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GP1

SUITABILITY EVALUATION OF RESTORING THE INTERVERTEBRAL DISC MECHANICS IN TREATING OSTEOPROTIC VERTEBRAL FRACTURE USING KYPHOPLASTY WITH PMMA OR CALCIUM-P BASED CEMENT

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INTRODUCTION: The biomechanical tests about the filler materials paid little attention to vertebral endplate or intervertebral disc in treating compression fracture. Impact of cement leakage into disks on the development of adjacent fractures was noted. There is only a limited understanding how the load shift of the intervertebral disc after a kyphoplasty with different cement. The intervertebral disc should be showed altered disc pressure profile.

MATERIALS AND METHODS: 3D finite-element osteoporotic model of L1–L3 were developed. The influence of augmentation level as well as bipedicular filling with PMMA or CaP based cement was investigated. The risk factors (anterior wall deficiency and superior endplate cleft) were also taken into consider as variables. Last, a leakage of cement was also simulated.

RESULTS: The stresses and strains in the vertebrae close to an augmentation were increased, and change their distribution with different risk factors. In PMMA groups, higher stresses and strains were noted over endplate and disc when risk factors exist. The pressure in a bulge of the augmented endplate and disc were increased to almost 20% of its value before the augmentation, resulting in a stiffening of the intervertebral disc. In CaP cement, in leakage model, seem to show more suitable in mechanics if leakage happened.

DISCUSSION: With an intact endplate, the two augmented cements shows no significantly difference in restoring of strength and stiffness. With a damaged endplate,

overgrowth stiffness located superior endplate by using PMMA maybe show an impact factor for further adjacent deformity. The change of pressure in disc with a damaged endplate was supposed to develop abnormal intradiscal pressure in flexion also been shown to increase loading of the adjacent anterior vertebral cortex. Our study indicated a compression fracture treated with kyphoplasty by PMMA or CaP based cement must be evaluated according the damaged structures.

GP2

ASSESSMENT OF PAIN BEHAVIOR IN A RAT MODEL OF INTERVERTEBRAL DISK INJURY USING THE CATWALK GAIT ANALYSIS SYSTEM

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INTRODUCTION: There are few reports examining low back pain behavior in animal models. The CatWalk is a computer-assisted gait analysis system that provides an automated way to assess gait function and pain-related alterations of this behavior. The purpose of current study is to investigate pain behavior in a rat model of IVD injury using the CatWalk gait analysis system.

METHODS: In the IVD injury group, L5/6 disks were injured with a 24-gauge needle.

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Simultaneously, the neurotracer Fluoro-Gold (FG) was injected into the L5/6 IVDs. In the sham group, FG was injected into the L5/6 IVDs only. Animals in an additional control group received no operation. One, 2, 3, and 4 weeks after surgery, the gait of rats in the three groups was investigated using the CatWalk system. One, 2, and 4 weeks after surgery, in IVD injury and sham groups, dorsal root ganglia (DRGs) from the L1 to L6 levels were resected. DRGs were immunostained for calcitonin gene-related peptide (CGRP).

RESULTS: In the IVD injury group, the mean stands of hind paws and the mean duty cycle of front paws at some time points were significantly higher compared with the sham group. Furthermore, the mean stride length of the front and hind paws and the mean swing speed of the front and hind paws at some time points were significantly shorter compared with the sham group. The proportion of CGRP-immunoreactive, FG-labeled neurons among all FG-labeled DRG neurons in the IVD injury group was significantly higher than the corresponding proportion in the sham group.

DISCUSSION: These results suggest that IVD injury produced significant changes in rat gait, including longer stance phases and shorter strides. In the future, we may be able to apply the CatWalk system to the evaluation of behavior associated with pain in rat and mouse models of low back pain.

GP3

HYPERTROPHY OF THE LIGAMENT FLAVUM IN DEGENERATIVE LUMBAR STENOSIS ASSOCIATED WITH THE INCREASED EXPRESSION OF FRACTALKINE (CX3CL1)/CX3CR1 CHEMOKINE

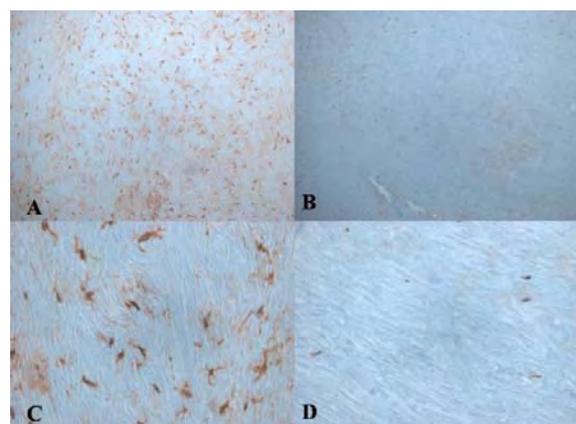
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INTRODUCTION: Fractalkine (CX3CL1) and its receptor (CX3CR1) comprise a chemokine system involved in leukocyte recruitment and adhesion in chronic inflammatory disease, but its role in spinal degenerative diseases is unknown. The purpose of this study is to investigate

- 1) The role of CX3CL1/CX3CR1 chemokine on hypertrophy of the ligamentum flavum in lumbar spinal stenosis compared with that of non-degenerative spinal condition.
- 2) Correlation between expression of CX3CL1/CX3CR1 chemokine and thickness of ligamentum flavum.

METHODS: The mRNA concentrations of CX3CL1/CX3CR1 chemokine were analyzed in the surgically obtained ligamentum flavum specimens from lumbar spinal stenosis (LSS) (n =10) and non-degenerative spinal condition (NDS) (n =11) by real-time PCR. The localization of CX3CL1/CX3CR1 chemokine within the ligamentum flavum was determined using immunohistochemical study. Plasma levels of soluble FKN (sFKN) and CX3CR1 were measured by enzyme-linked immunosorbent assay (ELISA), respectively. The thickness of the ligamentum flavum was measured with axial T1-weighted magnetic resonance imaging.



RESULT: The CX3CL1/CX3CR1 chemokine positive cell ratio in the LF observed in LSS group was substantially higher than in NDS group (P= 0.030). In ELISA, the plasma levels of sFKN were significantly increased in LSS

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patients compared with patients in the other groups ($P = 0.006$). There was greater CX3CL1/CX3CR1 expression in LSS patients as quantified by RT-PCR ($P = 0.004, 0.01$). Thickness of LF in patients was significantly correlated with serum CX3CL1 level ($r = 0.48, P < 0.01$) and with RNA Expression of CX3CL1/CX3CR1 ($r = 0.62, P < 0.01$) ($r = 0.64, P < 0.01$)

DISCUSSION: This study identified for the first time that increases in Fractalkine and CX3CR1-expressing monocytes, T lymphocytes, and NK cells are significantly related to LF hypertrophy, which may provide new conceptual and therapeutic approaches for treating spinal stenosis.

GP4

COMPARATIVE STUDY OF LUMBAR INTERVERTEBRAL DISC BIOMECHANICAL CHARACTERISTICS WITH OR WITHOUT HYDROGEL INJECTION AFTER NUCLEUS DISCECTOMY

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INTRODUCTION: Injecting hydrogels as substitute of nucleus pulposus after nucleus discectomy partially restores the geometric structure of lumbar intervertebral discs. This study investigated both the static and dynamic mechanical properties of lumbar intervertebral discs with or without hydrogels injection after nucleus discectomy.

METHODS: The lumbar intervertebral discs of three miniature pigs were randomized to normal group (with respectively intact intervertebral discs), mimic group (with hydrogel injection after discectomy) and control group (without hydrogel injection after discectomy). All of the specimens were subjected to static and dynamic compression tests sequentially, then stress/strain curves in the static test and storage modulus, loss

modulus and phase angle in the dynamic test were worked out respectively with help of software.

RESULTS: In the static compression test, mimic group have a similar stress/strain curve with normal group, whereas control group shows obvious difference. In the dynamic test, results of the storage modulus, loss modulus and phase angle showed similar tendency that the maximum mean values (297.2~362.5KPa, 15.7~24.0KPa, 2.4~4.6°, respectively) were in control group and the minimum (187.2~226.2KPa, 10.1~14.8KPa, 2.0~3.5°, respectively) in normal group. And the mean values in mimic group were 242.8~290.5KPa, 12.4~18.2KPa, 2.3~4.1°, respectively. It should be noted that values of the storage modulus were elevated with increasing frequency, while values of the loss modulus and phase angle were reduced with increasing frequency.

DISCUSSION: Injecting hydrogels after nucleus discectomy can not only better reserve the normal lumbar geometric structure but also improve the biomechanical properties compared with simple discectomy.

GP5

SPINO-PELVIC-RHYTHM IN NORMAL SUBJECTS AND HIGH-CLASS ATHLETES WHO OVERCAME CHRONIC LOW BACK PAIN

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PURPOSE: Spino-Pelvic-Rhythm (SPR) is reported to be a good parameter to under-

stand the spine kinematics. We evaluated SPR in normal subjects and high-class athletes who overcame chronic low back pain (LBP).

METHODS: Eighteen male without LBP (mean: 36 yrs) and three high-class athletes (mean: 37 yrs) who overcame LBP participated. They have a history of LBP at least 2 years before, and presently, they have no LBP. First, we measured the finger-to-floor distance (FFD) at the upright posture, and the value was indicated as 100%. Using a spinal mouse, spinal alignment was measured at the following 4 points, i.e., (1) upright posture meaning 100% of FFD, (2) forward bend at 50%, (3) 25% and (4) 0% of FFD meaning finger contacting the floor. The changes of the angle of thoracic and lumbar spine as well as the pelvis were calculated.

RESULTS: In the normal subjects, from point 1 to 2 (phase I) spino-pelvic angle moved 104 degree entirely. In this phase, lumbar spine moved mainly. The lumbar/ pelvic (LP) ratio was 4.0. In the second phase (point 2 to 3), it changed only 16 degree and the ratio was 1.0. In phase III (point 3 to 4), majority of the entire motion was found in the pelvis, and the ratio was 0.4. All three high-class athletes including Olympic medalist of throwing, professional baseball player and ex-world champion of mixed martial arts, showed totally different SPR. In phase I, pelvis moved greater than normal subjects, and the LP ratio was 0.5, 1.2 and 1.3. In the second phase, lumbar spine mainly moved and, the LP ratio was 3.2, 4.0 and 3.2.

DISCUSSION AND CONCLUSION: As the normal SPR, the lumbar spine moved mainly at the initial phase. At the final stage, pelvis moves mainly. Three athletes showed similar abnormal rhythm. They tried to move pelvis more and to reduce the lumbar motion at the initial phase. This may be due to the defense mechanism against chronic back pain and/or stabilization effects of the spine by strenuous core muscle exercise.

GP6

NOVEL TWO-COMPONENT INTERBODY FUSION DEVICE IMPROVES BONE-IMPLANT INTERFACE WITHOUT COMPROMISING STABILITY: A CADAVER STUDY

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INTRODUCTION: A novel two-piece articulating ALIF device allows limited motions of the treated vertebral level for lordotic adjustments until a supplementary pedicle screw system is rigidly fixed. A potential benefit is the reduction of bone-implant relative motions with a positive impact on fusion time and sagittal balance. The aim of the study is to compare the rigidity and implant alignment of the two-piece ALIF fusion device with a one-piece ALIF in a 360° setting.

METHODS: Seven lumbosacral (L3-S1) human cadaver specimens were tested (age 50-60) in a universal spine tester. The flexibility of the intact specimen, the specimens instrumented with a two-component ALIF (Statur® -L, FBC Device ApS, Denmark) and a one-piece ALIF (Pezo™ -A, Ulrich, Germany), both supplemented with a pedicle screw system (tangoRSTM, Ulrich, Germany) was tested using pure moments of ± 7.5 Nm in three principal motion directions. For assessment of the bone-implant interface, fluoroscopic images were captured during motion. Three-dimensional vertebral motion was measured using an optical motion capturing system (Vicon Mx, Vicon, UK). Paired t-tests were performed to determine statistical significance at a $p < 0.05$ level.

RESULTS: No statistically significant differences in rigidity were found between the one and two-piece ALIF in the 360° setup (e.g., $3.5^\circ \pm 1.9^\circ$ for the one-piece and 4.2°

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$\pm 1.8^\circ$ for the two-piece ALIF in flexion/extension), while both configurations significantly reduced the range of motion compared to the intact condition ($p < 0.05$). Significantly less motion at the implant-endplate interface was found for the two-piece device ($1.0^\circ \pm 0.6^\circ$) in comparison to the one-piece ALIF ($4.2^\circ \pm 1.7^\circ$) in flexion/extension.

DISCUSSION: The two-piece ALIF significantly reduced the relative motion at the bone-implant interface without compromising stability. Theoretically, this can reduce the risk of implant subsidence, improve fusion and establish better sagittal balance.

GP7

BIOMECHANICAL CHARACTERIZATION OF A NOVEL LOW-STIFFNESS POSTERIOR SPINAL IMPLANT UNDER ANTERIOR SHEAR LOADING IN A DEGENERATIVE SPINAL MODEL

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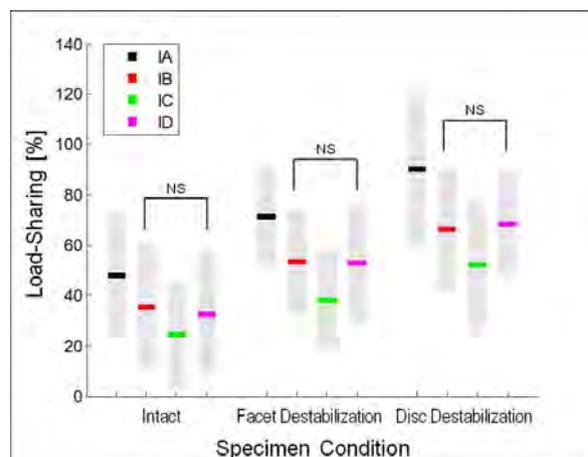
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INTRODUCTION: Dynamic implants have been developed to address potential adjacent level effects due to rigid instrumentation. Prior to clinical use, implants should be rigorously tested *ex vivo*. The objective of our study was to determine how implant type and specimen condition affects implant load-sharing and specimen translation under an applied anterior shear force in a novel

biomechanical model.

METHODS: A previously validated human cadaveric model of degenerative spondylolisthesis for testing implants in shear was used. Lumbar FSUs (N=15) were tested under a static 300 N axial compression force and a cyclic anterior shear force (5-250 N). Translation was tracked with a motion capture system. Four implants (Medtronic, Inc.) were instrumented with strain gauges to determine the shear force supported by the implant: Implant A Titanium, Implant B Oblong PEEK, Implant C Round PEEK, and Implant D BalanCTM (PEEK rod with a C-shape section and silicone insert). Each implant was affixed to each specimen, and they were tested in 3 conditions (intact, facet gap, disc lesion), with the latter 2 simulating a degenerative spine.

RESULTS: Specimen condition and implant type affected load-sharing and anterior translation ($p < 0.0001$). Load-sharing increased across all specimen conditions and decreased across the first 3 implants (Fig. mean \pm SD). Implants D and B supported similar shear forces for all specimen conditions ($p > 0.2$). Translation tended to increase with the first three implants. However, implants D and B allowed similar translations for all specimen conditions ($p > 0.3$).



DISCUSSION: We tested a novel dynamic implant (Implant D) and compared the results to those for three implants ranging from high- to low-stiffness (implants A, B,

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and C). Implant D behaved similarly to implant B in both load-sharing and translation despite having a different design and stiffness. Complex implant design and specimen-implant interaction necessitate pre-clinical testing of novel implants.

GP8

EFFECTS OF SEQUENTIAL UNILATERAL FACETECTOMY ON CERVICAL SPINAL STABILITY

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INTRODUCTION: Classical biomechanical studies have concluded that instability of the cervical spine occurs after a complete laminectomy and resection of more than 50% of the bilateral capsule or facet joints at one cervical level. No study has ever evaluated the effects of unilateral sequential facet resection without laminectomy. This study is the first to assess spinal stability after unilateral sequential facet resection.

METHODS: Human cadaveric C2-T1 specimens ($n = 7$) were tested intact, and then underwent a sequential right unilateral facetectomy at the C6 – C7 level. The width of the facet joint was measured and sequential resection was made as a percentage of the facet width (25 %, 50 %, 75 % and 100 %). The following loading conditions were applied using a robotic spine testing system: Applied moments (2.0 Nm) with head weight load of 40N were used to simulate flexion-extension (FE), lateral bending (LB), and axial rotation (AR). Vertebral motion was measured using an optoelectronic system. Mean relative range of motion (ROM) was compared among groups using repeated measures analysis of variance at a

significance level of 0.05.

RESULTS: For FE, no statistically significant change in motion was observed following sequential unilateral facet resection compared to intact state. In LB, only the complete unilateral facet resection (100%) resulted in a significant increase in motion of 8% ($p = 0.005$). In AR, there was a significant increase in motion following 75% (18.5%, $p = 0.03$) and 100% (33.8%, $p < 0.001$) facet resection, respectively.

CONCLUSION: Unilateral facet resection does not significantly increase FE motion. However, significantly greater cervical spine mobility in LB and AR occurs following unilateral facet resection of 75% or more. We conclude that unilateral facet resections are not as destabilizing as are bilateral facetectomies with laminectomy. Unilateral facet resection less than 75% did not generate instability in any plane of motion.

GP9

DOES HEAD WEIGHT AFFECT CERVICAL SPINE STABILITY? AN IN VITRO ROBOTIC BIOMECHANICAL STUDY

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INTRODUCTION: Many biomechanical studies on cervical spine stability with extremely strong clinical relevance were performed without accounting for the head weight. A biomechanical study of a constant vertical load (head weight loading) while simulating flexion-extension (FE), lateral bending (LB) and axial rotation (AR) may improve the in vivo applicability of biomechanical test results. This study hopes to provide insight into the effect of head weight on cervical spine motion and stability.

METHODS: Flexibility tests were conducted

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on seven human cadaveric specimens, C2–T1, using a robotic spine testing system. The system was used to test two conditions: intact and destabilized (Complete Unilateral C6 – C7 Facetectomy). Continuous applied moment, ± 2 Nm was used to simulate FE, LB and AR with and without a constant head weight of 40N. The head weight was applied in the direction of gravity. The test was repeated again following complete unilateral facetectomy. Mean overall range of motion (ROM) of C2 – T1 was compared among groups using repeated measures analysis of variance at a significance level of 0.05.

RESULTS: We found a significant reduction in motion with the application of a head weight (12.1% decrease, $p = 0.02$) in AR for the intact condition. A similar reduction was observed in the destabilized condition (16.1% decrease, $p = 0.05$). There was a significant decrease in LB motion when head weight load was applied in the intact state (12.4%, $p = 0.01$), with a larger reduction in motion for the destabilized condition (21.6%, $p < 0.001$). Intact FE motion was not significantly affected by the addition of head weight ($p = 0.66$). However, FE motion decreased significantly with head weight in the destabilized state (6.7% decrease, $p = 0.01$).

CONCLUSION: Application of a constant head weight load with flexibility testing reduces the overall ROM of the cervical spine. The magnitude of the effect is larger following complete unilateral facetectomy.

GP10

DO PEDICLE SCREWS THAT HAVE BREACHED THE PEDICLE WALL PROVIDE STRONGER PURCHASE AS COMPARED TO SMALLER PEDICLE SCREWS PLACED INTRA CORTEX?

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INTRODUCTION: The pedicle diameters at the thoracolumbar levels in elderly patients and the pedicle diameters at the thoracic levels in scoliosis patients are sometimes very small. The question arises: Do pedicle screws that are inserted and breach the pedicle wall provide stronger purchase as compared to pedicle screws of smaller diameter that are placed intra cortex in the pedicle. The purpose of our study was to answer this question using cadaveric thoracolumbar vertebrae.

METHODS: Twelve thoracolumbar vertebrae (T6-L2) were harvested from eight male fresh cadaveric spines (mean age 85.3 years). Pedicle screws were inserted in each of the pedicles. On one pedicle the screw to be inserted was chosen so as to be oversized in the pedicle, and on the other pedicle the screw to be inserted was chosen so as to fit the pedicle intra cortex. The pedicle diameter “a” and the screw diameter “b” were measured, and the breached percentage of oversized screw “ $(b-a) \times 100/a$ ” was calculated (Figure 1). Biomechanical testing: An adaptor was attached to the protruding end of each pedicle screw and then, using a materials testing machine (Shimadzu Corporation, Kyoto Japan), each pedicle was tested as follows: 1) toggling was applied in a cephalocaudal direction for 500 cycles at 0.3 Hz at ± 50 N; 2) the screws were then pulled out by applying a tensile force down the long axis of the screw: displacement rate of 20.0 cm/min.

RESULTS: The mean pullout strength for the

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oversized pedicle screws was 684.9 ± 352.5 N and for the intra cortex pedicle screws was 640.5 ± 301.1 N; the difference was not significant ($p < 0.05$). There was significant positive correlation between extent of breach and pullout force. In other words the oversized pedicle screws within 12.4% might be stronger than intra cortex pedicle screws (Figure 1).

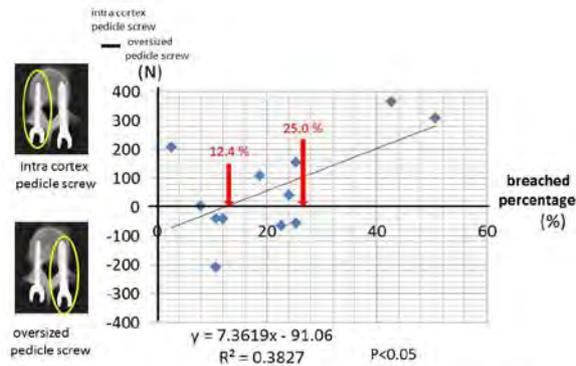


Figure 1. There was significant positive correlation between extent of breach and pullout force.

DISCUSSION: Pedicle screws that breach the pedicle wall do not provide stronger purchase as compared to smaller pedicle screws that are placed intra cortex?

GP11

BIOMECHANICAL EFFECT OF THE PROGRESSION OF DISC DEGENERATION AT L5/S1 ON ADJACENT DISCS IN A LUMBAR SPINE

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INTRODUCTION: When lumbar disc degeneration occurs at one level, whether treated or not, degeneration frequently develops at mobile segments above or below the degenerated segments referred to adjacent segment disc disease (ASDD). Aim of the current study is to understand how progressive degeneration at L5/S1 affects the biomechanics of the adjacent segments.

METHODS: A refined poro-elastic non-linear 3D finite element model of a lumbar spine and hybrid method of analyses were used to

determine the biomechanical effects of single level disc degeneration on the adjacent segments. Four different grades of disc degeneration (Thompsons Grades 2 to 5) were modeled at L5/S1 level and their comparative effect on adjacent disc biomechanical characteristics were studied under all the three physiological moment loading conditions.

RESULTS: At adjacent L4/5 segment: Grade 5 disc at L5/S1 produced least increase in motions of 3% under flexion and largest under extension (125%), while under torsion and lateral bending it produced 18% increase in motions. When the increase in motions in all the three principal directions were combined, grade 4 and grade 5 at L5/S1 produced an increase nearly twice and seven times respectively as those produced when L5/S1 had grade 3 disc. As the degenerative grade at L5/S1 increased from 2 to 5, total facet forces increased from 77 N to 162 N under extension and 145 N to 230 N under torsion. Annular stresses also increased with a sharp increase in stress value as the L5/S1 disc grade changed from 4 to 5.

CONCLUSIONS: Largest increase in motion, facet forces as well annular stresses at the adjacent discs in the lumbar spine was seen with grade 5 disc at L5/S1. Grade 3 and 4 did not produce substantial increase in adjacent disc motions as well as annular stresses leading to the conclusion that single level disc degeneration induces ASDD only when the deceased disc is degenerated to the highest grade.

GP12

INVESTIGATION OF EQUIVALENT STRESS OF ADJACENT VERTEBRAE AFTER BALLOON KYPHOPLASTY BY A CT-BASED FINITE ELEMENT METHOD

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INTRODUCTION: Balloon kyphoplasty (BKP) is a minimally invasive surgical procedure for treatment of painful vertebral compression fractures. It has numerous benefits including a simple procedure, early pain control and height restoration of the collapsed vertebral body. Consequently, the number of treatments using this procedure has risen significantly. However, complications such as new vertebral fractures have been reported. The aim of this study was to evaluate equivalent stress of adjacent vertebrae after BKP using the finite element (FE) method.

METHODS: Six patients were enrolled in this study. The mean age was 77.0 years and the duration of follow-up was 4.8 months. All patients underwent CT within 1 week of BKP treatment. Three-dimensional, four-functional unit, FE models were constructed from the CT data using MECHANICAL FINDER software (cement model). In addition, a cancellous bone model was developed. The model was a cement model where the cement data was replaced with the cancellous data of adjacent vertebrae. The equivalent stress of cement and cancellous bone, and the front half of the adjacent vertebral body of both groups, were analyzed and compared.

RESULTS: The mean equivalent stress of cement was significantly larger compared with cancellous bone (1.8 ± 0.7 and 0.6 ± 0.4) ($p < 0.05$). The mean equivalent stress of adjacent vertebrae of the cement model and cancellous bone model was 2.9 ± 1.1 , and 3.1 ± 1.0 , respectively. There was no significant difference.

DISCUSSION: Cement was stiffer than cancellous bone, so replacing cement data with cancellous data decreased the stiffness of the vertebrae. However, there was no

change in equivalent stress of adjacent vertebrae. This result suggests that the incidence of adjacent fractures after BKP has no relationship to stiffness of the treated vertebra.

GP13

HISTOMORPHOMETRIC AND RADIOGRAPHIC CHANGES AFTER WALLIS IMPLANTATION IN RATS

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INTRODUCTION: Clinical effectiveness of the PEEK-non-fusion spine implant WallisTM is well documented. However, there is a lack of evidence on the long-term behavior of this implant on bone, in particular its influence on structural changes of bone elements of the lumbar spine. The aim of this study was to investigate histomorphometric and radiographic changes in the rat model after WallisTM implantation.

METHODS: Twenty-four male rats aged eleven weeks underwent surgery for implantation of WallisTM implants or for a sham procedure in three groups of eight animals each each: 1) implantation at level L4-5; 2) implantation at level L5-6 and 3) sham surgery. Eleven weeks postoperatively

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resorption at the implant-bone interface was measured via X-ray, bone mineral density of vertebral bodies was analyzed using osteodensitometry, and bone mineral content as well as resorption of the spinous processes were examined by histomorphometry.

RESULTS: Resorption of the spinous processes at the site of the interspinous implant was found in all treated segments. There was no significant difference in either bone density of vertebral bodies or histomorphometric structure of the spinous processes between adjacent vertebral bodies, between treated and untreated segments and between groups.

DISCUSSION: These findings indicate that resorption of spinous processes, as a result of implant loosening, inhibit the targeted load redistribution through the PEEK-non-fusion interspinous device in the lumbar spinal segment of the rat. This leads to reduced long-term stability of the implant in the animal model. These results suggest that PEEK-non-fusion interspinous devices like the Wallis™ implants may have time-limited effects and should only be used for specified indications.

GP14

BIOMECHANICAL ANALYSIS OF THE THORACIC SPINE FOLLOWING DECOMPRESSIVE PROCEDURES

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INTRODUCTION: This study evaluated the effect of the rib cage on thoracic spine stability following sequential decompressive surgeries and instrumented fusion.

METHODS: Human cadaveric spines with intact rib cages, C7-L1 (n = 9). An industrial robot was used to apply a ± 5 Nm moment applied along the spine to simulate flexion-extension (FE), lateral bending (LB) and axi-

al-rotation (AR). The specimens were first tested in their intact state, and then tested after each of the following sequential surgical decompressive procedures at T4 – 5 consisting of 1) laminectomy; 2) unilateral facetectomy; 3) unilateral costotransversectomy and subsequently 4) instrumented fusion from T3 - T7. Range of Motion (ROM) between T1 - T12 and T3 - T7 were measured for each specimen using an optoelectronic motion system. Statistical analysis between and within group comparisons was done using repeated measures analysis of variance ($p < 0.05$ was considered statistically significant).

RESULTS: We found that in all three planes of motion, the sequential decompressive procedures caused no statistically significant change in motion between T3 - T7 and T1 - T12 when compared to intact. In comparing between intact and fusion, our study found that fusion reduced intrinsic motion between T3 - T7 by 85.4% ($p = 0.0003$), 92.8% ($p = 0.0046$) and 91% ($p = 0.0004$) for axial rotation, flexion-extension and lateral bending respectively. We also found that ROM between T1 - T12 also decreased under fusion by 22% ($p = 0.0013$), 21% ($p = 0.0020$) and 28.2% ($p = 0.0004$) for axial rotation, flexion-extension and lateral bending compared to intact.

CONCLUSION: Thoracic spine stability was not significantly affected by sequential decompression procedures in thoracic segments at the level of the true ribs in all three planes of motion. Placement of posterior instrumented fusion increased study segment rigidity at intrinsic levels and also reduced overall ROM of the thoracic spine.

GP15

3D-CT SIMULATION STUDY OF THE ILIAC SCREW FOR THE FIRM FIXATION

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INTRODUCTION: Distal fixation in thoracolumbar spine surgery is crucial. Iliac screw technique has been reported with good clinical results; however, several studies showed high rates of iliac screw loosening. In the osteoporotic bone, adequate purchase with a screw will be acquired only by the contact to the cortex, and the use of longer and larger-diameter screw has been recommended. The shape of the ilium is complex, and the ideal direction or size of the screw has not been fully clarified. In this study, the contact between iliac screw and the cortex of the ilium was analyzed by using 3D-CT simulation.

METHODS: Twelve adult pelvic CT data were analyzed using originally written software. Screw was placed from the posterior superior iliac spine (PSIS) to the anterior inferior iliac spine. In this study, we assumed that the insertion point at PSIS was fixed, and the screw tip could move freely under the condition that whole screw was located inside the cancellous bone of the ilium. First, maximum screw diameter was decided in each screw length (50-120 mm) by changing the direction of the screw three-dimensionally. Second, we investigated whether or not screw with a maximum size can move in the ilium, and calculated the area where the tip of the screw can move (moving area).

RESULTS AND DISCUSSION: The moving area became small as length of the screw became long in all cases. However, moving area did not disappear except one case when screw length is thought to be long

enough (100mm) in clinical use. Further, the moving area was vertically long linear shape in remaining eleven cases, which indicate that the screw tip can move to the cranial-to-caudal direction. These results show that the single iliac screw is not enough for firm fixation even if the screw diameter and direction are appropriate especially in the case of osteoporosis. Dual iliac screw will resolve this problem when two screws with enough diameters are set at the cranial and caudal end respectively.

GP16

IS THERE AN ASSOCIATION BETWEEN ABDOMINAL MUSCLES AND DEGENERATIVE SPONDYLOLISTHESIS?

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INTRODUCTION: The pathogenesis of degenerative spondylolisthesis is not well understood, with many etiological factors identified. The aims of this study were to investigate the contributions of abdominal muscle and aponeurosis morphology to L4-5 and L5-S1 vertebral slip and to devise models for the prediction of vertebral slip.

METHODS: Axial abdomino-pelvic computed tomography scans from 200 subjects were examined. Those with spondylolysis were excluded (n=14), and spondylolisthesis was expressed as a continuous measure in the remaining subjects. Muscle parameters (abdominal and paraspinal muscle area and density, aponeurosis width) and bony parameters (vertebral slip, lumbar index, disc index, facet joint angle) were measured for each vertebral or intervertebral level. Multiple linear regression analyses were performed to form six hypothesis-driven and predictive models for percent vertebral slip.

RESULTS: Increasing lateral abdominal muscle (LAM) area (p=0.01) and decreasing rec-

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tus abdominis muscle (RAM) area ($p=0.02$) were significant predictors of vertebral slip at the L5-S1 level. Measures of aponeurosis width did not contribute to L5-S1 vertebral slip. Neither muscle morphology or aponeurosis width parameters were significant predictors of slip at the L4-5 level. More sagittal facet joint orientation and decreasing lumbar index were also significant predictors of vertebral slip at both levels in all models.

DISCUSSION: In addition to previously identified osseous factors such as facet angle and lumbar index, this retrospective imaging study shows that abdominal muscle area may be associated with vertebral slip at the L5-S1 level. The reduction in RAM area may represent increased musculoaponeurotic laxity, which predisposes to vertebral slip by lowering intra-abdominal pressure. The association with increased LAM area may be the result of a compensatory response to vertebral slip, which increases intra-abdominal pressure to brace an unstable spine.

GP17

MUSCLE INJURY IN RATS INDUCES UP-REGULATION OF INFLAMMATORY CYTOKINES IN MUSCLE AND PAIN-RELATED NEUROPEPTIDES IN DORSAL ROOT GANGLIA INNERVATING MUSCLE. -THE PATHOLOGICAL-MECHANISM OF CONTINUOUS MUSCLE PAIN-

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INTRODUCTION: Invasion of back muscle after spinal surgery often causes continuous pain, yet the pathological-mechanisms behind continuous muscle pain remain unclear. The aim of the current study was to compare in rats the behavior of the sensory nervous system, and to investigate histological changes and inflammatory cytokines in injured muscle. **METHODS:** In this study, we used the right gastrocnemius contusion model via a drop-mass technique because a back muscle injury model would be difficult for evaluating pain behavior. Exp.1: Pain behavior was measured using CatWalk at twelve hours, 1, 2, 3 days, and 1, 2, 3 weeks after muscle contusion. the bilateral gastrocnemius was resected. Samples were H-E stained and TNF- α , IL-6, and NGF levels were quantified by ELISA. Exp.2: To detect DRG neurons innervating the gastrocnemius, fluorogold (FG) was applied to the surfaces of bilateral gastrocnemius 1 week before muscle contusion. DRGs from L4 to L6 levels were resected at 1, 2, and 3 weeks after contusion, then immunostained for CGRP (pain-related neuropeptide). The ratio of CGRP and FG double-labeled DRG neurons among all FG-labeled neurons was calculated.

RESULTS: Pain behavior: The swing speed of right hind paw was significantly lower than that of left hind paw through 1 day. Histology: At 3 weeks, accumulation of granulated tissue and myofibrillogenesis for repaired tissue was observed. Inflammatory cytokines: Up-regulation of TNF- α , IL-6 and NGF levels in the right side of right side compared to the left side was observed up to 2 days but became less marked subsequently. DRG: The expression of CGRP was significantly higher in the right side than in the left side until two weeks. **DISCUSSION:** In this model, pain response and increase in inflammatory cytokines recovered immediately, but pain-related neuropeptides remained up-regulated for 2 weeks. These differences may explain the pathological-

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mechanism of continuous muscle pain.

GP18

CARBON NANOTUBE-REINFORCED CALCIUM PHOSPHATE CEMENT FOR DRUG DELIVERY IN MULTIPLE MYELOMA BONE DISEASE TREATMENT

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INTRODUCTION: Current approaches in treating multiple myeloma fracture or lesion focus on developing osteoconductive fracture stabilizing fillers capable of carrying therapeutic agents to promote bone regeneration, which cannot be achieved by conventional PMMA methods.

METHODS: We have developed a biocompatible carbon nanotubes (CNT) reinforced calcium phosphate-based cement (CPC) that exhibits desirable mechanical and handling properties. This novel composite was capable in carrying an inhibitor against NF- κ B activated osteoclast differentiation. NF- κ B inhibitor MG132 was incorporated into the CPC or CPC/CNT during the setting process, and the cement was submerged in culture medium for 24 hours. This MG132-containing medium was harvested and added to ACHN indicator cells or preosteoclast RAW 267.4. NF- κ B activation in ACHN cells was detected by real-time RT-PCR analysis of NF- κ B-induced IL-8 after 4 hours of TNF α treatment, and cell viability was assessed by crystal violet staining after 12 hours. Inhibition of RAW 264.7 differentiation was investigated after 5-day TNF α treatment by staining for TRAP positive osteoclast-like cells.

RESULTS: Media from CPC/MG132 and CPC/CNT/MG132 both showed potent inhibitory effect on TNF-induced NF- κ B-mediated IL-8 gene expression. After 5-day TNF α treatment, with MG132 present in the medium, the number of TRAP positive cells decreased significantly.

DISCUSSION: The results have demonstrated that our cement was effectively able to carry MG132. Inhibition of osteoclast differentiation by the CPC/CNT/MG132 medium in a 5-day experiment confirmed the sustained release of the drug from this combination. Together with its salient weight bearing and bioactive properties, our data suggest that the CPC/CNT is a promising filler material for bone augmentation in multiple myeloma related vertebral lesion or fracture.

