There were 17 patients (14%, 5 males 12 females) who developed RF during follow-up period. Radiological parameters were compared between patients with RF and without RF (NRF). Risk factors of RF were assessed with univariate and multivariate logistic regression analysis.

**RESULTS:** Among 24 patients with osteotomy at lumbar spine, 8 patients developed RF. Furthermore, 6 patients had RF in 17 (35.3%) osteotomy patients with discs preserved at both cephalad and caudal to osteotomy level (floating PSO), while 2 RF in 7 non-floating PSO (28.6%). In sagittal plane, preoperative lumbar lordosis (LL) was significantly smaller in RF (-0.3°) compared with NRF (-15.6°) and surgical correction angle of LL was larger in RF (31.2°) than NRF (16.6°).

There was no significant difference in sagittal vertical axis preoperatively and at final follow-up. The number of level of interbody fusion was 2.7 in RF and 1.7 in NRF which was significant difference. Multivariate logistic regression analysis revealed floating PSO at lumbar spine (OR 45.6), male gender (OR 59.6) and number of interbody fusion (OR 5.2) were significantly associated with RF.

**DISCUSSION:** PSO/VCR are useful technique for the correction of rigid spine. However, as these techniques require resection of both anterior and posterior elements, the risk of RF may increase. Surgical strategies are required to avoid the floating fusion or to preserve the spinal elements as much as possible.

**GP212**

**SEVERE WOUND PAIN IMMEDIATELY AFTER FUSION SURGERY USING PERCUTANEOUS PEDICLE SCREW: A COMPARATIVE STUDY WITH WILTSE APPROACH.**

Tanaka H.1, Hoshino M.1, Tujio T.1, Seki M.1, Ando Y.1, Iwakiri K.1, Kobayashi A.1, Nakamura H.2; 1Spine Center, Shiraniwa Hospital, Nara; 2Dept. of Orthopedic Surgery, Osaka City University Graduate School of Medicine, Osaka, Japan

**INTRODUCTION:** Percutaneous pedicle screw (PPS) is a typical procedure in minimally invasive spine stabilization surgery, and it was reported to have many benefits including reduction in infection rates, paraspinal muscle damage, and residual low back pain. However, the outcomes (wound pain in particular) immediately after surgery are currently poorly defined. The purpose of this study was to analyze the difference in early postoperative outcomes between PPS and pedicle screw (PS) using Wiltse approach.

**METHODS:** Eleven patients (5 men and 6 women, mean age 67.2 years) who underwent 1- or 2-level PLIF using PPS technique
were enrolled (PPS group). As Control, 11 patients who underwent PLIF with PS insertion using Wiltse approach were selected (Wiltse group) after matching for sex, age, and number of levels fused. Postoperative usage of analgesics (diclofenac, pentazocine), intraoperative usage of an anesthetic, operative time, blood loss (intra- and post-operative), and blood test data (CK, CRP, WBC, RBC, and Hb; pre- and postoperative day 1, day 4, and day 7) were compared between the two groups. Student's t-test was used for statistical comparison.

RESULTS: The average usage of analgesics (pentazocine) immediately after surgery was marginally higher in PPS group than in Wiltse group (1.1 ± 1.2 and 0.3 ± 0.5 times, respectively; P = 0.08). There were no significant differences in other outcome measures (usage of diclofenac, intraoperative usage of anesthetics, operative time, blood loss, and blood test data).

DISCUSSION: Compared to the Wiltse group, patients in the PPS group required analgesics more frequently after surgery. Because the other outcome measures showed no significant differences, differences in the number of skin incision (5 vs. 1) and the PS insertion route (intra- vs. intermuscular) caused a difference in the severity of wound pain after surgery. To achieve minimal invasiveness in fusion surgery using PPS, improvement of wound pain control is needed.

GP213
RELATIONSHIPS OF PRE-OPERATIVE PARAVERTEBRAL MUSCLE VOLUME, FAT INFILTRATION, AND LUMBAR LORDOSIS WITH POST-OPERATIVE FUNCTION IN THE PATIENTS WHO UNDERWENT SPINAL SURGERY FOR LUMBAR DEGENERATIVE DISEASE

Dong-Eun Shin, Ahn T-K, Kyung-Chung Kang, Chul-Kee Hong; Department of Orthopaedic surgery, CHA Bundang Medical Center, Korea, KyungHee University Medical

Colledge in Seoul, Korea

Back muscle is considered to be a critical factor for back pain and functional disability in patients with lumbar degenerative diseases. However, there are few reports regarding relationships between pre-operative paravertebral muscle status and post-operative dysfunction. Between 2010 and 2011, we retrospectively reviewed 20 patients with degenerative lumbar spinal disease who underwent posterior lumbar interbody fusion (PLIF). The evaluation included pre-operative paravertebral muscle size (CSA, Cross sectional area), fat infiltration grade (I, II, III) on MRI image and lumbar lordosis and post-operative Oswestry Disability Index(ODI). The relationships among them were analyzed. The mean CSA of paravertebral muscle at L3-4 and L4-5 level were 21.94±3.35cm2, 21.36±3.27cm2. The fat infiltration grade were grade I(10%), II(55%), and III(35%). The mean lumbar lordotic angle of pre- and post-operative were 41.02±17.54°, and 42.30±11.13°. The CSA of paravertebral muscle showed inverse correlation with post-operative ODI (L3-4: r=.582, p=.036, L4-5:g=-.568, p=0.006), but fat infiltration grade and lumbar lordotic angle did not show correlation with post-operative ODI (p>.05). In patients who underwent PLIF for lumbar degenerative lumbar disease, pre-operative paravertebral muscle size is considered to have significant effects on post-operative functional disability.

GP214
THE EVALUATION OF THE PAIN ORIGIN OF NON-UNION OSTEOPOOROTIC VERTEBRAL FRACTURE USING THE VERTEBRAL BLOCK PROCEDURE BEFORE THE OPERATION

Tsuyoshi Kato, Toshitaka Yoshii, Hiroyuki Inose, Tsuyoshi Yamada, Satoshi Sumiya, Takuya Oyaizu, Takashi Hirai, Kenichiro Sakai, Atsushi Okawa; Tokyo Medical and Den-
**GENERAL POSTERS**

**INTRODUCTION**: In recent years, vertebroplasty (VP) using CPC or PMMA is one of the most common minimally invasive surgeries as the treatment for nonunion of osteoporotic vertebral body fracture (OVF). However, the evaluation for the cause of the pain has not been made clearly. This time, we made preoperative evaluation about the pain origin before VP by vertebral body block using anesthesia.

**METHODS**: Inclusion criteria were primary OVF with back pain over 40mm VAS. We checked the contrast inside the OVF cleft which were injected by trans-pedicle injection about the leakage to around vertebral body or inside spinal canal. And then 0.5% bupivacaine was injected and we evaluate the block effectiveness by checking the VAS change about low back pain. Using CT imaging to confirm the posterior wall of the vertebral body injuries, or the size and shape of the nonunion lumen, we could decide how we operate the OVF, by BKP or CPC-VP, w/wo posterior instrumentation and/or w/wo decompression.

**RESULTS AND DISCUSSION**: 41 cases (male 11, female 30 cases, average age 76), T12: 9, L1: 16 cases, the other 16 cases, were carried out. There were the spinal canal leakage in 3 cases, and we determined that there is no adaptation of VP and went the decompression and fusion. 33 of the 38 cases the vertebral block were effective, so we made VP operation. Of other 5 cases 3 cases were treated conservatively, and the other 2 cases were evaluated the pain occurred from kyphosis. The need for minimally invasive surgery the like VP is dramatically increasing in our country, however, evaluation for the back pain was difficult, due to disuse or osteoporosis, or kyphosis or non-union OVF. This time, it was effective as an evaluation before surgery performed vertebral body contrast and vertebral block in all cases to consider the VP. It is also so simple prognosis that would be considered very useful.

**GP215**

**ANALYSIS OF FACTORS AFFECTING ACTIVITY OF DAILY LIFE AT DISCHARGE IN BALLOON KYPHOPLASTY PATIENTS**

Tomohiro Shirai1, Nao Shimizu1, Mai Toyota1, Noriko Fukuda1, Toshiaki Kotani2; 1.Dept. of Rehabilitation, Seirei Sakura Citizen Hospital, Chiba, Japan, 2.Dept. of Orthopaedic Surgery, Seirei Sakura Citizen Hospital, Chiba, Japan

**INTRODUCTION**: Balloon kyphoplasty (BKP) is an effective procedure for reducing pain in patients with vertebral compression fractures; however, few studies have investigated the activities of daily life (ADL) after BKP. The purpose of the present study is to investigate the factors affecting ADL at discharge after BKP.

**METHODS**: Twenty-eight vertebral compression fracture patients who had BKP were included in this study. Patients were divided into two groups at discharge: independent ADL (I group) and non-independent ADL (non-I group). There were 16 and 12 patients in the I and non-I groups, respectively. Age, sex, BMI, VAS (pre-BKP, 2 days post-BKP, and at discharge), ability for basic movement scale (ABMS) and Barthel Index (BI) (pre-BKP, 2 days post-BKP), number of hospitalized days, and the days needed to walk 50 meters post-BKP were compared between the two groups. Logistic regression analysis was also performed.

**RESULTS**: The patients who performed independent ADL at discharge had higher pre- and post-BKP ADL scores. In the I group, patients had the following significantly different findings compared with the non-I group: a lower age and VAS (2 days post-BKP and at discharge); higher ABMS and BI (pre-BKP and 2 days post-BKP); and fewer hospitalized days and fewer days needed to walk 50 meters. Logistic regression analysis
revealed that the following factors affected ADL at discharge: BI pre-BKP (odds ratio: 1.087, P < 0.05) and ABMS 2 days post-BKP (odds ratio: 3.108, P < 0.05).

**DISCUSSION:** The factors affecting ADL at discharge were the pre-BKP BI and the ABMS 2 days post-BKP. For BKP patients, pre- and post-BKP movement ability can affect the movement ability at discharge.

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**GP216**

**MASSIVE DISC HERNIATION: RISK FACTOR ANALYSIS**

_Sang Soo Eun M.D., Yun Suk Hong M.D., Sang Ho Lee M.D., Ph.D.*, Department of Orthopaedic surgery, Wooridul Hospital, Seoul, Korea *Department of Neurosurgery, Wooridul Hospital, Seoul, Korea_

**OBJECTIVE:** To find characteristics and risk factors of massive disc herniation.(MDH)

**BACKGROUND:** Some previous study showed clinical course and conservative treatment effects of MDH. But there is no data of risk factor analysis. This study is to find characteristics and risk factors for MDH.

**METHODS:** From June 2009 to October 2010, 99 patient diagnosed as MDH underwent disc removal surgery. Age, sex matched control group (1:1) with disc herniation who underwent disc removal surgery were compared. Level, direction, migration, and location of disc herniation were recorded. Symptom duration, presence of motor weakness, voiding difficulty, previous trauma history, operation history and presence of lysis were analyzed. Patient’s height, weight, BMI were also compared. VAS-B, VAS-L, ODI scores and recurrence rate were obtained. Chi-square test and Mann-Whintney U test and multivariate analysis were performed statistically.