GP19

BIOMECHANICAL CONTRIBUTION OF TRANSVERSE CONNECTORS IN THE SETTING OF A THORACIC PEDICLE SUBTRACTION OSTEOTOMY

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INTRODUCTION: Little data is available to guide longitudinal construct planning after a pedicle subtraction osteotomy (PSO) in the thoracic spine. Previous studies have suggested transverse connectors (TC) may enhance torsional rigidity. However, the biomechanical effect of augmentation with one or two TC after PSO has not been previously evaluated.

METHODS: 7 fresh-frozen human cadaveric thoracic spines (T3-T11) were prepared and intact range of motion (ROM) testing was performed with non-destructive loading (± 6 Nm) in a six-degree-of-freedom spine simulator. The specimens were instrumented

from T4-T10 with bilateral 5.5-mm pedicle screws and 5.5-mm contoured rods, and a PSO performed at T7. ROM was subsequently analyzed in the unaugmented construct, with 1 TC (T8-T9) and then 2 TC (T5-T6 and T9-T10). ROM was analyzed in axial rotation, flexion-extension, and lateral bending loading planes over T4-T10 and at the PSO level (T6-T8).

RESULTS: After PSO and instrumentation with a thoracic pedicle screw-rod construct, T4-T10 ROM was significantly reduced in all planes of motion from the intact condition ($p < 0.05$). Augmentation with either 1 or 2 TC did not significantly increase construct stability in flexion-extension and lateral bending compared to the unaugmented construct ($p > 0.05$). In contrast, during axial rotation, T4-T10 ROM was reduced by 43% following addition of 2 TC ($p < 0.05$), and was also reduced by 26% following 1 TC ($p > 0.05$), but did not reach statistical significance. Focal segmental stability (T6-T8) at the PSO level had similar improvement in axial rotation stability following the addition of transverse connectors, with a 48% decrease in axial rotation after 2 TC ($p < 0.05$), and addition of 1 TC decreased axial ROM by 29%, but again did not reach statistical significance ($p > 0.05$).

DISCUSSION: Two TC significantly improved torsional rigidity but no differences in stability for all planes of motion were observed with the use of one TC.

GP20

THE BIOMECHANICAL CONSEQUENCES OF ROD REDUCTION FOLLOWING THORACIC PONTE OSTEOTOMY AND LUMBAR FACETECTOMY

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INTRODUCTION: When a residual mismatch occurs between the rod and pedicle screw head, a rod persuasion device has been found to have deleterious consequences on pedicle screw pull-out strength (POS) in the thoracic spine. We investigated the ability of complete facet osteotomies in the thoracic and lumbar spine to counteract the detrimental effect on POS caused by the rod reduction technique.

METHODS: Fifteen ($n=15$) thoracic and nine ($n=9$) lumbar three-level, fresh-frozen human cadaveric specimens were prepared. Thoracic Ponte osteotomies and lumbar facetectomies were performed and instrumented. The right side rod was intentionally contoured with a 5 mm residual gap and was then reduced using a rod-reduction device. On the left side (paired control), a rod with no residual rod-screw mismatch was placed. To simulate screw depth adjustment as an alternative to rod reduction, a screw from the bottom level of each three-segment specimen was backed out one complete revolution. Inline biomechanical testing was performed and pullout strength (POS) measured in Newtons (N).

RESULTS: After rod reduction, pedicle screws had significantly decreased POS compared to the control group (thoracic: 40% decrease; 419 ± 426 N versus 708 ± 462 N, $p=0.002$ and lumbar: 36% decrease; 961 ± 352 N versus 613 ± 563 N, normalized $p=0.048$), and remained statistically significant after adjusting for BMD. Eleven (73%) thoracic and two (22%) lumbar pedicle screws had visible pull-out/failure during the reduction attempt. In both the thoracic and lumbar specimens, no significant difference was detected in POS between the backed-out screw and paired control (824 ± 402 N versus 790 ± 364 N, $p=0.41$, thoracic; 790 ± 390 N versus 635 ± 374 N, $p=0.16$, lumbar).

DISCUSSION: Despite facetectomies to improve flexibility of the spine, the rod reduc-

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tion device still significantly decreased pedicle screw pullout strength; typically resulting in outright failure of the screw-bone interface.

GP21

TAPPING INSERTIONAL TORQUE PREDICTS BETTER PEDICLE SCREW FIXATION AND OPTIMAL SCREW SIZE SELECTION

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INTRODUCTION: Several studies have evaluated pedicle screw insertional torque (IT) and its direct correlation with pullout strength. The objective of this study is to investigate tapping insertional torque and its ability to predict pedicle screw pullout strength and optimal screw size.

METHODS: 20 osteoporotic (mean BMD 0.60 ± 0.07 g/cm²) human cadaveric thoracic vertebral levels were used. 5 specimens were used for a pilot study, as no established values for optimal tapping IT existed. Optimal tap size was selected as the tap diameter 1 mm smaller than the optimal screw size. During optimal tap size insertion, all peak tapping IT values were found to be between 2 and 3 in-lbs. Thus, the threshold tapping IT value for optimal pedicle screw and tap size was determined to be 2.5 in-lbs and a comparison tapping IT value of 1.5 in-lbs was selected. Next, 15 specimens were instrumented using a paired comparison between the two threshold tapping IT values (Group 1: 1.5 in-lbs; Group 2: 2.5 in-lbs). Pedicle screws were in-line tested and load to failure was measured in Newtons(N).

RESULTS: The pedicle screw pullout strength was significantly increased (23%) in 2 (877.9 ± 235.2 N) compared to 1 (712.3 ± 223.1 N, $p=0.017$). The peak tapping

IT was significantly increased (50%) in 2 (3.23 ± 0.65 in-lbs) compared to 1 (2.15 ± 0.56 in-lbs, $p=0.0005$). The peak screw IT was also significantly increased (19%) in 2 (8.99 ± 2.27 in-lbs) compared to 1 (7.52 ± 2.96 in-lbs, $p=0.02$). An increased rate of optimal pedicle screw size selection was found in 2 with 9 of 15 (60%) pedicle screws compared to 1 with 4 of 15 (26.7%) pedicle screws within 1 mm of the measured pedicle width. A moderate correlation existed for tapping IT with both screw IT ($r=0.54$) and pedicle screw POS ($r=0.55$).

DISCUSSION: Tapping IT directly correlates with pedicle screw IT, pedicle screw pullout strength, and optimal pedicle screw size. Tapping IT provides a reliable method to intra-operatively judge fixation strength.

GP22

A NOVEL LOAD SHARING LUMBAR INTERBODY FUSION DEVICE (INTERPLATE®) PROVIDES BETTER STABILITY COMPARED TO THE PEDICLE SCREW SYSTEM.

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INTRODUCTION: Fusion with rigid instrumentation resolves issues related to pseudoarthrosis. However, excessive rigidity may lead to stress shielding and graft resorption. To mitigate this, dynamic designs have been evaluated in the past, but they had varied clinical outcomes. An optimal load sharing must exist between unrestrained motion and rigid fixation. A novel integrated plate-cage system was developed that has dynamic features to enable load sharing with the graft. The purpose of this study is to compare the stability of this system to the standard pedicle screw system (PSS+C).

METHODS: Six ligamentous FSUs (3 L23 & 3 L45) were used. Pure moments were applied in steps up to 10 Nm to simulate physiological rotations in all planes. The procedure was repeated with a follower load of 400N in flexion and extension. Motion was recorded using the Optotrak System. After testing intact, anterior discectomy was performed and cage of appropriate size was inserted close to posterior wall and InterPlate (IP+C) was implanted and tested for ROM (Fig1a-c). The IP+C was removed and PSS+C was implanted without changing the cage position and tested again. A statistical paired-t analysis was performed for significant differences between the two groups.

RESULTS: Without preload, IP+C and PSS+C significantly ($P<0.05$) reduced ROM in all rotations compared to intact. With preload, both systems significantly reduced the motion in extension compared to intact. In flexion, only PSS+C significantly reduced the motion (Fig 1d). The increase in ROM for IP+C compared to PSS+C was significant in bending and flexion. The increase in ROM for IP+C with preload in both extension and flexion was significant when compared to PSS+C.

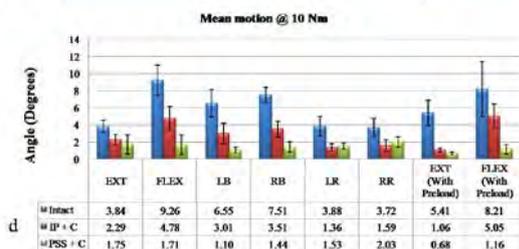


Fig.1 Specimen implanted with (a) cage after anterior discectomy, in conjunction with (b) InterPlate system (IP+C), and (c) pedicle screw system (PSS+C) (d) Mean and standard deviation of ROM for intact, cage in conjunction with InterPlate system (IP+C) and Pedicle screw system (PSS+C).

DISCUSSION: IP+C provided significant segment stability compared to intact which is essential to promote the fusion process. However, it is more flexible compared to

PSS+C. This aspect may enhance the load sharing with the graft compared to pedicle screw rigid fixation.

GP23

INITIAL RESULTS OF A FIVE-YEAR IN VIVO LONGITUDINAL STUDY ON LUMBAR SEGMENTAL AXIAL MOTION AND LOW BACK PAIN

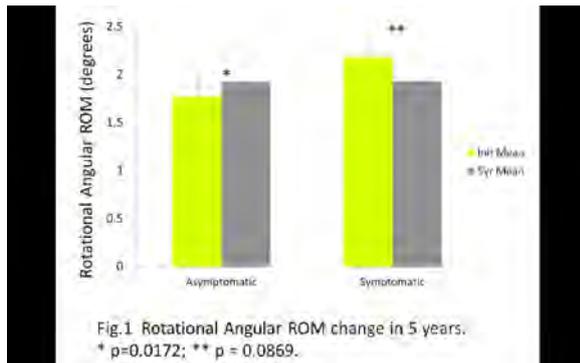
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INTRODUCTION: Spinal instability, manifested usually in torsion, is related to low back pain pathogenesis and disc degeneration. Axial torsion is also known to be the motion that is most susceptible to changes brought on by disc degeneration (DD). This five-year longitudinal study aims to evaluate these in a cohort of controls and low-back pain subjects.

MATERIALS: Supine and 50° rotated-torso images of the lumbar spine of 83 volunteers (aged 22-59) were acquired at the beginning and after five years in this IRB-approved study. For the follow-up images, 23 subjects were available. The CT data was converted to point cloud 3D models to analyze the segmental axial rotation angular ranges of motion. T2-weighted MRIs were also acquired to grade the discs. Differences between genders and symptoms were sought with unpaired t-tests. ANOVA was used to find significant associations between age and spinal level. Data is presented as mean±SEM. Significance was set at $p<0.05$.

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RESULTS: Fig. 1 shows an increase in the rotational ROM for controls after five years ($p=0.0172$), while the symptomatic group showed a decreasing trend ($p=0.0869$). Age did not influence changes in the rotational ROM ($p>0.43$). Disc grade scores in females increased in five years ($p=0.0054$), but for males they did not ($p=0.66$). Younger subjects (ages 20-30) saw a significant increase in disc degeneration grade ($p=0.0018$), while the older subjects (ages 40-50) maintained theirs ($p=0.80$). Spinal level did not show influence on disc grade either: upper levels (L1-L4: $p=0.14$) and lower (L4-S1: $p=0.27$).

DISCUSSION: This preliminary report shows changes in spine parameters in a five year period related to torsional kinematics. Notably, the increase in rotational ROM for the control group is evidence of increasing instability. However the symptomatic group exhibited a trend towards stabilization after five years. Data also shows an increase in disc grade scores in the younger subjects that stabilize in the older group.

GP24

FAILURE UNDER CYCLIC LOADING IN A LUMBAR DISC SHIFTS FROM INNER ANNULLUS LAYERS TO PERIPHERAL ANNULUS WITH INCREASING DISC DEGENERATION.

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INTRODUCTION: Epidemiological studies have reported increased incidence of annular lesions in lumbar discs with increasing disc degeneration severity. It is hypothesized that disc failure location will shift from inner annulus layers in healthy disc to the peripheral annulus in degenerated discs.

METHODS: A previously validated 3D, non-linear poro-elastic finite element model of L4-L5 lumbar motion segment was modified to represent Thompson grade III and IV disc degeneration. Damage accumulation in healthy and degenerated discs was simulated by incorporating continuum damage mechanics formulation. Models were subjected to cyclic compression and flexion. Failure location and number of load cycles to failure were compared for different grades of disc degeneration.

RESULTS: The number of load cycles to failure decreased considerably with increasing severity of disc degeneration. The numbers of load cycles to failure predicted for grade III and IV degeneration discs under cyclic compression decreased by 53% and 93% respectively when compared with the corresponding result in the healthy disc. In healthy and grade III degeneration discs, damage initiated in the inner posterior annulus and progressed radially towards the periphery with increasing number of load cycles. In grade IV degeneration disc, damage initiated at the posterior outer periphery of the annulus and propagated circumferentially.

CONCLUSIONS: The current finite element models predicted the incidence of radial fissures in healthy and mildly degenerated discs while peripheral rim lesions were simulated in moderately degenerated disc. This may be because in a healthy disc most of the load is shared by nucleus that exerts pressure at the inner annulus creating higher stresses. On the other hand, in a degenerated disc the load gets transferred to annulus creating higher stresses at the outer annulus. Results were consistent with the

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experimental and clinical observations in terms of the region of failure.

GP25

IN VIVO CHARACTERIZATION OF THE 3D LUMBAR FORAMEN GEOMETRY

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INTRODUCTION: There are many spinal treatment options that require accurate knowledge of the lumbar foramen boundary. Alas, its definition is elusive due to the persistent use of planar methods to determine the dimensions of a true 3D contour. This study aims to introduce innovative 3D CT-based analysis methods for the lumbar foramen.

METHODS: This IRB-approved study obtained CT scans in supine position of 59 healthy volunteers (31M/28F) that were used to create the 3D lumbar vertebral surface models. A floating spherical coordinate system was moved along the nerve root path inside each foramen using an algorithm that calculated the distance from this center to the closest foramen elements (facet joints, disc, pedicles). Its outcomes were: foramen height (FH, distance between any two points furthest apart from each other) and the foramen width (FW, distance between any two points closest together). These two parameters were correlated with the vertebral posterior wall height, segmental lordotic angle, disc height and MR disc grade (Pfirrmann's). ANOVA and Pearson's correlation were used for statistical analyses. Significance level was set at $p < 0.05$.

RESULTS: Both FH and FW decreased with age. FH and FW in the lower lumbar levels were significantly smaller than in the upper levels. In L5/S, there was moderate or weak negative correlation between FH and ages,

and moderate or weak positive correlation between FH versus disc height, posterior wall height and disc grade. There was almost no significance between FH and SLA (except L1/2), and height (except L1/2). Of note, there was a moderate negative correlation between FW and age. There were no differences between FW and disc height or segmental lordotic angle.

DISCUSSION: The present study provided 3D foramen geometries of an asymptomatic cohort measured in vivo. Although data is limited to bony geometry, it could be used as base line data for diagnosis of foraminal stenosis and planning of treatment modality.

GP26

CHANGES IN NUCLEUS PULPOSUS MRI SIGNAL INHOMOGENEITY SHOW DISC DEGENERATION PROGRESS

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INTRODUCTION: MRI can monitor clinically the quality of the intervertebral disc through changes in the Nucleus Pulposus' (NP) signal intensity. We propose that the location of the NP centroid weighted by signal intensity could be a parameter to define the signal homogeneity of a region of interest in MR data.

METHODS: T2-weighted sequences from a 1.5T MR unit provided mid-sagittal cuts from 65 asymptomatic volunteers (31M/34F, 22-59 y.o.) used in this IRB-approved study. Three spine surgeons graded 288 lumbar IVDs with a clearly identifiable NP boundary (Grade I: $n=47$, Grade II: $n=173$, Grade III: $n=68$). A custom written script was used to define the boundary, geometric and weighted centroids of each NP. The weighted centroid was located inside the region of the contour that had

highest homogeneous MR NP signal, but did not necessarily coincide with the geometric centroid. The distances between them in the plane of the sagittal MR slice were calculated and compared with ANOVA. Statistical significance set at $p < 0.05$.

RESULTS: In 85.8% of NPs, the weighted center was located posterior to the geometric center. The distance on the longitudinal axis in Grade II discs was significantly larger than that in Grade I discs ($p = 0.035$, Fig.1).

The distance on the axis perpendicular to the longitudinal axis in Grade III discs was significantly larger than that in Grade I and Grade II discs ($p < 0.01$).

DISCUSSION: In the majority of NPs, the weighted centers were located posterior to the geometric centers. Grade II inter-centroid distances were larger than in Grade I discs. This may suggest progressive signal intensity decrease in the anterior part of NP during early stages of disc degeneration. With advancing degeneration, the decrease of signal intensity reached the posterior part of the disc and the weighted centers moved toward the geometric centers. This study showed the feasibility of the inter-centroid distance as a NP homogeneity indicator.

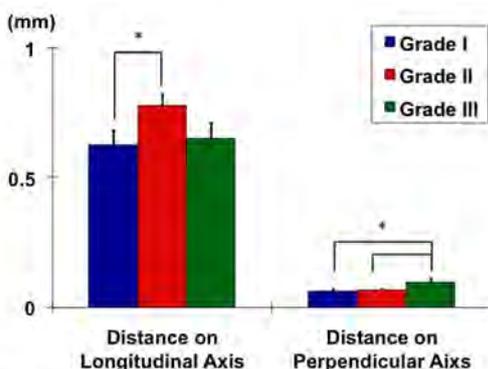


Figure 1 Average distances on longitudinal and perpendicular axis. Asterisk denotes significant differences between groups ($p < 0.05$).

GP27

THE EFFECT OF DIFFERENCE IN HAMSTRINGS FLEXIBILITY ON LUMBO-PELVIC RHYTHM

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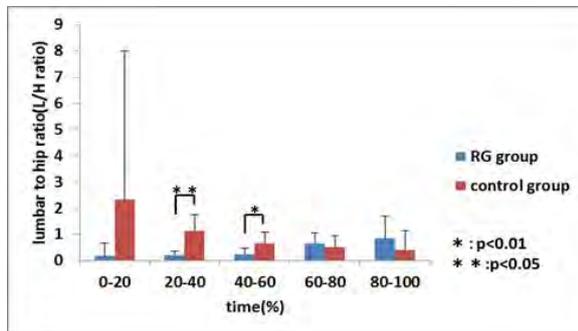
INTRODUCTION: The purpose of this study was to investigate effect of difference in hamstrings flexibility on lumbo-pelvic rhythm.

METHODS: Thirteen young rhythmic gymnasts (RG group) and 10 healthy women (control group) participated in this study. After the markers were attached to the particular points, the sagittal movements of lumbar spine and pelvis during forward bending were collected by a digital camera at a frequency of 30 Hz. Lumbar angle (LA) and pelvic tilting angle (PTA) were defined as the angle of Th12-L3 to L3-S1, and the angle of the horizontal to anterior superior iliac spine-posterior superior iliac spine lines, respectively. The lumbar to hip ratio (L/H ratio) was calculated from LA and PTA. To normalize, we divided total time of forward bending into every 20%. Moreover, finger floor distance (FFD) was measured to investigate hamstrings flexibility. Group differences were assessed using independent t-tests for each movement variables.

RESULTS: The FFD of RG group and control group were -23.4 ± 2.6 cm and -14.0 ± 8.1 cm, that show a significant difference between the groups ($p < 0.001$). In RG group, the average of LA and PTA during total forward bending were $28.5 \pm 10.6^\circ$ and $93.3 \pm 9.7^\circ$, respectively. Additionally, in control, the values were $43.3 \pm 8.7^\circ$ and $65.2 \pm 9.2^\circ$, respectively. The above comparisons of LA and PTA between two groups shows signifi-

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cant differences ($p=0.002$, $p<0.001$). The L/H ratio during total forward bending is summarized in Figure 1



There were significant differences between the groups in 0-20%, 20-40% and 40-60% of forward bending ($p=0.001$, $p=0.015$).

DISCUSSION: In RG group, L/H ratio was small. It suggests that flexible hamstrings which causes large pelvis anteversion has lumbar spine less flexed.

Conclusion: RG group performed forward bending by large anteversion of pelvis and small flexion of lumbar spine. Flexible hamstrings decrease the load of spine during forward bending.

GP28

EFFECT OF MENTAL STRESS ON LOW BACK LOAD WHILE LIFTING AN OBJECT

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INTRODUCTION: In addition to ergonomic factors such as frequent lifting, work-

related psychosocial factors are significant in the onset of disabling back pain. Although the ergonomic effects on low back load while lifting have been investigated and are widely accepted in the workplace, few studies have investigated the effect of psychosocial factors on low back load while lifting. The aim of this study was to determine the effect of mental processing on low back load during lifting.

METHODS: Thirteen healthy subjects lifted a box from the ground in four different lifting tasks in randomized order: (1) squat posture, with the back and hips flexed and knees extended; (2) stoop posture, with the back and hips extended and knees flexed; (3) squat posture with mental processing using arithmetic tasks; and (4) stoop posture with mental processing using arithmetic tasks. A 3D motion analysis system and four force plates were used to record kinematic and kinetic data. Dynamic tri-axial low back joint moments and low back compression force were calculated as index parameters of low back load under these experimental conditions.

RESULTS: Mental processing significantly increased peak low back compression force and low back extension moment, but not lateral flexion or rotation moment, while lifting in both lifting postures. Also, mental processing decreased forward pelvic tilt in the stoop posture and increased trunk bending angles in the squat posture.

DISCUSSION: Mental stress during lifting tasks appears to affect both trunk and pelvis angles in the sagittal plane for squat and stoop postures, resulting in increased low back load. The present findings might help to explain the effect of not only the ergonomic demands of lifting tasks but also the psychosocial factors responsible for the onset of disabling back pain.

GP29

BIOMECHANICAL ANALYSIS OF FUSION SEGMENT RIGIDITY UPON STRESS AT BOTH THE FUSION AND ADJACENT SEGMENTS - A COMPARISON BETWEEN UNILATERAL AND BILATERAL PEDICLE SCREW FIXATION

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INTRODUCTION: The biomechanical stability of unilateral pedicle screw fixation related to the extent of decompression remains unknown. The purpose of this study was to investigate the effects of unilateral pedicle screw fixation on the fusion segment and the superior adjacent segment after one segment lumbar fusion using validated finite element (FE) models.

METHODS: Four L3-4 fusion models were simulated according to the extent of decompression and the method of pedicle screws fixation in L3-4 lumbar fusion. These models included hemi-laminectomy with bilateral pedicle screw fixation in the L3-4 segment (BF-HL model), total laminectomy with bilateral pedicle screw fixation (BF-TL model), hemi-laminectomy with unilateral pedicle screw fixation (UF-HL model), and total laminectomy with unilateral pedicle screw fixation (UF-TL model). In each scenario, intradiscal pressures, annulus stress, and range of motion at the L2-3 and L3-4 segments were analyzed under flexion, ex-

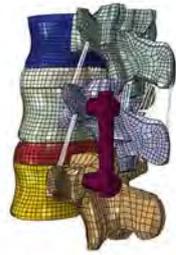
tension, lateral bending, and torsional moments.



a. BF-HL model



b. BF-TL model



c. UF-HL model



d. UF-TL model

RESULTS: Under four moments, the unilateral fixation leads to a reduction in the ROM increase at the adjacent segment after fusion, compared to bilateral fixation. At the fusion segment, larger motions were noted at the fusion segment in the UF-HL and UF-TL models under four moments, compared with the bilateral fixation models. The UF-TL model demonstrated a vulnerability to torsional moments at the fusion segment, with an increase in remaining motion at the fusion segment. Four models showed increased maximal von Mises stress on the AF at the adjacent segments under the four moments, and unilateral fixation models led to a prominent reduction in increased AF stress at the adjacent segment under the four moments

DISCUSSION: The use of unilateral pedicle screw fixation is only warranted in limited decompression procedures such as hemi-laminectomies. However, reduced stiffness in fusion segment would have a beneficial effect on stress of adjacent segment.

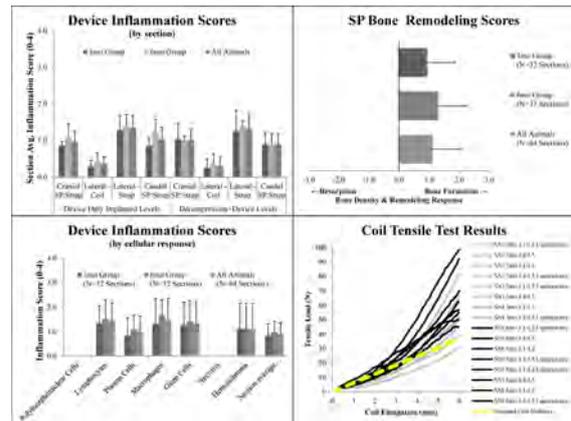
GP30

IN VIVO RESPONSE TO A PARASPINOUS TENSION BAND DEVICE WITH TITANIUM COIL. AN OVINE IMPLANTATION STUDY

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INTRODUCTION: Posterior lumbar dynamic stabilization devices have been proposed as an alternative to fusion. Dynamic components and fixation elements may elicit a biological response, affecting patient health or implant performance.

METHODS: Eight sheep were implanted with two paraspinous tension bands (PTB; L1/2, L4/5) under IACUC approval. Each PTB comprised two titanium coil springs secured to the spinous processes (SPs) with UHMWPE straps. Four sheep were sacrificed each at 3 and 6 months. PTB components, local and distant tissues were examined macroscopically, and then evaluated histologically for qualitative changes and graded for inflammatory response, device findings and bone remodelling with a scoring system based on ISO standards. One coil from each PTB underwent tensile testing to evaluate the functional impact of adherent tissue.



RESULTS: All animals were healthy until euthanasia. Gross examination revealed fibrous encapsulation of the PTB contiguous with midline ligamentous structures. Histopathology with nondecalcified sections identified fibrovascular tissue that infiltrated the coils. Minimal inflammation was associated with the coils. The strap was associated with slightly higher yet mild inflammatory scores. Bone remodeling indicated adaptation to the PTB, trending toward bone formation by the SPs. No reaction in distant tissues or device debris was found; only minor fraying of the cut end of the straps. Coil stiffness increased approximately 33% at 3 mo and 57% at 6 mo. Through the first 50% of elongation, stiffness was largely unaffected, with most of the increase beyond 50% elongation.

DISCUSSION: These results demonstrate feasibility of the PTB as an alternative to spinal fusion. Inflammation was mild, with negligible inflammation associated with the coils and the response to the straps comparable to that reported for sutures. The coils remained functional, with increased stiffness beyond 50% elongation as load was transferred to adherent tissue.

GP31

INSTABILITY OF POSTERIOR VERTEBRAL WALL CAUSES CANAL ENCROACHMENT IN THE ELDERLY WITH VERTEBRAL PSEUDOARTHROSIS

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INTRODUCTION: The purpose of this study was to elucidate effects of loading associated with SCE in patients with insufficient bone union following vertebral fractures in the elderly using computed tomography (CT) myelography in two different positions.

METHODS: Seventeen patients (mean age, 77.4 years) with various degrees of neurological deficit due to insufficient bone union at both vertebral body and posterior vertebral wall were prospectively examined in this study. CT myelography was performed in both semi-sitting and supine positions. Kyphotic angle, rate of dural compression, ratio of occupation by bony fragments and posterior vertebral body height ratio were measured and compared between positions.

RESULTS: Ratio of occupation by bony fragments was significantly higher in the semi-sitting position (47.9%) than in the supine position (33.9%, $p < 0.001$). Similarly, posterior vertebral body height ratio was significantly lower in the semi-sitting position (67.8%) than in the supine position (76.3%), indicating a significant loss of vertebral height in the semi-sitting position ($p < 0.001$). Rate of dural compression was likewise significantly higher in the semi-sitting position (48.6%) than in the supine position (33.3%; $p < 0.001$). Change in ratio of occupation by bony fragments, change in posterior vertebral body height ratio and

angular instability between positions were 13.9%, 8.5% and 13°, respectively. A significant correlation was identified between change in ratio of occupation by bony fragments and change in posterior vertebral body height ratio ($p = 0.001$).

CONCLUSIONS: Our study demonstrated that collapse of the non-united posterior vertebral wall and intracanal protrusion of vertebral fragments would occur simultaneously with axial loading, causing SCE. CT taken in semi-sitting position appears quite useful to evaluate the amount of SCE by an unstable posterior wall.

GP32

DEVELOPMENT OF A NOVEL PERCUTANEOUS GUIDE WIRE (S-WIRE™) FOR PERCUTANEOUS PEDICLE SCREW INSERTION –ITS EFFICACY AND SAFETY–

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INTRODUCTION: In minimally invasive spinal fusion surgery such as MIS-TLIF, the placement of percutaneous pedicle screw (PPS) is necessary, but several intraoperative complications have been reported. One of the serious complications is the great vessel and bowel injuries due to the anterior migration and penetration of the guide wire through the anterior cortex of the vertebral body. We have established a novel percutaneous guide wire (S-wire™) in MIS-TLIF procedure. Our aim was to investigate the biomechanical characteristics of S-wire™ in cadaveric spines by comparing conventional wire, and evaluate the efficacy

and safety of S-wire™ in the clinical trial.

METHODS: S-wire™ consists of a hollow and braided wire which extends at the one side of the tips. Fresh cadaveric lumbar spines from L1 to L5 (N=3) were used for biomechanical comparison between S-wire™ and a conventional wire. The push-out (1 cm migration) and penetration forces were measured in two wires.

RESULTS: A braided part of S-wire™ was moderately bent or unraveled when the axial force was applied, resulting in the increased resistance against anterior migration. The mean push-out force in S-wires™ and conventional wires were $15.5 \pm 1.9\text{N}$ and $5.7 \pm 0.8\text{N}$ ($P < 0.0001$), respectively. The mean penetration forces in S-wires™ and conventional wires were $69.1 \pm 4.2\text{N}$ and $37.1 \pm 4.8\text{N}$ ($P < 0.0005$), respectively. In the clinical trial of a total number of 212 S-wires™, neither penetration of the anterior wall nor breakage of wire was observed. Interestingly, 181 of 212 S-wires™ (85%) revealed increase of pull-out force after the placement.

DISCUSSION: S-wire™ could prevent the anterior migration and the penetration of the anterior wall of the vertebral body and it is safe and useful device for not only MIS-TLIF but balloon kyphoplasty.

GP33

FINITE ELEMENT ANALYSIS FOR COMPARISON OF SUPRASPINOUS OSTEOTOMIES TECHNIQUE WITH CONVENTIONAL LAMINECTOMY

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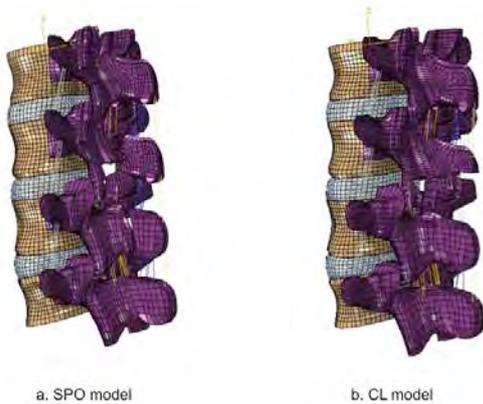
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INTRODUCTION: It is unknown whether osteotomies at the base of the spinous processes might increase the risk of spinal instability despite preservation of the supraspinous and inter-spinous ligaments. Therefore, the aim of this study was to evaluate and compare the biomechanical behavior of the lumbar spine after posterior decompression with spinous process osteotomies (SPO) technique or conventional laminectomy (CL) technique using finite element model.

METHODS: Three validated lumbar FE models (L2-5) which represented intact spine and two decompression models using SPO and CL technique were developed. Decompression procedures were simulated at the L3-4 segment in the SPO and CL models. Under 400 N pre-compressive loading, 7.5 Nm moments simulated flexion, extension, lateral bending, and torsion were imposed. In each model, the ranges of motion, the maximal von Mises stress of the annulus fibrosus, and the intradiscal pressures at the index segment (L3-4) and adjacent segments (L2-3 and L4-5) were analyzed. Facet contact forces were also compared among three models under the extension and torsion moments.

RESULTS: Compared to the intact model, the CL and SPO models had increased range of motion and annulus stress at both the index segment (L3-4) and the adjacent segments under flexion and torsion. The SPO model demonstrated a reduced range of motion and annulus stress than the CL model. The both of CL and SPO models had the increase of the facet contact force at the L3-4 segment under the torsion moment, compared to that of intact model. In contrast, under the extension moment, three models demonstrated the similar facet contact force even at the L3-4 model.

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DISCUSSION: The spinous process osteotomy technique for decompression led to better postoperative stability under flexion and torsion than the conventional laminectomy. This suggests that the continuity of PLC has importance for the stability of lumbar spine even after decompression surgery.

GP34

CORRELATION BETWEEN INTRADISCAL PRESSURE AND DISC HEIGHT: EFFECT OF FOLLOWER LOAD AND ROTATION

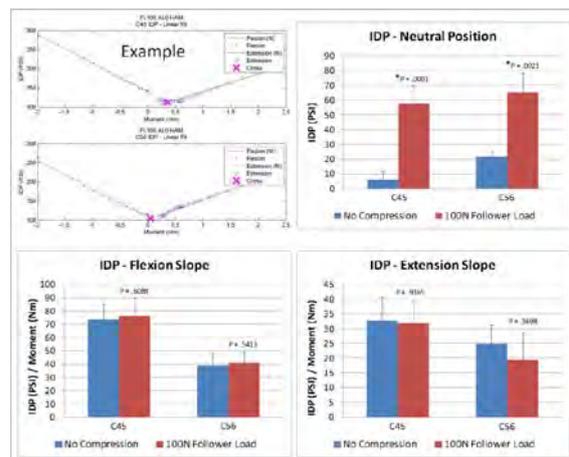
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INTRODUCTION: The relationship between in vivo and in vitro intradiscal pressure (IDP) remains unclear. This study sought to explore this relationship in an in vitro cervical spine model by simulating the only known in vivo study (Hattori, 1981). The current study combined simulated muscle loading (Follower Load, FL) with a robotic/UFS testing system to more closely (Pospiech, 1999) replicate Hattori's in vivo methodology. Finally, in an attempt to bridge the gap between in vivo and in vitro the relationship between disc height (as calculated by CT) and IDP was explored.

METHODS: FL (100N) was applied to N=12 human (C37) cervical cadaveric specimen and the robot was then controlled to a pure moment target of 2.0 Nm for flexion and

extension (FE). IDP was recorded and IDP slope/intercept were calculated based on a moment-IDP curve. Disc height was calculated via CT scan and correlated with IDP (Pearson).

RESULTS: C45 and C56 IDP measured in the neutral position was significantly increased with application of FL, but the IDP slope with increasing FE rotation was not. C5-6 tended to have a higher IDP in the neutral position than C45 but a lower IDP slope as a result in FE rotation. IDP and disc height showed no correlation in the neutral position, however a significant correlation was observed for flexion with no compression (.709, *p=.015) and for flexion (.666, *p=.025) and extension (.629, *p=.038) with application of FL.



DISCUSSION: The effects of adding FL compression approximates the effect of the patient going from the supine to seated position. However, data showed a higher increase in IDP with flexion than extension, whereas Hattori's study showed the opposite effect on average, although this was not consistent and depended on degeneration grade. The high significant correlation between IDP slope and disc height may give insight into the mechanics of IDD and is of great interest to researchers and clinicians.

GP35

IN VIVO MRI MEASUREMENT OF SPINAL CORD DISPLACEMENT IN THE THORACOLUMBAR REGION: PART 2 - COMPARISON BETWEEN UNILATERAL AND BILATERAL STRAIGHT LEG RAISE TESTS.

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INTRODUCTION: Following on from our previous study (Rade et al 2012) we further measured spinal cord displacement during the passive bilateral SLR in asymptomatic subjects and compared these data with those of the unilateral. The corollary is then to develop a better understanding of the local mechanical responses and possible clinical implications.

METHODS: Sixteen asymptomatic male volunteers were scanned with 1.5T magnetic resonance scanner (Siemens Avanto, Erlangen, Germany) using T2 weighted turbo spin echo fat saturation sequence (TR 3880ms, TE 80ms, 10 slices, slice thickness 3mm, gap 0.3mm, FOV 400mm², pixel size 1.3mm*0.9mm). Coronal slices were aligned with spinal cord.