**RESULTS:** There were 65 males and 34 females. The mean age was 44 years (range 22-77 years). Levels of involvement, migration, and location of disc herniation were not different in two groups. Direction of herniation was different in two groups statistically. (P<0.05) Symptom duration, aggravation time was shorter in MDH group. (P<0.05) MDH showed higher incidence of motor weakness. (P<0.05) Voiding difficulty did not showed significant difference. History of trauma was higher in MDH. (P<0.05) Height, weight and BMI do not seem to affect incidence of massive disc herniation. Previous operation history and presence of lysis was higher in MDH. (P<0.05) VAS-B, VAS-L, ODI did not show significant difference. Recurrence rate was higher in MDH. (P<0.05)

**DISCUSSION & CONCLUSIONS:** This is first study to analyze the characteristics and risk factor in MDH. Symptom duration, aggravation time, and motor weakness are related to MDH. The history of trauma, previous surgery in index level and presence of lysis in lower level of vertebra are the risk factor for MDH.

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**GP217**

**MRI VERSUS CT FOR THE DIAGNOSIS OF LUMBAR SPINAL STENOSIS**

_Sang Soo Eun M.D.*, Wei Chiang Liu M.D.; *Department of Orthopaedic surgery Department of Radiology_

**OBJECTIVE:** The purpose of the study was to compare the effectiveness of CT and MRI in visualizing soft tissues in lumbar spinal stenosis (LSS), and to correlate the images with preoperative symptoms.

**MATERIALS AND METHODS:** A total of 163 patients who had undergone unilateral laminotomy for bilateral decompression to treat LSS at L4-5 were retrospectively analyzed. The narrowed spinal canal area was measured on axial images with CT and MRI, and compared with the acquired dimensions from preoperative Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) scores.
RESULTS: The mean compromised spinal canal areas were 75.08 mm² on MRI and 63.13 mm² on CT, which were significantly different. Mean VAS for back pain was 5.37, and 7.94 for leg pain. Mean ODI was 55.17%. There was no significant correlation noted between clinical parameters and narrowed spinal canal area.

CONCLUSION: Spinal canal area was more narrowed on CT than on MRI in axial cuts. This finding can be explained by the superior ability of multidetector CT to discriminate cortical bone from soft tissue such as the ligamentum flavum. Our study highlights the value of CT examination in combination with MRI prior to LSS surgery.

GP218
DOES TRANEXAMIC ACID EFFECTIVELY REDUCE BLEEDING AFTER SPINAL FUSION SURGERY IN PATIENTS WHO TAKING LOW DOSE ASPIRIN?
Kyu-Jung Cho, M.D., Young-Tae Kim, M.D., Beom-Ho Seo, M.D.; Department of Orthopedic Surgery, College of Medicine, Inha University, Incheon, Korea

INTRODUCTION: Low dose aspirin is commonly used for preventive purposes in patients who have had myocardial infarction and stroke. However, in spinal surgery, aspirin has been reported to increase the bleeding tendency. The objective of this retrospective study was to evaluate the efficacy of tranexamic acid (TXA) in reducing blood loss after spinal fusion surgery in patients who taking low dose aspirin

MATERIALS AND METHODS: Fifty-five patients who taking low dose aspirin undergoing spinal fusion surgery for spinal stenosis were included in this study. Twenty-five patients who administered TXA were compared with 30 patients who had not taken TXA. Blood loss through drain, amount of blood transfusion, and hematological laboratory findings were evaluated.

RESULTS: For a mean period of 38.7 months, 100mg aspirin was administered. It was discontinued at least 7 days before surgery. There were no differences in patient demographics and number of fused vertebral levels. The first 24 postoperative hours blood loss through drain showed a significant difference between 766.58±346.88ml in the TXA group and 1036.14±558.93ml in the control group (p=0.006). The amount of total blood loss through drain was significantly less in the TXA versus control group, 970.44±521.66ml vs 1286.41±663.80ml (p=0.027). However, the period until the removal of hemovac drain after surgery was 2.96±1.08 days in the TXA group and 2.32±0.94 days was in the control group with no significant difference (p=0.074). In the TXA group, the packed red blood cell (pRBC) transfused volumes for the first 24 postoperative hours was significantly lower than in the control group (725.21±251.4ml vs 1107.69±530.5ml, p=0.038). There were no differences in the amount of transfused fresh frozen plasma volumes and hematological profiles.

CONCLUSIONS: TXA had an effect to reduce bleeding after spinal fusion surgery in patients who taking low dose aspirin.

GP219
POSTERIOR LUMBAR INTERBODY FUSION USING SINGLE CAGE AND UNILATERAL POSTEROLATERAL FUSION WITH LOCAL BONE.- AVERAGE 5 YEARS FOLLOW UP RESULTS-
Kyu-Jung Cho, M.D., Young-Tae Kim, M.D., Geon-Ho Kim, M.D., Jong-Hyeok Yang, M.D.; Department of Orthopedic Surgery, College of Medicine, Inha University, Incheon, Korea

INTRODUCTION: To evaluate the mid-term clinical and radiological results of posterior lumbar interbody fusion using single cage and unilateral posterolateral fusion with local bone in degenerative lumbar spine diseases. (Fig. 1)
MATERIALS AND METHODS: We evaluated 52 patients who had been followed up for at least 3 years after surgery. Clinical results were evaluated using Oswestry Disability Indices (ODIs), and bony fusion, lumbar lordosis angles, segmental lordosis angles, and disc space height and adjacent segment disease (ASD) were assessed in the radiographs.

RESULTS: The average age at the time of surgery was 62 years-old. The follow-up period was 60.6 months (range 3-9 year). The bony fusion was achieved in 49 of 52 patients with 94% fusion rate. ODI improved from 58.6±21.08% before surgery to 32.13±17.45% at the final follow-up (p=0.002). Preoperative lumbar lordosis angles & segmental lordosis angle were significantly improved from 33.60±9.3 to 36.40±11.8 and from 14.40±5.9 to 16.50±5.6, respectively with surgery (p=0.019, p=0.0004). The disc space height was also improved with surgery from 9.1±3.1mm to 12.6±2.4 mm (p=0.047). Radiographic ASD occurred in 23% (12 of 52) of patients, and clinical ASD developed in 7.6% (4 of 52) patients. Revision surgery was performed in 3 of 4 patients with clinical ASD.

CONCLUSION: Posterior lumbar interbody fusion using single cage and unilateral posterolateral fusion with local bones demonstrated satisfactory bony fusions and good clinical results in the mid-term follow-up, and are considered effective in the restoration of lumbar lordosis angles, segmental lordosis angles, and disc space height.

GP220
SURGICAL OUTCOME OF POSTERIOR FUSION FOR OSTEOPOROTIC VERTEBRAL COMPRESSION FRACTURE AT MIDDLE TO LOWER LUMBAR SPINE
1,11Satoshi Suzuki, 2,11Naobumi Hosogane, 3,11Ken Ishii, 3,11Tomohiro Hikata, 3,11Nobuyuki Fujita, 4,11Kenya Nojiri, 5,11Hitoshi Kono, 6,11Etsuo Yorimitsu, 7,11Masahiro Kato, 8,11Daisuke Ichihara, 9,11Eiji Okada, 3,8,11Hiroko Isihihama, 10,11Kota Watan; 1 Department of Orthopedic Surgery, Sano Kosei General Hospital, Sano, Tochigi, Japan 2 Department of Orthopedic Surgery, National Defense Medical College, Tokorozawa, Saitama, Japan 3 Department of Orthopedic Surgery, Keio University, Shinjuku, Tokyo, Japan 4 Department of Orthopedic Surgery, Isehara Kyodo Hospital, Isehara, Kanagawa, Japan 5 Department of Orthopedic Surgery, Keiyo Orthopedic Hospital, Tatebayashi, Gunma, Japan 6 Department of Orthopedic Surgery, Hino Municipal Hospital, Hino, Tokyo, Japan 7 Department of Orthopedic Surgery, Saiseikai Utsumomiya Hospital, Utsumomiya, Tochigi, Japan 8 Department of Orthopedic Surgery, Saitama City Hospital, Saitama, Saitama, Japan 9 Department of Orthopedic Surgery, Saiseikai Central Hospital, Minatoku, Tokyo, Japan 10 Department of Advanced Therapy for Spine and Spinal Cord Disorders, Keio University 11 Keio Spine Research Group (KSRG), Tokyo, Japan

INTRODUCTION: Surgical treatment of osteoporotic vertebral compression fracture (OVCF) at middle to lower lumbar spine is challenging. The purpose of this study was to evaluate the surgical outcomes of posterior fusion for OVCF at middle to lower lumbar spine.

METHODS: This is a multicenter retrospective study of 18 patients over 60 years old who underwent posterior surgery for OVCF at L3-5. There were 11 females and 7 males
with a mean age of 74.5 years (60-90 years). OCVF was located at L3 in 9 patients, L4 in 7 patients, L5 in 2 patients. Morphology of the fractured vertebra, local kyphosis, lumbar lordosis, and surgical procedures were evaluated with X-ray. We defined radiological outcome as poor in the patients with back out of screws, progression of vertebral collapse or patients who required revision surgery. The rest of the patients were defined as fair and compared with poor group.

RESULTS: Vertebroplasty (VP) augmented posterior fusion was performed in 5 patients, VP and PLF without instrumentation in 2 patients, PLF in 7 patients, shortening osteotomy in 3 patients, and VCR in 1 patient. Mean level of fusion was 2.6 levels (2 to 5). There were 7 patients categorized as poor (back out of screws and progression of collapse in 2 patients, revision in 3 patients,) and 11 patients as fair. In fair group, anterior intervention such as augmentation with VP, VCR, or shortening was performed in 8 patients, while only in 1 patients in poor group, which showed significant difference in number of cases. There were no significant differences in the preoperative morphology of collapsed vertebra or sagittal alignments between two groups.

DISCUSSION: OCVF at middle to lower lumbar spine is relatively rare and its surgical management is challenging due to anatomical restriction to obtain sufficient anchoring points especially in lower lumbar spine. Our study suggests that adding anterior intervention to augment anterior stability may help to improve surgical outcome.

GP221
Efficacy of Minimally Invasive spine Stabilization for Spinal Infection
Shinichi Ishihara1.2.5, Ken Ishii2.5, Yasuhito Kaneko4.5, Haruki Funao3.5, Yasuyuki Fukui1.5 Yoshiaki Toyama2.5, Takahiro Koyanagi4.5, and Morio Matsumoto2.5; 1 Department of Spine and Spinal Cord Center, International University of Health and Welfare Mita Hospital 2 Department of Orthopedic Surgery, School of Medicine, Keio University 3 Department of Orthopedic Surgery, Nerima General Hospital 4 Department of Orthopedic Surgery, Kawasaki Municipal Kawasaki Hospital, Kanagawa, Japan; 5 Keio Spine Research Group (KSRG), Japan

INTRODUCTION: Though most patients with spinal infection are typically treated with antimicrobial therapy, several cases required surgical treatment such as an anterior approach for debridement and fusion with autologous bone graft. Minimally invasive spine stabilization (MIST) using percutaneous pedicle screws (PPS) has recently become available. Here, we report clinical outcomes of MIST with PPS in the patients with spinal infection.

METHODS: Eight patients who underwent MIST using PPS for spinal infection were retrospectively reviewed. The subjects included 4 men and 4 women with a mean age of 64.6 years (39-85 years). The mean follow-up (f-u) period was 31.3 months (minimum 6M f-u). The subjects consisted of pyogenic spondylitis in 7 cases and tuberculous spondylitis in 1 case. Fusion levels were T6-L1.T7-L2.T12-L2.L1-3.L1-S1.L3-5.L4-5.L4-S1, respectively. MIST with PPS combined w/wo anterior spinal fusion was performed in 4 cases each.

RESULTS: Isolated pathogens were Staphylococcus aureus, Enterobacter aerogenes, Streptococcus intermedia and tuberculo-
age period of 39.0 days. Average recovery rate of JOA scores at the final f-u was 73.8 (25-100) %. VAS for back pain significantly improved from 8.3 to 0.8. Bony union was obtained in all patients. There are no complications associated with the surgical procedure.

**DISCUSSIONS:** MISt procedure provides less invasive and effective stabilization for unstable and/or destructive spines. In the present study, intractable spinal infections were cured by MISt procedure, suggesting that stabilization of unstable spine by MISt reduced the local inflammation and infection. MISt can be a promising treatment option for intractable spinal infection.

**GP222**

Efficacy of Ankle-Brachial Index as a Preoperative Screening in Spine Surgery


**INTRODUCTION:** Ankle-Brachial Index (ABI) is widely used for the screening of peripheral arterial disease (PAD). The aim of this study is to investigate the efficacy of ABI as a preoperative screening in spine surgery.

**METHODS:** For the screening of PAD, ABI was routinely measured in all the candidates for spine surgery in our institution. A total of 1427 patients who had undergone spine surgeries between June 2010 and June 2013 were included in this study. They were 730 males and 697 females with a mean age of 63 years. We reviewed ABI, age, co-morbidities (diabetes mellitus: DM, cerebrovascular disease: CVD, and ischemic heart disease: IHD) and smoking status. CT- or MR-angiography was used for a definitive diagnosis of PAD when ABI was less than 0.9. Fisher’s exact test or chi-square test was used for statistical comparison.

**RESULTS:** 36 patients (2.5%) showed less than 0.9 of ABI. PAD was diagnosed in 23 patients (1.6%) through CT- or MR-angiography. The prevalence of PAD was 3.5% in the patients over 70 years, and 0.6% in those under 70 years; the difference was significant (P<0.05). The rate of DM was 56.5% in the PAD group, which was significantly higher than 18.9% in the non-PAD group. Patients with CVD or IHD were more likely to have PAD, however the differences were not significant. Smoking rate was 17.4% in the PAD group versus 2.8% in the non-PAD group; the difference is significant (P<0.05). Patients under 70 years with PAD had any co-morbidities and/or smoking habit.

**DISCUSSION:** Elastic stocking is widely used to prevent deep vein thrombosis and pulmonary embolism, but is a potential risk to cause acute limb ischemia in case of PAD. The current study showed that advanced age, DM and smoking habit were the risk factors for PAD. In the patients under 70 years, however, ABI measurement might be unrequired as a preoperative PAD screening when they have no co-morbidities and/or smoking habit.

**GP223**

Clinical Outcomes of Recapping Hemilaminoplasty in the Treatment of Lumbar Foraminal Lesions


**INTRODUCTION:** We examined clinical outcomes of recapping hemilaminoplasty in the treatment of lumbar foraminal lesions.
**METHODS:** Surgical procedures included (1) detaching hemilamina by T-saw, (2) neuroforaminal decompression, and (3) replacing the lamina to the original position with poly-L-lactic acid (PLLA) screws. A total of 45 patients (25 males, 20 females, 58 years) were retrospectively reviewed with a minimum one-year follow-up. The pathologies included foraminal disc herniation in 42 patients, and foraminal stenosis in three. Clinical outcomes were evaluated by VAS (0-100) of low back pain, leg pain and leg numbness, and JOA score. In 23 patients (10 males, 13 females, 62 years) with a minimum two-year follow-up, intervertebral instability and facet joint degeneration were evaluated using functional radiography and CT scan. Mean follow-up period was 64 months. Paired t-test was used for statistical comparison.

**RESULTS:** VAS of low back pain, leg pain and numbness were 50, 71 and 46 preoperatively, which were improved to 24, 22 and 22, respectively. JOA score is also improved from 14/29 to 22/29. In 23 patients with a minimum 2-year follow-up, 3 patients (13%) had ipsilateral facet joint space narrowing; 5 patients (22%) had contralateral facet joint osteosclerosis and growing osteophyte. Only 3 cases were reoperated due to recurrent disc herniation. No additional surgeries were required for intervertebral instability and/or osteoarthritis.

**DISCUSSION:** Recapping hemilaminoplasty is a safe technique by directly observing exiting nerve root during neuroforaminal decompression without spinal fusion. However, there might be a potential risk for progression of spinal instability and/or facet joint degeneration. The current study showed that 35% of the patients developed facet joint degeneration but did not require additional surgery. The current procedure is advantageous in the treatment of lumbar foraminal lesions without spinal instability.

**GP224**

**RISK FACTORS FOR ADJACENT SEGMENT DEGENERATION AND CHANGE OF SAGITTAL PROFILE AFTER SURGICAL CORRECTION OF LUMBAR DEGENERATIVE KYPHOSCOLIOSIS WITH Iliac SCREW**

>In-Soo Oh, MD1, Kee-Yong Ha, MD2; Department of Orthopaedic Surgery, Incheon St. Mary's Hospital1, Seoul St. Mary's Hospital2, College of Medicine, The Catholic University of Korea, Seoul, Korea

**INTRODUCTION:** Although various procedures were introduced to correct deformity and fusion using iliac screw in LDK, there have been no clinical reports on degree of surgical correction and on changes of adjacent segment.

**METHOD:** A total of 32 patients, who had undergone surgical correction and lumbar/thoracolumbar fusion with pedicle and iliac screw instrumentation for LDK with a minimum 2-year follow-up were included for the present investigation. 10 cases with ASD (group 1) and 22 cases without ASD (group 2) were compared to see pre and postoperative change of sagittal view of spine and change of adjacent segment. As coronal spinal parameter, we used kyphosis of thoracic spine (T4-T12)(TK), lordosis of lumbar spine (L1-S1) (LL) and T9 offset. As pelvic parameter, sacral slope (SS), pelvic slope (PS) and pelvic incidence (PI) angle were measured. As coronal parameter, Cobb’s angle was measured. All deformity type of patients was classified using SRS-Schwab classification. Risk factors of ASD were evaluated using variables of SRS-Schwab classification.

**RESULTS AND DISCUSSION:** Patients were average 68.8(53~81). Among ASD, there were 6 cases of proximal junctional kyphosis (60%), 4 cases of vertebral fracture (40%). There is no statistical difference in age. Group 1, rather than group 2, showed significant increment in PI (preoperative: 62.69±9.39° vs. 53.66±8.66°, postoperative:
62.81±9.39° vs. 53.06±12.14°) (P=0.017, 0.017). Postoperative SS and TK showed more statistical significant in group 2. Curve types, classified using SRS-Schwab classification, are all corrected using iliac screw and after correction, coronal curve type is N curve, PI minus LL are all increased, PT showed tendency to decrease. Cases with preoperative SVA more than 9.5cm and with post operative PI minus LL less than 20 degree were at higher risk of developing ASD.

**GP225**

**LONG-TERM RADIOLOGICAL OUTCOMES IN SHORT SEGMENT POSTERIOR LUMBAR INTERBODY FUSION USING EXPANDABLE CAGES**

Toshitaka Yoshii MD, PhD, Kiyoshi Mochida MD, PhD, Akio Tsuchiya MD, PhD, Tsuyoshi Kato MD, PhD, Yoshiyasu Arai MD, PhD, Atsushi Okawa MD, PhD; Department of Orthopaedic Surgery, Tokyo Medical and Dental University, Tokyo, Japan

**INTRODUCTION:** Previous studies in posterior lumbar interbody fusion (PLIF) have reported that wedge-shaped cages have advantages over rectangular cages to obtain segmental lordosis. L-Varlock is an expandable cage: parallel-sided at insertion, wedge-shaped after expansion, which can be useful to achieve successful sagittal alignment. In this study, we investigated the efficacy of expandable cages to enhance and maintain segmental and lumbar lordosis in PLIF.

**METHODS:** 26 consecutive patients (30 segments), who underwent one- or two-level PLIF using expandable cages, were prospectively evaluated. Intraoperative changes in segmental lordosis were assessed using fluoroscopy, at the prone position, after decompression, after insertion and after expansion of the cages, and after posterior compression. Radiological outcomes were evaluated with a minimum of 7-year follow-up and were compared with control group of patients using rectangular cages.

**RESULTS AND DISCUSSION:** The mean lordosis of the fused segment was 10.1±4.7 degrees (deg) preoperatively, increased in the prone position under general anesthesia (12.7±4.7 deg), increased after posterior decompression (14.6±5.3 deg), decreased with cage insertion (12.2±5.0 deg), increased with cage expansion (17.2±5.0 deg), and further increased with posterior compression (20.9±5.3 deg). All of these changes were statistically significant. The postoperative increase in segmental lordosis was higher than the control group. The segmental lordosis was well preserved after weight bearing (18.4±5.6 deg) and during the follow-up period: 17.9±5.1 degrees at 1 year and 16.8±4.8 degrees at the final follow-up. The lumbar lordosis at L1/S1 (pre: 38.3±12.3 deg) was significantly enhanced postoperatively (45.3±13.4 deg) and well preserved at the final follow-up (43.6±13.6 deg). In conclusion, expandable cages were useful to enhance segmental lordosis and maintain sagittal alignment during the long-term follow-up in short segment PLIF.