Displacement of the conus relative to the adjacent vertebral body during bilateral SLR was quantified and compared with data on the right SLR, left SLR and the neutral (anatomic) position. Each movement was performed twice in order to provide intraclass correlation coefficients (ICC). Four practitioners performed the maneuvers in a random sequence in order to avoid possible series effects.

RESULTS: Compared to the position of the

conus in the neutral (anatomic) position, the medullar cone displaced caudally in the spinal canal by 5.2 ± 1.5 mm with bilateral SLR ($p=0.000$). This displacement was also statistically significant when compared with the right SLR ($p=0.000$) and left SLR ($p=0.000$). The ICCs were as follows: bilateral SLR = 0.994, right SLR = 0.997, left SLR = 0.996, unilateral SLR (right and left SLR compared) = 0.997. Number of required subjects to get statistically significant results ($p<0.05$) is 3 for Bilateral SLR.

CONCLUSIONS: The results showed that the distal displacement of the medullar cone was significantly greater (almost double) with the bilateral compared to the unilateral SLR. We hypothesize that this greater movement may be because more force was transmitted to the cord through a larger number nerve roots with the bilateral than unilateral SLR.

GP36

THREE DIMENSIONAL ASSESSMENT OF LUMBAR FACET JOINT TROPISM IN ASYMPTOMATIC AND LOW BACK PAIN SUBJECTS

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INTRODUCTION: Facet joint (FJ) orientation and tropism are important parameters to analyze FJ pathogenic contributions to various types of spinal diseases. However, limited data on orientation data and lack of a proper tropism definition make this topic controversial. This study aims to describe relationships between lumbar FJ 3D orientation, tropism, age, gender, level, and presence of chronic low back pain (LBP) and to evaluate possible cutoff values to define tropism.

METHODS: IRB-approved in vivo 3D orientation measurements of lumbar FJs were per-

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formed on 92 volunteers (58 asymptomatic/34 chronic LBP subjects) using CT-based 3D facet joint surface models. Each facet joint surface was represented by its normal vector, which was subsequently plotted on a unit sphere. Differences in symmetry between left and right orientation vectors (tropism angle) were calculated between each unit vector and its corresponding mirror image. Angle differences were evaluated with unpaired t tests. Gender, age and level effects were analyzed by a one-way ANOVA with Fischer post hoc test, and significance set at $p < 0.05$. Cutoff values attempted were the mean and one standard deviation of angle difference, 5 and 10 degrees, and were analyzed by a chi-square test.

RESULTS: The orientations of both superior and inferior facets changed gradually from sagittal to coronal orientation from L1 to L5. More coronal orientation of L1 superior facets and more horizontal orientation of L5 inferior facets revealed transitional features of spine. The mean tropism angle was 7.65° . The mean angle difference of symptomatic group was significantly larger than that of asymptomatic group. The cutoff values over mean angle difference showed significantly more tropism in symptomatic group than asymptomatic group, the others did not.

CONCLUSION: Our results of more tropism in symptomatic group based on a three-dimensional orientation model supports the hypothesis of causative role of tropism to LBP.

GP37

MODIC CHANGES FOLLOW BONE REMODELING PRINCIPLES

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INTRODUCTION: Etiology of Modic changes is not well understood.¹ We hypothesize that Modic changes are a direct consequence of changes in biomechanical environment due to disc herniation and thus obey Wolff's law of bone remodeling.

METHODS: Strain energy density theory of adaptive remodeling was implemented in our experimentally validated 3D finite element model of lumbar spine (L3-L5). The algorithm was executed for flexion (10Nm), extension (10Nm), and compression (400N) after posterolateral disc herniation at L4-L5 IVD (nucleus pulposus-NP volume removed - 2cm^3 ; annulus fibrosus (AF) incised - 44mm^2).

RESULTS: In L5, the average apparent densities decreased by 55% beneath the herniated region due to no load transmission and hence decrease in strain energy density (SED) of that region, Figure 1.

Average apparent density increased by 101%, in the regions beneath the unaffected NP due to increase in SED. Likewise, apparent density of L4 showed an increase of 129% in the region above the unaffected NP.

DISCUSSION: Decreases in the density around herniated region are similar to loss of trabecular bone and bone marrow depletion observed clinically as Modic changes.¹ Our data concur with previous studies which state that Modic changes may be due to changes in biomechanical environment of the surrounding bone.^{2, 3} Bone resorption occurred near the affected areas in the vertebra below the herniated IVD, with increases in bone densities in other areas, both in agreement with literature.²

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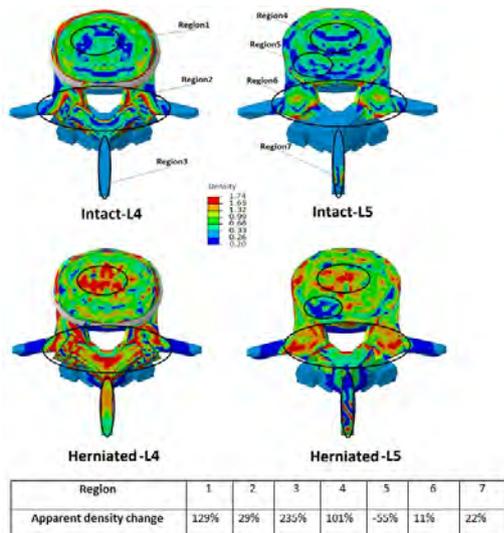


Figure 1: Transverse cut at L4 & L5 vertebrae showing optimized apparent density distributions before and after herniation (g/cm^3)

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GP38

CHANGES IN ENDPLATE THICKNESS AFTER DISC HERNIATION – A BIOMECHANICAL PERSPECTIVE

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INTRODUCTION: Morphological features of endplates play a major role in intervertebral disc (IVD) health, but the opposite could also be true with changes in IVD affecting the morphological features of endplates. We hypothesize that changes in biomechanical environment due to disc herniation will change the thickness of the endplates at the index level.

METHODS: Strain energy density theory of adaptive remodeling was implemented in our experimentally validated 3D finite element model of lumbar spine (L3-L5).¹ The model response for flexion (10Nm), extension (10Nm), and compression (400N) after posterolateral disc herniation at L4-L5 IVD were predicted. The volume of nucleus pulposus (NP) removed was 2cm^3 and area of annulus fibrosus (AF) incised was 44mm^2 .

RESULTS: Regional endplate thickness changed substantially after disc herniation, Figure 1. However, the mean value was close to the initial value of endplate thickness (0.5mm) assigned in the model.

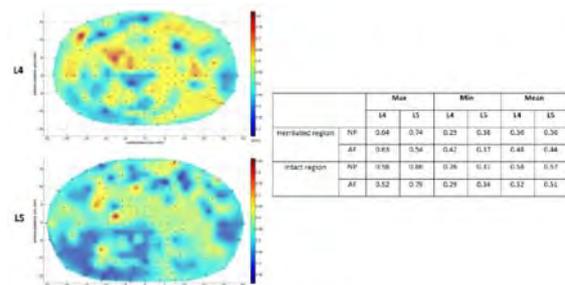


Figure 1: Contour plots showing changes in thickness of L4-IEP and L5-SEP following remodeling after disc herniation

DISCUSSION: Change in morphology is attributed to the Wolff's law of bone remodeling. It is quite evident from the contour that the posterolateral (left) region of the vertebral endplate became thinner and the remaining region became thicker. Central regions of endplate (associated with NP) were more affected than the peripheral regions (associated with AF). Changes in endplate morphology are very critical as it could change the nutrient permeability of the endplates affecting the IVD, starting a vicious cycle of degeneration.

GP39

EFFECT OF AN INTERSPINOUS IMPLANT ON IN VIVO DYNAMIC LUMBAR SPINE STIFFNESS AND BIPLANAR INTERSEGMENTAL MOTION

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INTRODUCTION: This study examined the effect of an interspinous implant on lumbar spine stiffness and intersegmental accelerations in the dorsoventral (DV) and axial (AX) planes in an in vivo ovine model.

METHODS: Dynamic lumbar spine stiffness and intersegmental accelerations were quantified in eight anesthetized adolescent Merino wethers 68.4 kg (s.d.=4.5 kg). Two, 6, and 12 Hz oscillatory loads were randomly applied to the L3 spinous process in the prone and oblique positions using a previously validated technique. In each position, measurements were obtained with the lumbar spine intact; and following insertion of an InSwing® interspinous device at L3-L4 secured by a tension band. DV stiffness (N/mm) was calculated over 6 trials during 10 seconds of testing at each loading frequency in each position. L3-L4 accelerations were derived from tri-axial accelerometers mounted to steel pins rigidly affixed to the L3 and L4 spinous processes. Stiffness and accelerations for each position and condition were compared using one-way ANOVA with repeated measures and post-hoc analyses.

RESULTS: Mean DV stiffness ranged from 6.73 to 28.67 N/mm intact compared to 12.39 to 40.32 N/mm for the interspinous implant condition. Significant increases in DV lumbar spine stiffness were observed for

6 Hz ($p=0.002$) and 12 Hz ($p=0.011$) testing. Significant decreases in DV accelerations at L3-L4 were also found for 12 Hz testing ($p=0.024$). In the AX plane, significant 2- to 6-fold reductions in intersegmental accelerations were found for 2 Hz testing ($p=0.026$, $p=0.001$) in animals with an interspinous implant.

DISCUSSION: This experimental model provides novel evidence that an interspinous device with tension band provides increased segmental and intersegmental lumbar stability in the DV and AX planes and further confirms the frequency dependence upon stiffness testing. These results may be useful when considering non-fusion devices for patients with symptomatic lumbar instability.

GP40

T2 VALUES OF HUMAN LUMBAR DISCS: TEMPLATE-BASED SEGMENTATION AND VARIATIONS WITH AGE, SEX AND LEVEL

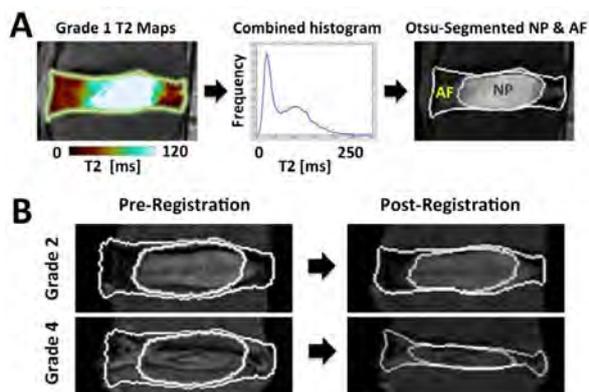
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INTRODUCTION: Quantitative MRI is useful for evaluation of disc degeneration. However, segmentation of NP and AF can be difficult, when the signal intensity from the NP is low and indistinct from the AF. Aim of this study was to describe a template-based technique to segment NP indirectly, and to report age- and level-dependent changes in T2 of human discs.

METHODS: Lumbar spines (L1 to L5) from cadavers ($n=84$, 58 ± 10 yrs, 18F, 66M) were obtained from tissue bank and imaged at 3T. Spin echo T2 mapping was performed: mid-sagittal plane, FOV=16 to 20 cm, slice=3 mm, TR=2000 ms, TE=10 to 90 ms (8 TEs). Discs ($n=334$) were Pfirrmann-graded (1=normal, 5=degenerate) and T2 values determined. Using grade 1 discs ($n=11$),

template of AF boundary and NP region of interest (A) was created, and applied to other discs using affine registration (B) to match target AF. Using this method, T2 values of NP and AF of each disc was determined.

RESULTS: Grade 1 discs readily segmented into NP and AF due to bimodal distribution of T2 values (A), unlike higher grade discs. T2 values of the NP varied with age ($p < 0.001$) but not with sex ($p = 0.4$) or level ($p = 0.5$). T2 values of the NP decreased at a rate of -1.1 ms/yr (intercept 136 ms), a significant correlation ($p < 0.001$, $r^2 = 0.22$). This was stronger than that between Pfirrmann grade and age ($r^2 = 0.10$). T2 values of the AF did not vary with age ($p = 0.9$), sex ($p = 0.54$) or level ($p = 0.5$).



DISCUSSION: A template-based method of NP segmentation was developed and used to assess cadaveric discs. The novel technique is useful when other methods of directly segmenting NP fail due to low image contrast, as is often the case for degenerating discs. Additional studies to compare accuracy of this method to reference standards would be useful. Our findings of non-effect of gender and significant decrease in T2 of the NP with aging agree with past studies. Advances in knowledge include histogram of T2 values in discs, rate of change of T2 values with age.

GP41

SHEAR STIFFNESS OF BABOON INTERVERTEBRAL DISC ASSESSED BY MR ELASTOGRAPHY

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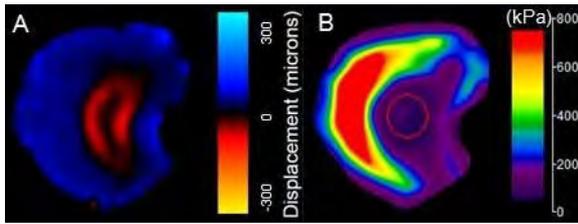
INTRODUCTION: There are many techniques to characterize disc degeneration such as x-ray and MRI methods. However, no techniques exist to directly assess the material properties of the intervertebral disc (IVD) within the intact spine. Magnetic resonance elastography (MRE) is a sensitive, phase contrast-based imaging technique for non-invasively mapping the mechanical properties of tissues. The objective of this study is to determine if MRE is capable of detecting shear wave propagation and generating a shear stiffness map for an axial cross-section of the IVD.

METHODS: A fresh frozen lumbar spine segment (L3-L4) was tested with posterior elements removed to increase flexibility. Shear vibration at 1,000 Hz was applied to the upper vertebral body while the lower vertebral body was fixed using a custom-built testing fixture. The disc specimen was imaged with a spin echo-based MRE sequence in a standard 1.5T GE full-body MRI scanner with a 5-in diameter receive RF coil (TE/TR = 50/290 ms).

RESULTS: Propagating waves were seen in an axial cross-section of the IVD in all three motion-encoding directions. A representative filtered wave image showing the shear wave displacement pattern is shown (Fig. 1A). Distinct wave patterns can be seen in the annulus and nucleus pulposus, with the nucleus showing a much shorter wavelength ("softer"). A shear stiffness map was generated from the MRE data in the IVD (Fig. 1B). Although the wavelength was too long in the annular region to reliably approximate stiffness, the nucleus showed an

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average shear stiffness of 79 ± 15 kPa.



DISCUSSION: These results suggest MRE is capable of detecting shear wave propagation in the IVD, creating a stiffness map of the IVD, and can differentiate the nucleus and annulus regions. Based on these results, MRE could provide a valuable tool to study the mechanical properties of healthy and degenerated discs, with the potential for investigating conservative treatments for patients with low back pain.

GP42

EX-VIVO RESPONSE OF SPINAL CARTILAGINOUS TISSUES TO FLEXION-EXTENSION OF RABBIT FUNCTIONAL SPINAL UNIT

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INTRODUCTION: Intervertebral disc (IVD) degeneration is characterized by degradation of disc extracellular matrix and is frequently coupled with facet cartilage (FC) degradation. Mechanical loading plays an important role in degeneration, yet flexion-extension (FE) has not been investigated and simultaneous cellular responses to mechanical loading in IVD and FC remain unknown. The goal of this study was to elucidate the influence of repeated FE simultaneously in IVD and FC using viable functional spinal units (FSU) loaded ex vivo.

MATERIALS AND METHODS: Freshly harvested rabbit L4-5 FSUs are mounted within a chamber that interfaces with a serial-

linkage robot capable of six-axis motion. Media (10% FBS) is pumped through the chamber (1.25 ml/min), and temperature and gas concentrations are controlled to 37 °C and 5/5% CO₂/O₂. FSUs are subjected to three cycles of FE using adaptive displacement control to determine the pure moment path. FSUs are rotated through (1) large amplitudes—moment-angle curves enter the linear region and (2) small amplitudes—moment-angle curves remain within the toe region. Following three cycles of preconditioning, FE kinematics are repeated for 1 h at 0.33 °/s. Unloaded FSUs (L2-3) serve as controls. Outcome measures include relative mRNA expression of catabolic (MMP-3 and ADAMTS-5), inflammatory (COX-2), and anabolic (Agg) genes alongside changes in mechanical outcomes—load relaxation and hysteresis.

RESULTS: Large amplitudes relative to small ones showed relative mRNA expression changes that were pro-inflammatory in NP and FC, catabolic in FC, and anti-anabolic in NP. Hysteresis changed over loading cycles in the large amplitude but not the small amplitude FSUs.

DISCUSSION: Preliminary data suggest larger amplitudes of FE, which reflect physiologic motion extremes, promote inflammation and matrix degradation in the NP and FC.

GP43

Empty

GP44

STATIC AND DYNAMIC COMPRESSIVE CHARACTERIZATION OF LUMBAR INTER-VERTEBRAL DISCS OF THE ADULT NEW ZEALAND WHITE RABBIT FOLLOWING IN VIVO DEGENERATION OR EX VIVO ANNULAR PUNCTURE

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GENERAL POSTERS

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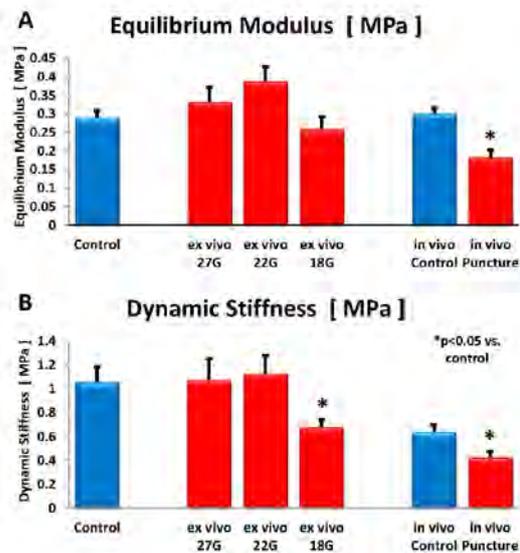
INTRODUCTION: In animal models, intervertebral disc (IVD) degeneration, induced in vivo by anular puncture, involves mechanical, biochemical, geometric, and histologic changes. The effect of anular puncture on biomechanical properties depends on defect dimensions, but has not been studied in rabbits. The objectives of this study were to investigate the biomechanical consequences of defect size made with 18-27G needles during ex vivo anular puncture and of degeneration induced in vivo by 18G anular puncture (equilibrium modulus and dynamic stiffness of lumbar IVDs) of the rabbit.

METHODS: Adult rabbits, 9-15 months, 4.5-5kg were used. Ex vivo study: Rabbits (n=10) were sacrificed and 40 bone-disc-bone units (BDB) were obtained (L1/2-L4/5). IVD thickness was determined (μ CT and 3D models) and anular puncture was performed (27, 22, 18G). In vivo study: Rabbits (n=8) were subjected to anular puncture (18G; L2/3 and L4/5) to induce IVD degeneration. After 1 month, 32 BDB segments were obtained. Biomechanics: BDB samples were tested in unconfined compression between porous platens (10 and 15% offset), allowed to stress-relax to equilibrium, then subjected to dynamic oscillations of 0.5% amplitude at 1 Hz. Equilibrium modulus and dynamic stiffness were determined.

RESULTS: Ex vivo puncture with an 18G needle, but not smaller needles, caused a decrease in dynamic IVD compressive properties without affecting IVD thickness ($p < 0.05$). In contrast, in vivo puncture led to decreases in both static and dynamic compressive properties ($p < 0.05$) and a reduction in IVD thickness ($p < 0.01$). (Fig.1A, B)

DISCUSSION: Anular puncture with an 18G needle had distinct effects on IVD ex vivo and in vivo, indicating that softening is due to both direct mechanical perturbation and response to injury in vivo. Using both static

and dynamic biomechanical tests may give greater insight into the functional changes induced by anular injury.



GP45

IN VIVO THREE-DIMENSIONAL LUMBAR KINEMATICS: DIFFERENCES BETWEEN STATIC AND DYNAMIC MEASUREMENTS

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INTRODUCTION: It is unclear how well static radiographic measurements represent lumbar kinematics during dynamic movement. The purpose of this study was to compare in vivo lumbar kinematics when assessed under static and dynamic conditions.

METHODS: Three healthy subjects (25 \pm 1yrs) consented to participate in this IRB-approved study. Three-dimensional lumbar kinematics were determined using a biplane X-ray system and a volumetric bone-model-based tracking process that has been validated in vivo to have sub-millimeter accuracy. Each subject performed a two-handed straight-legged lifting task with three weights (10, 20, 30 lbs.) while biplane radiographs were collected at 30 images per second. Biplane radiographs were also col-

lected with the subjects holding the weights stationary at approximately 45° and 60° of trunk flexion. Intervertebral flexion-extension (FE) and disc compression-distraction were compared at each vertebral level from L2 to S1 at the instants where the total L2/S1 angle determined from the dynamic trial most closely matched the total L2/S1 angle at each static position (Figure 1).

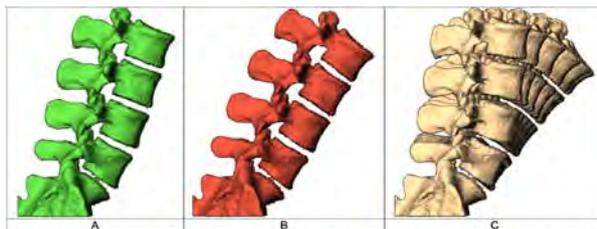


Figure 1. Three-dimensional lumbar tracking results for 45° (A) and 60° (B) of trunk flexion, and at six selected instants of the dynamic trial (C) when lifting a 20kg weight. Intervertebral flexion-extension and disc compression-distraction were compared at the instants at which the L2/S1 angle determined from the dynamic trial most closely matched the L2/S1 angle at each static position.

RESULTS: Intervertebral FE range of motion averaged $10.0 \pm 4.1^\circ$, $11.3 \pm 2.0^\circ$, $13.8 \pm 1.6^\circ$, and $14.5 \pm 3.2^\circ$ for the L2/L3, L3/L4, L4/L5 and L5/S1 motion segments, respectively. Static versus dynamic intervertebral FE differences averaged $1.0 \pm 0.5^\circ$, and these differences were not affected by weight, motion segment or trunk flexion angle. Static versus dynamic differences in disc strain averaged $6.6 \pm 5.2\%$ in the anterior annulus and $15.4 \pm 14.1\%$ in the posterior annulus, and these differences were more pronounced in more flexed positions.

DISCUSSION: The results suggest that while lumbar kinematics measured in static positions may represent dynamic kinematics sufficiently for clinical use, the small angular differences substantially affect estimates of lumbar disc deformation. Data should be collected during dynamic motion when attempting to evaluate lumbar disc stress and strain.

GP46

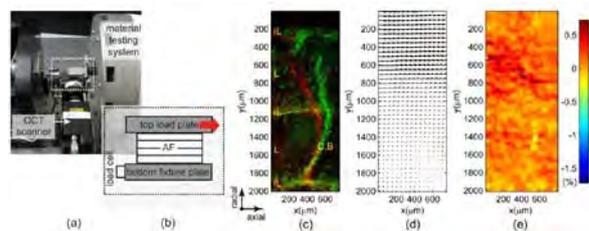
OPTICAL COHERENCE TOMOGRAPHIC ELASTOGRAPHY MEASURES INHOMOGENEOUS STRAIN IN ANNULUS FIBROSUS LOADED IN SHEAR

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INTRODUCTION: Shear stress is considered to be an important contributor health of the annulus fibrosus (AF). AF in shear mechanics has been studied, but structural interactions between lamellar and inter-lamellar/cross-bridge networks are not well understood. We utilized optical coherence tomography (OCT), which can capture AF mesostructural features, to obtain elastographic strain distributions during shear loading.

METHODS: Fresh-frozen porcine lumbar AF tissues (N=4) were subjected to shear strains of 20% and 40%. A swept-source OCT system was paired with a materials testing system to visualize a $2 \times 2 \times 1.8 \text{ mm}^3$ volume within AF samples loaded in shear (Fig. 1a-b). Using optical flow analysis, shear strain distributions were computed (Fig 1c-e). Images were then segmented to differentiate lamellar and inter-lamellar/cross-bridge strain.



RESULTS: Local AF shear strains in inter-lamellar/cross-bridge network were $4.0\% \pm 1.2$, $6.6\% \pm 2.5$ for 20 and 40% applied shear strain, respectively. Lamellar shear strains ($8.0\% \pm 3.3$, $12.3\% \pm 2.6$ at 20 and

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40% respectively) were significantly higher than those measured in the interlamellar/cross-bridge structures.

DISCUSSION: To our knowledge, this is the first study to quantify strain distributions between the lamellar and interlamellar/cross-bridge compartments of the AF. This was achievable due to the mesoscale imaging capabilities of OCT. Based on our results, it can be concluded that the two compartments behave distinctly during AF shear. Their differential mechanics might play important roles in tissue damage and cell regulation. Figure 1. (a) Custom-designed shear testing system with OCT scanner. (b) Schematic illustration of tissue loading. (c) OCT images of mesoscale structures before (red) and after (green) applying shear load. L=lamellar. IL=Interlamellar. CB=Cross-bridge. (d) Displacement vectors (arrows) obtained from optical flow analyses. (e) Strain map for the corresponding area shown in (d).

GP47

DIRECTED VERTEBROPLASTIC CEMENT INJECTION AT LYTIC METASTATIC LESION RESTORES STRENGTH WITH MINIMUM CEMENT VOLUME

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INTRODUCTION: Metastatic disease in the thoracolumbar spine represents a large and growing problem, which can lead to pain, pathologic fracture and neurologic compromise. Over the last two decades, the utilization of PMMA for percutaneous vertebral stabilization has increased. This study was conducted to examine and compare the biomechanical effectiveness of the standard

(anterior PMMA augmentation from cranial to caudal endplate) and directed vertebroplasty (VP).

METHODS: 32 specimens were harvested from 6 cadavers (T5-S1, age 74 ± 14 , BMD 0.7 ± 0.2). Each consisted of one full vertebra and 2 adjacent hemi-vertebrae (physiologic load transmission/sharing). Lytic lesions with peripedicular cortical disruption were created and filled with adipose tissue to simulate tumor bulk. Specimens were randomly distributed between 3 groups: lesion alone (control), standard VP, and directed peripedicular augmentation using a targeted system into the lytic lesion. Specimens then underwent unconstrained compression using a bilateral cable system passing through the approximate center of rotation of the vertebral body.

RESULTS: Height reduction was significantly higher in the anterior body ($p=0.003$). Mean height loss was least for the group with directed VP (Table 1). The use of directed VP demonstrated the least increase in kyphosis. Average injected cement volume for the directed VP was 49% less than the standard VP ($p<0.0005$). The injected cement to vertebral body volume ratio was lower for directed than for standard VP. Data demonstrated that cement augmentation significantly increased normalized failure stress in lumbar specimens ($p=0.04$).

Table 1: Results Summary (* statistically significant, $p<0.05$).

	Average vertebral body height loss (mm)				Average Tilt Angles Following Fracture (degrees)			
	Anterior Ipsilateral	Anterior Contralateral	Posterior Ipsilateral	Posterior Contralateral	Ipsilateral Tilt AP	Contralateral Tilt AP	Lateral Tilt Anterior	Lateral Tilt Posterior
Control	-1.1±1.6	-1.1±1.5	-0.2±1.0	-0.2±0.9	-2.6±3.4	-2.4±3.3	0.0±2.2	0.0±1.4
Standard VP	-1.0±1.5	-1.5±2.0	-0.1±1.5	-0.5±1.0	-2.6±4.4	-2.9±5.3	0.6±2.2	0.6±2.5
Directed VP	0.8±1.5	0.5±1.8	0.4±0.5	0.1±0.9	-1.3±3.5	-1.4±2.0	-0.4±1.6	0.8±1.2
	Average Injected Cement Volume (cc)		Percentage Body Fill (injected cement to body volume)		Average normalized failure stress (MPa/BMD)			
	Lumbar	Thoracic	Lumbar	Thoracic	Lumbar	Thoracic		
Control	—	—	—	—	11.54±0.5	5.0±3.8		
Standard VP	*6.4±2.1	*22.0±2.7	24.6±8.0		*3.0±2.2	5.3±2.2		
Directed VP	*3.2±0.9	*9.6±3.9	13.7±5.3		2.37±1.6	3.3±0.9		

DISCUSSION: Data suggest that an optimum threshold cement injection volume may exist, at which vertebral body strength is improved with minimum cement volume. Findings suggest that fixation by directed VP can achieve similar augmentation to standard VP with an anterior fill, while requiring roughly half the PMMA cement injection volume.

GP48

GENOME-WIDE PAIN-, NERVE- AND NEUROTROPHIN-RELATED GENE EXPRESSION IN THE DEGENERATING HUMAN ANNULUS

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INTRODUCTION: In spite of its high clinical relevance, the relationship between disc degeneration and low back pain is still poorly understood. Genome-wide gene expression studies utilizing ontology searches provide an efficient methodology for identification of clinically relevant genes.

METHODS: Ontology searches were used in a genome-wide analysis of pain-, nerve-, and neurotrophin-related gene expression patterns in specimens of human disc tissue. Control, non-herniated clinical and herniated clinical specimens of human annulus tissue was studied following IRB approval. Analyses were performed on more degenerated (Thompson grade IV and V) discs vs. less degenerated discs (grades I-III), on surgically operated discs vs. control discs, and on herniated vs. control discs; immunohistochemistry was also performed.

RESULTS: Analyses of more degenerated vs. less degenerated discs identified significant upregulation of well-recognized pain-related genes (bradykinin receptor B1, calcitonin gene-related peptide and catechol-O-methyltransferase). Nerve growth factor was significantly upregulated in surgical vs. control and in herniated vs. control discs. All three analyses also found significant changes in numerous proinflammatory cytokine- and chemokine-related genes. Nerve, neurotrophin and pain-ontology searches identified many signaling/functional genes with known disc importance. Immunohistochemistry confirmed the presence of calcitonin gene-related peptide, catechol-O-methyltrans-

ferase and bradykinin receptor B1 at the protein level.

DISCUSSION: Since the degenerating human disc is primarily an avascular tissue site into which disc cells have contributed high levels of proinflammatory cytokines, these substances are not cleared from the tissue and remain there over time. We hypothesize that as nerves grow into the human annulus, they encounter a proinflammatory cytokine-rich milieu which may sensitize nociceptors and exacerbate pain production.

GP49

MATRIX METALLOPROTEINASE-12, MACROPHAGE METALLOELASTASE, IS CONSTITUTIVELY EXPRESSED AND PRODUCED IN THE HUMAN INTERVERTEBRAL DISC IN VIVO

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INTRODUCTION: Matrix metalloproteinase-12 (MMP-12), also known as macrophage metalloelastase, degrades elastin and other extracellular matrix (ECM) components including type IV collagen, fibronectin, laminin, gelatin, vitronectin, chondroitin sulfates and fibrinogen. To date, no study has assessed the presence or gene expression of MMP-12 in the intervertebral disc. The objective of this study was to determine if MMP-12 is present in the degenerating human annulus utilizing immunohistochemistry and microarray analyses.

METHODS: IRB approval was obtained for this study. Since MMP-12 also has known relationships to cytokine and chemokines, we examined human intervertebral disc tissue expression of MMP-12 using microarray analysis in discs from 23 subjects; immunohistochemical localization studies were performed in 18 specimens.

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RESULTS: Molecular studies showed that MMP-12 exhibited a 1.45 fold significant down regulation in more degenerated discs compared to healthier discs ($p = 0.006$). Immunohistochemistry showed localization of MMP-12 in disc cells, but not disc extracellular matrix (ECM).

DISCUSSION: MMP-12 is involved with elastin degradation; the elastic extension property of the intervertebral disc is an important biologic function. From cartilage literature we know that MMP-12 can be mediated by local cytokines via a number of pathways. Here we have shown novel documentation of the expression and production of MMP-12 by cells of the human disc. Since MMP-12 has been implicated in the breakdown of numerous ECM components, including elastin, in other cells and tissues, and since MMP-12 has additional roles involving proinflammatory cytokines in other tissues, we look forward to future research which will better elucidate the role of MMP-12 in disc health and disease.

GP50

FEASIBILITY OF NP CELL ACTIVITY UPREGULATION BY HTERT GENE TRANSFECTION

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OBJECTIVE: To investigate the NP cells activity and phenotype preservation after rAAV2-hTERT transfection.

METHODS: Nucleus pulposus cells were transfected with rAAV2-hTERT at multiplicities of infection of 1×10^5 genomes per cell. The expression of hTERT mRNA and protein were assessed by RT-PCR and Western-blot at 5,10,15,30 and 60 days post-transfection; Real-time PCR and Elisa were used to test proteoglycan and type II collagen secreted

by nucleus pulposus cells, comparison analysis were performed between the test group and the control.

RESULTS: NP cells could be effectively transfected by rAAV2, positive hTERT mRNA and protein expression could be detected at 5,10,15,30 and 60days post transfection. No positive hTERT mRNA and protein expression was detected at the control group. The hTERT gene expression reached a peak at 10days post transfection and dropped slowly with increasing culturing time. RAAV2-hTERT transfection effectively upregulated the proteoglycan and type II collagen expression which was significantly higher than the control. As to the expression of type I collagen, however, no significant difference was detected between the test and control.

CONCLUSION: RAAV2-hTERT could effectively transfect NP cells and upregulate the proliferative capacity and extracellular matrix expression of NP cells cultured in vitro. This hTERT activated NP cell has the potential to be used in the biological therapy for degenerative disc disease.

GP51

INJECTION OF BUPIVACAINE INTO DISC SPACE TO DETECT PAINFUL NONUNION AFTER ALIF SURGERY IN PATIENTS WITH DISCOGENIC LOW BACK PAIN.

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INTRODUCTION: Bupivacaine is commonly used for the treatment of back pain and the diagnosis of its origin. Nonunion is sometimes observed after spinal fusion surgery; however, whether the nonunion causes pain is controversial. In the current study, we aimed to detect painful nonunion by injecting bupivacaine into the disc space of

patients with nonunion after ALIF surgery for discogenic low back pain.

METHODS: From 52 patients with low back pain, we selected 42 who showed disc degeneration at only one level (L4–L5 or L5–S1) on magnetic resonance imaging and were diagnosed by pain provocation on discography and pain relief by discoblock (the injection of bupivacaine). They underwent ALIF surgery. If the patients showed low back pain and nonunion 2 years after surgery, we injected bupivacaine into the nonunion disc space. Patients showing pain relief after injection of bupivacaine underwent additional posterior fixation using pedicle screws. These patients were followed up 2 years after the revision surgery.

RESULTS: Of the 42 patient subjects, 7 showed nonunion. Four of these did not show low back pain; however, 3 showed moderate or severe low back pain. These 3 patients showed pain reduction after injection of bupivacaine into their nonunion disc space and underwent additional posterior fixation. They showed bony union and pain relief 2 years after the revision surgery.

DISCUSSION: Injection of bupivacaine into the nonunion disc space after ALIF surgery for discogenic low back pain is useful for diagnosis of the origin of pain.

GP52

MOLECULAR INTERACTIONS BETWEEN HUMAN CARTILAGINOUS ENDPLATES AND NUCLEUS PULPOSUS CELLS: A PRELIMINARY INVESTIGATION

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INTRODUCTION: Impaired endplate permeability due to degeneration and calcification is considered to be a key contributor to intervertebral disc (IVD) degeneration. An up-regulation of metalloproteinases and inflammatory cytokines has been observed in degenerated IVDs. We hypothesize that the cartilaginous endplate (CEP) contributes to the regulation of disc matrix degradation via molecular interactions with the disc tissue.

METHODS: To identify these possible molecular interactions we analyzed in a bioassay conditioned media of cartilaginous endplates (CEP-CM) from disc degeneration patients (n=4) with regard to their influence on matrix turnover and inflammatory factors on nucleus pulposus cells (in alginate beads) of the same patient. The CEP-CM was further analyzed by protein array for inflammatory cytokines. Further CEP samples underwent histological (n=15), ultrastructural (n=8) and cell biological analysis (n=5) to determine alterations of tissue structure and differentiation potential of CEP cells.

RESULTS: NP-cells exposed to their donor-corresponding CEP-CM exhibited dose-dependent up-regulation of inflammation-factors (IL 1 β , IL-6, IL-8 – up to 400-fold), matrix metalloproteinases (MMP3, MMP13 – up to 1000-fold) and a slight decrease in matrix protein expression. Pro-inflammatory cytokines were identified in the CEP-CM. The occurrence of apoptotic cells and degraded matrix fragments as well as the differentiation capacity of CEP-derived cells varied strongly between donors.