**GP226**

**ENTRY ZONE OF ILIAC SCREW TO MAINTAIN THE MAXIMAL LENGTH**

Soo-An Park1, Dai-Soon Kwak2; 1Department of Orthopedic Surgery, Uijeongbu St. Mary’s Hospital, The Catholic University of Korea, Uijeongbu-si, Gyeonggi do, South Korea 2Catholic Institute for Applied Anatomy, The Catholic University of Korea, Seoul, South Korea

**INTRODUCTION:** Spine pelvic fixation sometimes demand longer, multiple iliac screws or one-rod connection. However, traditional technique is not clear enough to plan it preoperatively. This study evaluated the entry zone of iliac screw to maintain the maximal length.
**METHODS:** The 3-D model of L5-Sacrum Pelvic bone was reconstructed with CT scans of 100 cadaveric bodies using the Mimics software. One virtual iliac screw (10mm-diameter) was applied to the posterior superior iliac spine (PSIS) aiming the anterior inferior iliac spine (AIIS). In each model, multiple axial views that cross from the PSIS (with extending 20mm superiorly and inferiorly with 10mm interval) to the AIIS were collected. On each view, the maximal screw length (MSL: the length to perforate the cortex or to touch the anterior cortex) and the protruding width of posterior iliac spine (PW) were measured. Consecutive difference of each parameter between adjacent entry points (EP) was analyzed statistically.

**RESULTS:** The MSL was longest at the EP of inferior 10mm (112.3mm/SD15.1), was not significantly different with that of the PSIS (111.3mm/20.7), and was significantly longer than that at the inferior 20mm (103.3mm/17.6). Superiorly, the MSL at the EPs of 10mm (99.4mm/33.0) and 20mm (76.7mm/39.7) became significantly shorter than those of inferior adjacent EPs. The PW was greatest at the EP of superior 10mm (19.1mm/3.9), and became significantly shorter at those of superior 20mm (18.4mm/4.4) and PSIS (16.2mm/3.2). Inferiorly, the PW at the EPs of 10mm (9.6mm/3.9) and 20mm (4.7mm/3.0) became significantly shorter than those of superior adjacent EPs.

**DISCUSSION:** Starting the iliac screw inferiorly allows the long screw, but the PW becomes thinner inferiorly. Starting it superiorly may not allow the long screw, but the PW is thicker superiorly. Inferiorly approached iliac screw may allow the longer length, the space for second iliac screw superiorly, one-rod connection, but may violate the sacroiliac joint.

**GP227**
**ASSOCIATION BETWEEN PSYCHOLOGICAL DISORDER AND LOW BACK PAIN AFTER DECOMPRESSION SURGERY FOR LUMBAR SPINAL STENOSIS**

*Nobuyuki Fujita*(1), *Tomohiro Hikata*(1), *Kota Watanabe*(2), *Ken Ishii*(1), *Akio Iwanami*(1), *Masaya Nakamura*(1), *Yoshiaki Toyama*(1) and *Morio Matsumoto*(1); 1 Department of Orthopaedic Surgery, Keio University School of Medicine, Japan 2 Department of Advanced Therapy for Spine and Spinal Cord Disorders, Keio University, Japan

**INTRODUCTION:** We conducted a retrospective study on risk factors of low back pain after surgery for lumbar spinal stenosis.

**METHODS:** 99 patients (60 males and 39 females with a mean age of 69.4 years) who underwent laminectomy between September 2008 and June 2012 were included in the study. We assessed ages at surgery, operative time, estimated blood loss, the number of surgical levels and pre-operative imaging findings, as well as JOA scores before and one year after surgery, Roland Morris Disability Questionnaire (RDQ), and JOA Back Pain Evaluation Questionnaire (JOAPEQ). Comparisons were made on one-year post-operative JOAPEQ between a group with Visual Analog Scale (VAS) for low back pain below 5 (Group A) and that with VAS of 5 or above (Group B).

**RESULTS:** The number of subjects in Groups A and B were 61 and 38, with a mean age of 68.9 and 70.4, respectively. No significant difference was observed in operative time, estimated blood loss, the average number of surgical levels and the numbers of slipage. Moreover, there was no significant difference in the average numbers of severe degenerative facet joints on CT (0.97/0.86) and severe degenerative discs on MRI (1.28/1.14). The score of pre-operative RDQ were significantly higher in Group B (9.5/12.1). In pre-operative JOAPEQ, no
significant difference was observed in mean scores for lumbar function, walking ability, social life function. The mean scores for low back pain (51.3/35.7) and mental health (51.2/40.7) were significantly lower in Group B. Especially, a strong correlation was observed between post-operative low back pain and mental health in pre-operative JOABPEQ.

DISCUSSION: There was no association between low back pain 1 year after decompression surgery and pre-operative spondylolisthesis, degenerative discs or facet joint OA. Interestingly, we found that low back pain after decompression surgery was associated with pre-operative psychological disorders.

GP228

DECOMPRESSION WITH COFLEX INTER-LAMINAR DYNAMIC STABILIZATION FOR DEGENERATIVE LUMBAR STENOSIS: PROSPECTIVE 3-5 YEARS FOLLOW-UP EVALUATION.

Yong Hai, Lijin Zhou, Yuzeng Liu, Shibao Lu, Qingjun Su, Jincai Yang, Li Guan, Nan Kang.; Orthopedic Surgery, Beijing Chaoyang Hospital, Capital Medical University, Beijing, China

INTRODUCTION: To evaluate the clinical efficacy and safety of posterior Coflex dynamic stabilization for the treatment of degenerative lumbar stenosis, a prospective clinical and radiographic study was conducted and 3-5 years outcome was reported.

METHODS: Between September, 2007 and August, 2009, 48 consecutive patients with degenerative lumbar stenosis were prospectively enrolled and treated with selective decompression and Coflex inter-laminar dynamic stabilization. There were 23 male and 25 female (age 60.3 years 48-79). 46 patients underwent single level procedure and 2 patients with two level procedures. The outcome evaluations were utilizing VAS scale, Modified ODI score, and radiographic results with the ROM of surgery and adjacent level as well as complications. All data were analyzed and patient’s satisfaction was evaluated at final follow-up examination.

RESULTS: Follow-up examinations were conducted at 1, 3, 6, 12, 24, 36 months post-operatively and clinical and radiographic evaluations were carried out. All patients were followed at least 36 months (36-60 months, average 45.2 months). The average VAS scale was 8.1 pre-op, 2.9 post-op and 2.5 at latest follow up. The ODI score was 54.3 pre-op, 21.8 post-op and 24.5 at the latest follow up. All data above were statistically significant improved. During follow up, the range of motion (ROM) of operated levels were maintained (2-6",average 3.6") and there was no significant increase of ROM in adjacent level. Seven cases of Coflex device related complications (14.6%) were occurred but no patient underwent revision surgery for it.

DISCUSSION: From this prospective study from single institute, mid-long term satisfactory clinical outcome could be achieved in patients with single level of DLS treated by selective decompression and posterior Coflex inter-laminar dynamic stabilization, with few device related complications and ASD occurred.

GP229

EVALUATION OF SAGITTAL BALANCE IN LUMBAR DEGENERATIVE DISEASES USING CURVE HARMONY ANGLES

Zhaomin Zheng M.D. Ph.D, Hui Liu M.D. , Sibeil Li M.D. , Jiranru Wang M.D., Hao Yang M.D., Hua Wang M.D., Zemin Li M.D.; Department of Spine Surgery, The First Affiliated Hospital of Sun Yat-sen University, 58 Zhongshan 2nd Road, Guangzhou, 510080, China

INTRODUCTION: The relationship between adjacent curves on spinopelvic sagittal
plane is important to maintain sagittal balance. Parameters quantifying this relationship is still lacking. The current study is to use Curve Harmony Angle (CHA) to quantify the relationship between adjacent curves and pelvis for sagittal balance evaluation.

**METHODS:** Radiographic analysis of 68 normal population (NP) and 52 patients of Lumbar Spinal Stenosis (LSS) and Degenerative Scoliosis (DS) are performed by measuring sagittal parameters including Sacrum Kyphosis Angle (SKA). Correlation study among parameters was performed. CHAs (Cervical-Thoracic Angle (CTA); Thoracic-Lumbar Angle, TLA; and Lumbar-Sacral Angle, LSA) were identified and comparative study among NP, LSS and DS were performed. Comparative study according to Schwab Adult Deformity Classification of CHA in different balance status was performed to test the reliability of CHA.

**RESULTS:** All subjects showed typical changes of sagittal parameters. Sacral Kyphosis Angle (SKA) was shown closely correlated to important sagittal positioning parameters. In NP, LL was correlated with PI and SS; PI was correlated with PT and SS (P<0.01); TK was correlated with LL and Cervical Lordosis (CL). CHAs were found within small ranges in NP. LSS and DS showed characteristic patterns of CHAs. In LSS, with its typical change (LL decreases, PT increases), TLA became greater and LSA smaller. In DS, the change was more severe, and the cervical spine was involved in the compensation, leading to CTA decrease. SVA of LSS and DS became greater to different extension. Compensatory Balance group showed smaller LSA than Balance group; Imbalance group showed smaller CTA, LSA and greater TLA.

**DISCUSSION:** CHA between normal population and different lumbar disorders or among different balance status showed characteristic changes. CHA can be used to evaluate the clinical sagittal balance and outcomes of surgical correction in the treatment of lumbar degenerative disease.

**GP230**

DEVELOPMENT OF L4-5 DISC DEGENERATION INTO DEGENERATIVE SPONDYLOLISTHESIS OR SPINAL STENOSIS

Zhaomin Zheng M.D. Ph.D, Hui Liu M.D., Sibei Li M.D., Jiranru Wang M.D., Hao Yang M.D. Zemin Li M.D., Hua Wang M.D., Xiang Li M.D.; Department of Spine Surgery, The First Affiliated Hospital of Sun Yat-sen University, 58 Zhongshan 2nd Road, Guangzhou, 510080, China.

**INTRODUCTION:** Degenerative Spondylolisthesis (DS) and Lumbar Spinal Stenosis (LSS) are important types of spondylolisthesis and lumbar degenerative diseases causing low back pain (LBP). Spinopelvic sagittal balance has been emphasized recently and considered of importance in pathological mechanism of many spinal disorders, and spinopelvic sagittal malalignment in DS and LSS has also been noticed. But the role of spinopelvic sagittal alignment in the development of L4-5 disc degeneration into DS or LSS has not yet been fully clarified. The purpose of the current study is to compare the spinopelvic sagittal balance parameters among Normal Population (NP), LSS and DS, and investigate the role of sagittal alignment in the pathological mechanism of DS and LSS development.

**METHODS:** 40 NP, 30 single segment L4-5 DS without LSS and 25 LSS without spondylolisthesis patients were enrolled. Comparative analysis of sagittal parameters and disc degeneration grades among NP, DS and LSS were performed.

**RESULTS:** Compared to NP and LSS, DS showed significantly greater Pelvic Incidence (PI), Sacral Slope (SS) and Lumbar Lordosis (LL), while LSS showed significantly smaller Pelvic Tilt (PT) and Ratio of PT and SS (PT/SS). DS showed significantly greater L5 slope than NP and LSS. In both Great-PI
group and Small-PI group, all above results remained. LSS showed significantly higher degenerative grade of each adjacent disc than DS. Population with adjacent segment degeneration (ASD) showed higher incidence of pelvic retroversion (PT/SS =1), and LSS showed greater proportion of ASD than DS.