DISCUSSION: Our results indicate interactions between the CEP and the NP tissue via molecular factors that may up-regulate matrix degrading enzymes and inflammatory cytokines and thereby influence the pathophysiology of disc degeneration. Ongoing

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investigations are necessary to further identify the regulative role of potential molecular factors that are responsible for these degenerative alterations.

ACKNOWLEDGEMENT: Funded in part by FP7-EU-Project Genodisc (HEALTH-F2-2008-201626)

GP53

SENESCENT DISC CELLS EXHIBIT SEVERELY PERTURBED MATRIX HOMEOSTASIS

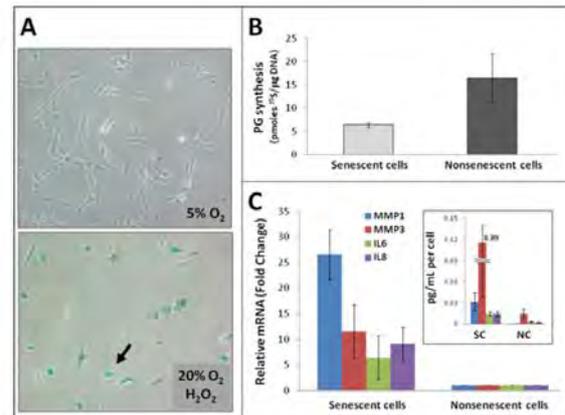
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INTRODUCTION: Age-related disc matrix proteoglycan (PG) loss is primarily a cell-driven process due to a combination of reduced PG synthesis and increased PG proteolytic breakdown. However, the disc cell population(s) with perturbed PG homeostasis has not been identified. The link between aging and senescent cells was noted in human discs, but it is still not known if senescent disc cells differ in matrix homeostasis from their non-senescent counterparts. Hence the goal of this study is to determine PG homeostatic characteristics of senescent disc cells.

METHODS: Culture of human nucleus pulposus (hNP) cells isolated from surgical specimens were induced to enter senescence by treating with 0.5mM H₂O₂ for 2 hours followed by culturing the cells for 4 days in fresh media (F-12, 10% FBS, 1% PS); the same procedure was repeated twice to induce complete senescence. Cellular senescence (SA β -gal), PG synthesis (35S-sulfate incorporation), mRNA expression (qRT-PCR) and protein levels (ELISA) of selected catabolic factors in the culture conditioned media were determined.

RESULTS: Most (>90%) of the hNP cells were stained positive for SA β -gal following H₂O₂ treatment, confirming induction of senescence. H₂O₂-induced senescent hNP

cells incorporated 6.3 ± 0.6 pmoles 35S-sulfate/ μ g DNA, about a threefold lower than that seen in untreated non-senescent hNP cells. Compared to non-senescent hNP cells, senescent hNP cells greatly up-regulated mRNA expression of MMP-1 (27X), MMP-3 (12X), IL-6 (6X) and IL-8 (9X), the protein products of which were also found in dramatically elevated levels in culture conditioned media.



DISCUSSION: Strong oxidant-induced disc senescent cells exhibited greatly perturbed matrix homeostasis, showing decreased capacity for new PG synthesis as well as enhanced expression and secretion of key inflammatory cytokines and matrix metalloproteinases, the latter may have profound catabolic effects on neighboring cells and the extracellular matrix.

GP54

PROLYL HYDROXYLASE 3 (PHD3) MODULATES CATABOLIC EFFECTS OF TUMOR NECROSIS FACTOR ALPHA ON CELLS OF THE NUCLEUS PULPOSUS THROUGH CO-ACTIVATION OF NUCLEAR FACTOR KAPPA B/P65 SIGNALING

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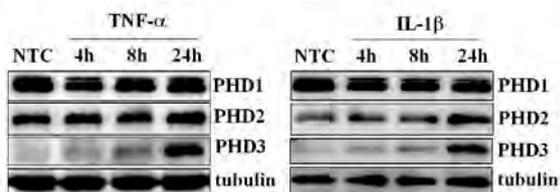
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INTRODUCTION: We have recently shown that prolyl-4-hydroxylases (PHD) 1, 2 and 3 are expressed in the nucleus pulposus (NP). However, the regulation and function of PHDs under inflammatory conditions that characterize degenerative disc disease is not yet known. The first objective of the study is to determine if expression of PHDs is regulated by TNF- α and IL-1 β through NF- κ B signaling in the NP cells. The second objective is to determine if PHDs are involved in regulation of NF- κ B signaling.

RESULTS: Real-time RT-PCR and Western blot analysis clearly show that TNF- α and IL-1 β induces PHD3 expression (Fig. 1).



Western blot analysis of PHDs expression in NP cells treated TNF- α and IL-1 β for 24 h. PHD1 expression level is not changed. The expression level of PHD2 and PHD3 is induced by both cytokines. The induction of PHD3 protein level at 24 h is striking.

Lentiviral delivery of Sh-P65 and Sh-IKK β confirms that cytokine dependent PHD3 expression is NF- κ B dependent. Next, we investigated if PHD3 participates in TNF- α dependent signaling and target gene expression. Loss of function studies clearly indicate that PHD3 serves as a co-activator of NF- κ B signaling activity in NP cells. Finally, to examine the role of PHD3 in controlling TNF- α dependent target gene expression, we transduced NP cells with lentivirus expressing ShPHD3. We observed that when PHD3 is silenced there is a significant decrease in TNF- α -induced expression of catabolic markers that include ADAMTS5,

syndecan4, MMP13 and COX2, at the same time there is restoration of aggrecan and collagen type II expression.

DISCUSSION: The experiments described in this investigation demonstrated for the first time that in NP cells, expression of PHD3 was controlled by the inflammatory cytokines TNF- α and IL-1 β . Our studies also revealed that NF- κ B controlled cytokine dependent PHD3 expression. A second major observation was that PHD3 promoted cytokine-induced NF- κ B/p65 signaling activity. These findings lend strong support to the hypothesis that PHD3 is part of regulatory circuit, with NF- κ B enhancing the impact of the inflammatory cytokines, a critical step in the pathogenesis of the degenerative disc disease.

GP55

VERTEBRAL CARTILAGE ENDPLATE LESIONS: A MORPHOLOGICAL STUDY TO EVALUATE THE EFFECTS OF OSTEOPOROSIS AND DISC DEGENERATION IN RATS

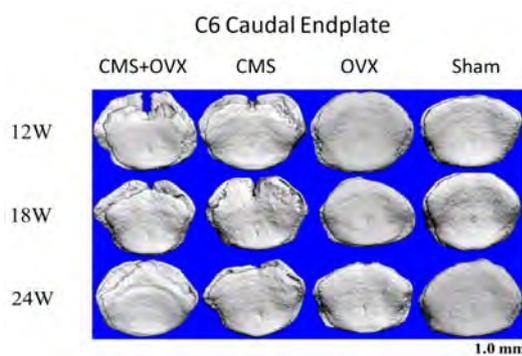
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INTRODUCTION: Osteoporosis (OP) may coexist with disc degeneration (DD) in patients, but their compound effect on the cartilage endplate lesion remains unknown. This study was to evaluate compounding effect of OP and DD on cartilage endplate lesions at 12, 18 and 24 weeks after surgeries combined ovariectomy (OVX) with cervical muscle section (CMS) in rats.

METHODS: 52 SD female rats were assigned randomly into the CMS and OVX, the CMS, OVX and Sham groups (n=14, 14, 14, 10). The C6/C7 segment and tibia were harvested at 12, 18 and 24 weeks after surgery. Specimens were scanned using micro CT and then stained. OP was evaluated by structural indices of the C6 body and the

tibial metaphyseal region. After the lesion was identified on axial CT images, ratio of the lesion area to the whole endplate area was calculated. Intervertebral disc height (IDH) was measured, and DD was graded for each sample.

RESULTS: OP occurred at 12 weeks after OVX as structural indices was dropped significantly, and became severe afterwards. Maximum lesion was on the ventral cartilage endplates at 12 weeks after CMS surgery, and was severe in the compound group (28%, $P < 0.05$) and the caudal endplate ($P > 0.05$). The lesion was shrunk and calcified in situ at 18 and 24 week. The CMS surgery resulted in a significant decrease of IDH, while the OVX added surgery led to IDH decreasing significantly at 24 weeks ($P = 0.043$). DD scores were higher following CMS or OVX surgery. DD score correlated to the lesion at 12, 18 and 24 weeks ($P < 0.01$), and IDH at 18 and 24 weeks ($P < 0.01$) respectively.



DISCUSSION: Our results suggested that disc degeneration induced cartilage endplate lesion while osteoporosis appeared to deteriorate the lesion more to the degenerating discs. The lesion may be related to cartilage endplate wearing at the early stage and calcification in situ later. The lesion and IDH were associated with the DD levels. The results imply that osteoporosis may accelerate the disc degeneration at specific time.

GP56

EXPRESSION OF THE TISSUE RENIN-ANGIOTENSIN SYSTEM IN RAT AND BOVINE INTERVERTEBRAL DISCS

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INTRODUCTION: The renin-angiotensin system (RAS) plays a vital role in regulating the physiology of the cardiovascular system. Recent studies have shown that locally produced angiotensin II (Ang II), the "tissue renin-angiotensin system (tRAS), contributed to inflammation and fibrosis in many organs. We have previously reported that tRAS was expressed by rat intervertebral disc (IVD) cells. In this study, we compared (1) the expression of tRAS by bovine (a chondrodystrophoid animal) and rat IVD cells, and (2) examined the biological role of tRAS by rat IVD cells using Ang II peptide.

METHODS: tRAS expression by rat and bovine IVD cells was examined using real-time polymerase chain reaction (PCR) (rat) and immunohistochemistry (rat and bovine). Rat annulus fibrosus (AF) cells in monolayer culture were used to examine the biological role of tRAS in vitro. The effect of Ang II peptide on extracellular matrix metabolism was assessed by real-time PCR.

RESULTS: mRNA of tRAS components, including angiotensin converting enzyme (Ang II), Ang II receptor type 1, Ang II receptor type 2, and Cathepsin D (a renin-like enzyme), were clearly confirmed by real-time PCR analysis. In AF and nucleus pulposus (NP) cells from rat and bovine in monolayer culture, immunohistochemical analysis showed that the expression of each tRAS component was clearly observed. In rat IVD tissues, immunoreactivity to each antibody for tRAS components was also observed. Proliferation of rat AF cells was mildly stimulated by Ang II peptide. Ang II peptide also had a minor stimulatory effect on the

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expression of extracellular matrix components, growth factors and catabolic proteins.

DISCUSSION: Our results demonstrate that the tRAS components necessary to activate tRAS have been found in normal rat and bovine IVD cells. To elucidate the association between tRAS and the process of IVD degeneration, the expression and function of tRAS in the human degenerated IVD should be examined in a future study.

GP57

SIGNATURE MIRNA EXPRESSION PROFILE OF SPINAL FUSION USING EQUINE BONE PROTEIN EXTRACT, RHBMP-2 AND AUTOGRAFT DURING THE PROCESS OF ANTERIOR LUMBAR INTERBODY FUSION

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INTRODUCTION: Using microarray technology and data analysis, we examined the gene-expression profiles after implantation of equine boneprotein extract, rhBMP-2 and autograft and found the different molecular mechanisms underlying the diverse patterns of histological ossification. However, the mechanisms of the epigenetic adjustment have not yet been delineated in detail.

METHODS: Eighteen pigs underwent a 3-level ALIF procedure at L3-4, L4-5, and L5-6 in the present study using equine bone protein extract, rhBMP-2 and autograft, respectively. The fused vertebral bodies of 6 animals at each time-point were observed for 2, 4, or 8 weeks post-operatively. The pooling RNA from each tissue sample analyzed by CapitalBio Corporation for miRNA microarray and Porcine Genome Array (Affymetrix) experiments. Hierarchical clustering with average linkage was carried out by Cluster 3.0. The differentially expressed genes and Micro-RNAs were performed

conjoint analysis by Gene Ontology (GO) terms and Kyoto Encyclopedia of Genes and Genomes (KEGG) pathways based on the human accession id, using MAS platform.

RESULTS: Forty eight Micro-RNAs were highlighted in comparing among equine boneprotein extract, rhBMP-2 and autograft at different time points, which regulated over 100 genes in bone regeneration. Accompanying with the down-regulations of miR-129, 140, 133, etc, the genes related to inflammatory were up-regulation, ALIF using equine bone protein extract in particular. The genes related to bone formation were increased following the decreased of miR-19, 29, 218, etc.

DISCUSSION: The rhBMP-2 recruits progenitor cells, proliferation and differentiation and then leads to preferable membranous ossification and bone remodeling. Conversely, equine bone protein extract results in endochondral ossification via upregulation of cartilage-related genes. MicroRNAs participate the bone regeneration after the transplantation of equine bone protein extract, rhBMP-2 and autograft.

GP58

CANINE NOTOCHORDAL CELL-SECRETED FACTORS PROTECT MURINE AND HUMAN NUCLEUS PULPOSUS CELLS FROM APOPTOSIS BY INHIBITION OF ACTIVATED CASPASES -9, AND -3/7

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INTRODUCTION: Effective therapies that may stop or reverse disc degeneration remain elusive. A minimally invasive method through which nucleus pulposus cell viability could be achieved would revolutionize

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the treatment of degenerative disc disease. We have investigated if non chondrodystrophic (NCD) canine disc (IVD)-derived notochordal cell conditioned medium (NCCM) and chondrodystrophic (CD) canine IVD-derived conditioned medium (CDCM) are able to protect murine and human NP cells from apoptosis.

METHODS: We developed NCCM and CDCM from hypoxic culture of freshly isolated NPs from NCD and CD canines respectively. We obtained murine NP cells from 9 different C57BL/6 mice and human NP cells from 4 patients who underwent surgery for discectomy. Cells were cultured with aDMEM/F-12 (control media), NCCM or CDCM under hypoxic conditions (3.5% O₂) and treated with IL-1 β +FasL or Etoposide. All media were supplemented with 2% fetal bovine serum. We then determined the expression of specific apoptotic pathways in the murine and human NP cells by recording caspase-8, and -9 and -3/7 activity.

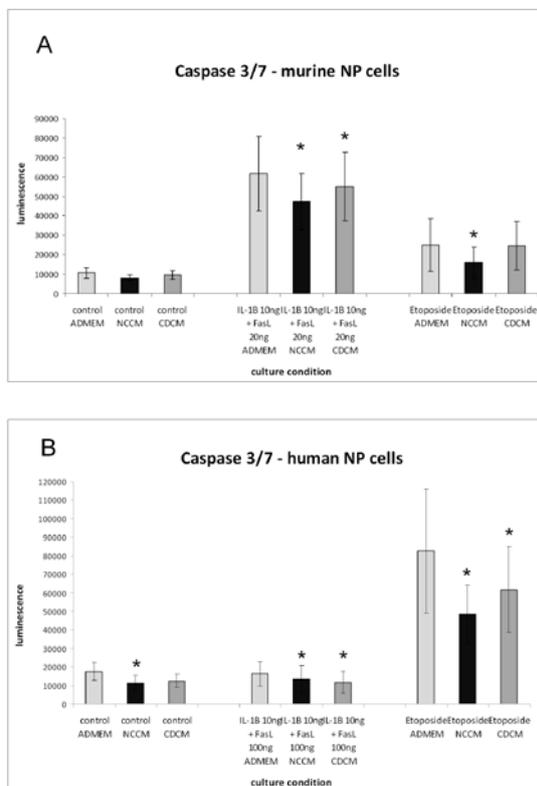


Fig. 1 – Assays for activated Caspase 3/7 for murine (A) and human (B) cells.
* = significant as compared to ADMEM in the same treatment group (control/ IL-1 β +FasL/ Etoposide)

RESULTS: In murine NP cells, NCCM inhibits

IL-1 β +FasL- and Etoposide- mediated apoptosis via suppression of activated caspase-9 and caspase-3/7, CDCM demonstrated an inhibitory effect on IL-1 β +FasL mediated apoptosis via caspase-3/7 (Fig1A).

In human NP cells, NCCM inhibits Etoposide- mediated apoptosis via suppression of activated caspase-8, caspase-9 and mainly caspase-3/7. CDCM demonstrated an inhibitory effect on Etoposide- mediated apoptosis via suppression of activated caspase-8, caspase-9 and mainly caspase-3/7, though not as effective as NCCM (Fig1B).

DISCUSSION: Soluble factors secreted by the NCD IVD NP strongly protect murine and human NP cells from induced apoptosis via suppression of activated Caspase -9 and -3/-7. A better understanding and harnessing of the restorative powers of the notochordal cell could lead to novel cellular and molecular strategies for treatment of DDD

GP59

ABILITY OF T2 MAPPING AND T1 RHO MAPPING TO EVALUATE LUMBAR INTERVERTEBRAL DISC DEGENERATION AND GLYCOSAMINOGLYCAN CONTENT OF THE NUCLEUS PULPOSUS

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INTRODUCTION: T2 mapping and T1 ρ mapping by MRI are non-invasive quantification tools to measure intervertebral disc (IVD) degeneration. MRI T2 relaxation time is a quantitative parameter that is sensitive to change in collagen and water content, and T1 ρ relaxation time reflects water and sulfated glycosaminoglycan (GAG) content in the nucleus pulposus of IVDs. The purpose of this study was: (1) to evaluate degenerative IVDs quantitatively with T2 mapping and T1 ρ mapping, (2) to analyze water and GAG content histologically, and (3) to inspect the efficacy of a quantitative imaging of the degenerated IVDs.

METHODS: Eight-week-old New Zealand White rabbits were used in this study. IVDs were punctured 10, 5, 1 or 0 (control) times with an 18-gauge needle at each level. MRI was performed 4 weeks and 8 weeks after injury and water and GAG content of the nucleus pulposus were calculated.

RESULTS: GAG content in the nucleus decreased in all the puncture groups compared with the control group. Conversely, there was no strong correlation of GAG content and the number of punctures or duration after injury. Water content was lower in the puncture groups than in the control group, and lower in the 8 weeks group than the 4 week group. T1 ρ mapping showed stronger correlation of GAG and water content than T2 mapping. GAG and water content decrease with the progression of IVD degeneration in the puncture groups.

DISCUSSION AND CONCLUSIONS: Previous studies reported that the degeneration of IVDs correlates with the number of punctures. This study shows that GAG and water content tended to decrease in early stage of IVD degeneration and that T1 ρ mapping evaluated the degenerating IVDs more accurately than T2 mapping. GAG and water content were lower in IVDs punctured once than in the control. Therefore, T2 relaxation and T1 ρ times can detect early stages of IVD degeneration. Quantitative MRI has the

potential to detect degeneration and evaluate repair and regeneration.

GP60

THE MECHANISM OF THE INFLAMMATORY RESPONSES IN THE INTERVERTEBRAL DISC HERNIATION EXPLORED BY CO-CULTURE MODEL IN VITRO

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INTRODUCTION: We have clarified that Fas ligand (FasL) is expressed on human NP cells and that the interaction between NP cells and macrophages causes the inflammatory responses which are considered to cause pains in the intervertebral disc herniation. A Disintegrin And Metalloproteinase (ADAM)10 is reported to regulate FasL cell surface expression. Therefore, we assumed that FasL and ADAM10 participate the inflammatory responses in the intervertebral disc herniation. To validate this assumption, We explored the function of FasL and ADAM10 using co-culture model in vitro.

METHODS: FasL over-expression and ADAM10 knock-down were induced by transferring FasL plasmid and ADAM10 shRNA plasmid respectively into human NP cell line using the electroporation method. Human NP cell line and macrophage (GM-CSF) cell line were co-cultured on the different surfaces of microporous membrane. After 12- and 24-hour co-culture, each cell was collected respectively. The mRNA-quantification of pro-inflammatory cytokines (IL-1 β , TNF- α , and IL-6) and ADAM10

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were estimated with the real-time RT-PCR. And the qualitative analysis of proteins of those was detected by the Western Blotting.

RESULTS: The production of all pro-inflammatory cytokines and ADAM10 increased significantly in the case of co-culture, differing from the cases of independent culture respectively. This tendency was more remarkable in the case of co-culture with FasL over-expression. On the other hand, ADAM10 knock-down induced to decrease both the expression of FasL and the production of pro-inflammatory cytokines.

DISCUSSION: It has been reported that the reverse signaling in the TNF family contributes to the production of pro-inflammatory cytokines. In our results, it seems reasonable to conclude that FasL has great possibility to regulate the production of pro-inflammatory cytokines and that ADAM10 regulates the FasL reverse signaling and participates the inflammatory responses in the intervertebral disc herniation.

GP61

CATABOLIC EFFECTS OF ENDOTHELIAL CELL-DERIVED MICROPARTICLES ON INTERVERTEBRAL DISC CELLS

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INTRODUCTION: Neo-vascularization, a prominent feature of injured and degenerated discs, requires the invasion of endothelial cells, the primary producer of microparticles (MPs). MPs, also known as microvesicles or exosomes, are 0.1 to 1 μm particles shed from cell plasma membrane

blebs in response to stimulus or stress. MPs consist of membrane and cytoplasmic sub-components along with a number of proteins and extracellular RNA characteristics of their parental cells. Emerging evidence suggest that MPs are biologic information messengers with important roles in both in pathological and non-pathological processes. Because the interaction between endothelial MPs and disc cells are likely to occur during neovascularization, the objective of this study is to evaluate the influence of the endothelial MPs on disc cells metabolism.

METHODS: Endothelial microparticles (EMPs) were isolated as described (J Cell Physiol. 2012 227:534-49) from the culture media of a microvascular endothelial cell line grown on monolayer culture for two weeks. 15 μl of 14mg/ml EMPs (total protein) were added to each well of the 6-well plate of human annulus fibrous (hAF) cell cultures, and the cultures were incubated for 3 days. Gene expression of MMP-1, MMP-2, MMP-3, MMP-13, and aggrecan were determined by qRT-PCR.

RESULTS: Increased gene expression of MMP-1, MMP-2, MMP-3 and MMP-13 were observed in EMP-treated hAF cells compared to untreated hAF cells. In contrast, aggrecan gene expression decreased in EMP-treated hAF cells compared to untreated hAF cells.

DISCUSSION: Endothelial cell microparticles promote catabolic metabolism in disc cells. If confirmed in vivo, this could represent a new mechanism by which disc extracellular matrix is degraded during the degenerative process.

GP62

THE NOTOCHORDAL CELL VIABILITY AFFECTED BY DYNAMIC MECHANICAL LOADING VIA ALPHA5/BETA1 INTEGRINS IN RAT IVDS

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INTRODUCTION: It is essential to clarify the notochordal cell (NC) viability to elucidate intervertebral disc (IVD) degeneration, but it remains unclear. The $\alpha 5\beta 1$ integrin is a transmembrane protein that mediates biologic interactions between cells and extracellular matrix. The aim of this study was to assess the NC viability affected by dynamic mechanical loading via $\alpha 5\beta 1$ integrins in rat IVDs.

METHODS: Consecutive two en-bloc coccygeal IVDs were dissected from 24 male SD rats. Discs were assigned to following conditions and cultured for 6 days using an organ culture system, Group T; with an inhibitory peptide treatment against $\alpha 5\beta 1$ integrin (GRGDSP), Group L; with mechanical loading (1.3MPa, 1Hz at initial state), Group TL; both with treatment and loading, Group C; without any treatment or loading. Cell viability analysis was examined using calcein green staining. Histomorphology was assessed by Masuda's degeneration scale. Immunopositivity of a NC marker (galectin-3) and $\alpha 5\beta 1$ integrins were evaluated by the percentage of positive cells. mRNA expressions of aggrecan, collagen type-1/-2, MMP-3/-13, and $\alpha 5\beta 1$ integrins were calculated by real-time RT-PCR.

RESULTS: Cell viability of Group L (65.9%) and Group TL (77.9%) was decreased than Group C (91.6%) in the nucleus pulposus (NP) ($P < 0.05$). Degenerative changes were mainly seen in the NP. Histological grade of Group TL was lower than Group L. Immunopositivity of galectin-3 was decreased in Group L (3.6%) and TL (30.1%) compared to Group C (81.7%) ($P < 0.05$). The % positive cells of $\alpha 5\beta 1$ integrins were sig-

nificantly 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 $\alpha 5\beta 1$ 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 $\alpha 5\beta 1$ integrin expressions in rat IVDs.

GP63

A QUANTITATIVE PROTEOMIC ANALYSIS OF THE NON-CHONDRODYSTROPHIC AND CHONDRODYSTROPHIC CANINE NUCLEUS PULPOSUS

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INTRODUCTION: The morphology of the intervertebral disc (IVD) nucleus pulposus (NP) varies dramatically between the notochordal cell-rich non-chondrodystrophic (NCD) and the notochordal cell poor chondrodystrophic (CD) canine as does their respective susceptibility to degenerative disc disease (DDD). Here we used iTRAQ quantitative proteomic analysis to determine the differential protein/peptide 'fingerprint' of the NCD and CD canine NP.

METHODS: NPs obtained from the IVDs of 8 (4 NCD and 4 CD) dogs were mechanically homogenized/centrifuged and identical aliquots of soluble proteins from the supernatant were then analyzed using 4-plex iTRAQ analysis. Proteins/peptides separated on a nano-LC column and the eluting peptides were analyzed a minimum of two times each on either a QStar Elite or the 5600 Tri-

ple TOF instrument and the subsequent MS data were then analyzed using ProteinPilot software. Proteins demonstrating consistent differential expression in either the NCD or CD samples greater than two-fold relative to the reference pool were selected for further investigation.

RESULTS: Dramatic differences in the expression of a number of important extracellular matrix-related proteins within the NPs of these two canine sub-species were detected. Significant differences in protein expression were: Fibronectin, decorin, biglycan, cartilage intermediate layer protein (CILP), cartilage oligomeric protein (COMP), fibromodulin, biglycan, and isoform B of proteoglycan-4 (lubricin) all of which were dramatically under expressed in the NCD canine NP as compared to the CD canine NP.

CONCLUSIONS: We have determined that the small leucine rich proteoglycans (SLRPs) or interstitial proteoglycans such as decorin, biglycan as well as fibromodulin were far more abundant in the CD NP homogenate as compared to the NCD canine. Degenerative changes underway in the CD as compared to the NCD NP animal may make this an ideal biological entity with which to study the biology of DDD.

GP64

LUMBAR INTERVERTEBRAL DISC INJURY IN RATS INDUCES UPREGULATION OF TRPV1 EXPRESSION IN THE SENSORY NERVE INNERVATING THE DISCS

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INTRODUCTION: Low back pain (LBP), which is caused by the sensory nerve innervating a degenerated intervertebral disc (IVD), can be induced by several inflammatory peptides. However, there is little clinical information on the effects of some inflammatory peptide inhibitors on LBP. Recent studies have shown that the capsaicin receptor TRPV1 responds to acidity, pH fluctuation, and temperature and is related to inflammation and pain. We aimed to determine the therapeutic significance of TRPV1 in cases of LBP by immunohistochemical evaluation of its levels in the sensory nerve innervating injured rat IVDs.

METHODS: 8w-old female rats were used in this study. In the disc-injury group, L5/6 discs were injured 10 times with a 24G needle; simultaneously, the neurotracer Fluoro-gold (FG) was injected into the L5/6 IVD (injured group, N=5; sham group, N=5). The L5/6 IVD and the dorsal root ganglion (DRGs) from L1 to L6 were resected at 7 days after surgery. The expression levels of TRPV1 and induction levels of the calcitonin gene-related peptide (CGRP) in the DRGs were evaluated using immunohistochemistry. Then, the rate of TRPV1-immunoreactive (IR) DRG cells among FG-labeled DRG cells and the rate of CGRP-IR DRG cells among FG-labeled DRG cells in both groups were compared statistically.

RESULTS: The rate of TRPV1-IR cells was significantly higher in the injured group (42.5%) than in the sham group (29.5%) ($p < 0.05$). Similarly, the rate of CGRP-IR cells was higher in the injured group (45.0%) than in the sham group (20.1%) ($p < 0.05$). And, the rate of TRPV1-IR cells and CGRP-IR cells were practically equal in both groups.

DISCUSSION: Disc injury in rats increased the levels of TRPV1 and CGRP in DRGs. It was reported degenerative IVDs condition related to inflammatory mediators such as acidity and pH fluctuation. These results

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suggest inflammatory mediators induce TRPV1 expression in degenerative IVDs. Thus, TRPV1 may serve as a new target for the treatment of degenerative discogenic LBP.

GP65

CERVICAL INTERVERTEBRAL DISC INJURY PRODUCES UP-REGULATION OF TRPV1 AND NEUROPEPTIDES IN SENSORY DISC-INNERVATING NERVES IN RATS

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INTRODUCTION: Cervical intervertebral discs induce obscure neck and interscapular pain. However, the detailed mechanism of discogenic cervical pain is unknown. It was recently reported that TRPV1-a capsaicin receptor-that senses acid, pH fluctuation, and temperature change in human intervertebral disc(IVD), is related to inflammatory pain. The goal of this study was to evaluate by immunohistochemistry(IHC), the up-regulation of TRPV1 calcitonin gene-related peptide(CGRP) as the inflammatory neurotransmitter innervated sensory nerve in rat cervical intervertebral injured disc.

METHODS: We used 8w-old male SDrats. In the disc-injured group, C5/6 discs were injured 10 times with a 24G needle; simultaneously, the neurotracer Fluorogold(FG) was injected into the C5/6 IVD(disc-injured groupN=5,sham groupN=5). Dorsal root ganglion(DRGs) from the C1 to C8 levels were resected 7days after surgery. Using IHC, we evaluated the DRGs with

TRPV1 and CGRP. Subsequently, the rate of TRPV1-immunoreactive(IR) DRG cells among the FG-labeled DRG cells and the rate of CGRP-IR DRG cells among the FG-labeled DRG cells were compared in each groups.

RESULTS: FG-labeled cells from C5/6IVD were bilaterally distributed from C2 to C8 DRG. The rate of TRPV1-IR cells among the FG-labeled cells was significantly higher in the disc-injured group(55.3%) than in the sham group(23.2%)($p<0.05$). Similarly, the rate of CGRP-IR cells among the FG-labeled cells was significantly higher in the disc-injured group (59.4%) than in the sham group(31.0%)($p<0.05$).

DISCUSSION: These results showed that the innervated sensory nerves from C5/6IVD were distributed from DRGs C2 to C8 and might induce discogenic cervical pain over a wide area. Furthermore, disc injury in rats increased TRPV1 and neuropeptides in DRGs. These results suggest that these inflammatory mediators from degenerative IVDs relate to the mechanism of degenerated discogenic cervical pain, and TRPV1 may play the role of a new target of one's therapy

GP66

LONGITUDINAL EVALUATION OF SCHMORL NODES, MODIC CHANGES AND RELATED LOW BACK PAIN

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INTRODUCTION: The association of MRI findings such as Schmorl nodes (SNs) and Modic changes (MCs) with low back pain is somewhat controversial. Furthermore the association between SNs and MCs is not well known. Therefore we investigated the association among SN, MCs and low back pain.

MATERIALS AND METHODS: SNs and MCs

on lumbar MRI were observed in total 135 patients between 2004-2005. Another MRI was taken on those same patients again more than 24 months later. We retrospectively reviewed their medical records and MRI to have low back pain and changes in size of SNs and type of MCs at the initial examination and final follow-up.

RESULTS: At the initial examination, SNs were observed in 335 vertebrae out of total 675 vertebrae. In these vertebrae, MCs type I were observed in 74 vertebrae (25.1%), type II were observed in 35 vertebrae (11.9%), type III were 11 vertebrae (3.7%). At the final follow-up, vertebrae increasing size of SNs were observed in 69 vertebrae (37.7%), and those decreasing size of SNs were observed in 71 vertebrae (38.8%). In the 69 vertebrae increasing size of SNs, nonexistent MCs were 37 (53.6%), MCs type I were 27 (39.1%), MCs type II were 27 (39.1%) and no MCs type III at the initial examination. In the 71 vertebrae decreasing size of SNs, nonexistent MCs were 23 (32.4%), MCs type I were 31 (43.7%), MCs type II were 12 (16.9%) and MCs type III were 5 (7.0%) at the initial examination. Ten patients were diagnosed that their low back pain were caused from SNs. All of their SNs were observed at the upper lumbar and associated with MCs type I.

DISCUSSION: It was revealed that longitudinal changes in size of SNs and type of MCs in lumbar spine were not uncommon. Although association among SNs, MCs and low back pain was still unclear, all patients who were diagnosed as SNs related low back pain had MCs type I. These MCs type I might be reflected bony edematous of vertebral body caused by SNs.

GP67

DISCOGENIC DIFFERENTIATION OF HUMAN BONE MARROW MESENCHYMAL STEM CELL USING ADENOVIRAL-HYPOXIA INDUCIBLE FACTOR-1A

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INTRODUCTION: Recently, various approaches to biological repair and regeneration of the intervertebral disc cell function are under investigation, including gene therapy, growth factor injection, cell therapy and cell-based tissue engineering. In this study, we investigate mesenchymal stem cells (MSC) isolated from human bone marrow can be induced into IVD cells using various oxygen concentration and adenovirus-hypoxic inducible factor 1 alpha construct (Ad-HIF-1a).

MATERIAL AND METHODS: The bone marrow MSCs (BMSCs) were obtained from patients' iliac crest during surgery for lumbar spinal stenosis. BMSCs were cultured in sequential change in oxygen tension and with transduction of Ad-HIF-1a. Controls were cultures with normal oxygen tension and Ad-GFP. RT-PCR was performed to detect expressions of aggrecan, type II collagen, HIF-1 α and GLUT-1 at the mRNA, western blot was used for proteoglycan synthesis.

RESULTS: BMSCs with Ad-HIF-1 α showed increased expression of aggrecan, GLUT-1 and type II collagen mRNA at 24 and 48 hours in normoxic condition compared to control. Then same cultures switched to hypoxic condition (6%) and cultured for 48 hour more. BMSCs with Ad-HIF-1 α , initially under normoxic(48hr) then hypoxic condition(48hr) demonstrated more enhanced expression of aggrecan, GLUT-1 and type II

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collagen mRNA at 96 hours compared to cultures with normoxic condition continuously. In proteoglycan synthesis, BMSCs with Ad-HIF-1 \square and sequential change in oxygen tension (normoxic then hypoxic) exhibited increased synthesis of proteoglycan compared to controls.

DISCUSSION AND CONCLUSION: Making cellular environment simulating hypoxic condition by transducing Ad-HIF-1 \square renders more discogenic phenotypical expression. Moreover BMSCs with Ad-HIF-1 \square and initial normoxic then hypoxic condition provides optimal phenotypical expression and matrix synthesis. Hence meticulous modification of oxygen related gene and oxygen tension in BMSCs might open new arena for disc engineering.

GP68

A NOVEL PHARMACOLOGICAL ACTION OF PROSTAGLANDIN E1 FOR INTERVERTEBRAL DISC DEGENERATION AND INNERVATION.

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INTRODUCTION: Degeneration of intervertebral disc (IVD) and following innervation are considered to be one of the mechanisms of developing chronic low back pain (LBP). Since the extracellular matrix in IVD mainly consists of type I and II collagen, matrix metalloproteinase (MMP)-1 is thought to play an important role for degeneration of the tissue. Nerve growth factor (NGF) expressed by IVD is known to stimulate peripheral nerves to penetrate into the degenerated tissue. Our previous work demonstrated that PGE2 inhibits MMP-1 and NGF expression in a negative feedback fashion in human IVD cells stimulated with interleukin (IL)-1. These observations prompted us to examine whether PGE1, which is clinically used in Japan, also has

similar actions.

METHODS: Isolated cells from human IVD were stimulated with IL-1 with or without PGE1 or PGE2 in the presence or absence of a selective COX-2 inhibitor (NS398). The expressions of MMP-1 and NGF were quantified by realtime-PCR. NGF production was measured by ELISA. MMP-1 production was determined by Western blotting.

RESULTS: IL-1 strongly induced both NGF and MMP-1 expressions in human IVD cells. These expressions were enhanced when the cells were stimulated in the presence of NS398 at the concentrations at which PGE2 release was substantially inhibited. The over-inductions of MMP-1 and NGF were reversed when PGE1 as well as PGE2 was supplemented to the culture.

DISCUSSION: Our previous findings revealed that PGE2 has suppressive roles for both MMP-1 and NGF expression, thereby inhibition of COX-2 activity may have limited efficacy since it cancels the suppressive action of PGE2. Although PGE1 is widely used and relieves LBP, its pharmacological action has been unknown except for peripheral vasodilation. Our findings that PGE1 inhibited MMP-1 and NGF expressions suggest that PGE1 could prevent IVD from degeneration and innervation. This would be a novel pharmacological action of PGE1 for the treatment of patients with LBP.

GP69

ELEVATED LEVELS OF INFLAMMATORY MARKERS FOLLOWING EXPOSURE TO REPETITIVE LIFTING AND MENTAL LOAD BY SUBJECTS WITH DIFFERENT PERSONALITY TRAITS

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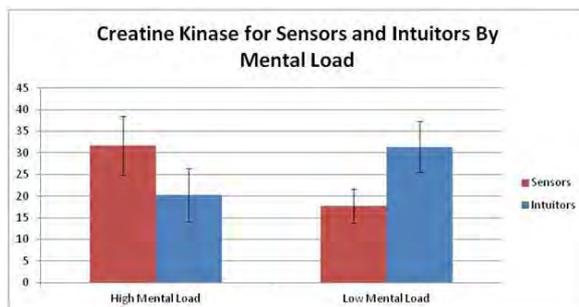
INTRODUCTION: Recent research indicates

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an inflammatory response to occupational loading of lumbar spine tissues. Mental stress has been shown to alter inflammatory responses and slow wound healing. Inflammation is the basic process the body uses to respond to cellular injury or infection so the presence and modification of an inflammatory response to occupational tasks is of concern as it may impact the development of occupationally related low back pain.

METHODS: Two groups of 10 subjects grouped by preference for sensor or intuitor personality traits performed two, two hour bouts of repetitive 6.8kg lifting combined with a high or low mental workload task separated by one week. Spinal loading was assessed using an EMG-assisted subject-specific biomechanical model and immune markers (WBC counts, Creatine Kinase (CK), Substance P (SP), TNF α , IL-1, IL-6, IL-8, IL-10, cortisol) were collected before and 0, 2 and 20 hours after exposure.

RESULTS: CK, WBC percentages, TNF α , IL-6 and IL-8 changed over time. SP levels and WBC percentages differed between sensor/intuitor preferences. Cortisol levels differed between mental load conditions. A significant interaction was found between sensor/intuitor preference and mental load for CK (figure) and SP levels.



DISCUSSION: The results suggest a well-regulated inflammatory response follows moderate occupational lifting exposure. Inflammatory markers had not returned to baseline 20 hours after exposure – corresponding to when a worker would return to

work. This creates potential for repeated inflammatory exposure before previous inflammation has resolved. Further, the inflammatory response appears to be influenced by mental load, subject personality and a mismatch between personality preferences and job task demands. The presence and modification of this inflammatory injury process has implications for workers who regularly perform repetitive lifting.

GP70

TNF-ALPHA INDUCED WNT SIGNAL IN INTERVERTEBRAL DISC CELLS.

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INTRODUCTION: Low back pain has been associated with intervertebral disc (IVD) degeneration. We previously reported that Wnt/ β -catenin (hereafter called Wnt) signal plays an essential role in the control of cell proliferation and cell senescence in IVD cells. (Hiyama et al. Arthritis and Rheum 2010). However, little is known about how upstream stimuli regulate Wnt signal in IVD cells. Elevated levels of pro-inflammatory cytokines have been reported to be present in degenerate discs including tumor necrosis factor alpha (TNF-alpha). Therefore, the major objective of the investigation in this study was to examine whether TNF-alpha regulates the Wnt signal by IVD cells.

METHODS: Nucleus pulposus (NP) cells were isolated from 11-week-old Sprague-Dawley (SD) rat lumbar discs (n=20). The expression of beta catenin messenger RNA (mRNA) and protein in rat NP cells after the treatment of TNF-alpha was assessed by using several transfection experiments, real-time PCR, western blot and immunofluores-

cence analyses.

RESULTS: Rat NP cells exhibited increased beta-catenin mRNA (1.5-fold) and protein upon stimulation with TNF-alpha compared to control cells. In addition, T-cell-specific transcription factor (TCF) promoter activity (TOPflash) was found to increase the following stimulation with TNF-alpha (10ng/ml). We analyzed the role of TNF-alpha in the regulation of aggrecan and col2. We assessed the effects of TNF-alpha on aggrecan and col2 reporter activity. The cells were cultured for 48 hours after transfection, and the reporter activity was measured thereafter. The transfected cells were treated with or without a TNF-alpha, and the reporter activity was measured. The aggrecan and col2 reporter activity was suppressed in a TNF-alpha treatment.

DISCUSSION: The present study demonstrates for the first time that in nucleus pulposus, TNF-alpha regulate Wnt signal, which plays a key role in pathogenesis of degenerative disc disease by promoting aggrecan and col2 degradation.

GP71

THE EFFECTS OF NOTOCHORDAL CELLS AND CHONDROCYTE-LIKE CELLS ON THE MORPHOLOGY OF SPINAL NERVE TISSUE: AN EXPERIMENTAL STUDY IN RATS

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INTRODUCTION: Lumbar disc herniation and sciatica are common conditions in which interactions between intervertebral discs (IVD) and neural tissue are considered to be involved in the underlying pathophys-

iology. The IVD cells, notochordal cells (NC) and chondrocyte-like cells (CHC) can, according to previous studies, affect nerve tissue, but the detailed mechanisms of such effects are incompletely known. The aim of the present study was to investigate the morphology of spinal nerve tissue exposed to the two disc cell populations and subjected to mechanical displacement and nucleus pulposus (NP) application.

METHODS: A total of 61 Sprague Dawley rats were used in this study. L4 spinal nerves were exposed to NC (25,000 cells), CHC (25,000 cells), NP (3 mg), mechanical displacement + application of NP or F12 diluent. Sham and naïve rats were used as control animals. Seven days after surgery the L4 spinal nerve with its DRG were harvested and prepared for blinded neuropathological analysis using light microscopy.

RESULTS: The rats subjected to displacement + application of NP of the spinal nerve showed more extensive nerve tissue damage as compared to all the groups without mechanical deformation of the spinal nerve.

DISCUSSION: Light microscopic examination was performed to evaluate the possible influence of the deposition of two relevant cell types derived from IVD as well as NP, F12 diluent and mechanical displacement, on the morphology of spinal nerve tissue. The results indicate that application of NC, CHC or NP, per se, did not structurally affect neural tissue compared to spinal nerves which had been mechanically displaced and subjected to application of NP. These observations support the concept that spinal nerve involvement in association with disc herniation is based on a combination of mechanical spinal nerve deformation and biological effects mediated via nucleus pulposus.

GP72

SIMILAR PATTERNS OF CELLS MIGRATING FROM NICHES IN THE INTERVERTEBRAL DISC REGION AND IN THE KNEE JOINT REGION DETECTED BY IN SITU LABELLING AN EXPERIMENTAL STUDY IN THE NEW ZEALAND WHITE RABBIT

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INTRODUCTION: Regeneration of the intervertebral disc (IVD) and articular cartilage (AC) is sparsely described. Recently, potential stem cell niches were described lateral to the epiphyseal plate in different mammal IVDs (rat, pig, rabbit,) and in knee joints, (KJ)(rabbit,) and cellular migration in the IVD region reported. The aim of the present study was to examine the direction of cellular migration from niches by in situ labeling toward/ within the IVD and compare to AC of the KJ.

METHODS: 12 rabbits were used in this in situ labelling study. Two different types of cell tracers; 10 µl iron-nanoparticles (Endorem[®], BraunMedical, Germany) or the fluorochrome compound (CDFA, Invitrogen, USA) were injected under anaesthesia, using image intensifier into niche areas of IVDs(two lumbar levels) and KJ(proximal tibia). Negative controls were naive IVDs and tibia from the same animals. Animals were sacrificed after 2-3 and 5-6 weeks. Labelled cells were visualized by the ferric-iron-staining-method (Preussian-blue-

reaction) and by confocal imaging (Laser-MAI-TAI DeepSee microscope).

RESULTS: Fe⁺ cells with elongated migratory phenotype were detected within annulus fibrosus (AF) in all injected animals (all time points)(>1200 µm from the injection site). Most Fe⁺ cells were observed in outer AF, in a few animals Fe⁺ cells were seen in middle part of AF. In the KJ, Fe⁺ cells were detected in 56% of the animals in the AC. Results were supported by confocal imaging analyses.

DISCUSSION: Detection of labeled cells in cartilaginous tissues, after in situ labeling of local cells in niche areas, indicates that cells migrate from niches toward/into cartilaginous tissues. The similar pattern of cellular migration within IVD and KJ areas suggest similar mechanisms of growth/regeneration in different types of cartilaginous tissues. Knowledge of cellular migration patterns and potential possibilities to stimulate these cells is of interest from clinical tissue engineering perspective.

GP73

DO INTERVERTEBRAL DISCS DEGENERATE BEFORE OR AFTER HERNIATION?

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INTRODUCTION: Herniated disc tissue removed at surgery usually appears degenerated, and MRI often reveals degeneration in adjacent discs and vertebrae. This has fostered the belief (which has medicolegal significance) that a disc must degenerate before it can herniate. We hypothesise that degenerative changes in herniated disc tissue differ from those found in discs that have degenerated in-situ, and are consistent with being consequences rather than

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causes of herniation.

METHODS: 21 surgically-removed herniated (extruded) discs were compared with 11 age-matched discs that had reached a similar Pfirman grade of degeneration without herniating. Histology was used to grade degenerative features separately in three tissue types: nucleus, inner annulus, and outer annulus. Immunofluorescence, using laser-scanning confocal microscopy and 30µm frozen sections, was used to quantify nerves, blood vessels, and cells positive for matrix-degrading enzymes (MMPs). Mann-Whitney U tests were used to compare 'herniated' and 'degenerated' tissues.

RESULTS: Herniated tissues had significantly greater fissuring, greater proteoglycan loss, greater infiltration by inflammatory cells, greater neovascularisation as indicated by CD31, greater innervation as indicated by PGP 9.5 and Substance P, and greater expression of MMPs 1 and 3. Differences were most marked in the outer annulus, less in the inner annulus, and not significant in the nucleus.

DISCUSSION: Herniated annulus tissue is disrupted and therefore able to swell, lose proteoglycans and allow invasion by inflammatory cells, blood vessels and nerves. These events could explain most observed differences between 'herniated' and 'degenerated' annulus. Results for nucleus tissues suggest that disc herniation (in our patients) did not occur because of accelerated nucleus degeneration. Results therefore support our hypothesis, and warn against assuming that degenerative changes must precede (or cause) disc herniation.

GP74

IN VIVO RETENTION AND BIOACTIVITY OF IL-1RA MICROSPHERES IN THE RAT CAUDAL INTERVERTEBRAL DISC

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INTRODUCTION: Inflammation plays a central role in the progression of disc degeneration. We recently demonstrated in vitro that IL-1ra delivered from poly(lactic co-glycolic acid) (PLGA) microspheres could attenuate the degradative effects of IL-1β for up to 20 days. The objectives of this in vivo study were: 1) to investigate whether PLGA microspheres could be retained in the NP, and 2) to test whether IL-1ra delivered from those microspheres could effectively inhibit IL-1β induced glycosaminoglycan loss using a rat caudal disc model.

METHODS: PLGA microspheres were fabricated using the water-oil-water double emulsion technique. For retention studies, microspheres were labeled with coumarin-6 to facilitate post-mortem localization, and injected into the caudal discs of 6 rats, euthanized at 1, 7, 14, 28 and 56 days. Microspheres were located using fluorescent microscopy. To see if microspheres could effectively inhibit IL-1β in vivo, 4 discs for each of 4 rats were allocated to: intact; saline; IL-1β; or IL-1β+IL-1ra microspheres. Rats were sacrificed at 7 days and NP GAG content was measured.

RESULTS: Release kinetics demonstrated that these microspheres could deliver a sustained dose of IL-1ra for up to 35 days. Fluorescently labeled microspheres were visible in the disc at all time points except 56 days. The GAG content of discs injected with IL-1β alone was significantly lower than that of the intact controls and the microsphere treatment group. For discs injected with both IL-1β and IL-1ra microspheres, GAG content was not different from intact controls.

DISCUSSION: Local sustained delivery of therapeutics for disc degeneration is important as the avascular nature of the disc limits the efficacy of systemic delivery, and repeated injections are impractical and may induce damage. In this study we demon-

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strated that IL-1ra delivered from microspheres prevents IL-1 β induced GAG loss in vivo, and that microspheres are retained in the disc space for 4 weeks.

GP75

M1 MACROPHAGE EXISTS IN THE NON-HERNIATED DEGENERATIVE DISC.

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INTRODUCTION: In herniated disc disease, intervertebral disc and macrophages interaction play important role not only disc absorption but also inflammatory reaction and pain. In non-herniated degenerative disc, CD68-positive cells exist. Macrophage is classified M1 macrophage (inflammation inducing) and M2 macrophage (anti-inflammatory). But CD68-positive cell's derivation (chondrocyte phenotype change or infiltrating from extra disc) and class in non-herniated degenerative disc are not still clarified. In this study, we clarified the existence of macrophages and their classification.

MATERIALS AND METHODS: 33 non-herniated degenerative 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 ($\times 400$) fields, and expressed as cells per high-power field. We compared correlation between Pfirman 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: Among 33 specimens, 32 specimens showed CD68 positive cells. CD68 positive cell were frequently observed in the

cleft of nucleus pulposus, and pore space of lamella complex and cleft in annulus fibrosus. There was no correlation between CD68 positive cells in high-power field and Pfirman MRI grading scale. M1/M2 ratio was 95.5/4.5.

DISCUSSION: Non-herniated degenerative 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.

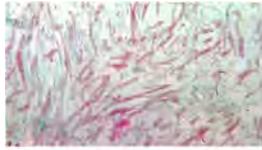
GP76

PATHOGENESIS OF OSSIFICATION OF LIGAMENTUM FLAVUM

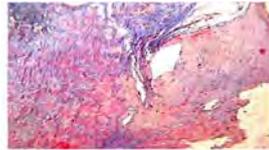
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INTRODUCTION: Ossification of ligamentum flavum (OLF) is a rare disorder. Present study aims at histopathological analysis of OLF with special emphasis on the alterations in the elastin fibers, collagen, matrix, cellularity, chondrocyte proliferation and osteoid metaplasia.

METHODS: The study involves histopathologic examination of surgically harvested ligamentum flavum (LF) specimens from 10 OLF, five with degenerative spinal stenosis and five normal LF as controls. The specimens were studied with Hematoxylin and Eosin (H&E), Verhoff's van Gieson (VvG), Toluidine blue (TB), Masons trichrome (MT) and Alcian Blue (AB). All specimens were analysed qualitatively for 1.elastic fiber orientation, integrity and loss, 2) Collagen bundles 3) Fibrosis 4) Chondroid metaplasia 5) Chondrocyte proliferation and 6) Osteoid metaplasia. The quantitative analysis was done using SCION image analysis software.



All ten OLF specimens showed extensive loss of elastic fibers associated with cartilage matrix formation.



There were many areas of irregularly oriented elastic fibers, areas of ossification and in between there was a transitional area of cartilage matrix with chondrocytes progressing towards ossification.

RESULTS: All ten OLF specimens showed extensive loss of elastic fibers associated with cartilage matrix formation. There were many areas of irregularly oriented elastic fibers, areas of ossification and in between there was a transitional area of cartilage matrix with chondrocytes progressing towards ossification.

Elastic fiber occupying ratio was 60.96%, 40.25% and 22.66%; no of Chondrocytes per mm² was 37.56, 93.35 and 117.68; area of chondroid matrix (%) was 11.34, 32.37 and 73.56 and the area of osteoid matrix (%) was 0, 9.37 and 33.43 respectively for normal controls, degenerative group and OLF group. The areas of cartilage matrix were more on the dorsal side compared to the dural side of LF. In contrast, cartilage matrix osteogenesis was more in dural than dorsal surface of LF.

CONCLUSIONS: In OLF, loss of elastic fibers was associated with proliferation of collagen fibers, fibrosis, chondrogenesis and osteogenesis. The pathological process initiates in the dorsal surface with chondroid metaplasia gradually elevating the mature cartilage matrix towards the dural surface

GP77

A NOVEL NUCLEOTOMY MODEL WITH INTACT ANULUS FIBROSUS TO TEST INTERVERTEBRAL DISC REGENERATION STRATEGIES

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INTRODUCTION: New cells/hydrogel based treatments for intervertebral disc (IVD) regeneration need to be tested on animal models before clinical translation. Ovine IVD represents a good model but doesn't allow the injection of a significant volume into intact IVD. The objective of the study was to compare different methods to create a cavity into ovine nucleus pulposus (NP) by enzymatic digestion (E), mechanical discectomy (M) and a combination of both (E+M), as a model to study IVD regeneration strategies with intact anulus fibrosus (AF).

METHODS: Ovine lumbar functional spinal units (FSU) were used. The transpedicular approach via the endplate route (2mm tunnel) was performed to access the NP with AF intact. FSUs were treated through M (Arthroscopic shaver), E (Trypsin/Collagenase) and E+M. The cavity was macro- and micro-scopically evaluated. The degradation of GAG (gel chromatography) around the cavity (inner AF) was assessed. The cavity volume was quantified through μ CT after injection of Agarose gel/Contrast agent.

RESULTS: The cavity has been successfully created using all methods. The M group showed high reproducibility, low GAG degradation and no endplate thinning compared to other groups. The histology analysis demonstrated NP matrix degradation in E groups while the proteoglycan content was still homogenous in the M. The percentage of the cavity volume normalized to the total IVD volume was $5.2\% \pm 1.6$ in E, $5\% \pm 1.4$ in E+M and $4.2\% \pm 0.1$ in M.

DISCUSSION: M represents the best method to create a reproducible and less destructive cavity in the NP. Indeed, E-based methods perform better in terms of cavity volume but the GAG of the surrounding tissue may be affected. While a lesion of the endplate might lead to further IVD degeneration, this approach is minimal invasive

(2mm) and can be easily sealed using bone cylinder, cements or scaffolds. The biomechanical characterization and in vivo evaluation are on going.

GP78

THE TRANSPEDICULAR APPROACH AS NEW ROUTE FOR INTERVERTEBRAL DISC REGENERATION

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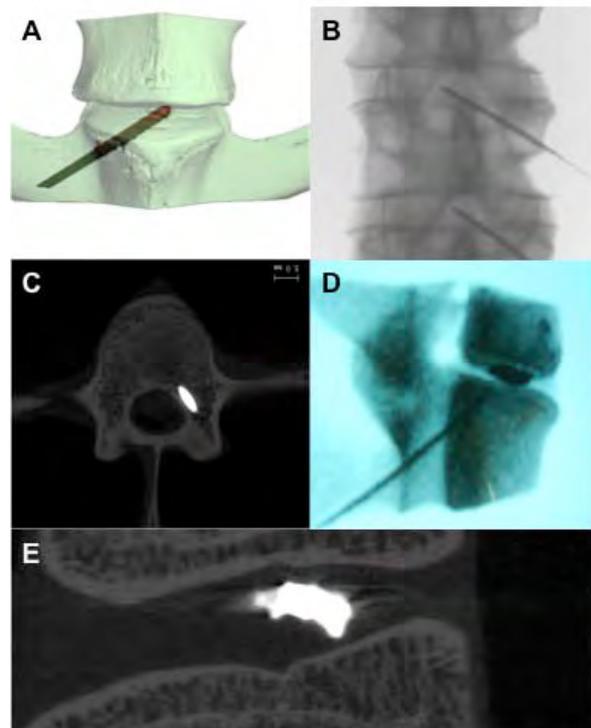
INTRODUCTION: Present delivery approaches of therapeutic agents (growth factors/cells/hydrogels) within the intervertebral disc (IVD) need to be through injection, via the annulus fibrosus (AF). However, it has been demonstrated that even a small needle puncture of the AF leads to further degeneration and disc herniation [1]. The aim of the study is to describe a novel transpedicular approach to deliver therapeutic agents into IVDs of ovine and human cadaveric spinal segments.

METHODS : Lumbar ovine and human functional spinal units (FSUs) were used. Under fluoroscopy, a 2 mm K-wire has been introduced in the caudal vertebra of FSU. The K-wire was inserted through the pedicle and the inferior endplate to the nucleus pulposus (NP). μ CT (HR-pQCT) was performed to assess the right position of the K-wire in the pedicle. Discography and nucleotomy have been performed using barium sulfate (BS) through a 16G cannula and arthroscopic shaver (2mm), respectively. Nucleoplasty was performed delivering agarose gel/BS and evaluated through μ CT. The bony tunnel was sealed with a porous polyurethane scaffold.

RESULTS: Fluoroscopy and μ CT images showed that the NP could be approached

through the pedicle and the endplate both in ovine and human spine (Fig-A/B), without affecting the spinal canal and the neural foramina (Fig-C). The BS was delivered into the IVD (Fig-D). Nucleotomy was successfully performed and the cavity filled with the gel. NP was removed from the disc by the transpedicular approach and filled with the gel (Fig-E).

DISCUSSION: The transpedicular approach represents a new route to the NP for IVD regeneration, whilst maintaining the AF intact. The injection of BS into the NP, demonstrated the feasibility of a drug/cell therapy to treat early disc degeneration (IDD) through this approach. The tunnel might be also used to perform nucleoplasty in moderate or severe stages of IDD allowing the delivery of a hydrogel/cells construct.



[1] Carragee, Spine 2009

GP79

THE ROLE OF ADVANCED GLYCATION END-PRODUCTS IN THE DEGENERATION OF THE INTERVERTEBRAL DISC

+Tang, SY(1); Morse, LJ(2); Chen, L(2); Sharan, AD(3)

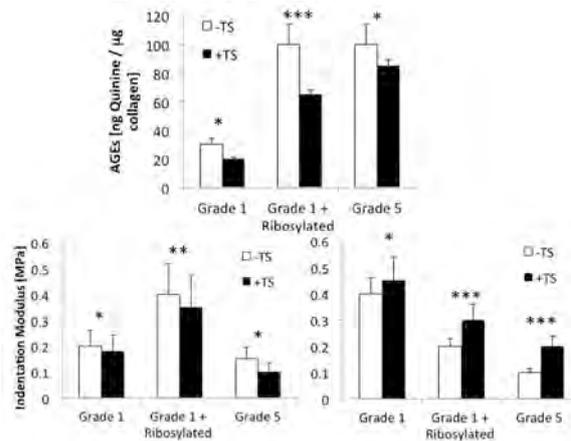
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INTRODUCTION: Intervertebral Disc (IVD) degeneration occurs with cellular & matrix changes that result in altered mechanical & cellular behavior. Advanced glycation endproducts (AGEs), the result of sugar-protein binding IVD tissue during degeneration, but its role remains unknown. AGEs may play a significant role in IVD degeneration by modifying tissue material behavior & inducing inflammation in IVD cells.

METHODS: Cadaver lumbar discs (11 donors, 56 discs) of varying Thompson grades were split into the annulus (AF) & nucleus (NP) tissues and then divided into 3 groups: control; elevated AGEs (in vitro induction); & AGEs-breaker group. Each sample was microindented to quantify the elastic & viscoelastic behavior, & then assayed for proteoglycans (PG), AGEs, collagen, & water. To determine the effects of AGEs on IVD cell inflammation cascade, primary AF & NP cells were extracted from the bovine caudal discs, cultured to confluency, & then exposed to either (BSA)-AGEs, BSA, or control media for 3 days. The gene expression of RAGE, IL-1, IL-6, NFκB, & TNFα were examined by PCR.

RESULTS: NP exhibited reduced PG, water content, & AGEs content in degeneration, while the AF had reduced PG & water content, but significant increases in collagen & AGEs. AF stiffened with degeneration, while the NP declined in viscoelasticity. The high

AGEs discs exhibited mechanical changes consistent with degeneration, & treating these discs with AGE-breakers reverted them to a healthy state. Both NP & AF cells exhibited increases in RAGE and inflammatory cytokine expression with dose-dependently with AGEs.



DISCUSSION: AGEs accounted for a significant decline in NP viscoelasticity & AF stiffening. Removal of AGEs restored the mechanical properties in these discs. Primary IVD cells increase inflammatory cytokines when exposed to AGEs. Taken together, these results demonstrate the prominent role that AGEs plays in IVD degeneration and a possible therapy for IVD degeneration.

GP80

EFFECT OF THE NON-PROTEIN BIOACTIVE COMPOUND, NEURTROPIN® ON INTERLEUKIN-1B-INDUCED EXPRESSION LEVELS OF CYTOKINES, MATRIX ENZYMES AND PAIN MARKERS IN HUMAN INTERVERTEBRAL DISC EXPLANT CULTURES

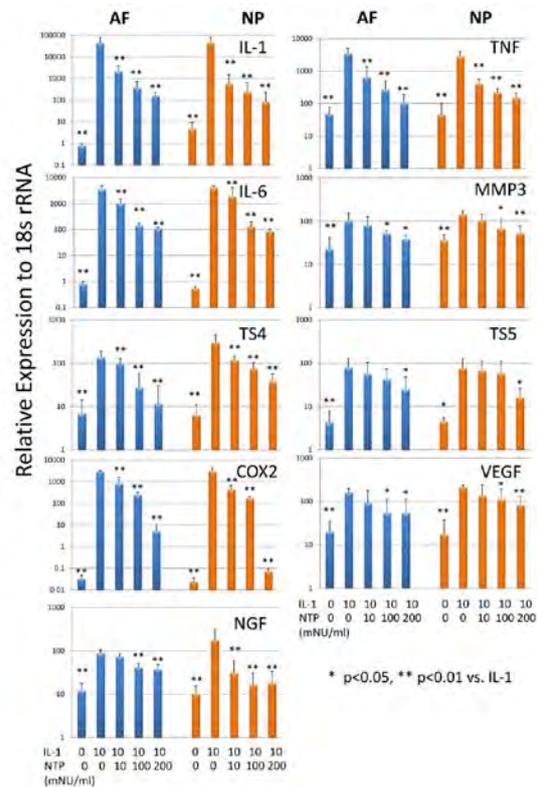
*Pichika, Rajeswari; *§Yamaguchi, Tomonori; *Fujiwara, Tatsuhiko; †Bae, Won C, *Lenz, Mary E; δNaiki, Mitsuru; *Masuda, Koichi

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INTRODUCTION: Disc degeneration increases innervation, causing low back pain. Animal model studies showed that pain correlates with increased nerve growth factor (NGF) expression. Disc injury initiates proinflammatory cytokine production resulting in hyperalgesia. Cytokines that are mediators of pain (IL-1 β /tumor necrosis factor- α (TNF- α)) are localized in degenerated discs. Treatment of chronic pain with NSAIDs, Opioids and anti-depressants has a number of side effects. Neurtropin® (NTP), a non-protein extract from inflamed skin of rabbits inoculated with vaccinia virus, is used to treat pain. NTP, shown to suppress TNF- α and cyclooxygenase-2 (COX-2) expression, stimulates proteoglycan synthesis by human and bovine intervertebral disc (IVD) cells. The purpose of this study was to determine if NTP suppresses the expression of cytokines, matrix enzymes and pain markers induced by IL-1 β in human IVD explant cultures.

METHODS: Anulus fibrosus (AF) and nucleus pulposus (NP), dissected from human cadaveric IVDs (grades 2-3; n=3, age: 53.3 \pm 8), were cultured as explants in triplicate in DMEM/F12+0.1%ITS for 24 hours then treated: 1)Control 2)IL-1 β (5ng/ml) 3) IL-1 β +NTP (10, 100 and 200mNU/ml, Nippon

Zoki Pharma, Japan) for 48hrs. Expression levels of cytokines (IL-1 β , IL-6, TNF- α), enzymes (TS4, TS5, MMP3) and pain markers (NGF, VEGF and COX-2) were analyzed.



RESULTS: NTP addition to IL-1 β -stimulated cultures significantly down-regulated expression of IL-1 β , TNF- α , IL-6, COX-2, TS4 and TS5 in a dose-dependent manner (Figure). For MMP3, NGF and VEGF, higher doses of NTP (100 and 200 mNU/ml) suppressed mRNA expression.

DISCUSSION: NTP significantly suppressed the IL-1 β -induced expression of cytokines, MMP3, TS4, TS5, NGF and COX2 by NP and AF explant cultures, suggesting that NTP may be anti-inflammatory and have beneficial effects on pain and IVD homeostasis. Further studies may prove the usefulness of intradiscal injections of NTP as a valid therapeutic approach.

GP81

CLONIDINE, AN ALPHA-2 ADRENERGIC AGONIST DECREASES CYTOKINE, MATRIX DEGRADATION AND ASSOCIATED PAIN MARKER EXPRESSION IN HUMAN INTER-VERTEBRAL DISC EXPLANT CULTURES

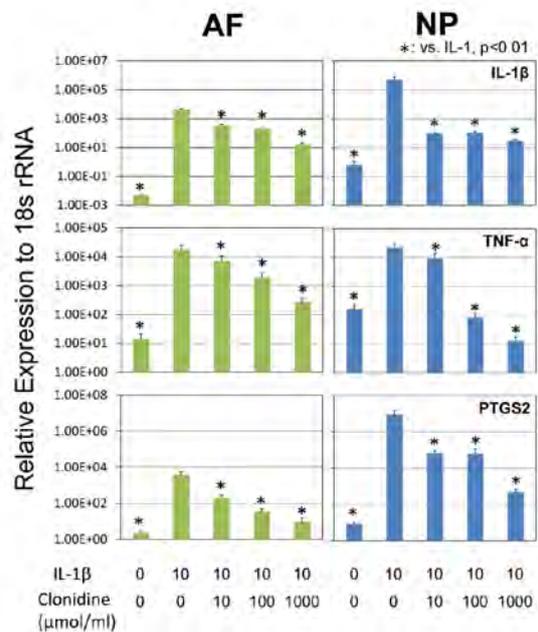
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INTRODUCTION: Treatment of chronic low back pain (LBP) in disc degenerative disease is often limited to pain alleviation and/or invasive surgical intervention. Opioids prescribed to relieve pain are associated with undesirable side effects. Clonidine has been used as a spinal analgesic in humans to treat chronic LBP. Clonidine provides neurological blockade in patients with LBP by a mechanism resulting from axonal membrane stabilization, an α_2/α_1 -agonist effect on neurons, or a combination of these two effects. The aims of the present study were to determine the direct effects of clonidine on disc tissues, specifically in suppressing the expression of cytokines, matrix-degrading enzymes, and pain markers (cyclooxygenase-2, nerve growth factor) by human intervertebral disc (IVD) explant cultures.

METHODS: Anulus fibrosus (AF) and nucleus pulposus (NP) tissues dissected from human cadaveric IVDs (n=5, age 64.2±10) were cultured as explant cultures for 24h (DMEM/F12+ITS) then treated: 1)control 2) IL-1 β (10ng/ml) 3)clonidine hydrochloride (10, 100, 1000 μ mol/ml) 4)clonidine+IL-1 for 48hrs. Nitrite (NO) and PGE2 media levels and mRNA expression of cytokines (IL-1 β , IL-

6, TNF- α), enzymes (ADAMTS4/5, MMP3) and pain markers (NGF and PTGS2) were measured.



RESULTS: IL-1 β significantly increased total NO and PGE2 release and the mRNA expression levels of cytokines, matrix enzymes and pain markers (p<0.05). Clonidine dose-dependently decreased the IL-1-induced release of nitrate and PGE2 into the media and decreased expression levels of all markers tested (p<0.05).

DISCUSSION: We demonstrated the suppressive effects of clonidine on NO and PGE2 production and mRNA expression of various cytokines, matrix-degrading enzymes and pain markers under IL-1 stimulated conditions in human IVD tissues. Our data suggest that clonidine is not simply an α_2/α_1 -agonist, but may be involved in multiple mechanisms in the pain generation associated with degenerative disc disease.

GP82

ENDPLATE ROUGHNESS IN HUMAN LUMBAR SPINES: VARIATIONS WITH AGE, LEVEL AND REGION

WC Bae, J He, I Shieh, +T Yamaguchi, +N Inoue, K Masuda

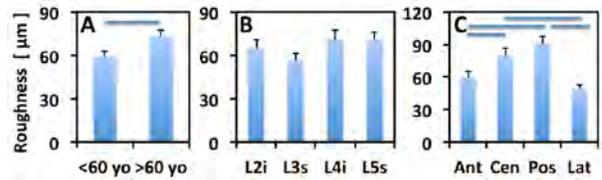
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INTRODUCTION: The cartilaginous endplates (CEP) form interfaces between the intervertebral disc (IVD) and vertebral body. Calcification of the CEP, which increases surface roughness and clogs open pores, may hinder solute transport and lead to disc degeneration. The goal of the study was to determine variations in micro-CT measure of endplate roughness with age, level, and region.

METHODS: Nine cadaveric lumbar spines were obtained and divided into two groups based on age: <60 yr (51±3 yr, 3M, 2F) and >60 yr (70±6 yr, M). Cylindrical disc-bone cores (n=173) were harvested from anterior, central, posterior and lateral regions of L2 inferior (L2i), L3 superior (L3s), L4i, and L5s. Cores were imaged using micro CT at 9 μm. Using Matlab, images were thresholded and coordinates of endplate surface were determined. Baseline contour was then subtracted to determine local surface roughness. Effects of age, level, and region on surface roughness were determined using 3-way ANOVA with posthoc test.

RESULTS: Endplate roughness varied with age group ($p<0.05$) and region ($p<0.001$), but not with level ($p=0.3$). Roughness was higher (A) in aged samples (73±41 μm) than younger samples (59±35 μm). Level-wise, roughness varied from 56 to 71 μm (B), but no differences were found. Region-wise, lateral region had the lowest roughness (49±30 μm), followed by anterior (49±30 μm), central (80±39 μm), and posterior (91±36 μm) regions (C). Both the lateral and anterior regions had significantly lower

(each $p<0.05$) roughness than the central or the posterior regions.



DISCUSSION: Higher roughness in aged samples is similar to previously reported results in human and animal endplates, and may contribute to disc degeneration in aged population. Regional variation in roughness was independent of aging and may reflect intrinsic structure. This study is limited since roughness is an indirect measure of calcification, and it is unclear if increased roughness values reflects altered transport.

GP83

INTERVERTEBRAL DISC REPAIR USING NEONATAL HUMAN DERMAL FIBROBLASTS IN THE RABBIT MODEL

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INTRODUCTION: Transplanting cells to repopulate the intervertebral disc (IVD) and to provide growth signals to resident cells may be effective in reversing disc degeneration. Human dermal fibroblasts from the patient's skin tissue or from a donor tissue may be a promising cell source. The purpose of these studies is to determine the effects of neonatal human dermal fibroblast cell (nHDF) therapy on the progression of IVD

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degeneration.

METHOD: New Zealand white rabbits (n=16) received an annular puncture using an 18-gauge needle to induced disc degeneration. nHDFs (Invitrogen) were labeled with infrared dye. Four weeks after injury, rabbit IVDs were treated with nHDFs (n=8), or saline (n=8). At two (n=2 per group) and eight weeks post-treatment (n=6 per group), animals were sacrificed. X-ray, T2 weighted magnetic resonance imaging (MRI) and infrared images were obtained. IVDs were isolated for histological, biochemical and RNA analyses.

RESULTS: The infrared images showed that nHDFs were retained in the IVD at both 2 and 8 weeks after transplantation. There was a 10% increase in the disc height index after 8 weeks of treatment with nHDFs when compared to 4 weeks after injury ($p \leq 0.05$) while there was no significant difference in the saline group. In the RNA analysis at 8 weeks after treatment, the collagen type II/collagen type I ratio, a marker for disc repair, was 1.63 in the IVDs treated with nHDFs and 1.0 in those treated with saline. There was no significant difference in the biochemical measures, MRI indices and histological scores between the two groups. However, NP cellularity in the histological grading in the nHDF treated discs were higher than the saline treated discs ($p \leq 0.05$).

DISCUSSION: After 8 weeks of treatment, nHDFs were retained in the IVD, there was some disc height recovery, NP cellularity increased, and the ratio of Collagen type II and I gene expression was favorable suggesting that nHDF is a promising cell therapy option for disc degeneration.

GP84

INTERVERTEBRAL DISC CELLS PRODUCE INTERLEUKIN-8 (IL-8) IN RESPONSE TO INFLAMMATORY STIMULI

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Markova, ‡D. Greg Anderson, MD, †Gabriella Cs-Szabo, PhD, #Sherrill L. Adams, PhD, *Howard S. An, M.D.