**DISCUSSION:** Lumbar spine morphology of great LL determined by great PI is a risk factor of L4-5 DS. L5 slope is a parameter can be used to predict the risk of L4-5 DS. Adjacent Segments Degeneration (ASD) is the driving factor of pelvic retroversion for compensation of lumbar sagittal malalignment and differs the development of L4-5 disc degeneration into degenerative spondylolisthesis or spinal stenosis.

**GP231**

**LMP-1 SUPPRESSES INTERVERTEBRAL DISC DEGENERATION BY INHIBITING MMPS EXPRESSION**

Zhaomin Zheng M.D. Ph.D, Hui Liu M.D., Hehai Pan M.D., Jiranru Wang M.D., Hua Wang M.D., Wenbin Ding M.D., Hao Yang M.D., Zemin Li M.D.; Department of Spine Surgery, The First Affiliated Hospital of Sun Yat-sen University, 58 Zhongshan 2nd Road, Guangzhou, 510080, China.

**INTRODUCTION:** LIM mineralization protein-1(LMP-1) is an intracellular regulatory molecule in bone formation. Previous studies have proved that it has beneficial effects on intervertebral disc regeneration in vitro and in vivo. However the mechanism of LMP-1 suppresses intervertebral disc degeneration remains unknown. The purpose of the present study was to identify the protective role of LMP-1 in a TNF-a induced intervertebral disc degeneration cell model.

**METHODS:** TNF-a induced extracellular matrix degradation of rat nucleus pulposus cells (NPCs) was used to imitate intervertebral disc degeneration. Cultured NPCs were transfected with rLMP-1 siRNA to knock down the LMP-1 expression, sulfated glycosaminoglycan (sGAG) dyeing, real-time polymerase chain reaction (RT-PCR), and western blotting were used to analyze proteoglycan, mRNA, and protein levels, respectively. Two days later, the mRNA levels of MMPs were measured.

**RESULTS:** In vitro experiments revealed that the sulfated glycosaminoglycan (sGAG) level was significantly reduced with the rLMP-1 siRNA treatment, while the mRNA level of MMP3 and MMP13 increased. TNF-a down-regulated the proteoglycan expression in NPCs, knocking down LMP-1 expression had significantly elevated levels of MMP3 and MMP13 mRNA, accompanied with the decrease of sGAG level.

**DISCUSSION:** LMP-1 suppresses TNF-a induced intervertebral disc degeneration by inhibiting MMPs expression.

**GP232**

**RECOMPRESSION OF CEMENTED VERTEBRAE AND ITS RISK FACTORS FOLLOWING MIDTERM FOLLOW-UP AFTER PERCUTANEOUS KYPHOPLASTY**

Chongyan Wang; Fengdong Zhao; Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University.

**INTRODUCTION:** Percutaneous kyphoplasty is widely used for osteoporotic vertebral compression fracture since its significant postoperative pain relief and excellent restoration of vertebral body height, while relatively high costs and complications including neurological deficit have been noted these years. However, a high incidence of recompression in cemented vertebrae during follow-up was always ignored.

**METHOD:** The anterior vertebral height, middle vertebral height, kyphotic angle of treated vertebrae and Visual Analog Scale scores were measured preoperatively, 1 day postoperatively and at final follow-up(3-34 months postoperatively). We also assessed
the following covariates: age, sex, body weight, height, treated vertebral level, lumbar spine bone mineral density, intravertebral cleft, anterior vertebral body restoration, middle vertebral body restoration, the minimum distance between cement and endplate, antiosteoporotic treatment after surgery. Paired t-test and multiple logistic regression analysis were used to analyse data.

RESULTS: We continuously analysed 93 vertebrae of 75 patients with a mean follow-up of 9.8 months (3-34 months). The mean restoration of anterior and middle vertebral height were 14.8% and 10.2% respectively, while the mean loss of anterior and middle vertebral height were 8.1% and 9.3% respectively at final follow-up. Restoration of anterior vertebral height and middle vertebral height, intravertebral cleft, the distance between cement and endplate were positively associated with recompression during the follow-ups (P<0.05).

DISCUSSION: The restoration of cemented vertebral height after percutaneous kyphoplasty could be partly offset by recompression during mid-term follow-up, which could be as a consequence of insufficient fill of vertebrae and repeated “microfractures” during kyphoplasty. Percutaneous kyphoplasty is an effective treatment for osteoporotic vertebral compression fracture but needs proper patient selection.

GP233
THE LOCAL APPLICATION OF VANCOMYCIN IN SPINE SURGERY AND CHANGES TO BACTERIAL RESISTANCE PROFILES
Frank Valone III M.D.; Shane Burch M.D., Sigurd H. Berven M.D., Bobby Tay M.D., Vedat Deverin M.D., Serena S. Hu M.D.; University of California, San Francisco Department of Orthopaedic Surgery

INTRODUCTION: Vancomycin placement in the surgical wound has come under recent investigation. Sweet et al. showed a significant reduction in spine surgical site infections. No data is available on how this novel treatment has altered bacterial resistance. The aims of this study are to: analyze bacteria and resistance patterns in spine surgery infections, and determine if there is an association between Vancomycin placement and Vancomycin resistant bacteria.

METHODS: All surgical site infections within an academic tertiary care spine center were analyzed from 2007 – 2013. Antibiotic resistance profiles as well as bacteria type were analyzed by epoch. Additionally, a retrospective consecutive case series analysis was performed on 1013 surgical cases completed from 2011-2013 with varying application of Vancomycin.

RESULTS: 126 bacteria were isolated from 81 surgical site infections from 2007-2013. Resistance profiles and bacteria type were analyzed (Table 1). The most prevalent bacteria isolated: 2007: MSSA (36%); 2008: MSSA, MRSE (13.5%); 2009: MRSE (41.2%); 2010: MRSE (33.3%); 2011: MSSA (54.6%); 2012: MSSA (18.8%); 2013: MSSE (40%). Only two Vancomycin resistant bacteria were found: Enterococcus Faecium 2008 & 2012. Additionally, from 2011-2013 Vancomycin was placed 475 times (47%). The single patient with the Vancomycin resistant bacteria in 2012 did not receive Vancomycin in the surgical wound prior to the development of the infection.

DISCUSSION: This study provides retrospective data that suggests that Vancomycin resistant bacteria are rare in spine surgery infections. Additionally, there has not been an increase in Vancomycin resistant surgical site infections. Lastly, there was not a significant association between Vancomycin placed intra-operatively and Vancomycin resistant bacteria. This study is an integral first step in monitoring how the application of Vancomycin will alter the bacteria, and resistance profiles in spine surgical site infections.
A CLINICAL STUDY ON PRESERVING SPINOUS PROCESS AT DECOMPRESSION SURGERY FOR LUMBAR SPINAL STENOSIS

Hatakeyama Kenji, Aihara Takato, Urushibara Makoto; Funabashi Orthopedic Hospital

INTRODUCTION: Minimally invasive spine surgery (MIS) has become common for recent years. However, few reports revealed superiority in clinical outcomes compared to conventional spine surgery. The purpose of this study was to evaluate the clinical results of bilateral decompression via unilateral approach (BDU) as MIS for preserving spinous process.

METHODS: We evaluated the clinical outcome of BDU (n=24) and those of laminotomy with cutting the basal part of spinous process (ML; n=26). All of these surgeries were performed using microscopy by one surgeon from 2010 to 2012. As clinical index, we used Japanese Orthopaedic Association Back Pain Questionnaire (JOABPEQ) score and VAS score of low back pain (LBP), leg pain and leg numbness. We compared them at before-surgery, 1 month, 3 months, 6 months and 12 months after surgery between two groups.

RESULTS: There was no difference between two groups for age, the number of levels decompressed, all five factors of JOABPEQ score and VAS scores before surgery (p>0.2). Improvement of JOABPEQ score of BDU group tended to be better than that of ML group at all times, but not significantly different (p>1.0). As to VAS scores, there was also a tendency that BDU was superior to ML at all times but not significant, either. In both groups, JOABPEQ scores were better at 3 or 6 months after surgery and worst at 1 month. Average VAS scores of BDU were lower than ML at all times, but not significant.

DISCUSSION: We make an effort to preserve spinous process, because we think that it is important for spinal stability and has function of posterior loading. However, within one-year follow up, no statistical superiority was seen on this study for preserving spinous process. We think further follow up and more cases are needed to prove the superiority of this surgery.

THE RISK FACTORS OF SURGICAL SITE INFECTION AFTER LUMBAR INSTRUMENTATION SURGERY

Keiichi Sato, Kenji Hatakeyama; Funabashi Orthopedic Hospital, Funabashi-city, Japan

INTRODUCTION: Surgical Site Infection (SSI) has a possibility to lead to serious sequelae. It would suffer the patients and medical staffs as well as increasing hospital stay and cost. Therefore, prevention is important.

METHODS: Three hundred thirty-nine cases, who underwent lumbar instrumentation surgery between January 2008 and April 2013 in our hospital, were evaluated for SSI risk factors. For deciding SSI; we used criteria of SSI prevention guidelines by the U.S. Centers for Disease Control and Prevention (CDC).

RESULT: The SSI incidence was 3.8% (13/339 cases). Men and low BMI were identified as independent risk factors by multiple logistic regression analysis (odds ratio Men; 28.4, low BMI; 0.7). There was a
significant differences in the point of sex; men 7.6% (12/156 cases) women 0.5% (1/183 cases) (p<0.05). Also there was a significant differences in BMI; slender 23.0% (3/13 cases), standard 3.6% (8/217 cases), obesity 1.8% (2/109 cases) (p<0.05).

**DISCUSSION:** SSI prevalence was reported from 3 to 7% in previous reports. Therefore we thought that of our hospital (3.8%) might be appropriate. In this study, “men” and “slender” were risk factors for SSI. However, not only did not find any report describing those risk factors, but also many previous reports and CDC guideline insisted that obesity was major risk factor. We considered, “men” had thin layer of subcutaneous fat and “slender” had thin muscles in addition to thin fat so that more compressive stress was generated between instruments and back tissues, resulting in minute injury. There was no poor nutrition case with low serum total protein among SSI group. However, especially in case of slender, we thought there were some kinds of poor conditions that cannot be measured.

**GP236**

**PATHOMECHANISMS OF SCIATICA INDUCED BY DISC HERNIATION: ULTRA-STRUCTURAL CHANGES OF VASCULAR COMPONENT IN THE PERIRADICULAR ADHESIVE TISSUE.**

Shigeru Kobayashi, MD, PhD, Kenichi Takeno, MD, PhD; Department of Orthopaedics and Rehabilitation Medicine, Faculty of Medical Sciences, The University of Fukui.

**INTRODUCTION:** The straight-leg-raising (SLR) test is one of the most significant signs for making a clinical diagnosis of lumbar disc herniation. Our previous study showed that intraradicular blood flow and electro-physiological values apparently disturbed during the SLR test in patients with disc herniation. In this study, the mechanisms responsible for the adhesive nerve root were studied by examining herniated tissue collected at operation from patients with lumbar disc herniation.