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INTRODUCTION: The mechanism of discogenic back pain is not well understood. A better understanding of the underlying pathophysiology for discogenic axial back pain is needed to facilitate the development of targeted therapies for this prevalent disease. We hypothesize that certain cytokines, specifically interleukin (IL)-8, in intervertebral disc (IVD) tissues from patients with discogenic back pain differ from those in non-painful disc tissues and that IL-8 can be expressed by IVD cells.

METHODS: IVD tissues from patients who underwent surgery for discogenic pain confirmed with discography (painful discs) or spinal deformity reconstruction (control discs) were collected and paired according to MRI grade. Using cytokine array analysis, cytokine levels in the painful and control discs were compared. To determine if cytokines can be expressed by IVD cells, cells were isolated from surgical and donor nucleus pulposus (NP) and annulus fibrosus (AF) tissues and stimulated with IL-1 β (10 ng/mL) or TNF- α (10 ng/mL) for 24 hours. IL-8 gene expression was analyzed using real-time PCR and IL-8 protein levels in the supernatant were analyzed using enzyme-linked immunosorbent assays.

RESULTS: Among the 42 cytokines studied, there was a trend for IL-8 levels to be elevated in patients with discogenic back pain ($p = 0.19$). IL-8 gene expression was upregulated in both NP and AF cells that were stimulated with either IL-1 β or TNF- α .

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High levels of IL-8 protein were detected in the supernatant of cells after stimulation.

DISCUSSION: We have shown, for the first time, that IL-8 is present in painful IVDs, thus providing a physiological basis for pain generation. We have shown that cultured IVD cells produce massive amounts of IL-8 in response to inflammatory stimuli (e.g., TNF- α and IL-1 β).

GP85

BIGLYCAN DOWN-REGULATES TNF-ALPHA-INDUCED PROTEASE AND CYTOKINE GENE EXPRESSION IN HUMAN INTERVERTEBRAL DISC CELLS

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INTRODUCTION: Inflammatory mediators like TNF- α (TNF) can trigger release of cytokines and enzymes to the matrix. Blood vessels and nerves can grow into compromised tissue leading to pain. We found that the concentration of biglycan (BGN) is significantly increased in IVDs of the elderly who clinically rarely experience discogenic back pain. Our goal was to determine if BGN could counteract the effect of TNF and play a protective role in IVD degeneration and pain generation.

METHODS: Annulus fibrosus (AF) and nucleus pulposus (NP) cells from 8 deceased human donors were treated with TNF (1 and 10 ng/ml) in the absence or presence of 2.2 μ g/ml BGN. NF- κ B signaling was determined by Western blots; gene expression of matrix metalloproteinases (MMP)-1, MMP-13, interleukin (IL)-8, nerve growth factor (NGF), and GAPDH by real-time PCR, and TNF receptor density by immunohistochemistry. One-way ANOVA with Tukey post-hoc

analysis was performed.

RESULTS: NP cells were more sensitive to TNF than AF cells ($p < 0.005$). NP cells had a higher density of TNF receptor (TNFR) than AF cells. TNF treatment resulted in significantly elevated levels of pNF- κ B compared to the control ($p < 0.01$), which was down-regulated by BGN. TNF significantly up-regulated the expression of MMP-1, MMP-13, NGF and IL-8 ($p < 0.05$); TNF+BGN treatment resulted in the down-regulation of these mRNA species compared to TNF alone ($p < 0.05$).

DISCUSSION: The difference in sensitivity of NP and AF cells to TNF is partly due to differences in cell-surface TNFR. TNF can upregulate NGF expression, promoting nerve ingrowth, and of IL-8, which may stimulate invading nerve endings. BGN can counteract the effect of TNF- α by reducing expression of MMPs, NGF and cytokines thus inhibiting pain generation. We propose that BGN protects against TNF, leading to reduction of matrix degeneration and inhibition of pain generation through a potential mechanism of stimulating the Erk pathway or reducing TNFR on the cell surface

GP86

THE SAFETY AND EFFICACY OF MESENCHYMAL STEM CELLS FOR PREVENTION OR REGENERATION OF INTERVERTEBRAL DISC DEGENERATION: A SYSTEMATIC REVIEW

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INTRODUCTION: Mesenchymal stem cells (MSCs) have been used to halt the progression or regenerate the disc with hopes to prevent or treat discogenic back pain. However, the safety and efficacy of the use of

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MSCs for such treatment in animal and human models at short and long term assessment (i.e. greater than 48 weeks) have not been systematically addressed. This study addressed a systematic review of comparative controlled studies addressing the use of MSCs to that of no treatment/saline for the treatment of disc degeneration.

METHODS: Online databases were extensively searched. Controlled trials in animal models and humans were eligible for inclusion. Trial design, MSC characteristics, injection method, disc assessment, outcome intervals, and complication events were assessed. Validity of each study was assessed addressing trial design. Two individuals independently addressed the aforementioned.

RESULTS: Twenty-two animal studies were included. No human comparative controlled trials were reported. All three types of MSCs (i.e. derived from bone marrow, synovial and adipose tissue) showed successful inhibition of disc degeneration progression. From three included studies, bone marrow derived MSC showed superior quality of disc repair when compared to other treatments, including TGF- β 1, NP bilaminar co-culture and axial distraction regimen. However, osteophyte development was reported in two studies as potential complication of MSC transplantation.

CONCLUSIONS: Based on animal models, the current evidence suggests that in the short-term MSC transplantation is safe and effective in halting disc degeneration; however, additional and larger studies are needed to assess the long-term regenerative effects and potential complications. Inconsistency in methodological design and outcome parameters prevent any robust conclusions. In addition, randomized controlled trials in humans are needed to assess the safety and efficacy of such therapy.

GP87

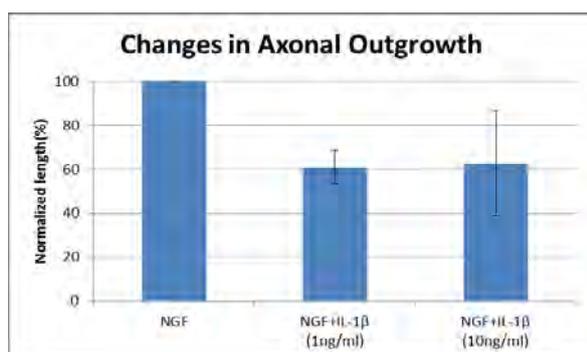
EFFECTS OF IL-1BETA ON AXONAL OUTGROWTH FROM ADULT RAT LUMBAR DORSAL ROOT GANGLIA USING A NOVEL 3D CULTURE SYSTEM

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INTRODUCTION: Increased innervation of the intervertebral disc (IVD) by neurons originating from dorsal root ganglia (DRG) has been implicated in low back pain. As a first step toward improving our understanding of interactions between disc cells and the DRG in the inflammatory environment of a degenerate disc, we developed a novel experimental system to measure axonal outgrowth of adult rat lumbar DRG neurons into collagen hydrogels, and examined the effects of IL-1 β treatment.

METHODS: Lumbar DRGs were harvested from adult Sprague-Dawley rats, bisected to expose cell bodies, and seeded onto type I collagen gels prepared in 24-well Transwell inserts. DRGs were then cultured with 0, 1, and 10 ng/ml of IL-1 β (n=3 per group) in NGF-supplemented media. After 7 days, collagen constructs with DRGs were fixed and whole mount staining for neurofilament was performed. Simple Neurite Tracer (Fiji/ImageJ) was used to measure neurite lengths from confocal image stacks. Lengths of the ten longest neurites per DRG were compared among groups.



RESULTS: Robust neurite outgrowth into collagen gels was observed in all groups. Treatment by IL-1 β significantly decreased ($p < 0.05$) neurite outgrowth by 39% (1ng/mL) and 38% (10ng/mL) compared with the NGF-only group. However, there was no significant effect of IL-1 β concentration.

DISCUSSION: This study utilized a novel 3D culture system to investigate factors governing neuronal ingrowth. Advantages of such a system include the use of physiologically-relevant adult DRGs, maintenance of native DRG microenvironment for cell bodies, and the presence of appropriate biophysical cues for neurons invading a compliant collagen matrix. We found that adult rat lumbar DRGs responded well, with NGF promoting neurite outgrowth over separate NGF-free treatments. Similar to previous studies, IL-1 β significantly decreased the lengths of growing axons. We are currently using this system to investigate the role of disc cell interaction in these processes.

GP88

NOVEL INSIGHTS INTO THE HALLMARKS OF HUMAN NUCLEUS PULPOSUS CELLS WITH PARTICULAR REFERENCE TO CELL VIABILITY, PHAGOCYtic POTENTIAL AND LONG PROCESS FORMATION

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INTRODUCTIONS: As a main cellular component within the disc, nucleus pulposus (NP) cells play important roles in disc physiology. However, little is known on the biologic hallmarks of human NP cells. Therefore, the present study aimed to address the features of human NP cells.

METHODS: Human NP samples were collected from normal donors, patients with scoliosis and disc degeneration as normal, disease control and degenerative NP, respectively. The NP samples were studied using transmission electron microscopy and TUNEL assay. Pre-digested NP samples were studied using flow cytometry with PI/Annexin V staining.

RESULTS: Both control and degenerative human NP consisted of mainly viable cells with a variety of morphology. Both necrosis and apoptosis were noted in human NP as forms of cell death with increased apoptosis in degenerative NP, which was further confirmed by the TUNEL assay. Phagocytic NP cells had the hallmarks of both stationary macrophages with lysosomes and NP cells with the endoplasmic reticulum. Annulus fibrosus cells have similar morphologic characteristics with NP cells in terms of cell nest, phagocytosis and intracellular organs. Moreover, NP cells with long processes existed in degenerative and scoliotic NP rather than normal NP. When cultured in glucose-free medium, NP cells developed long and thin processes.

DISCUSSION: Human degenerative NP consists of primarily viable cells. We present direct and in vivo evidence that both human annulus fibrosus and NP cells have phagocytic potential. Moreover, NP cells with long processes exist in both scoliotic and degenerative NP with lack of glucose as one of the possible underlying mechanisms.

GP89

EVALUATION OF NON-SPECIFIC LOW BACK PAIN USING A DETAILED VISUAL ANALOGUE SCALE FOR PATIENTS IN MOTION, STANDING AND SITTING: CHARACTERIZING NON-SPECIFIC LOW BACK PAIN IN ELDERLY PATIENTS

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INTRODUCTION: This study aimed to evaluate low back pain using a detailed visual analog scale (VAS) scoring system. Because of our clinical impression that elderly patients have low back pain while in motion and standing, but less pain when sitting, we investigated characteristics of non-specific low back pain (NSLBP) in elderly patients.

METHODS: One hundred eighty-nine patients with NSLBP were included. The patients were divided into an elderly group (≥ 65 years-old; $n=56$) and a young group (< 65 years-old, $n=133$). Low back pain was evaluated by (i) a traditional VAS scoring system (0-10 cm), (ii) the Oswestry Disability Index (ODI), and (iii) a new detailed VAS scoring system in which pain is independently evaluated in three different postural situations (in motion, standing, and sitting).

RESULTS: Mean scores for the traditional VAS and ODI for low back pain were 4.8 and 24.6 in the elderly group and 5.0 and 23.2 in the young group with no significant difference found between the groups. Mean scores for the detailed VAS for low back pain (motion, standing, and sitting) were (3.8, 3.7, and 2.8) in the elderly group, (4.4, 3.8, and 4.2) in the young group. The results showed no significant differences between

the two groups in low back pain while in motion and standing. However, the elderly group showed significantly lower VAS score for low back pain while sitting compared to the young group.

DISCUSSION: In this study, differences in characteristics of NSLBP between elderly and young patients were successfully detected by a detailed VAS scoring system. The detailed VAS revealed that elderly patients with NSLBP have significantly less pain than the young group when sitting. This minor modification of the traditional VAS may be useful for characterizing and evaluating low back pain.

GP90

LUMBAR SCOLIOSIS IN RHEUMATOID ARTHRITIS -EPIDEMIOLOGIC RESEARCH WITH A DXA COHORT-

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INTRODUCTION: The prevalence of lumbar scoliosis in the normal adult population has been reported, but that in patients with rheumatoid arthritis (RA) remains unclear. The aim of this study was to identify the prevalence of and risk factors for lumbar scoliosis in patients with RA using lumbar images obtained from dual-energy X-ray absorptiometry (DXA).

METHODS: Subjects comprised 241 patients with RA who underwent annual DXA. Cobb angles of the lumbar spine were measured by lumbar anteroposterior DXA and the prevalence of lumbar scoliosis (curvature $\geq 10^\circ$) was calculated. Correlations between lumbar scoliosis and potential risk factors (age, sex, duration of RA, T-score of lumbar spine and hip, and severity of hand deformity) were analyzed.

RESULTS AND DISCUSSION: The prevalence of lumbar scoliosis in RA patients was

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32.0%. Mean Cobb angle was $7.1 \pm 5.5^\circ$ among all subjects, compared to $13.6 \pm 4.4^\circ$ (range, 10-32 $^\circ$) among subjects with scoliosis. Subjects with scoliosis were significantly older (67.8 years) than those without (61.6 years, $p < 0.0001$). T-score of the hip was significantly smaller in subjects with scoliosis (-1.79) than in those without (-1.26, $p = 0.0005$). Multivariate logistic regression analysis revealed age as the sole risk factor for lumbar scoliotic changes in RA patients (odds ratio, 1.069; 95% confidence interval, 1.032-1.108; $p = 0.0002$). The prevalence of lumbar scoliosis in RA patients was about three- or four-times higher than prevalences from previous reports in DXA cohorts irrespective of RA. Increased age represented an independent risk factor for lumbar scoliosis in patients with RA.

GP91

COMPARISON OF IMAGE QUALITY AND RADIATION EXPOSURE FROM C-ARM FLUOROSCOPES WHEN USED FOR IMAGING THE SPINE

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INTRODUCTION: There are no previous published studies comparing mobile C-arm machines commonly used in clinical practice for imaging the spine. We sought to compare the fluoroscopic images produced by 4 different fluoroscopes for image quality and radiation exposure when used for imaging the spine.

METHODS: Anterior-posterior and lateral images of the cervical, thoracic, and lumbar spine were taken of a cadaver placed supine on a radiolucent table. The fluoroscopy units used for the study included: 1. GE OEC 9900 Elite (2010 model), 2. Philips BV Pulsera (2009 model), 3. Philips BV Pulsera (2010 model), and 4. Siemens Arcadis

Avantic (2010 model). The images were then downloaded, placed into a randomizer program, and evaluated by a group of spine surgeons and neuroradiologists independently. The reviewers, who were blinded to the fluoroscope the images were from, ranked them from best to worst using a numeric system. In addition, the images were rated according to a quality scale from 1 to 5, with a 1 representing the best image quality. The radiation exposure level for the fluoroscopy units was also compared and was based on energy emission.

RESULTS: According to the mean values for rank the following order of best to worst was observed: 1. GE OEC > 2. Philips 2010 > 3. Philips 2009 > 4. Siemens. The exact same order was found when examining the image quality ratings. When comparing the radiation exposure level difference it was observed that the OEC was the lowest, and there was a minimum 30% decrease in energy emission from the OEC versus the other C-arms studied.

DISCUSSION: This is the first time the spine image quality and radiation exposure of commonly used C-arm machines has been compared. The OEC was ranked the best, produced the best quality images, and had the least amount of radiation.

“Glenn Rechtine, M.D., Associate Chief of Staff, Department of Veterans Affairs, Bay Pines VA Healthcare System, Bay Pines, Florida.” Adjunct Professor, Departments of Surgery and Orthopaedic Surgery, University of South Florida and Department of Orthopaedic Surgery, University of Rochester. “This material is the result of work supported with resources and the use of facilities at the Bay Pines VA Healthcare System.”

“The contents of this paper do not represent the views of the Department of Veterans Affairs or the United States Government.”

GP92

STIR MRI AND SPECT BONE SCAN IN THE EVALUATION OF PAINFUL OSTEOPOROTIC VERTEBRAL FRACTURES

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INTRODUCTION: STIR MRI is the currently preferred investigation of choice in assessing suitability of vertebral body fractures for vertebroplasty. The Short T1 Inversion Recovery (STIR) offers high sensitivity for the presence of oedema. Bone scan was traditionally used in assessing suitability of osteoporotic fractures for vertebroplasty and has been shown to have a 93% positive predictive value (1). No such figures exist for STIR MRI. Our aim was to assess the relationship of the STIR MRI and Spect bone scan in these fractures.

METHOD: A prospective analysis of 36 consecutive patients with painful osteoporotic thoracolumbar fractures. Each patient had a MRI and a radionuclide spect bone scan. The MRI's and bone scans were assessed for high signal and increased uptake respectively in the vertebral body by an independent radiologist.

RESULTS: 24 female and 12 males with 53 thoracolumbar fractures were assessed. There were 33 thoracic fractures and 20 lumbar fractures. The mean age was 65 years (range 20-91). Bone scan showed increased radionuclide uptake in 41 fractures. Of these, only 24 (58.5%) demonstrated high signal change in the STIR images. In the 12 normal bone scans, 10 (83.3%) also showed no STIR high signal. Only 2 (16.7%) of the normal bone scans showed a high STIR sequence signal. STIR sequence images were normal in 27 fractures. Of these 17 (63%) had increased uptake on bone scan. When there was a high signal on STIR sequences, 24/26 (92.3%) of bone scans showed increased uptake.

DISCUSSION: Bone scan was more sensitive than STIR in detecting changes associated with painful osteoporotic fractures. It is not clear to us why STIR MRI has superseded bone scan in the assessment of these fractures. We are not aware of any literature that suggests that MRI has a better positive predictive value than a bone scan. By just relying on MRI 40% of fractures may be denied treatment.

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GP93

DEVELOPMENT OF A COMPUTER-BASED CLINICAL DECISION SUPPORT TOOL FOR SELECTING APPROPRIATE REHABILITATION INTERVENTIONS FOR INJURED WORKERS

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INTRODUCTION: Selecting the interventions that will lead to successful outcomes remains a challenging task. The purpose of our project was to develop a classification algorithm and accompanying computer-based clinical decision support tool to help categorize injured workers toward optimal rehabilitation interventions based on unique worker characteristics.

METHODS: Population-based historical cohort design. Data were extracted from a Canadian provincial workers' compensation database on all claimants undergoing work

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assessment between December 2009 and January 2011. Data were available on: 1) numerous personal, clinical, occupational, and social variables; 2) type of rehabilitation undertaken; and 3) outcomes following rehabilitation (receiving time loss benefits or undergoing repeat programs). Machine learning, concerned with the design of algorithms to discriminate between classes based on empirical data, was the foundation of our approach to build a classification system with multiple independent and dependent variables.

RESULTS: The population included 8,611 unique claimants. Subjects were predominantly employed (85%) males (64%) with diagnoses of sprain/strain (44%). Baseline clinician classification accuracy was high (ROC = 0.86) for selecting programs that lead to successful RTW. Classification performance for machine learning techniques outperformed the clinician baseline (ROC = 0.94). The final classifiers were multifactorial and included the variables: injury duration, occupation, job attachment status, work status, modified work availability, pain intensity rating, self-rated occupational disability, and 9 items from the SF-36 Health Survey.

DISCUSSIONS: The use of machine learning classification techniques appears to have resulted in classification performance better than clinician decision-making. The final algorithm has been integrated into a computer-based clinical decision support tool that requires additional validation in a clinical sample.

GP94

DOES PERFORMANCE-BASED FUNCTIONAL CAPACITY EVALUATION ENHANCE RETURN TO WORK ASSESSMENT?

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INTRODUCTION: Functional capacity evaluations (FCE) are commonly used to identify work abilities and to inform decisions about return-to-work (RTW). FCE is time-consuming and expensive compared with self-report functional assessment. We studied whether use of FCE leads to better return-to-work outcomes.

METHODS: We conducted a cluster randomized controlled trial at a rehabilitation facility. Data were collected on all claimants undergoing RTW assessment at the facility since November 2011. Twenty-six clinicians at the facility are trained and experienced in performing the WorkWell FCE protocol. These clinicians were randomized into two groups, with 14 selected to conduct a structured functional interview instead of FCE. Outcomes included recommendation following assessment (RTW or other) and functional work ability level determined (sedentary, light, medium, heavy or very heavy level).

RESULTS: Therapist groups were comparable in terms of discipline, sex, and years of experience. To date, 339 claimants have been assessed of whom 163 were tested with FCE and 176 were tested with structured interview. Claimants were predominantly job attached (79%) males (65%) with sub-acute or chronic musculoskeletal conditions. Groups were similar with the exception of a higher proportion of males in the interview group (70% versus 60%). No statistically significant difference was observed between groups in assessment outcome (52% RTW in interview group versus 47% for FCE, $p=0.38$). However, a statistically significant difference was observed on functional work ability levels (58% sed/light for the interview group versus 41% for FCE,

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p<0.001).

CONCLUSIONS: Performance testing appears to lead to higher functional work ability levels, but no difference in RTW recommendations. Whether determinations using the two methods lead to different RTW outcomes remains to be determined. Data collection is ongoing and claimants will be contacted over the following year to determine RTW status.

GP95

PRESCRIPTION OPIOIDS FOR BACK PAIN AND USE OF MEDICATIONS FOR ERECTILE DYSFUNCTION

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INTRODUCTION: Men with chronic pain may experience erectile dysfunction related to depression, smoking, age, or opioid-related hypogonadism. The prevalence of this problem in back pain populations and the relative importance of several risk factors are unknown. We sought to examine associations between use of medication for erectile dysfunction or testosterone replacement and use of opioid therapy, patient age, depression, and smoking status

METHODS: This was a cross-sectional analysis of electronic pharmacy and medical records for men with back pain in a large group model HMO during 2004. Relevant prescriptions were considered for six months before and after the index visit.

RESULTS: There were 11,327 men with a diagnosis of back pain. Men who received medications for erectile dysfunction or tes-

tosterone replacement (n = 909) were significantly older than those who did not, and had greater comorbidity, depression, smoking, and use of sedative-hypnotic medications. In logistic regressions, long-term opioid use was associated with greater use of medications for erectile dysfunction or testosterone replacement, compared to patients with no opioid use (OR 1.45, 95% CI 1.12, 1.87, p<0.01). Age, comorbidity, depression, and use of sedative-hypnotics were also independently associated with use of medications for erectile dysfunction or testosterone replacement. Patients prescribed daily opioid doses of 120 mg morphine-equivalent or more had greater use of medication for erectile dysfunction or testosterone replacement than patients without opioid use (OR 1.58, 95% CI 1.03, 2.43), even with adjustment for duration of opioid therapy.

DISCUSSION: Opioid dose and duration, as well as age, comorbidity, depression, and use of sedative-hypnotics were associated with evidence of erectile dysfunction. These findings may be important in the process of decision-making for long-term opioid use.

GP96

NOCTURNAL PAIN AND/OR PAIN IN RECUMBENCY OF CAUDA EQUINA TUMOR

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INTRODUCTION: Nocturnal pain relieved by walking and/or pain in recumbency (n-pain) is a specific clinical feature of a cauda equina tumor. However, the mechanism responsible for the pain generation is unknown. Previous reports postulated that n-pain is caused by stretching of the cauda equina with a change in body posture, whereas another report suggested that increasing pressure of CSF exerts downward

pressure on the nerve roots. To identify the mechanism responsible for n-pain, we reviewed the patients with a cauda equina tumor.

METHODS: Our series included 35 patients (24 men, 11 women, mean age 53.1 years). We classified the patients into 2 groups: 10 patients who experienced n-pain and 25 patients who had no history of n-pain. Data on the duration of symptoms, maximum occupation ratio in the subarachnoid space on MRI, and CSF blockage were investigated retrospectively. Multivariate logistic analysis was performed to identify the factors correlated with pain, including CSF blockage and occupation ratio > 70%.

RESULTS: Age did not differ significantly between the 2 groups, but the proportion of women was significantly higher in the pain group ($p < 0.05$). The mean duration from the initial symptoms to surgery was 4.0 months in the pain group, which was significantly shorter than the 15.5 months in the nonpain group ($p < 0.01$). The mean occupation ratio was 75.3% in the pain group, which was significantly higher than the 55.7% in the nonpain group ($p < 0.01$). Eight of 10 patients in the pain group and 8 of 25 in the nonpain group showed blockage of CSF ($p < 0.05$). The occupation ratio remained significant, even after adjusting for blockage of CSF.

DISCUSSION: All patients in the pain group exhibited a mobile tumor. It is difficult to understand how an unfixed tumor can stretch the cauda equina during a change in body posture. We postulate that a mobile and large tumor causes n-pain by obstructing CSF by acting in a ball-valve manner to increase the CSF pressure.

GP97

PREVALENCE AND CHARACTERISTICS OF DISK LEAKS

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INTRODUCTION: A variety of biologics and pharmaceuticals are under investigation for treatment of discogenic pain. Most of these treatments are administered by intra-discal injection. Leakage of these substances out of the disc could lead to two undesirable outcomes- a toxic effect on neural structures in the epidural space and insufficient dose delivered to the disc. The aim of this study was to quantify the risk of disk leakage.

MATERIALS AND METHODS: The records of all patients undergoing discography in a specialty spine practice over a five year period were reviewed. Each discogram was done under pressure monitoring and the pressure and volume that leaks (if present) occurred at were recorded.

RESULTS: A total of 1759 discs were injected. The prevalence of discs that leaked was 6.9%. The mean volume that a disc leaked at was 2.01 cc and the mean pressure 32 psi.

DISCUSSION: Discography is the only test that can determine whether a disc will leak on injection. The downside of a discogram is that disc puncture can initiate/worsen disc degeneration, which may interfere with the success of subsequent intra-discal treatments. These data demonstrate 1) the prevalence of leaky discs in patients undergoing discography for investigation of spinal pain is low (6.9%) and 2) among discs that do leak the average volume that can be injected is relatively high (2.01 cc). This data may allow discography to be eliminated prior to intra-discal treatments, depending on the pharmacology/toxicity of the injected substance.

GP98

INTERSPINOUS LIGAMENT LIDOCAINE AND STEROID INJECTIONS FOR THE MANAGEMENT OF BAASTRUP'S DISEASE

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INTRODUCTION: Baastrup's disease is associated with axial low back pain. Baastrup's disease has been more recently described as the "kissing spinous processes" disease. Several authors have reported methods for the diagnosis and treatment of the disease. However, there has been only one report of patients receiving interspinous ligament injections of agents for the treatment of Baastrup's disease.

MATERIALS AND METHODS: Seventeen patients showed severe low back pain between spinous processes at L3–L4 or L4–L5. X-ray imaging, CT, and MRI revealed kissing spinous processes, consolidation of spinous process, or inflammation of an interspinous ligament. Pain relief after lidocaine and dexamethasone administration into interspinous ligament as therapy for low back pain was examined and followed up.

RESULTS: Low back pain scores significantly improved immediately after injection of the agents into interspinous ligaments. At final follow-up (1.4 year), low back pain scores significantly improved compared with before treatment.

CONCLUSION: Findings from the current study indicate that lidocaine and dexamethasone administration into interspinous ligament in patients diagnosed with Baastrup's disease is effective for management of the pain associated with this disease.

GP99

PAINVISION APPARATUS IS EFFECTIVE FOR ASSESSING LOW BACK PAIN.

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INTRODUCTION: Tools developed to assess low back pain and its effect on quality of life are mostly dependent on subjective evaluation by patients in self-reported questionnaires. It is therefore difficult to compare scores between patients at different times. A newly developed device, PainVision PS-2100 (Nipro, Osaka, Japan), has been used to assess the perception of pain in a quantitative manner. In the current study, we aimed to evaluate the efficacy of PainVision for assessing low back pain.

METHODS: We assessed 89 patients with low back pain. The numeric rating scale (NRS) score, McGill Pain Questionnaire (MPQ) score, and degree of pain calculated using PainVision were measured twice at 4-week intervals in each patient. An electrode was patched on the forearm surface of the patients, and both the current for perception threshold and current at which the patient reported the same intensity as their low back pain were measured. The degree of pain was calculated automatically (degree of pain = 100 x (current producing pain comparable with low back pain - current at perception threshold/current at perception threshold)). Correlations between NRS and MPQ scores and the degree of pain were determined using Spearman's rank correla-

tion test.

RESULTS: There was a strong correlation between the NRS and MPQ scores at each time point ($r_s = 0.60$, $P < 0.0001$). The degree of pain also showed moderate correlation with NRS and MPQ scores at each time point ($r_s = 0.40$, $P < 0.03$). Change in the degree of pain over 4 weeks showed a moderate correlation with changes in NRS and in MPQ scores ($r_s = 0.40$, $P < 0.01$).

DISCUSSION: PainVision is as useful to assess low back pain as self-reported questionnaires.

GP100

THE EFFICACY OF SPINAL NERVE ROOT INFILTRATION FOR LUMBAR SPINAL CANAL STENOSIS WITH UNILATERAL RADICULAR SYMPTOMS

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OBJECTIVE: To investigate the efficacy of spinal nerve root infiltration (NRI) for unilateral radicular symptoms caused by lumbar spinal canal stenosis (LCS).

METHODS: Seventy-five consecutive cases of LCS with unilateral radicular symptoms treated by NRI were reviewed. Fifty-one patients had LCS without degenerative spondylolisthesis at the stenotic level (CS group) and 24 had LCS with spondylolisthesis (DS group). NRI was repeated upon patient request and number of treatments noted. The efficacy of NRI was investigated for at least 3 months after final NRI. The efficacy of NRI was classified into three grades as follows: excellent, pain scale 0–2 (10 being the degree of symptoms before NRI) or no need for medication; good, pain scale 3–6 or less need for medication; and poor, pain scale 7–10 or continuing need for medication. Furthermore, the efficacy of NRI in the DS and CS groups was

compared, and the relationship between the efficacy and the degree of slipping also evaluated.

RESULTS: In all 75 cases, the mean number of NRI treatments was 2.8 (range 1 to 6) and there was no relationship between treatment frequency and efficacy. For total cases, efficacy was: excellent, 40 cases (53%); good, 21 (28%); and poor, 14 (19%), 11 of which required surgical treatment. For the CS group efficacy was: excellent, 29 cases (57%); good, 17 (33%), and poor, 5 (10%). For the DS group efficacy was: excellent, 11 cases (46%); good, 4 (17%); and poor, 9 (37%). The rate of poor outcome in the DS group was significantly higher than in the CS group ($P < 0.05$) and all 9 cases of poor outcome showed more than 15% slip or disc ROM by more than 10°.

DISCUSSION: NRI was extremely effective for radicular symptoms caused by LCS, compatible with findings of previously published studies. However, efficacy in the DS group was significantly low and dependent on the degree of slipping. Therefore, the current study helps us to provide useful informed consent for patients requiring NRI.

GP101

THE TREATMENT OF NOCTURNAL LEG CRAMPS BY MEDIAL BRANCH BLOCKADE OF THE DEEP PERONEAL NERVE FOLLOWING LUMBAR SURGERY.

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INTRODUCTION: Patients with lumbar disease sometimes complain of leg cramps, even after successful lumbar spinal surgery. Effectiveness of physiological or pharmacological treatment for leg cramps has been reported. However, the use of peripheral nerve blocks has not been recognized as an

effective treatment. So, we evaluated the effectiveness of the block as a treatment for nocturnal leg cramps sustained after lumbar surgery.

METHODS: Forty-three postoperative patients underwent blockade of the medial branch of the deep peroneal nerve with 5.0 ml of lidocaine (1% solution without epinephrine), and we investigated the frequency and degree of relief every 2 weeks until 6 months after the blockade. Correlation of the effectiveness and another factors including patients' profile were also evaluated.

RESULTS: Compared with baseline before the block, the frequency of nocturnal leg cramps was reduced to less than a quarter in 60% of the patients, and reduced to less than half in 77%. The reduction of frequency of cramps was sustained for 16.8 ± 9.1 weeks in patients who had their nocturnal cramps reduced to less than half ($n=32$). The subjective severity of each cramp was reduced in 64% of patients. Patients with bilateral leg cramps demonstrated less effectiveness with the blockade. No adverse side effects were observed during the study in all patients.

DISCUSSION: Our findings demonstrate that blockade of the medial nerve branch of the peroneal nerve is an effective treatment for nocturnal leg cramps sustained after lumbar spinal surgery, which is easy to perform with low risk, and long lasting.

GP102

ASYMMETRIC MODIC TYPE 1 CHANGE AND ITS INTRADISCAL TREATMENT AMONG HIGH-CLASS ATHLETES WITH LOW BACK PAIN.

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INTRODUCTION: Modic type 1 is reported to be related to the backache and it may be related to the micro-instability of the lum-

bar segment. In the literature, there are many reports on low back pain and Modic type 1 change. However, there are only few reports of the Modic type 1 among athletes. The purpose of this paper is to review 8 cases showing Modic type 1 among high-class athletes.

METHODS: MRI was taken for athletes having chronic backache. T1-wt, T2-wt and STIR images were taken to understand the type of Modic changes. The dynamic radiographs were also taken to understand the instability. Intradiscal steroid injection was conducted to treat their low back pain due to the inflammation. Location of Modic change, clinical outcome and time course of Modic type was evaluated.

RESULTS: Total 8 athletes were diagnosed as Modic type 1 for their pain cause. All cases showed asymmetrical presentation. For 2 wrestlers, the changes are only in the anterior aspect. For 4 right-handed golfers, the change is seen at the right lateral corner of the endplate. For 1 baseball player, the site is at the right anterior corner. For remaining 1 hammer thrower, it is at the right corner. Any of them did not have the lumbar instability on the dynamic radiographs. All but one received intradiscal therapy at least once, and the chronic backache disappeared. After the treatment, with decreasing their low back pain the type was changed to type 2 or type 3, suggesting fatty marrow or sclerosis.

DISCUSSION AND CONCLUSION: Among high-class athletes, Modic change would appear without spinal instability and the change is appeared asymmetrically at the performance-specific location.

GP103

MULTI-DETECTOR CT-BASED ANALYSIS OF PELVIC INCIDENCE OF PATIENTS WITH LUMBAR SPONDYLOLYSIS

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INTRODUCTION: Lumbar spondylolysis is a stress fracture of pars interarticularis and hyperlordosis of lumbar spine is thought to be a risk factor of spondylolysis or spondylolisthesis. Pelvic incidence (PI) is an anatomical factor that is not influenced by individual position. Higher PI is associated with higher lumbar lordosis (LL).

MATERIALS AND METHODS: We analyzed 115 subjects (78 men and 37 women) with lumbar spondylolysis and 170 age- and sex-matched control subjects (110 men and 60 women) without spondylolysis. PI was measured from multi-detector computed tomographic (CT) images using 3-dimensional reconstruction. Originally modified Japanese Orthopedic Association (JOA) score, which focused on symptoms and an extent of difficulty in activity of daily living, was obtained from each control subject.

RESULTS: PI was significantly higher in subjects with spondylolysis ($51.5^\circ \pm 8.7^\circ$) compared with the control subjects ($47.6^\circ \pm 9.2^\circ$) ($p < 0.01$). In the male subjects, significantly higher PI was obtained in subjects with spondylolysis ($p < 0.01$). In the female subjects, there was no significant difference between subjects with and without spondylolysis. PI of control subjects did not correlate with modified JOA score ($r = -0.18$, $p < 0.05$)

DISCUSSION: These findings suggest that higher PI contributes to the biomechanical mechanisms of the development of lumbar spondylolysis, especially in male subjects. Based on the gender difference of the pelvic morphology, female subjects with spondylolysis may have other factors. Alt-

hough correlation between JOA score and PI was not found, subjects with greater PI tended to show lower JOA score.

GP104

MULTIMODAL ASSESSMENTS OF EFFICACY OF PHYSICAL THERAPY FOR PATIENTS WITH NEUROGENIC CLAUDICATION DUE TO LUMBAR SPINAL STENOSIS

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INTRODUCTION: It has been reported that preoperative depression status affects the postoperative outcome significantly in patients with lumbar spinal stenosis (LSS) treated with surgery. However, responders of physical therapy for patients with LSS are still unknown. The purposes of this prospective study were to examine the efficacy of physical therapy using multimodal assessments and to evaluate which patients with LSS were responders or not.