**METHODS:** The subjects were 18 patients with lumbar disc herniation who underwent microdiscectomy (11 men and 7 women, aged range, 17-59). The preoperative SLR test revealed that 12 patients experienced sciatica below an angle of 30 degrees and 6 patients from 30 to 60 degrees. Nerve root movement was clearly disturbed, being only 0 ~ 1 mm (0.2 ± 0.5 mm on average) during intraoperative SLR test. The periradicular and hernia specimens collected during surgery were examined by light and electron microscope.

**RESULTS:** In the histological examination, adhesions of transligamentous and sequestrated hernias showed the severe inflammatory changes with granulation between nerve root and herniated tissue. In the electron micrograph, high endothelial venules, development capillaries, and lymphatic vessels and were present in the adhesive tissue. Many macrophages and fibroblasts infiltration observed adjacent to the dura mater of nerve root, and many fibroblasts producing collagen fibers were observed in the adhesive tissue.

**DISCUSSION:** Periradicular vascularization will occur at site of inflammation by some chemical factors of herniated disc. The presence of periradicular adhesions will compound the nerve root pain by fixing the nerve in one position and thus increasing the susceptibility of the nerve root to tension or compression. Control of the periradicular inflammatory reaction is an important challenge when treating patients with disc herniation.
GP237

IMPACT OF RESIDENT INVOLVEMENT ON COMPLICATIONS FOLLOWING LUMBAR FUSION SURGERY

Sreeharsha V. Nandyala BA, Alejandro Marquez-Lara MD, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: Fundamental to the perpetuation of quality care in medicine is the need to train the next generation of medical practitioners. The goal of this study is to characterize the impact of trainee involvement on the rates of complications following lumbar spine fusion (LF) surgery.

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was searched to identify patients undergoing LFs between 2006 and 2011. Patients were divided into two cohorts based upon resident participation during the surgical procedure. Patient preoperative characteristics and peri-operative outcomes were assessed. SPSS v.20 was utilized for statistical analysis with a p-value of < 0.05 to denote significance.

RESULTS: A total of 5,680 LFs were identified between 2006 and 2011, including 1,917 (33.7%) with resident involvement. The resident cohort was older and demonstrated a greater number of comorbidities than the non-resident cohort. Operative time, length of stay, and intra-operative transfusions were greater in those cases with resident involvement. The incidences of postoperative superficial wound infection, blood transfusion, DVT, and sepsis were greater with resident involvement.

DISCUSSION: This study demonstrated several differences in outcome between the groups, notably an increased length of stay, and peri-operative complications in those cases with resident involvement. A significant limitation of the study is the inability to identify the extent of resident involvement during the surgical procedure. As such, further analysis is needed before definitive conclusions can be made regarding surgical outcomes associated with resident involvement.

GP238

PERIOPERATIVE OUTCOMES OF MULTI-LEVEL ANTERIOR-POSTERIOR LUMBAR FUSIONS

Sreeharsha V. Nandyala BA, Alejandro Marquez-Lara MD, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: Circumferential (anterior/posterior) lumbar fusion (APLF) is utilized for robust internal fixation of the lumbar spine. The surgical outcomes may vary based upon the number of spinal levels that require fusion.

METHODS: Data from the Nationwide Inpatient Sample (NIS) was queried from 2002-2011. Patients undergoing an APLF were identified and separated into three cohorts:1-2 levels, 3-7 levels, and 8+ levels. Patient demographics, comorbidities (CCI), length of stay (LOS), costs, and periopera-
tive outcomes were assessed. SPSS v.20 was utilized for statistical analysis with a p-value of < 0.001 to denote significance.

RESULTS: A total of 24,594 APLFs were identified in the NIS of which 20,398 (82.9%) were 1-2 level fusions, 3,964 (16.1%) were 3-7 level fusions, and 232 (0.9%) were 8+ level fusions. The 8+ level fusion cohort comprised of older patients with a significantly greater CCI than the other cohorts. In addition, patients in the 8+ level cohort incurred a significantly greater LOS and total hospital costs. Furthermore, the 8+ level fusion cohort demonstrated a greater incidence of postoperative complications. Lastly, the 3-7 level and 8+ level fusion cohorts demonstrated a significantly greater incidence of in-hospital mortality than the 1-2 level fusion cohort.

DISCUSSION: This study highlights an increasing trend of complication rates associated with a greater number of levels in APLF. The 8+ level fusion cohort incurred the greatest LOS and total hospital costs. These findings are likely due to the greater incidence of postoperative complications, an older and more comorbid patient population, and the invasiveness associated with an 8+ level fusion. The 3-7 level and 8+ level fusion cohorts demonstrated a significantly greater incidence of in-hospital mortality. In light of this data, further studies are warranted to characterize the risk factors for postoperative complications and mortality after circumferential lumbar fusion surgery.

GP239
PERIOPERATIVE OUTCOMES OF MULTILEVEL VERSUS SINGLE LEVEL LUMBAR SPINE SURGERY
Sreeharsha V. Nandyala BA, Alejandro Marquez-Lara MD, Steven J. Fineberg MD, Kern Singh MD; Department of Orthopaedic Surgery, Rush University Medical Center

INTRODUCTION: Lumbar fusion (LF) is commonly performed for both single- and multi-level degenerative pathology. The surgical outcomes may vary based upon the complexity of the LF.

METHODS: Data from the Nationwide Inpatient Sample was queried from 2002-2011. Patients undergoing a LF were identified and separated into two cohorts: 1-2 level and 3+ level fusions. Patient demographics, comorbidities (CCI), length of stay, costs, and perioperative outcomes were assessed. Regression analysis, with a 95% confidence interval, was utilized to demonstrate independent predictors of in-hospital mortality after LF. SPSS v.20 was utilized for statistical analysis with a p-value of < 0.001 to denote significance.

RESULTS: A total of 265,334 LFs were identified in the NIS of which 233,009 (87.8%) were 1-2 level fusions and 32,325 (12.2%) were 3+ level fusions. The 3+ level fusion cohort was significantly older and demonstrated a greater CCI than the 1-2 level cohort. In addition, patients requiring 3+ level fusions incurred a significantly longer hospitalization and greater total hospital costs. Furthermore, the 3+ level fusion cohort demonstrated a significantly greater incidence of postoperative complications and mortality. Lastly, regression analysis
demonstrated that age >65 years, coagulopathy, electrolyte disturbances, and pulmonary disorders were significant predictors of in hospital mortality after a LF.

**DISCUSSION:** Patients undergoing a multi-level LF demonstrated a longer hospitalization, greater hospital costs, and incurred an increased incidence of postoperative complications and mortality. These findings are likely due to an older and more comorbid patient population and the greater complexity associated with a 3+ level lumbar fusion. Further studies are warranted to help mitigate these risk factors and to account for the greater incidence of postoperative complications after multilevel LF surgery.

**INTRODUCTION:** A urinary tract infection (UTI) is an important and frequent postoperative complication. The purpose of this study is to analyze the risk factors associated with a UTI following lumbar spine surgery using data from the National Surgical Quality Improvement Program (NSQIP) database.

**METHODS:** The NSQIP database was queried to identify patients who underwent a lumbar fusion or decompression from 2006-2011. Two study cohorts were developed: patients with and without documented postoperative UTIs. Preoperative patient characteristics, surgery, and peri-operative outcomes were assessed. Regression analysis, with a 95% confidence interval, was utilized to identify risk factors for a postoperative UTI. SPSS v.20 was utilized for statistical analysis with a p-value of <0.001 to denote significance.

**RESULTS:** 22,676 lumbar spine procedures were identified in the NSQIP database, of which 336 (1.5%) developed a postoperative UTI. The UTI cohort was significantly older and demonstrated a greater number of comorbidities than the control group. Patients with a postoperative UTI demon-
strated a longer operative time, greater intraoperative blood transfusions, a longer hospitalization, and a greater incidence of postoperative complications and mortality than unaffected patients. Regression analysis demonstrated that age >65 years, female gender, obesity, hypertension, a history of stroke, and a greater operative time were associated with an increased risk of postoperative UTI.

**DISCUSSION:** This study demonstrates that UTIs after lumbar spine procedures are associated with worsened peri-operative outcomes including death. A number of significant risk factors were demonstrated to increase the risk of a postoperative UTI. Further studies are warranted to better characterize the associated risk factors in order to mitigate the incidence of postoperative UTIs and their impact on the peri-operative outcomes in lumbar spine surgery.

**GP241**

**COST OF “ZERO EVENT” COMPLICATIONS: COMPARISON OF ANTERIOR CERVICAL DISKECTOMY AND FUSION TO COMMON ORTHOPAEDIC PROCEDURES**

Kawaguchi, Satoshi1; Waagmeester, Garrett1; Anderson, Paul2; Arthur, Melanie3; Hart, Robert A.1; 1. Oregon Health and Science University, Portland, OR, United States 2. University of Wisconsin Hospital and Clinics, Madison, WI, United States 3. University of Alaska Fairbanks, Fairbanks, AK, United States

**INTRO:** The current healthcare economic environment has led to a designation of Deep Vein Thrombosis (DVT), Pulmonary Embolus (PE), and Surgical Site Infection (SSI) as “zero events”, implying that their incidence can be reduced to zero. It is proposed that the costs of managing these complications be borne by hospitals and health care providers, rather than billing to health care payers. Data regarding potential costs of such complications have not previously been reported. We used a billing database to compare the relative charges for said complications in association with Anterior Cervical Discectomy and Fusion (ACDF) and several other orthopaedic procedures.

**METHODS:** All patients with primary procedure codes indicating ACDF, Lumbar Interbody Fusion (LIF), Lumbar Laminectomy (LL), Total Knee Replacement (TKR) and Total Hip Replacement (THR) in the California State Inpatient Database from 2008-2009 were analyzed. Patients with diagnostic and/or treatment codes for DVT, PE, and SSI were separated from patients without these codes. Patients with more than one primary procedure or complication code were excluded. Hospitalization and treatment charges from primary surgery through 3 months post-op were calculated.

**RESULTS:** Incidence of “zero event” complications were lower for ACDF than for other orthopaedic procedures (0.6%, 0.1%, and 0.1% for DVT, PE, and SSI respectively). Median charges for ACDF were $73,432, comparable to THR and TKR and less than those for LIF for uncomplicated primary procedures (Table 1).

<table>
<thead>
<tr>
<th></th>
<th>ACDF</th>
<th>LIF</th>
<th>LL</th>
<th>THR</th>
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</thead>
<tbody>
<tr>
<td>N (Total)</td>
<td>17,053</td>
<td>21,897</td>
<td>17,329</td>
<td>67,832</td>
</tr>
<tr>
<td>N with DVT</td>
<td>94 (0.6%)</td>
<td>194 (1.0%)</td>
<td>215 (1.2%)</td>
<td>700 (1.0%)</td>
</tr>
<tr>
<td>Median total charges with DVT (Charge Multi)</td>
<td>$33,353,16 (4.2%)</td>
<td>$281,121 (4.3%)</td>
<td>$222,555 (4.3%)</td>
<td>$159,887 (4.3%)</td>
</tr>
<tr>
<td>N with PE</td>
<td>13 (0.1%)</td>
<td>46 (0.2%)</td>
<td>17 (0.1%)</td>
<td>103 (0.1%)</td>
</tr>
<tr>
<td>Median total charges with PE (Charge Multi)</td>
<td>$23,698,2 (4.3%)</td>
<td>$246,617 (4.1%)</td>
<td>$359,566 (4.3%)</td>
<td>$257,917 (4.3%)</td>
</tr>
<tr>
<td>N with SSI</td>
<td>6 (0.1%)</td>
<td>31 (0.2%)</td>
<td>29 (0.2%)</td>
<td>34 (0.1%)</td>
</tr>
<tr>
<td>Median total charges with SSI (Charge Multi)</td>
<td>$172,967 (5.3%)</td>
<td>$85,753 (6.7%)</td>
<td>$186,112 (5.8%)</td>
<td>$109,964 (2.5%)</td>
</tr>
<tr>
<td>Median total charges without complication</td>
<td>$73,432</td>
<td>$143,601</td>
<td>$51,817</td>
<td>$76,116</td>
</tr>
</tbody>
</table>

**DISCUSSION:** While incidence is low, “zero event” complications of orthopedic procedures increase the cost of care substantially. Charges for patients experiencing DVT, PE, and SSI in association with ACDF increase by factors of 4.2x, 2.9x, and 2.4x those for patients without such complica-
tions, respectively. If the shift occurs, cost projections by health care providers will need to incorporate added cost of care for patients experiencing complications.

**GP242**

**IS STANDALONE LATERAL INTERBODY FUSION SAFE FOR MULTILEVEL ADULT DEGENERATIVE SPINAL STENOSIS?**

*Kanwarpal Grewal, DO; Vedat Deviren, MD; Murat Pekmezci, MD; Lindsey Sheffrey, MD; University of California, San Francisco, California*

**INTRODUCTION:** Lateral interbody fusion (LIF) is frequently utilized in spinal surgery. There is still debate on the ideal patient for stand-alone LIF procedures. The authors propose that patients with degenerative multilevel spondylosis with facet hypertrophy in the absence of adult deformity and osteoporosis are candidates for stand-alone LIF procedures.

**METHODS:** A retrospective review of consecutive patients treated with LIF between 2009-2012 was performed. Clinical outcomes were assessed post-operatively at 3 week, 6 week, 3 month, 6 month and 1 year intervals with radiographs and CT scan for evaluation of subsidence and fusion. Oswestry Disability Index (ODI) and EQ-5D scores were collected at preoperative and latest follow-up visits.

**RESULTS:** Of the 178 patients who underwent LIF, five met the inclusion criteria. All patients had neurological claudication, radiculopathy and back pain. Average age was 79.2 years (70-88). The mean DEXA scan T-score was 1.06 (0.8-1.275) for the spine and 0.68 (-1.8-0.75) for the femoral neck. Three patients had 4 level (L1-L5) and two patients had 3 level (L2-L5) LIF procedure. Average length of stay was 3.4 days; estimated EBL was 50ml and no patient required blood products. No infections were reported. One patient had kyphoplasty for endplate fracture at 6 weeks. The mean follow-up was 1.1 years (9 months-1.6 yrs). Disc heights were restored from 2.17 mm to 6.05 mm postoperatively. Mean lumbar lordosis increased by 7 degrees (Avg 49.6° vs. 42.8° preop.) The ODI score improved from mean of 39.2 (range 28-58) to 21 (range 14-32) at final follow-up. The EQ-5D score improved from mean of 0.66 (0.44-0.77) to 0.77 (0.69-0.80) at final follow-up.

**DISCUSSION:** Stand-alone LIF has minimal perioperative complications and could be safely performed in selected patients requiring multilevel lumbar fusion. The proposed selection criteria resulted in decreased subsidence rates as well as good clinical outcomes at 1 year follow-up.

**GP243**

**FOUR RODS PREVENT ROD BREAKAGE AND PSEUDARTHROSIS IN PEDICLE SUBTRACTION OSTEOTOMIES.**

*Sachin Gupta, Murat Sakir Eski, Blythe Durbin-Johnson, Christopher Ames, Vedat Deviren, Munish Gupta; University of California at Davis, Sacramento, CA University of California San Francisco, San Francisco, CA*

**INTRODUCTION:** Pedicle Subtraction Osteotomies have been widely used to treat sagittal plane deformities. The purpose of this study was to assess two methods of posterior instrumentation (2 rods vs. 4 rods) used in the surgical technique when performing pedicle subtraction osteotomies.

**METHODS:** A retrospective review of consecutive pedicle subtraction osteotomies was performed at two centers where the only major difference in the technique was the use of 2 rods vs. 4 rods. Center 1 using 4 rods had 29 pts and Center 2 using 2 rods had 20 pts that were analyzed. The clinical as well as the radiographic data was reviewed. Statistical methods used were two-sample t-tests and Fisher’s Exact Test using R, version 2.13.0 (R Core Team, 2013).
RESULTS: All cases at both centers were revision cases. The mean preoperative SVA (p=0.014), CSVL (p=0.004), and PI + TK + LL (p=0.033) were significantly larger for Center 1 than for Center 2. Similarly, the mean postoperative thoracic kyphosis (p=0.001), SVA (p=0.049), CSVL (p=0.042), and PI + TK + LL (p<0.001) were significantly larger for Center 1 than for Center 2. Changes from preoperative to postoperative radiographic measurements did not differ significantly including the PSO angle between institutions. A rate of pseudarthrosis of 5 out of 20 with 2 rods was significantly greater than 1 out of 29 with 4 rods (P = 0.035). Rod breakage was higher 5 out of 20 with 2 rods than 0 out of 29 with 4 rods (P = 0.008). The broken rods were Stainless (5.5 mm & 6.35 mm) and CoCr (5.5 mm, 6.0 mm & 6.0 mm). Three out of five patients from Center 2 with a pseudoarthrosis had BMP used. The patient with a pseudarthrosis from Center 1 had an infection and developed a pseudarthrosis after rod removal. Rates of other major and minor complications did not differ significantly.

DISCUSSION: Both techniques can be successfully used to correct sagittal plane deformity. Four rods are more successful in avoiding pseudarthrosis and rod breakage.

GP244
NUCLEOUS PULPOSUS TISSUE ENGINEERING USING A NOVEL PHOTOPOLYMERIZABLE HYDROGEL AND MINIMALLY INVASIVE DELIVERY
* University of Pittsburgh Medical Center - Department of Orthopaedic Surgery, Ferguson Laboratory for Spine and Orthopaedic Research ** University of Pittsburgh - Center for Cellular and Molecular Engineering

INTRODUCTION: A recently developed photoinitiator lithium 2,4,6-phenylbenzoylphosphinite (LAP) (Fairbank et al. Biomaterials. 2009;30(35):6702-7) has improved the biocompatibility of photopolymerization by eliminating the requirements for UV irradiation or non-aqueous condition. UV light poses a concern for mutagenicity. In this study, methacrylated gelatin (MA-gelatin)/LAP monomer solution seeded with rabbit mesenchymal stem cells (MSC’s) was delivered to the disc via 30-Gauge needle with minimal disruption of the annulus fibrosus (AF). Visual light photopolymerization was then performed via optical fiber illumination through a 30-Gauge needle.

METHODS: 1) 10% w/v MA-gelatin/LAP gels seeded with MSC’s (1x106 cells/mL) were studied at 2 weeks with MTS proliferation assay. 2) 10% w/v MA-gelatin/LAP with and without with MSC’s (1x106 cells/mL) was delivered to the NP and photopolymerized. Whole disc organ culture was conducted for 1 week, after which samples were harvested for DMMB assay for total glycosaminoglycan (GAG).

RESULTS: 1) MSCs were viable and proliferative (23% increase in total viable cells) at 2 weeks. 2) Total GAG assay demonstrated increased GAG in the AF (26%) and NP (12%) with hydrogel plus MSC’s versus hydrogel alone. Discussion: Intervertebral disc tissue engineering still encounters challenges. Vadala et al. reported leakage of MSCs delivered to NP without a hydrogel carrier with a risk of osteophyte formation and compression of important structures such as the spinal cord. The present study confirms the potential utility of MA-gelatin/LAP hydrogels by showing cell viability, proliferation, GAG production, and no leakage. This technology may allow for nucleus pulposus tissue engineering with minimal disruption of the AF.
GP245
DIAGNOSTIC AND THERAPEUTIC EFFECT OF ANALGESIC DISCOGRAM WITH STEROID AND LIDOCAINE INJECTION
Jin Hwan Kim, M.D.,PhD. Jung Hoon Kim, M.D.,PhD. Jae Kwang Song, M.D.; Dept of Orthopedic Surgery, INJE University, ILSAN PAIK hospital

INTRODUCTION: We used analgesic discogram with steroid and lidocaine injection to pain relief of lumbar radiculopathy and furthermore determinate the fusion level for spinal stenosis with radiculopathy.

METHODS: From 2001 to 2010, 615 patients who had impressed radiculopathy and low back pain with spinal stenosis or IDD (Internal disc disruption) underwent discogram at our institution. Among them, 51 patients underwent surgical decompression and posterior interbody fusion at least 2 years follow up. We analyzed patients demographic data including Visual Analog Scale scores measuring as well as follow-up questionnaires. A good surgical outcome was defined as a residual VAS score of ≤3 and the patient’s opinion that s/he would do the surgery again and was either satisfied or very satisfied with the surgical outcome. Discogram was done the single needle technique with triangulation method and injected analgesics (1cc depomedrol and 2% lidocaine 0.5cc) after radiopaque dye provocation.

RESULTS: Over the 70%, 418 out of 615 patients showed temporally pain score improvement but score and duration of pain relief were varied. Among 47 patients who underwent surgery except loss of follow up, the degeneration type of discogram were irregular types in 40 cases, fissured types in 2 cases. When we injected nonionic contrast, only 4 patients reported a similar pain that they experienced. But, 36 patients had pain relief after concomitant steroid and lidocaine injection. Of the 47 patients, 36 (76%) had positive and 11 (24%) negative with analgesic discogram. Among 36 patients with positive discogram, 30 (83%) had good surgical outcomes after 2 years follow up. Whereas, 5 of the 11 patients with a negative discogram, had good surgical outcomes.

DISCUSSION: Analgesic discogram with steroid and lidocaine injection had temporally therapeutic effect of lumbar radiculopathy and disc degenerative disease. Analgesic discogram can be useful for determination of appropriate fusion level.

GP246
EFFICACY OF TOPPING-OFF SURGERY IN PREVENTING ADJACENT SEGMENT DEGENERATIVE STENOSIS OF THE LUMBAR SPINE: A RADIOPHGRAPHIC AND CLINICAL STUDY
Yang Jincai, Hai Yong, Chen Xiaolong, Guan Li, Su Qingjun, Kang Nan; Dept. of Orthopedic Surgery, Beijing Chaoyang Hospital, Capital Medical University, Beijing, China

INTRODUCTION: To investigate the radiographic change of adjacent segment degeneration after Topping-off (posterior lumbar interbody fusion above segment interspinous implant).