METHODS: Patients presenting with symptoms of neurogenic claudication caused by LSS (confirmed by MRI or CT) were enrolled. Patients were treated with manual therapy, stretching and strengthening exercises, and body-weight-supported treadmill walking once a week for 6 weeks. Clinical outcomes were measured using the Zurich Claudication Questionnaire (ZCQ); a visual analog scale of low back pain, leg pain, and leg numbness; the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire; the Pain Catastrophizing Scale; the Pain Anxiety Symptoms Scale; the Hospital Anxiety and Depression Scale; the Self-Rating Questionnaire for Depression (SRQ-D); and a Biodex isokinetic dynamometer. Accord-

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ing to Stucki's criteria for the satisfaction scores of the ZCQ subscales, patients were divided into the effective group (Group I) and the ineffective group (Group II). The characteristics of those patients with LSS who can obtain satisfactory results with our physical therapy programs were clarified.

RESULTS: Groups I and II had 22 and 12 patients, respectively. There were no differences in the demographic data and MRI findings between the two groups. At baseline, however, there was a significant difference in the SRQ-D (Group I, 7.1 points vs. Group II, 10.8 points).



Figure. The active straight leg raising (ASLR) test was considered to be positive if the subjects have lumbopelvic pain or discomfort (LPD) when they raised their heel 5cm above the bed and their LPD was alleviated when we press the transversus abdominis muscle (TAM) at the level of the anterior superior iliac spine.

DISCUSSION: Depressive symptoms interfere with the ability of patients to obtain an optimal physical therapy outcome. Our results suggest that assessments of depression are needed to improve the clinical outcomes of physical therapy for patients with LSS.

GP105

NEUROPROTECTIVE EFFECT OF HYPOTHERMIA FOLLOWING SPINAL CORD INJURY IN RATS- COMPARATIVE STUDY BETWEEN EPIDURAL AND SYSTEMIC HYPOTHERMIA-

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INTRODUCTION: Experimental moderate epidural hypothermia (MEH) or moderate systemic hypothermia (MSH) has been attempted for neuroprotection after ischemic

or traumatic spinal cord injury (SCI). However, there are no comparative study on neuroprotective effect of MEH and MSH following SCI. If hypothermia is to be considered as one modality for treating SCI, further studies on the advantages and disadvantages of hypothermia will be mandatory. This study was designed to compare neuroprotective effect of hypothermia between MEH and MSH following SCI.

METHODS: A spinal cord contusion was produced in all 32 rats, and these rats were randomly divided into 4 groups, 8 rats each group; (1) the control group (spinal cord contusion only), (2) the methylprednisolone (MP) group, (3) the MEH group (28°C for 48 hours), (4) the MSH group (32°C for 48 hours). The functional recovery was assessed using BBB scale and anti-apoptotic and anti-inflammatory effect were assessed.

RESULTS: The BBB scales in both the hypothermia groups were significantly higher than that of the control group at 6 weeks. The numbers of TUNEL-positive cells and OX-42 positive cells were significantly lower in both the MEH and the MSH groups compared to that of the control group. The p38 MAPK expression of the treated groups was significantly lower than that of the control group. The expression of caspase-8 and caspase-9 significantly decreased in the treated groups compared with that of the control group. However, in terms of caspase-3, only the MSH group has shown to be significantly lower than that of the control group.

CONCLUSION: This study presented that both systemic and epidural hypothermia demonstrated neuroprotective effects following spinal cord injury. Systemic hypothermia showed more neuroprotective effect by anti-apoptotic and anti-inflammatory effects.

GP106

RISK FACTORS AFFECTING PROGRESSIVE COLLAPSE OF ACUTE OSTEOPOROTIC SPINAL FRACTURE.

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INTRODUCTION: This study was designed to investigate the clinical and radiological risk factors related to progressive collapse of acute osteoporotic spinal fractures (OSF).

METHODS: In total, 100 patients with acute OSF were prospectively enrolled at a single institute. Five pathological fractures were excluded. Twelve patients dropped out of the study because of conversion to surgical treatment during follow-up. Eight patients were excluded as follow-up losses. Thus, 75 patients were analyzed. Clinical data and radiological data were recorded and analyzed. As a definition of progressive OSF, height loss $\geq 15\%$, kyphotic angle $\geq 10^\circ$ and the occurrence of an intravertebral cleft sign at the 6 month follow-up compared to the initial values were adopted. Correlation analysis and multiple logistic regression analyses were performed to elucidate the related clinical or radiological factors for progressive OSF.

RESULTS: The occurrence of intravertebral cleft was not related to any significant differences in the clinical results, and was only related to the fracture level in the regression analysis. A $\geq 15\%$ increase in height loss and a $\geq 10^\circ$ increase in kyphotic angle were related to worse clinical results. Mid-portion type fractures and involvement of the posterior wall were significant risk factors with relatively high odds ratios for progressive OSF under these criteria.

CONCLUSION: During the 6-month follow-up of conservative treatment for acute OSF, mid-portion type fracture, involvement of the posterior wall and the thoracolumbar area were predictive factors with relatively

high ORs for progressive collapse. These findings should be considered when treating patients with acute OSF. And more attention should be paid to patients with OSF and these risk factors during conservative management.

GP107

CLASSIFICATION FOR FORAMINAL STENOSIS ON A SAGITTAL MRI

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INTRODUCTION: Foraminal stenosis of the lumbar spine can cause lower limb pain. However, it requires endeavor to diagnose foraminal stenosis on MRI, because the compression to the spinal nerve is sometimes invisible on 2-dimensional images. The purpose of the present study was to classify the shapes of foramen on the sagittal MRI, and to apply the classification for the diagnosis.

METHODS: Patients who underwent lumbar spine surgery were investigated by electromyography, nerve-conduction studies, neurological findings, and spinal nerve infiltration to detect foraminal stenosis ($n = 203$). The shapes of the 2030 foramen were classified into 4 groups; the foraminal space below the caudal edge of the vertebra is remained (type 1); the space is totally occupied with disc below the caudal edge of the vertebra (type 2); the space is occupied with disc above the cranial edge of the disc (type 3); and the space is filled with the disc (type 4). The relation between the types and foraminal stenosis was studied.

RESULTS: On the sagittal MRI, 1927 foramen were classified into type 1, 58 into type 2, 40 into type 3, and 5 into type 4. Patients who were diagnosed as foraminal stenosis

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were 2 (0.1%) in type 1, 9 (16%) in type 2, 11 (28%) in type 3, and 5 (100%) in type 4. On the L5/S foramen, 7 of the 19 foramen (37%) were diagnosed as stenosis in type 2, and 6 of 12 (50%) in type 3. L5/S foraminal stenosis of type 2 tended to trigger radiculopathy compared with the others ($p < 0.05$).

DISCUSSION: Electromyography, nerve-conduction studies, neurological findings, and spinal nerve infiltration were performed to detect foraminal stenosis. These methods are useful but not suitable for the screening. Our results showed that 36% of patients in type 3 or 4 had foraminal stenosis symptoms. Furthermore, 65% had symptoms in type 3 or 4 at the L5/S. Sagittal MRI can be a convenient examination to pick foraminal stenosis.

GP108

IMPACT OF MUSCULAR TIGHTNESS ON LUMBAR SPONDYLOLYSIS IN ADOLESCENT ATHLETES

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INTRODUCTION: There have been few studies concerning the muscular tightness in lumbar spondylolysis (LS) in adolescent athletes. The purpose of this study was to investigate the impact of muscular tightness on LS in adolescent athletes.

METHODS: Approval of this hospital's ethics committee and informed consent to inclusion in this study from 83 adolescent athletes were obtained. Forty-six adolescent athletes with LS according to plain radiographs or MRI (S group) and 37 adolescent athletes without previous low back pain (C group) were included in this study. The flexibilities of the legs were evaluated as follows: (Fig.). The positive ratios of the TM and OB, the mean values of the right and left HBDs, SLAs, and HROMs were compared

between the S and C groups. Univariate analyses were performed using the χ^2 test for categorical variables and the Mann-Whitney U test for continuous variables. The odds ratios for significant variables and the 95% confidence intervals were calculated by multivariate logistic regression analysis.

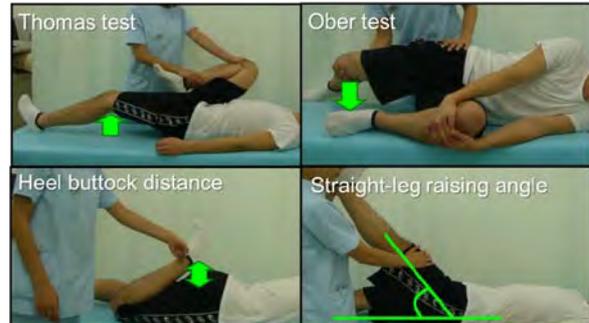


Figure. The flexibilities of the legs were evaluated with use of the Thomas test (TM) concerning the iliopsoas muscle, Ober test (OB) concerning the tensor fasciae latae muscle (TFL), heel buttock distance (HBD) concerning the rectus femoris muscle (RF), straight-leg raising angle (SLA) concerning the hamstrings, and the ranges of motion of the hip joints (HROM).

RESULTS: The positive ratios of the TM and OB in the S group (TM:81.3%, OB:83.3%) were significantly higher than those in the C group (TM:58.3%, OB:20.8%). The HBD in the S group (mean, 5.4cm) were significantly larger than that in the C group (mean, 2.4cm). However, there were no significant differences between S and C groups concerning the SLA and HROM. Multivariate logistic regression analysis showed that OB ($P=0.001$, odds ratio=12.9) and HBD ($P=0.038$, odds ratio=1.29) were the important factors of LS.

DISCUSSION: The results indicated that the high positive ratio of OB and large HBD were significantly associated with the LS in adolescent athletes. It has been reported that lumbar lordosis and pelvic tilt, which were caused by TFL and RF tightnesses, were risk factors of LS. These findings suggest that TFL and RF tightnesses may be a cause of LS in adolescent athletes.

GP109

A STUDY ON PATHOGENESIS OF LUMBAR SPONDYLOLYSIS USING MRI FINDINGS

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INTRODUCTION/AIM: Spondylolysis is thought as a stress fracture of the pars interarticularis (pars). However, there are still a lot of unknown factors affecting on its pathogenesis. In this study, to elucidate it, we evaluated MRI in patients with very early- and early-stage spondylolysis and analyzed the localization of the signal changes.

METHODS: A total of 28 patients (5 women and 25 men) with very early- or early-stage lumbar spondylolysis were included in this study. Mean age was 14.1 (10 to 17) years. We analyzed the localizations of MRI high signal change (HSC) around pedicle adjacent to the pars using both sagittal and axial views of T2- and STIR-weighted images. We divided the localizations of HSC into the following three zones (Zone1: pedicle-interarticularis, Zone 2: interarticularis-spinous process, Zone 3: extraosseous).

RESULTS AND DISCUSSION: HSCs were detected bilaterally in 18 vertebrae and 13 vertebrae. A total of 49 HSCs were analyzed. Thirty-one HSCs (63.3%) were found in only Zone 1, five HSCs (10.2%) were found in Zone 1 & 2, and seven HSCs (14.3%) were found in Zone 1 & 3. Six HSCs (12.2%) were found in Zone 1 & 2& 3.

Basically, MRI bone marrow changes on stress fracture of long bone shows signal changes in both proximal and distal sites across the fracture site, and sometimes in extraosseous region. In this study, more than half HSCs (63.3%) were localized in only one side across the fracture site (pars). This result suggests that lumbar spondylolysis is not a common stress frac-

ture. Also, a total of 13 HSCs (26.5%) including extraosseous region were found. In the past, Sairyo, et al. reported the extraosseous HSC and it causes radiculopathy, indicating hematoma in the vicinity of the fracture site. From the results of this study, spondylolysis is thought as an uncommon stress fracture.

GP110

PAINVISION APPARATUS IS EFFECTIVE FOR ASSESSING LEG PAIN AND NUMBNESS ORIGINATED FROM LUMBAR DISEASE.

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INTRODUCTION: Tools developed to assess low back / leg pain and its effect on quality of life are mostly dependent on subjective evaluation by patients in self-reported questionnaires. It is therefore difficult to compare scores between patients at different times. A newly developed device, PainVision PS-2100 (Nipro, Osaka, Japan), has been used to assess the perception of pain and numbness in a quantitative manner. In the current study, we aimed to evaluate the efficacy of PainVision for assessing leg pain and numbness originated from lumbar disease.

METHODS: We assessed 39 patients with leg pain and numbness originated from lumbar spinal stenosis. The numeric rating scale (NRS) score, Roland-Morris Disability Questionnaire (RDQ) score, and degree of pain and numbness calculated using PainVision were measured twice at 4-week intervals in each patient. An electrode was patched on the forearm surface of the patients, and both the current for perception threshold and current at which the patient reported the same intensity as their leg pain and numbness were measured. The degree

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of pain and numbness was calculated automatically (degree of pain and numbness = $100 \times (\text{current producing pain and numbness} - \text{current at perception threshold}) / \text{current at perception threshold}$). Correlations between NRS and RDQ scores and the degree of pain and numbness were determined using Spearman's rank correlation test.

RESULTS: There was a strong correlation between the NRS and RDQ scores at each time point ($r_s = 0.40$, $P < 0.05$). The degree of pain and numbness also showed moderate correlation with NRS and RDQ scores at each time point ($r_s = 0.40$, $P < 0.05$). Change in the degree of pain and numbness over 4 weeks showed a moderate correlation with changes in NRS and in RDQ scores ($r_s = 0.50$, $P < 0.01$).

DISCUSSION: PainVision is as useful to assess pain and numbness originated from lumbar spinal stenosis as self-reported questionnaires.

GP111

LACK OF VALUE IN SCREENING FOR FEAR OF MOVEMENT VIA THE TAMPA SCALE FOR KINESIOPHOBIA

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INTRODUCTION: The purpose of this study was to assess the role of baseline screening for fear of movement and pain-related fear - Tampa Scale for Kinesiophobia (TSK) - in a cohort of low back pain (LBP) patients completing active exercise-based treatment.

METHODS: This was a prospective study of LBP cases ($n=416$) treated at four spine care rehabilitation clinics in New Zealand between January 2008 and October 2012. In addition to baseline data on pain, function,

sociodemographics, all patients completed a Tampa Scale for Kinesiophobia (TSK). All patients had mechanical LBP with no neurology, as determined by the Saskatchewan Spine Pathway triage methodology.

RESULTS: The mean age of the cohort was 39.9 years ($SD=11.3$, range=18-69) with 63.7% males. The median symptom duration was 173 days (29% acute, 71% chronic). The average overall TSK score was 40.8 ($SD=9.03$, range 6-70). There were no baseline statistically significant differences in TSK scores based on dominant pain location, medication use, constancy, work status, presence of sleeping difficulties, symptom duration, smoking status, legal consultation or pain classification. Males had significantly higher scores than females (41.9 v 38.6) ($p=0.001$). There was no correlation between TSK scores and age or baseline function. For clinical outcomes, there was no correlation between TSK scores and number of days in treatment, change in numerical pain rating or functional improvement. There were no statistically significant differences in TSK scores based on global pain rating or return to work status.

DISCUSSION: The presence of pain-related fear, as measured by the Tampa Scale for Kinesiophobia (TSK) was not associated with higher disability, poorer function or more pain in this sample. In addition, baseline characteristics were similar regardless of TSK score. The lack of differences by TSK score revealed that screening for fear of movement was not worth the effort and provided little clinical benefit.

GP112

EFFICACY OF DIFFUSION-WEIGHTED IMAGING (DWI) BASED ON MRI TO EVALUATE HEMATOLOGICAL MALIGNANCIES IN LUMBAR SPINE.

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INTRODUCTION: Patients with hematological malignancies such as multiple myeloma, lymphoma, and leukemia, undergo the replacement of spinal hemopoietic bone marrow. Plain radiography and conventional MRI (C-MRI), including T1- and T2-weighted imaging, have been used to estimate pathologic lesion of low back pain (LBP). However, diagnosis of hematological malignancies is difficult in use of C-MRI. Diffusion-weighted imaging (DWI) based on MRI can provide a non-invasive method that reveals the microstructure of tissues on the basis of its ability to monitor the random movements of water molecules. DWI has been widely used clinically in the evaluation of malignancy for diagnosis of diseases. The aim of this study is to evaluate the potential of DWI in hematological malignancies in lumbar spine.

METHODS: 1437 patients with LBP from July 1 .2009 to June 30. 2012 were examined and underwent plain radiography, C-MRI, DWI-MRI of the lumbar spine, and blood examination. We measured the apparent diffusion coefficient (ADC) of bone marrow in vertebral bodies using 1.5-T MRI, and compared ADC in bone marrow with final diagnosis of lumbar spine.

RESULT: In 1437 patients, diagnosis were

lumbar spondylosis (70%), fracture (15%), lumbar disc herniation (LDH 6%), hematological malignancies (3.4%, multiple myeloma 1.9%, malignant lymphoma 1.3%, leukemia 0.2%), metastatic spinal tumor (3%), and infectious spondylitis (2.6%). Fracture, metastatic spinal tumor, and infection could be diagnosed by C-MRI. However, hematological malignancies were not diagnosed by C-MRI. The mean value of ADC in bone marrow in hematological malignancies (Mean: 1.86×10^{-4} mm²/s) was significantly higher than those of spondylosis and LDH (Mean: 1.31×10^{-4} mm²/s) ($p < 0.05$).

DISCUSSION: In LBP patients, 3.4% patients were hematological malignancies in current study. Only C-MRI did not clarify hematological malignancies, however, DWI may have the potential of diagnostic capacity in hematological malignancies.

GP113

PHARMACOLOGICAL ANXIOLYSIS WITH PROMETHAZINE AS AN ADJUNCTIVE THERAPY FOR ACUTE LOW BACK PAIN IN THE ADULT EMERGENCY DEPARTMENT

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INTRODUCTION: Low back pain (LBP) is a common and disabling problem presenting to the emergency department (ED); analgesia is an important step in immediate management. It has been proven that non-pharmacological methods of anxiety relief can be beneficial. A prospective randomised double-blind study carried out to determine

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whether combination treatment of promethazine and morphine was superior to morphine alone, for severe acute LBP.

METHODS: All patients admitted to the ED with simple acute LBP were candidates for the study. Patients included met the following criteria: LBP < 3 weeks duration, pain > 65 mm on a 100 mm visual analogue scale, age between 18-65, American Society of Anesthesiologists (ASA) grade 1 or 2, systolic blood pressure > 90 mmHg, no known hypersensitivity to the medications, able to provide informed consent. Pregnant women, LBP after traumatic event, history of malignancy, neurological deficiencies or atypical pain were excluded. 59 patients concluded the study and assessed for pain and anxiety reduction as well as satisfaction of treatment received.

RESULTS: Neither treatment regime proved superior in the relief of pain. Patients receiving promethazine and morphine, were more likely to require a longer duration of stay in the ED ($p=0.0427$). They were also more likely to experience adverse events; however, these findings were not statistically significant. Patients' satisfaction and ambulation status were similar for both groups.

DISCUSSION: We do not recommend routine administration of promethazine for anxiety and pain reduction in the treatment of acute LBP in the ED. Non-pharmacological methods of anxiety relief may still be helpful.

GP114

A VALIDATION STUDY OF A SYMPTOM SCALE FOR LUMBAR SPINAL STENOSIS

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INTRODUCTION: Lumbar spinal stenosis (LSS) has various symptoms and they change with activities of daily living and posture. We have developed and validated a self-administered symptom scale for LSS (Spine 37, 2012). The aim of this study was to a) verify a criterion validity using a lumbar extension test and a gait-loading test as objective indexes, and b) responsiveness of the LSS symptom scale.

METHODS: One hundred and sixty seven patients with a diagnosis of LSS completed questionnaires including the LSS symptoms scale before and after a medical therapy. A lumbar extension test and a gait-loading test were performed to evaluate standing and walking capacities. Subjects were divided into three groups according to these tests, low; less than mean-1/2 standard deviation (SD), middle; between low and high groups, high; greater than mean+1/2SD. The responsiveness to medication effects was analyzed with an interval of 8 weeks. ANOVA was used to test differences in the LSS symptom scale scores among groups.

RESULTS: In the lumbar extension test, a mean standing capacity was 164.6 ± 109 s. The LSS symptom scale score was significantly higher in accordance with a shorter standing time ($p < 0.01$). In the gait-loading test, the mean walking distance was 213.0 ± 154 m. The LSS scale scores in the low group was higher than that of the middle and high groups ($p < 0.01$). The changes of LSS scale scores were higher in accordance with improvement of symptoms by the two tests, both before and after medication.

DISCUSSION: The results suggested that the LSS symptom scale is a reliable and valid instrument with good responsiveness to non-surgical therapeutics. This scale may be

useful to evaluate patient's progress of symptoms, to establish standards for indication of treatment, and to assess treatment effectiveness.

GP115

EFFICACY OF ZOLEDRONIC ACID FOR CHRONIC LOW BACK PAIN ASSOCIATED WITH MODIC CHANGES IN MRI: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Modic changes (MC) are associated with low back pain (LBP) but no effective treatments are available. The aim of this randomized, placebo-controlled, double-blinded trial was to evaluate the efficacy of Zoledronic acid (ZA) for the chronic LBP of patients with MC in magnetic resonance imaging (MRI).

METHODS: Inclusion criteria were LBP for at least three months, an LBP intensity \geq 6/10 on 10-cm VAS or an Oswestry Disability Index (ODI) \geq 30%, and MC in MRI. Exclusion criteria included e.g. renal impairment, and willingness to retire early. Patients were randomized into single intravenous infusion of ZA 5 mg in 100 ml saline (n=20), or saline (n=20) groups. The primary outcome was LBP intensity and secondary outcomes disability (ODI), health-related quality of life (RAND-36), lumbar flexibility, sick leaves and pain medication use. The treatment differences at 1 and 12 months were analysed using ANCOVA with adjustments for age and gender.

RESULTS: At baseline, the treatment groups had no significant differences. Both the treatment difference in intensity of LBP (1.3, 95% CI -0.2 to 2.8; p=0.097) and proportion of patients with 20% improvement (ZA 55% vs. placebo 25%; p=0.105) tended

to favour ZA at 1 month. The improvements in ODI were of similar magnitude. At baseline, the treatment groups reported no differences in non-steroidal anti-inflammatory drug use, whereas at 12 months, only 20% of patients in the ZA group used these drugs compared to 60% in the placebo group (p=0.022). No significant differences were observed in RAND-36 or sick leaves. Flu-like symptoms emerged in 90% of patients in the ZA group, compared to 15% in the placebo group. Only one serious adverse effect, sinusitis requiring hospitalization, occurred in the ZA group.

DISCUSSION: The tendency for improvement was greater in the ZA group. Although the results are encouraging, larger studies are required to prove the efficacy of ZA. (ClinicalTrials.gov identifier NCT01330238)

GP116

MINIMAL CLINICAL IMPORTANT IMPROVEMENT (MCII) AND PATIENT ACCEPTABLE SYMPTOM STATE (PAAS) VALUES OF THE DALLAS PAIN QUESTIONNAIRE (DPQ) IN PATIENTS WITH LOW BACK PAIN

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INTRODUCTION: The DPQ has demonstrated its validity in patients with chronic low back pain (CLBP). Norms for clinically significant differences are missing. This work aimed to estimate Minimal Clinical Important Improvement (MCII) and Patient Acceptable Symptom State (PASS) values of DPQ.

METHOD: 168 patients with no specific LBP lasting for at least 4 weeks were evaluated at baseline and 6 months later after a non standardized treatment. Question for MCII addressed patient-reported response to treatment at FU on a 5-point Likert scale, and PASS a yes/no answer concerning satisfaction with present state. MCII was computed as the difference in mean DPQ scores between patients reporting treatment as effective vs. patients reporting treatment as not effective, and PASS was computed as the 3rd quantile of the DPQ score among patients who report being satisfied with their present state.

RESULTS: Mean (SD) intensity of back pain (0-10 VAS) and Roland Morris Disability Questionnaire scores were 5.5 (2.0) and 12.9 (5.0) at baseline, 3.7 (2.6) and 7.5 (6.5) at FU, respectively.

DPQ component (0-100)	Baseline	M6	MCII	PASS
Daily activity	60.5	40.6	22.2	29.4
Work leisure	57.8	37.2	23.1	23.1
Social interest	34.1	24.5	2.0	20.0
Anxiety				
depression	42.5	29.4	9.5	21.3
Total	48.7	32.4	14.2	23.9

The PASS total score threshold (23.9) correctly classified 84.1% of the patients who declared being unsatisfied with their present state.

DISCUSSION: These values give information of paramount importance for clinicians to interpret change over time of the DPQ measure. Authors should be encouraged to report the MCII and PASS in RCT and cohort

studies to help clinicians interpreting clinical results.

G117

QUANTITATIVE EVALUATION OF INJURED NERVE WITH DIFFUSION TENSOR IMAGING

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INTRODUCTION: Conventional imaging modalities are useful for the morphological evaluation of spinal nerves, but not for the quantitative evaluation of nerve damage. Diffusion tensor imaging (DTI) is a possible new diagnostic tool for lumbar spinal degenerative disease. Using DTI, a lower fractional anisotropy (FA) value is observed in symptomatic nerves than in asymptomatic nerves. The purpose of this study was to evaluate the efficacy of DTI in the quantitative evaluation of injured nerves.

METHODS: Twelve patients with single-sided radiculopathy who had undergone DTI using 3.0T magnetic resonance imaging (MRI) and surgical treatment were included. The FA values of lumbar nerve roots were calculated from FA maps in both injured and intact nerves. Minimum and mean FA values were investigated, and the differences between injured and intact nerves were also investigated. Neurological severity was assessed using the Japanese Orthopaedic Association (JOA) and visual analog scale (VAS) pain scores.

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RESULTS: In injured nerves, e.g., those compressed by disc herniation, lower FA values were found at the injured portion. The mean FA of injured nerves was 0.220; the mean difference between injured and intact nerves was 0.097. The mean and minimum FA values were not directly correlated with JOA and VAS scores; however, pre- and postoperative VAS scores were higher in patients with larger differences in intact and injured FA values.

CONCLUSIONS: Lower FA values were obtained at the compressed portion in injured nerves, and the difference between the FA values of the intact and injured nerves tended to correlate with neurological severity. This means that although it is difficult to evaluate an injury using only its FA value, it may be possible to utilize the difference between the injured nerve and an intact nerve. DTI is a possible new diagnostic tool for degenerated lumbar disease as it is capable of both detecting lesions and quantitatively evaluating nerve damage.

GP118

DEGENERATIVE CHANGES OF FACET JOINTS IN ADULTS WITH LUMBAR SPONDYLOLYSIS

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INTRODUCTION: Lumbar spondylolysis (spondylolysis) is a bony defect of pars interarticularis. Once bony discontinuity of bilateral laminae occurred, it is called a "floating lamina." In such a situation, biomechanical stresses on adjacent facet joints are thought to be decreased. In this study, we evaluated multi-detector CT to analyze degenerative changes of facet joints with

spondylolysis and compared with those with no spondylolysis.

METHODS: We have previously reported the incidence of lumbar spondylolysis in the general population in Japan based on multidetector computed tomography scans from 2000 subjects (Sakai T, et al. Spine, 2009). Among those, 107 subjects (37 women and 70 men) with L5 single-level spondylolysis were evaluated as spondylolysis group (Sp (+)). Mean age was 64.1(22 to 88) years. The gender- and age-matched control group (Sp (-)) was chosen randomly from the other subjects with no spondylolysis. Four changes (narrowing, sclerosis, osteophyte, bone cyst) of degenerative changes of facet joints (L4/5, L5/S) adjacent to the pars defects.

RESULTS AND DISCUSSION: In a total of 214 L4/5 facet joints, the following results were found (Sp (+): Sp (-)): narrowing (210: 187), sclerosis (200: 137), osteophyte (116: 82), and bone cyst (52:3). In a total of 214 L5/S facet, narrowing (210: 181), sclerosis (194: 145), osteophyte (65: 40), and bone cyst (16: 2) were found (Figure 1). Totally, degenerative changes of facet joints with lumbar spondylolysis were more severe than those of control, statistically significantly ($p < 0.05$). Unfortunately, the reasons of this result were not clarified in this study. But, there are many candidate reasons of the results in this study. Particularly, alignment, slip grade, morphological changes as facet tropism, facet orientation, should be investigated in the next step.

GP119

PROTEOMIC ANALYSIS OF LIGAMENTUM FLAVUM FROM LUMBAR SPINAL CANAL STENOSIS

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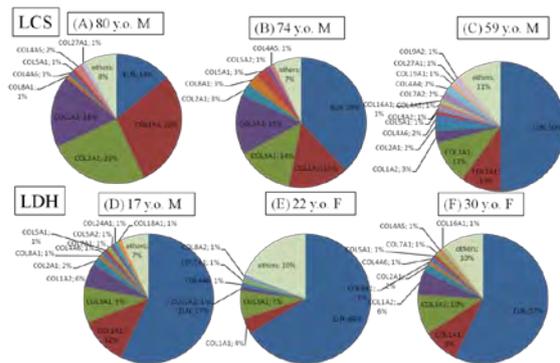
INTRODUCTION/AIM: Lumbar spinal canal stenosis (LCS) is a common lumbar spinal disorder in aged population. Hypertrophy of ligamentum flavum is one of main factors of LCS but its pathomechanism has not been clarified yet. In many diseases, proteomic analysis has been applied to understanding of their pathogenesis. Although proteomic analysis of ligamentum flavum was difficult due to the intrinsic insolubility of the tissue, Sato et al. succeeded in solubilization of ligamentum flavum. The purpose of this study is to analyze proteomic changes in components of the hypertrophic ligamentum flavum in the LCS patients.

METHODS: All samples of the ligamentum flavum were obtained from patients with LSC or lumbar disc herniation (LDH) at the time of operation, and divided them into the two groups. LCS group includes 3 male patients at the age of 80 (A), 74 (B), and 59 (C) years. LDH group includes 17 year-old male (D) and 22 (E), 30 (F) year-old female patients. All samples were axially cut into 1- μ m slices with cryotome. They were treated with CNBr under N₂ gas and digested with various enzymes. LC/MS/MS analysis has been performed. Analysis on protein database were performed using the Mascot software.

RESULTS AND DISCUSSION: In the LCS group, the contents of elastin were (A)14%, (B)38%, (C)50%, and the contents of collagen were (A)77%, (B)56%, (C)40%. In the LDH group, the contents of elastin were (D)57%, (E)66%, (F)57%, and the contents of collagen were (D)35%, (E)18%, (F)33%. The contents of elastin in LCS group were lower than those in LDH group and the contents of collagen in LCS group were higher than those in LDH group. Various types of colla-

gens were identified (Figure 1). Since elastin contributes to the elasticity (softness) of the tissue, the decrease of elastin in ligamentum flavum with hypertrophy affects not only the thickness of the tissue, but also the softness of that. These results may explain, at least in part, the cause of the LCS.

Figure 1: Samples from LCS and LDH patients



GP120

SPINO-PELVIC SAGITTAL ALIGNMENT IN ELDERLY PATIENTS WITH ISTHMIC SPONDYLOLISTHESIS

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INTRODUCTION: The risk for progression of isthmic spondylolisthesis appears to be greatest during the adolescent growth spurt and subsequently decreased to the minimum after adolescence. However, some of the patients have an onset of radiculopathy at an old age. Spinal sagittal alignment plays an important role in the development of spondylolysis and spondylolisthesis. However, there are few studies about spinal sagittal alignment of elderly patients with isthmic spondylolisthesis (IS). The purpose of this study is to evaluate spino-pelvic

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alignment of the patients with isthmic spondylolisthesis developing radiculopathy at old age.

METHODS: We analyzed 21 patients with isthmic spondylolisthesis developing radiculopathy at the age of 55 years or older (mean age 67), 28 patients with lumbar spinal stenosis (LSS) without slippage (mean age 67), 38 patients with degenerative spondylolisthesis (DS) (mean age 64) and 88 asymptomatic volunteers (Vo) (mean age 36). The following parameters were measured on the lateral whole-spine standing radiographs: lumbar lordotic angle (LLA), lumbosacral lordotic angle (L1S1), sacral slope (SS), pelvic tilting angle (PA) and pelvic lordosis (PRS1).

RESULTS: The measurements of spino-pelvic parameters were as follows: IS, LLA 24.2, L1S1 44.4, PA 20.6, SS 36.6, PRS1 32.9, Vo, 36.1, 42.9, 19.5, 34.4, 36.4, DS, 27.2, 40.7, 28, 29.2, 32.7, LSS 19.0, 31.2, 25.6, 26.9, 36.3 (degree), respectively. IS patients had small PRS1 and decreased lumbar lordosis, but lumbosacral hyperlordosis and pelvic anteversion.

DISCUSSION: IS patients have small pelvic compensatory ability because of a defect in the pars interarticularis. Lumbar hypolordosis with aging and pelvic anteversion set up lumbosacral hyperlordosis for postural compensation, resulting in onset of radiculopathy at old age. In surgical treatments for elderly IS patients with lumbosacral hyperlordosis, it must be considered to perform a sufficient decompression surgery.

GP121

THE DIFFERENTIAL IMAGING FINDINGS BETWEEN FRESH AND OLD OSTEOPOROTIC VERTEBRAL FRACTURES

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INTRODUCTION: It is difficult to differentiate fresh osteoporotic vertebral fractures (OVF) from old fractures. MRI is a potentially useful tool; however, there is no detailed report describing the changes found post-fracture. Here, we report intensity changes in MRI findings after a fracture and whether it is possible to differentiate fresh from old fractures.

METHODS: We examined 150 vertebrae in 147 patients. All patients had apparent pain onset and were evaluated using X-ray and MRI within 2 weeks of onset and reevaluated after 6 months. The anterior body height ratio was calculated from the X-ray as the anterior body height of the fractured vertebral body divided by the height of the adjacent intact vertebral body. The cutoff value of the fresh fracture was determined by ROC curve analysis. Based on the T1-weighted MRI, the intensity change of the posterior wall of the fractured vertebra was evaluated and classified as normal signal intensity or low signal intensity.



RESULTS: The anterior body height ratio declined from 83.9% at initial visit to 63.8% at 6 months. When the ratio >75% was defined as a fresh fracture, sensitivity was 82%, specificity was 68.7%, and positive predictive value (PPV) was 72.4%. With MRI, 126 vertebrae (84%) showed a low signal change at the posterior wall of the fractured vertebra in the fresh stage, which decreased to 62 vertebrae (42.7%) after 6 months (Figure). When the low signal change at the

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posterior wall of the vertebral body was defined as a fresh fracture, sensitivity was 84%, specificity was 58.7%, and PPV was 67%. With a combination of the above findings, the specificity improved to 88% and PPV improved to 85.1% respectively.

DISCUSSION: Almost half of the vertebral bodies with a low-intensity change at the posterior wall at the fresh stage had normalized in 6 months. The specificity and PPV in diagnosing a fresh OVF can be improved by combining an X-ray and the signal change of the posterior wall by MRI.

GP122

ESTABLISHMENT OF A NEW PARASPINAL INFECTION MOUSE MODEL EVALUATED NONINVASIVELY AND QUANTITATIVELY USING BIO-IMAGING

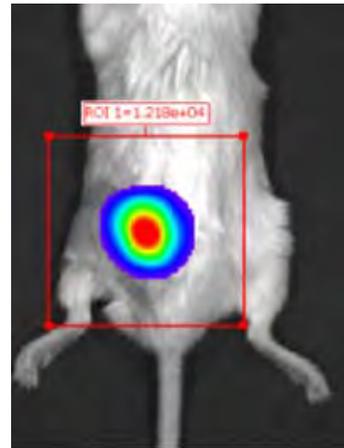
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INTRODUCTION: The infections in the spine and paraspinal regions cause progressive inflammation and destruction of bony structures, often resulting in prolonged pain and neurological symptoms. Treatment of the infection especially caused by multi-antibiotic resistant bacteria such as MRSA remains a challenging problem, and basic researches providing solutions for the problem are necessary. However, there are only

a few animal models which enable quantitative evaluation of infection in the paraspinal soft tissues. We have established a noninvasive quantitative mouse model of paraspinal muscle infection using bioluminescence imaging (BLI).

METHODS: Bioluminescent strains of MRSA were inoculated into the paraspinal muscle of BALB/c adult mice (N = 6). Photon intensity (PI = photons/sec/cm²/steradian) of the bacteria and background



were then sequentially measured using BLI over 4 weeks. Serological and histological analyses

were also performed.

RESULTS: Bacterial signal was detected in the paraspinal muscle immediately after the inoculation of MRSA. Mean PI of the bacteria plateaued at approximately 7days (2.16×10^4 PI) and could be stably measured over 4weeks. Serum levels of interleukin-6 and C-reactive protein were significantly higher at 7days in the infection model mice than the control mice. Histological analysis revealed that the muscle necrosis and cumulated neutrophils with bacterial colonies were observed in the paraspinal muscle at 7days.