METHODS: All lumbar spinal stenosis cases from the department of orthopedics of Beijing Chaoyang hospital that recieved PLIF+above segment Coflex between August 2008 and August 2012 were analyzed retrospectively. Analysis the gender, age, body mass index of all the patients. The X-ray films before and after surgery were measured and got some data (total lordosis, the height of disc, range of motion, lordosis and olithesis). One year follow-up were examined by MRI, observed the degeneration of intervertebral disc. All data used SPSS 12.0 to analysis.

RESULTS: There were 32 patients in Topping-off (male 21, female 11), including group one (L4/5 PLIF+L5S1 Coflex) 12 patients and group 2 (L3/4 PLIF+L4/5 Coflex) 20 patients. Age averaged 61.5 years old
(range, 30-79 years), follow-up averaged 24.6 months (range, 63-14 months). The average surgery time was (110±21)min. The average blood loss was (401±110)ml. Post-operation the ODI, JOA and VAS score improved. There was no significant difference in the height of disc of the Coflex segment and above segment between before and after surgery. Segmental lordosis of Coflex and total lordosis were all increased significantly(t=-1.9 and -2.0,P<0.05). The Coflex and above segment’s range of motion and olisthesis did not significantly. There was no significant difference in the number of the disc ch

**DISCUSSION:** Topping-off surgery is fit for the patients who have serious stenosis of lumbar spinal cord with mild and moderate stenosis of adjacent segment, which can restrict the adjacent segment’s range of motion and prevent excessive olisthesis of adjacent segment in both extension and flexion, also can sustain the height of Coflex segment. It shows a good result after short-term follow-up. Topping-off surgery plays an active role in preventing the adjacent.

**GP247**

**THE APPLICATION OF MINIMALLY INVASIVE SPINE STABILIZATION (MIST) FOR METASTATIC SPINAL TUMORS**

Kazuo Nakanishi, Toru Hasegawa; Kawasaki Medical School

**INTRODUCTION:** While the prognosis of cancer patients is getting better due to the improvement of cancer treatment, patients suffering from the generation of bone metastasis are on the increase. A technique of minimally invasive spine stabilization (hereinafter, MIST) is spreading in Japan, and this is being applied to infections and metastatic spinal tumors in addition to degenerative disorders. In this study, MIST was carried out for the treatment of metastatic spinal tumors, and the usefulness of this modality was investigated, although the outcomes are for short-term results.

**METHODS:** The subjects comprised 15 cases that underwent surgery using the MIST technique against metastatic spinal tumors. The cases included 8 men and 7 women, with a mean age at surgery of 64 years old. The primary tumor was: breast cancer in 3 cases, prostate cancer in 2 cases, thyroid cancer in 3 case, renal cancer in 1 case, and another cancer in 6 cases.

**RESULTS:** The mean postoperative follow-up period was 6.6 months, with death in: 3 cases following surgery. The number of fusion areas was 5.1. The mean surgery time was 171 minutes and the mean bleeding amount was 117 ml, and a mean time taken until recovery of 5.6 days. There were no complications. Regarding paralysis, the same or an improvement of 1 grade or more was observed compared to postoperative Frankel classification.

**CONCLUSIONS:** The following benefits of the MIST technique against metastatic spinal tumor exist. 1) Few infections. 2) Little bleeding. 3) Early recovery .4) No need to open the wound. 5) There is little invasion, so there are few complications to the radiation therapy. At the same time, there are drawbacks to MIST. 1) Learning curve. 2) Connecting the rod is difficult. 3) Bone grafting cannot be carried out. This technique allows for low-invasiveness, early recovery, as well as maintenance of ADL, and is believed to be a useful remedy when systemic conditions permit.

**GP248**

**POSTOPERATIVE TRANSLATION OF UPPER INSTRUMENTED VERTEBRA IS A RISK FACTOR FOR PROXIMAL JUNCTIONAL DEFORMITY IN THE CORONAL PLANE AFTER POSTERIOR LUMBAR FUSION SURGERY**

1,4Isogai Norihiro, 2,4Ishii Ken, 3,4Hosogane Naobumi, 2,4Hikata Tomohiro, 2,4Fujita Nobuyuki, 1,4Kaneko Yasuhiro, 1,4Koyanagi Takahiro, 2,4Nakamura Ma-
saya, 2,4Toyama Yoshiaki, 2,4Matsumoto Morio; 1 Kawasaki Municipal Hospital, Kawasaki, Kanagawa, Japan 2 Department of Orthopedic Surgery, School of Medicine, Keio University, Shinjuku, Tokyo, Japan 3 Department of Orthopedic Surgery, National Defense Medical College, Tokorozawa, Saitama, Japan 4 Keio Spine Research Group (KSRG), Tokyo, Japan

INTRODUCTION: The proximal junctional deformity in coronal plane (PJDC) is a potential complication after posterior lumbar fusion. There are few studies investigating the PJDC in detail. The purpose of this study was to identify risk factors of PJDC after posterior lumbar fusion.

METHODS: From January 2009 to December 2010, among 51 patients who underwent posterior spinal fusion for lumbar degenerative diseases with over 1 year follow-up (f-u) period, 26 patients with more than 5 of proximal junctional (PJ) angle which was identified as wedging angle between upper instrumented vertebra (UIV) and proximal adjacent vertebra in coronal plane or with more than 3mm of translation of UIV which was identified as distance between central sacral vertical line and center of UIV in coronal plane before surgery were retrospectively reviewed. Nine patients with a progression of more than 5 of PJ angle between immediately after surgery and the latest f-u were classified as PJDC group and other 17 patients were included in the control group. Age, Gender, diagnosis, fusion levels, radiographic parameters, and clinical course were evaluated. Radiographic parameters including PJ angle, translation of UIV and UIV tilt on coronal plane before surgery and during f-u were measured and compared between both groups.

RESULTS: The average translation of UIV immediately after surgery was 14.8mm in PJDC group and 6.7mm in the control group, which was significantly different (p<0.05). There were no differences in the other factors between the two groups. Eight patients in PJDC group complained new clinical symptoms due to PJDC at the mean f-u of 17.9 months after surgery and 4 of them required additional surgery.

DISCUSSION: In this study, we found that postoperative translation of UIV was a risk factor for PJDC after posterior lumbar fusion surgery. Attention should be paid to minimize postoperative translation of UIV in surgical planning to avoid PJDC and further poor outcome.

GP249

COMPLICATIONS FOLLOWING MINIMAL INVASIVE LATERAL INTERBODY FUSION FOR DEGENERATIVE LUMBAR DISEASE

Keung Nyun Kim, Do Heum Yoon, Yoon Ha, Seong Yi, Dong Ah Shin; Department of Neurosurgery, Yonsei University, Seoul, Korea

INTRODUCTION: Recently introduced MISS technique is the lateral transposas approach for lumbar interbody fusion. This MISS technique, which has been referred to as direct lumbar interbody fusion (DLIF) or extreme lumbar interbody fusion (XLIF), has been used in the surgical treatment of degenerative lumbar disease. The object of this study is to examine the complications during and following DLIF procedure.

METHODS: We performed DLIF procedures for 60 consecutive patients between May 2011 and Dec. 2012 for the following diagnosis: degenerative disc disease; adjacent segment degeneration; degenerative spondylolysis; lumbar degenerative scoliosis. Stand alone DLIF was done in 12 patients, and 43 patients underwent DLIF with posterior fixation. All posterior fixations were done with pedicle screw system. All the record and radiologic data were reviewed retrospectively focused on complications.

RESULTS: Overall complication rate was 23.3% including minor transient complications and major permanent ones. Most frequent complication was sensory change of
anterior thigh (6 cases) followed by psoas weakness (4 cases). These weakness and sensory changes were developed frequently after multi-level DLIF procedures. Although EMG monitoring was performed in all cases, one case of lumbar plexus injury was developed. A contralateral disc herniation and cage migration were occurred and additional surgeries were performed. On radiological evaluation, definite cage subsidence was occurred in 42% of stand-alone group and 15% of posterior fixation group (p<0.05).

**DISCUSSION:** DLIF is a safe and effective procedure for degenerative lumbar diseases with good clinical outcome. But complications can be occurred especially in multi-level procedures. End plate damage may be critical risk factor of cage subsidence following DLIF. Minimization of psoas muscle injury, careful EMG monitoring and skillful endplate preparation is recommended for preventing complications in DLIF procedures.

**GP250**

**EVALUATION OF BEHAVIOR AND EXPRESSION OF NAV1.7 IN DORSAL ROOT GANGLIA AFTER SCIATIC NERVE COMPRESSION AND APPLICATION OF NUCLEUS PULPOSUS IN RATS**

Yoshihiro Sakuma, MD, Miyako Suzuki, MD, PhD, Sumihsia Orita, MD, PhD, Kazuyo Yamauchi, MD, PhD, Gen Inoue, MD, PhD, Yasuchika Aoki, MD, PhD, Tetsuhiro Ishikawa, MD, PhD, Masayuki Miyagi, MD, PhD, Hiroto Kamoda, MD, PhD, Gou Kubota, MD, Yasuhiro Oikawa, M;

**PURPOSE:** Pathomechanisms of pain from lumbar disc herniation have not been fully elucidated. Prostaglandins and cytokines generated at the inflammatory site produce associated pain, however, non-steroidal anti-inflammatory drugs and steroid are sometimes insufficient in patients. Tetrodotoxin-sensitive voltage-gated sodium (NaV) channels are related to sensory transmission in primary sensory nerve. Especially, sodium channel Nav1.7 has emerged as one of analgesic targets. The purpose of current study was to evaluate painful behavior and expression of NaV1.7 in dorsal root ganglia (DRGs) after sciatic nerve compression and application of nucleus pulposus (NP) in rats.

**METHODS:** In the model, the sciatic nerve was compressed with NP for 2 seconds using forceps (n = 20), but without compression nor NP in sham-operated animals (n = 20). We used additional control group without any procedure (n=20) Mechanical hyperalgesia were measured every second day for 3 weeks using von Frey filaments. NaV1.7 expression in L5 DRGs was examined at 7 and 14 days after surgery using immunohistochemistry. The number of neurons immunoreactive for NaV1.7 was compared among the 3 groups.

**RESULTS:** Mechanical (during 14 days) was found in the nerve compression plus application of NP group rats, but not in the control and sham-operated animals (p<0.05). NaV1.7 expression in L5 DRGs was upregulated in the nerve compression plus application of NP group rats compared with the control and sham-operated rats (p<0.01).

**CONCLUSIONS:** Our results indicate that nerve compression plus application of NP produced pain-related behavior. We concluded that NaV1.7 expression in DRG neurons may play important role to mediate pain from a sciatic nerve which be compressed and applied of NP.
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