DISCUSSION: We have successfully visualized and quantified the bacterial growth in the mouse paraspinal muscles using BLI, which enabled us to monitor the infectious process in the live mice over a long period of time. The paraspinal muscle has strong fascia and can keep down spreading of the infectious lesion minimally. Our model can be used for investigation of pathophysiology of infections in the spine and paraspinal regions and assessing the effect of novel antibiotics and antibacterial implants.

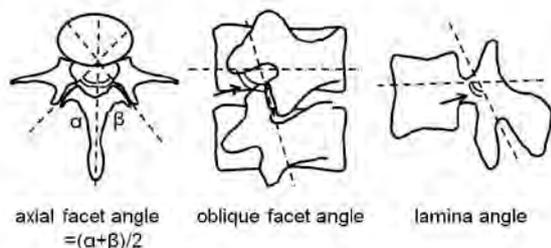
GP123**FACET ORIENTATION IN PATIENTS WITH LUMBAR DEGENERATIVE SPONDYLOLISTHESIS**

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INTRODUCTION: Several reports have indicated a correlation between lumbar degenerative spondylolisthesis (DS) and increased sagittal orientation of the facet joints. Sagittalization of lumbar facet joints is a major cause of DS, however, the majority of studies of lumbar facets were analyzed in the axial plane. We analyzed the spinal morphological character by examining both the axial and sagittal views in DS patients and compared these parameters to patients with lumbar spinal stenosis (LSS, without slippage) and low back pain (LBP, without slippage nor neurological symptoms).

METHODS: We analyzed 119 patients divided into 3 groups based on the clinical and imaging findings: 42 patients with DS, 39 with LSS, and 38 with LBP. The following parameters were measured from L2-3 to L5-S1 levels: axial facet angle (AFA) in an axial orientation, oblique facet angle (OFA) and lamina angle (LA) in sagittal orientations.



RESULTS: The AFA of the DS group was significantly smaller than that of the LSS and LBP groups at the slippage level. However,

the OFA of the DS and LSS groups had no significant difference at any of the levels. The AFA and OFA in the DS and LSS groups were smaller than those in the LBP group at all levels. From the L2 to L4 levels, the LA of the DS and LSS groups had a tendency to be larger than LBP group. At the L5 level, however, the LA was similar among all groups.

DISCUSSION: Patients with DS had more sagittally oriented facet joints in the axial plane than the two other groups at the slippage level. However, facet orientation was not horizontal in the DS group compared with the LCS group on the oblique and lateral planes. The sagittal orientation of facet joints is more likely due to a secondary remodeling of the joint orientation rather than a pre-existing morphologic feature.

GP124**EMPIRIC ANTIBIOTIC THERAPY FOR PYROGENIC SPONDYLITIS**

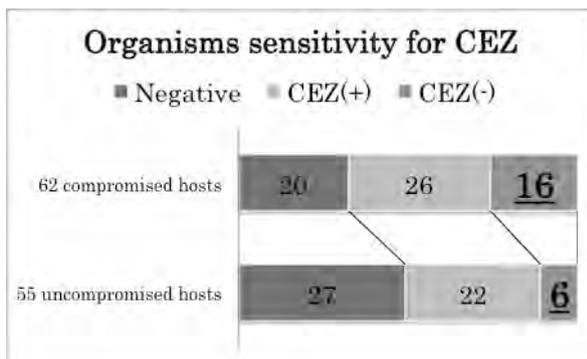
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INTRODUCTION: It is common practice to use first-generation cephalosporins (CEZ) empirically for pyogenic spondylitis before infectious organisms are isolated. Infectious organisms causing pyogenic spondylitis are commonly staphylococci and streptococci. The objective of this study is to review infectious organisms causing pyogenic spondylitis and to clarify what kind of antibiotics we should use empirically.

METHODS: We retrospectively reviewed cases of pyogenic spondylitis in 117 patients who were treated in our hospital from 1997 to 2011, including 75 men and 42 women with a mean age of 66.5 years (range 32 to 88 years).

RESULTS AND DISCUSSION: Conditions including diabetes mellitus, cancer, steroid use, hemodialysis, liver cirrhosis, and others compromised 62 patients (53%). Organisms

were isolated from 70 patients (42 compromised and 28 uncompromised patients), included *Staphylococcus aureus*, Methicillin-resistant *Staphylococcus aureus* (MRSA), streptococci, *Staphylococcus epidermidis*, and *Pseudomonas aeruginosa* and others. Organisms in 22 of 70 cases (31%) had no sensitivity for CEZ. In uncompromised hosts, 6 of 28 cases(21%) had no sensitivity for CEZ. On the other hand, in compromised hosts, 16 of 42 cases(38%) had no sensitivity for CEZ, including MRSA in 10 cases, *Pseudomonas aeruginosa* in 3 cases, and others in the remaining 3 cases. 6 cases required broad spectrum antibiotics and 10 needed anti-MRSA drugs. Antibiotic-resistant organisms were more commonly isolated from compromised patients (Figure).



In patients with negative cultures, CEZ was used empirically in 16 cases in uncompromised patients and broad spectrum antibiotics were needed in 1 case (6%). CEZ was used empirically in 8 cases in compromised patients and broad spectrum antibiotics were needed in 2 cases (25%).

This study suggests that broad spectrum antibiotics and anti-MRSA drugs should be used empirically for pyogenic spondylitis in compromised patients before isolating causative organism

GP125

THORACOLUMBAR VERTEBRAL ENDPLATE LESIONS IN YOUNG GYMNASTS

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INTRODUCTION: An increased frequency of radiologic abnormalities in the thoracolumbar spine has been reported among young gymnasts. The purpose of this study is to evaluate the incidence of thoracolumbar vertebral endplate lesions in young gymnasts.

METHODS: We examined the thoracolumbar spine of 126 young gymnasts aged 6-19 years (mean age, 15.4years) and 103 control subjects (23 baseball, 18 soccer, 11 athletics, 8 basketball, 8 volleyball, 8 tennis, and 27 other sports players) aged 10-18 years (mean age, 14.9 years). All subjects suffered from low back pain. We investigated the incidence of radiological abnormalities of vertebral endplate lesions in them. We divided the involved site into two regions, the Thoracolumbar Junction of the Spine "TL group" defined as T11 to L2 and the Lower Lumbar region "LL group" defined as L3 to S1. The incidences of these abnormalities were then compared between the TL group and LL group. The incidences of these abnormalities were then compared between the gymnasts and control subjects, and between the TL group and LL group.

RESULTS: Vertebral endplate lesions were seen in 38 lesions of 26 (20.1%) gymnasts and 2 lesions of 2 (1.9%) control subjects. They occurred significantly more often in the gymnasts than in the control subjects. The locations of the lesions were more frequent in the TL group (26 lesions) than in the LL group (12 lesions) among the gymnasts. No difference was found in the location of the lesions in the control subjects.

DISCUSSION: The young gymnasts demonstrated a higher rate of vertebral endplate lesions and occurred more often in the



thoracolumbar junction. There is a possibility that deep flexion of the trunk under high velocity exerts great pressure on the spine, especially on the anterior part of the vertebrae of the thoracolumbar junction.

(Figure) 18y.o male gymnast. Lateral

lumbar radiography showed deformation of vertebral endplate of L1 and kyphosis at the same level.

GP126

DIAGNOSIS OF INFECTIVE ENDOCARDITIS WITH PYOGENIC SPONDYLITIS

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INTRODUCTION: It is known that the pathogenesis of pyogenic spondylitis (PS) is mainly hematogenous and that infective endocarditis (IE) can cause persistent bacteremia. In recently a few reports has been recognized that IE may be the source of PS more frequently than has been believed. However, the incidence of IE in PS patients, and the outcome of these patients are still uncertain. The purpose of the present study was to investigate the incidence, the diagnostic methods, and the outcome for IE in patients with PS.

METHODS: We retrospectively reviewed 61 cases of PS diagnosed at our institution

from 2004 to 2012. There were 33 males and 28 females, with a mean age of 72 years old (range, 32 to 91 years old). The following data were recorded the causative organism, complications, echocardiographic studies, and outcome.

RESULTS: The causative organism was isolated in 45 patients (73.7%). MSSA was present in 14 cases, MRSA in 12 cases, and E.coli in 4 cases. 26 patients (42.6%) had complications, such as IE, meningitis, pseudomembranous colitis, and drug rashes. Blood cultures were performed for 88.5% of patients, and the positive detection rate was 61.1%. Transthoracic echocardiography was performed in 42.6% of all patients. IE was diagnosed in 4 patients (6.6%). All of their blood cultures were positive. Cardiac surgery was required for 3 patients, and refractory bacteremia occurred in 1 patient.

DISCUSSION: Some studies reported the prevalence of IE in patients with PS to range from 9.3% to 43.3%. In this study, the prevalence of IE was 6.6%, which was lower than in other studies. The reasons might be a lack of recognition of IE at our institution. Echocardiography was performed for only 43% of patients, so the search for IE may have been insufficient. In patients with PS, the possibility of complications of IE should be kept in mind, and patients should be evaluated by echocardiography and blood cultures.

GP127

AGONISTIC SWIMMING IN ADOLESCENCE: RISK FACTOR FOR SCOLIOSIS AND LOW BACK PAIN? RESULTS OF A CROSS-SECTIONAL STUDY

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INTRODUCTION: Swimming is widely practiced by adolescent in many countries, and

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has been considered for a long time a safe sport and even a scoliosis treatment. Recently this opinion has changed, but data are still scant.

AIM: Verify prevalence of postural changes, spinal deformities and LBP in adolescent agonistic swimmers compared to normal controls.

METHODS: 112 adolescents (62 girls) compared to 217 scholars (106 girls) of the same age range (12.5 and 12.1 respectively). We proposed a validated questionnaire to collect data on LBP. We collected a series of already validated measurements:

- plumbline distances from kyphosis apex of the C7 and L3 vertebrae
- ATR (Angle of Trunk Rotation) according to Bunnell.

According to previous studies, we considered these normal references:

- ATR: 5°
- C7: 15-55 mm
- L3: 30-60 mm

Statistics: ANOVA; χ^2 test; Kruskal Wallis test.

RESULTS: LBP: Compared to control, female swimmers had a higher prevalence (69% vs 53%, $p < 0.05$), and 49% of them had to reduce their recreational activity compared to 29% of control ($p < 0.05$). 30% of female swimmers had a medical visit for back pain vs 21%. In the male group the differences were not significant.

We found more spinal deformities in swimmers:

- ATR: 5.3 ± 2.7 (female swimmers) vs 4.5 ± 1.9 , $p < 0.05$.
- ATR $> 5^\circ$: Males (swimmers vs school) 58% vs 44%, $p < 0.05$; females 56% vs 51%, $p < 0.05$
- C7: Males (swimmers vs school) 41.4 ± 12.6 vs 33.6 ± 11.0 $p < 0.05$. Females 36.0 ± 16.7 vs 27.7 ± 12.3 .
- L3 > 60 : 16% vs 8% (female swimmers vs schoolgirls).

DISCUSSION: The correlation between swimming and LBP, scoliosis and

hyperkyphosis is quite new. Swimming is generally considered a complete sport and a treatment option but this is contradicted by our data. No causal effect can be determined with this study design, but a correlation exists.

CONCLUSION: Swimmers showed more LBP, scoliosis and hyperkyphosis than controls. These findings should change completely the perception of swimming.

GP128

IS SPINO PELVIC ALIGNMENT ASSOCIATED WITH OSTEONECROSIS AFTER THORACOLUMBAR VERTEBRAL COMPRESSION FRACTURE?

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INTRODUCTION: This study aims to examine which spino-pelvic parameters are associated with vertebral osteonecrosis after osteoporotic vertebral compression fracture (VCF).

METHODS: Forty six patients who underwent conservative treatment for a single-level thoracolumbar VCF (T10 to L3) were reviewed retrospectively. Pelvic incidence (PI), anterior deviation of C7 plumb line (C7PL) to the sacrum, distance of C7PL to the fractured vertebra, kyphotic wedge angle and mid-vertebral body height of fractured vertebra were measured on initial standing whole spine radiograph. As an outcome measure, presence or absence of vertebral osteonecrosis was evaluated radiographically at the final follow-up. Mean follow-up period was 18 months.

RESULTS: Multiple logistic regression analysis demonstrated that mid-vertebral body height of fractured vertebra ($p = 0.04$, odds ratio = 1.263) and distance of C7PL to the fractured vertebra ($p = 0.08$, odds ratio = 1.031) were associated with osteone-

crisis after VCF. Relative risk for osteonecrosis increased 1.6 times by 3 mm, 2.5 times by 5 mm, 8.2 times by 10 mm loss of mid-vertebral body height of fractured vertebra, and 2.4 times by 3cm, 4.3 times by 5cm and 19.5 times by 10cm anterior deviation of C7PL to the fracture site. Anterior deviation of C7PL to the sacrum ($p=0.27$), pelvic incidence ($p=0.49$), vertebral wedge angle ($p=0.50$) were not significant risk factors.

DISCUSSION: It was suggested that the larger anterior deviation of gravity center, the larger flexion moment to the fractured site, which led to the impairment of bone healing.

GP129

EVALUATION ON THE DEGENERATION OF FACET JOINT IN LUMBAR SPINE USING T2 MAPPING

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INTRODUCTION: Degenerative changes of lumbar facet joints seem to be associated with low back pain. The radiological evaluation of degenerative change of cartilage has been based on plain radiography, CT and MRI. In recent years, T2 mapping is one promising candidate for clinical quantitative imaging of cartilage in knee joint. Therefore we assessed that T2 mapping of lumbar facet joints yield a same feasibility.

MATERIALS AND METHODS: Twenty patients with grade I degenerative spondylolisthesis (9 men and 11 women; mean age 69.2 years) were examined by axial T2 mapping. The facet joint at the level of spondylolisthesis (L2-3; 1, L3-4; 5, L4-5; 11 patients), and adjacent cranial and caudal level were sliced and the regions of interest (ROIs) were selected manually. T2 values were compared between facet joints

at the level of spondylolisthesis and those at the adjacent levels for each patient. Statistical analyses were performed with SPSS version 20.

RESULTS: Mean T2 values of facet joint at the level of spondylolisthesis was 88.7 ± 9.9 msec on the right and 89.3 ± 8.5 msec on the left. Mean T2 values of facet joint at the cranial adjacent level was 76.3 ± 7.4 msec on the right and 77.7 ± 9.0 msec on the left. There was significant difference. Mean T2 values of facet joint at the caudal adjacent level was 81.3 ± 10.5 msec on the right and 82.5 ± 11.2 msec on the left. There was also significant difference.

DISCUSSION: It has been reported that T2 mapping reflects water content and collagen structure and indicates early degeneration of cartilage in such as large joint. In this study, T2 values of facet joint at the level of spondylolisthesis were increased as compared with those at the adjacent levels with significant difference. This result suggest that T2 mapping has an efficacy for evaluation of cartilage degeneration in small joint and particularly helpful to diagnose an early stage of osteoarthritis in facet joint.

GP130

CHARACTERISTICS OF LOW BACK PAIN IN ADOLESCENT PATIENTS WITH EARLY-STAGE SPONDYLOLYSIS EVALUATED BY A DE-TAILED VISUAL ANALOG SCALE

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INTRODUCTION: Early-stage spondylolysis (ESS) is one of the common causes of acute low back pain (LBP) in adolescent patients. Although accurate diagnosis of ESS is im-

portant to provide appropriate treatment, ESS is difficult to differentiate, using pain characteristics, from other low back disorders without the use of magnetic resonance imaging (MRI). The purpose of this study was to elucidate the characteristics of LBP in patients with ESS.

METHODS: Adolescent patients (n=79) with acute LBP were included (<1 month after onset). All patients were evaluated by plain radiography and MRI; patients who showed obvious pathological finding other than ESS (e.g., disc herniation, infection, etc.) were excluded. LBP was evaluated by a traditional VAS scoring system, the Oswestry Disability Index (ODI), and a detailed VAS scoring system in which pain is independently evaluated in 3 different postural situations (in motion, standing, and sitting).

RESULTS: Of 79 patients, 42 had ESS (ESS group: mean age: 14.4 years-old; 34 male/8 females) and 37 had no pathological findings that explained the LBP origin (non-specific LBP group (NS-LBP): mean age: 14.6 years-old; 21 males/16 females). ODI and traditional VAS scores were 16.5, 4.9 in the ESS group, and 26.3, 6.4 in the NS-LBP group, respectively. Both scores were significantly higher in the NS-LBP group. The results of the detailed VAS revealed that the ESS group showed significantly greater pain intensity while in motion, than in standing and sitting (4.2, 2.0, and 1.9, respectively), whereas the NS-LBP group showed similar pain intensity in the three situations (5.4, 3.9, and 5.1, respectively).

DISCUSSION: The present study revealed LBP characteristics capable of distinguishing ESS from the LBP of other low back disorders. Because early diagnosis is essential for the treatment of spondylolysis, MRI examination is recommended for those patients who have severe pain in motion, but less pain while standing and sitting.

GP131

DOES THE RESPONSE TO PHYSICAL THERAPY FOR CHRONIC NON-SPECIFIC LOW BACK PAIN VARY ACCORDING TO AGE?

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INTRODUCTION: There are few studies describing differences in response to physical therapy for non-specific chronic low back pain (CLBP) between elderly and adult patients. This study aimed to examine the response to physical therapy in elderly and younger adult patients with CLBP, and to elucidate differences in response between these two populations.

METHODS: Patients (n=47) with CLBP (>3 months) without lower-extremity symptoms were divided into the elderly group (≥65 yrs-old; n=18; mean age: 73.8 yrs; 8 males/10 females) and the younger group (<65 yrs-old; n=29; mean age: 45.2 yrs; 13 males/16 females) and received physical therapy for at least 3 months. Evaluation of the patients' low back pain (visual analog scale: VAS), disability (Oswestry Disability Index: ODI), and quadriceps muscle strength (Weight Bearing Index: WBI) were performed before treatment and at 1-, and 3-months follow-up.

RESULTS: VAS scores before treatment and at 1-, and 3-months follow-up were 4.0, 3.0, 2.7 in the elderly group, and 4.6, 3.3, 2.1 in the younger group, respectively. At 1-month follow-up, the elderly group did not show a significant decrease in VAS, while the younger group showed a significant decrease. At 3-months follow-up, the elderly group showed a non-significant tendency (p=0.087) towards less pain compared with

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before treatment, and the younger group showed a further significant decrease in VAS compared with the 1-month follow-up. The elderly group did not show significant improvement in ODI and WBI even at 3-months follow-up, while the younger group showed significant improvement at the 1-month follow-up.

DISCUSSIONS: This study showed that elderly patients with CLBP require a longer time to respond to physical therapy than younger patients. In elderly patients, although physical therapy for 3 months did not significantly improve disability and muscle strength, low back pain tended to improve, although the response was less and slower than in younger patients.

GP132

T2 MAPPING EVALUATION OF LUMBAR FACET JOINTS BEFORE AND AFTER SPINAL MOTIONS

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INTRODUCTION: Joint cartilage has ability of releasing and taking water that compose extracellular matrix by mechanical stress such as compression and shear force. In recent years, T2 mapping is one promising candidate for clinical quantitative imaging of cartilage, because T2 mapping reflects water contents and collagen structure. The purpose of this study is to reveal the changes of water contents in the cartilage of lumbar facet joint before and after lumbar spinal motions using T2 mapping.

METHODS: Twenty healthy volunteers (10 men and 10 women; mean age 19.3 years) were examined by axial T2 mapping. The facet joint at the center of intervertebral level of L1-2, L2-3, L3-4, L4-5 and L5-S1 were sliced and the regions of interest (ROIs)

were selected manually. T2 values were compared between each facet joints before certain lumbar spinal motions (flexion, extension and rotation) and those immediately after those motions.

RESULTS: In men, mean T2 values of facet joints before and after lumbar motion were 57.1 ± 6.2 and 49.0 ± 2.2 msec at the L1-2, 59.1 ± 4.3 and 49.8 ± 4.4 msec at the L2-3, 59.7 ± 5.6 and 51.1 ± 6.5 msec at the L3-4, 62.8 ± 6.1 and 50.9 ± 5.3 msec at the L4-5, and 57.2 ± 7.9 and 49.1 ± 6.6 msec at the L5-S1. In women, mean T2 values of facet joints before and after lumbar motion were 54.3 ± 11.8 and 42.8 ± 5.7 msec at the L1-2, 59.3 ± 11.3 and 47.4 ± 6.5 msec at the L2-3, 61.4 ± 10.0 and 53.8 ± 4.8 msec at the L3-4, 62.5 ± 7.0 and 50.2 ± 6.8 msec at the L4-5, and 62.9 ± 6.3 and 52.6 ± 6.1 msec at the L5-S1. At the all levels, there were significant differences ($p < 0.05$) between T2 values before and after lumbar motion.

DISCUSSION: T2 values of facet joints after lumbar motion was significant lower than those before lumbar motion at the all levels. These results suggest that water contents in cartilage of lumbar facet joints increased after lumbar motion. It is possible that extracellular matrix enhanced taking of water inward to oppose compression and shear force during lumbar motion.

GP133

CORONAL ALIGNMENT OF THE LUMBAR SPINE AND PELVIS IN PATIENTS WITH AN ANKYLOSED HIP

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INTRODUCTION: A fixed deformity at the hip joint may cause pelvic obliquity, with a secondary lumbar scoliosis. However, there have been few reports on the influence of

the fixed position at the hip on the coronal alignment of the spine. The present investigation examined the coronal alignment of the spine and pelvis in patients with an ankylosed hip (AS)

METHODS: The subjects included 19 male and 32 female patients (45-80 years of age) treated by THA due to unilateral AS after spontaneous (n = 24) or surgical (n =28) fusion of the hip joint. Patients with bilateral AS and a previous history of THA or BHA or spine surgery were excluded from the study. Regarding coronal spinopelvic alignment, the following parameters were measured: the lumbar scoliosis (LS; L1-L5 Cobb angle), pelvic tilt (PT) and ankylosed hip angle (AHA). The PT and AHA were defined as the angle between the inter-teardrop line and the horizontal line, and the long axis of the femur of the AH side. The variable was calculated a formula with the abduction side regarded as a positive angle and adduction side as a negative angle. For each parameter, correlations between parameters were evaluated by a regression analysis. $P < 0.05$ was considered to be significant.

RESULTS: The average angles of the LS, PT and AHA were 7.8° , 7.2° , and 12° , respectively. The correlation coefficients between the AHA and LS, AHA and PT, and PT and LS were 0.65, 0.55, and 0.72, respectively ($P < 0.01$).

DISCUSSION: Our study provides evidence to suggest that, in patients with AH, the abduction position is positively correlated with the downward PT and the convexity of the LS toward the AH side. On the other hand, the adduction position positively correlated with the results on the opposite side. These results are in good agreement with the clinical impression that an inadequate position in patients with AH could cause compensatory pelvic tilt and lumbar scoliosis in order to maintain proper body balance.

GP134

EARLY STAGE MRI FAT SUPPRESSION IMAGE PREDICT THE PROGNOSIS OF ACUTE OSTEOPOROTIC VERTEBRAL COMPRESSION FRACTURE TREATED BY HARD-CORSET TREATMENT

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INTRODUCTION: The vertebral body fracture is the most frequent type of osteoporotic vertebral fractures (OVFs). We reported more than 4/5 patients were suffering long-lasting pain over the year. From the view of the fracture treatment, that is too high rate of unsuccessfulness. The purpose of this study was to identify the pattern of the MR image that can predict a risk for delayed union or sever collapse of OVFs.

METHODS: All the patients over 40 years who visited our department and were diagnosed having fresh OVF 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 and 3months. The treatment was in all cases conservative using hard corset. The occurrence of pseudo-arthritis and degree of collapse were evaluated by using CT at three months.

RESULTS: A total of 20 patients were enrolled in this study. Mean age was 79.4 . Fracture level was 3 for T12, 7 for L1, 3 for L2, 2 for L5, and 1 for T8, T9, T11, L3, and L4. All of the cases showed the tendency that the area of low intensity in the fat suppression image collapsed. Six of them collapsed more than half of the vertebral height and became pseudo-arthritis. Four of those six had low intensity in fat suppression image more than half of the vertebral area, and two of those had spot low intensity in fat suppression image almost all vertebral area. Two collapsed less than half of the vertebra, but became pseudo-arthritis,

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which showed low intensity line in fat suppression.

DISCUSSION: This study showed the low intensity area of the fat suppression will collapse. So the low area of the fat suppression image can predict how much the vertebra will collapse afterwards. Furthermore if more than half of the vertebral area is low, the vertebra will be lead to pseudo-arthritis. So we can apply the vertebro- or kyphoplasmy in early stage to such patients who have large fat suppression low area to prevent pseudo-arthritis or further collapse.

GP135

EPIDEMIOLOGY OF LUMBAR SPINAL STENOSIS -MULTICENTER COHORT STUDY-

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INTRODUCTION: Epidemiological evidence of lumbar spinal stenosis (LSS) is not enough because its definition has not been clearly established. The objective of this prospective multicenter cohort study was to determine the degree of severity and define the disease state of LSS using common outcome measures.

METHODS: Patients who visited the hospitals located in 3 regions in Japan who were diagnosed with LSS were prospectively enrolled in this study. LSS was defined according to the North American Spine Society guidelines. Patients who had already been treated for LSS were excluded. A total of 238 patients (127 males) with a mean age of 71.5y were enrolled. Assessments were made at baseline and 1-year follow-up based on an LSS diagnostic support tool, the degree of stenosis from MRI, EuroQol

(EQ5D), Zurich Claudication Questionnaire (ZCQ), Hospital Anxiety and Depression Scale (HADS), and Pain DETECT (a diagnostic tool for neuropathic pain).

RESULTS: At 1 year, 170 (72%) patients were followed-up. 37 patients had operative treatment (22: decompression alone, 15: decompression and fusion) and 133 had non-operative treatment. Patients treated with surgery had severe symptoms and lower ADL scores than non-operative group. Both operative treatment and non-operative treatment improved EQ5D, ZCQ Symptom and Function score, but operative cohort significantly improved in all these measurements. The improvement of HADS was not statistically different between two groups. The total score for PainDETECT was significantly improved in operative cohort. Patients who had operative treatment had higher ZCQ satisfaction score than non-operative group.

DISCUSSION: It would appear from this study that both operative treatment and non-operative treatment improved the symptoms and the QOL in patients with LSS at 1-year follow-up. However, operative treatment significantly improved the symptoms and the QOL, and patients had higher satisfaction for operative treatment.

GP136

THE SPINAL STENOSIS Pedometer AND NUTRITION LIFESTYLE INTERVENTION (SSPANLI) PILOT

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INTRODUCTION: Owing to age and mobility limitations, people with lumbar spinal stenosis (LSS) are at risk for sedentary behavior and obesity. Obesity is one of the most important determinants of quality of life (QOL), and is linked to inferior outcomes of LSS surgery. Therefore, weight management

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in LSS is critical. BMI is the strongest predictor of function in LSS, suggesting that weight loss may promote physical activity and provide a unique treatment option for increasing function. Currently there is a lack of research on weight loss in LSS. We propose a lifestyle modification approach of physical activity and nutrition education, delivered through an online platform.

METHODS: The e-health platform was developed. We recruited 10 overweight or obese individuals with LSS. Baseline and follow-up testing included dual energy x-ray absorptiometry, blood draw, 3-day food record, 7-day accelerometry, questionnaire, and walking test. Intervention: During Week 1, participants received a pedometer, a personalized consultation with a Dietitian, and an Exercise Physiologist. For 12 weeks participants logged on to the website to access personal step goals, walking maps, nutrition videos, and a discussion board. Follow-up, including structured interviews, occurred at Week 13.

RESULTS: Nine participants had a mean age of 67.5 ± 6.7 yrs (60% female). A significant decrease was observed in fat mass, and symptom severity (Swiss Symptom Scale) ($p < 0.05$). Non-significant improvements were observed for waist circumference, pain, ODI, and obesity bio-markers. 70% lost weight, 50% increased walking capacity, and 60% increased QOL. The mean increase in steps was 15%.

DISCUSSION: The SSPANLI intervention was shown to be feasible, attractive to participants, and effective. This intervention provides people with LSS the opportunity to participate in their own health management, potentially improving access to care, and outcomes of surgery. Efficacy is being assessed in a randomized trial.

GP137

STAPHYLOCOCCUS DECOLONIZATION IN ELECTIVE SPINE SURGERY IS EFFECTIVE

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INTRODUCTION: Surgical site infections (SSIs) may be prevented by screening and decolonizing Staphylococcus (MSSA/MRSA) in elective spine patients.

METHODS: A prospective study was conducted from 4/2012-10/2012 evaluating 135 consecutive elective spine patients. Eleven patients cancelled, and 12 swabs were not repeated on the day of surgery, leaving 112 patients (26 primary cervical, 59 primary lumbar, 3 revision cervical, and 24 revision lumbar). Patients were screened for nasal MRSA/MSSA colonization 2-6 weeks prior to surgery. Those who were positive underwent decolonization using intranasal mupirocin twice a day and chlorhexidine body wash daily 5 days before surgery. Patients were reswabbed on the day of surgery to determine if the decolonization protocol was effective. Statistical analysis was performed using chi-squared and McNemar tests.

RESULTS: For pre-operative nasal swabs, 27 patients (23.9%) were positive for MSSA colonization and 2 patients (1.8%) were positive for MRSA colonization. On the day of surgery, 4 patients (3.5%) were positive for MSSA and 0 patients were positive for MRSA. The reduction in MSSA colonization was significant ($p < 0.001$), and there were no patients with MRSA on the day of surgery. Patients undergoing primary ($p = 0.06$), lumbar ($p = 0.30$) and no fusion ($p = 0.05$) surgery were more likely to be positive for MSSA prior to surgery, with no difference between groups for MRSA. On the day of surgery, all 4 patients positive for MSSA were primary lumbar patients, with 2 fusion

and 2 laminectomy cases. During the study period, 2 primary lumbar patients developed SSIs (MRSA and Streptococcus), both of which were successfully treated with I&D and IV antibiotics. Neither patient was positive on either MRSA/MSSA screening prior to or on the day of surgery.

DISCUSSION: Our study demonstrates that MRSA/MSSA decolonization in elective spine cases is effective. Ongoing studies are evaluating whether screening will reduce postoperative infections.

GP138

A NEW PREDICTIVE INDEX FOR BACK MUSCLE DEGENERATION AND SAGITTAL ALIGNMENT ASSOCIATED WITH AGING

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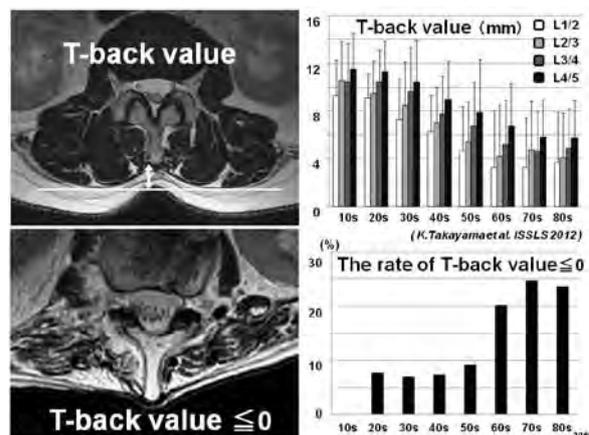
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INTRODUCTION: It is widely accepted that maintaining both lumbar lordosis and paraspinal muscle function is important in the prevention of low back pain. Our study focused on the groove between the left and right lumbar paraspinal muscles to obtain a simple index for evaluating back muscle degeneration. We have already reported that the cross-sectional area (CSA) of a paraspinal muscle tends to decrease with age. Our new index, referred to as the T-back value, strongly correlated with CSA. The aim of this study was to determine the rate of occurrence of T-back values ≤ 0 and to evaluate the imaging features in patients showing these T-back values.

METHODS: A total of 704 patients who underwent an MRI of the lumbar spine at our hospital during 2010 were included in this study. Sagittal T2-weighted MRI was used to measure lumbar lordosis (L1-S1 angle). Axial

T2-weighted MRI was used to measure CSA and fat infiltration of the paraspinal muscle at the intervertebral disc level from L1 to L5. To quantify the depth of the groove between the paraspinal muscles, our own image indicator, the T-back value, equal to the length of the bulge of the muscle to the attachment of the spinous process, was also measured. We then determined the rate of occurrence of T-back values ≤ 0 with age and evaluated the imaging features of them.

RESULTS: Of the 704 patients, 45 male (13%) and 80 female (22%) had T-back values ≤ 0 , and their mean age was 68 years. The occurrence of T-back values ≤ 0 increased markedly in individuals over 60 years of age. Their mean lumbar lordosis was 19.5 degrees. CSA of the paraspinal muscle decreased and fat infiltration increased to a greater extent in elderly patients than in patients with good sagittal balance. Patients with T-back value ≤ 0 included young patients who exhibited decreased lumbar lordosis without degenerative changes and elderly patients with degenerative changes such as disc narrowing, vertebral fractures, and focal kyphosis.



GP139

EFFECT OF WORKSITE EXERCISE ON BACK AND CORE MUSCULAR ENDURANCE IN FIREFIGHTERS

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INTRODUCTION: Achieving an optimal level of physical fitness is important for workers, such as firefighters, who are exposed to physically-demanding environments and at risk for low back pain. The purpose of this study was to: 1) assess the efficacy of a worksite exercise program on the development of back and core muscular endurance in firefighters; and 2) explore barriers and facilitators to participation in the exercise program.

METHODS: An RCT was conducted with career firefighters (n = 96) from a municipal fire department. Participants were randomized by fire station to exercise (n = 54) (supervised work-site core stability and progressive resistance exercise for the back extensors, 2X/week, 24 weeks) or control (n = 42). All participants continued their usual fitness routines. Back and core muscular endurance was assessed by standard fitness tests before and after the intervention. Focus groups were held with participants, using open-ended questions to identify barriers and facilitators to participation in the exercise program.

RESULTS: At 24 weeks, adjusted isometric back and core muscular endurance times were 12% (p = 0.021) and 21% (p < 0.001) greater, respectively, for the exercise group compared with control. Related side effects were generally usual responses to exercise, minor, self-limiting, and did not disrupt job performance. Key facilitators to exercise were group cohesiveness, competitiveness, interest in exercise, financial incentives, and perceived health benefits. Key barriers were

lack of self-motivation, lack of support from colleagues, and inadequate time to exercise.

DISCUSSION: A supervised worksite exercise training program is safe and effective in improving back and core muscular endurance in firefighters. Future exercise programs in research or implementation settings aimed at preventing low back pain in firefighters should address barriers and facilitators to improve participation and outcomes.

GP140

RELATIONSHIPS BETWEEN LOW BACK PAIN-RELATED CEREBRAL SUBSTRATES AND SURROUNDING NEURAL NETWORKS, AND PSYCHOPHYSICAL CHARACTERIZATION IN CHRONIC LOW BACK PAIN PATIENTS. - A FUNCTIONAL MAGNETIC RESONANCE IMAGING STUDY -

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BACKGROUND: Functional magnetic resonance image (fMRI) is used to investigate brain activation in patients with chronic pain. It is reported that there are brain areas, which presents deactivation in common by various tasks or sensory and cognitive activities in recent years. This area is called default mode network (DMN).

The aim of the present study was to investigate the relationships between LBP-related cerebral substrates included DMN, and psychophysical characterization in chronic low back pain (cLBP) patients.

METHODS: Nine cLBP patients and 8 healthy subjects (HS) were enrolled in this study. Three 30-second blocks of pressure

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stimulus were applied with 30 seconds of intervening rest conditions during the imaging (3.0 Tesla MRI scanner). Short-form McGill Pain Questionnaire (MPQ) Japanese version was used to evaluate sensory and affect of pain. Blood oxygenation level-dependent (BOLD) signal was analysed using BrainVoyager QX^{OR} software. The correlation with the BOLD signal of the area obtained by subtraction analysis and MPQ score was examined.

RESULTS: In the HS group, the right insular cortex and prefrontal cortex (PFC), the left anterior cingulate cortex (ACC) and posterior cingulate cortex were activated by a stimulus, while the bilateral DMN were deactivated. In the cLBP group, the bilateral DMN and left supplemental motor area were deactivated. The BOLD amplitude of the right DMN deactivation in the cLBP group was smaller than in the HS group. In the subtraction analysis, at the PFC and ACC, the BOLD amplitude was activated in the HS group, while deactivated in the cLBP group. The correlation coefficient of the %BOLD signal and MPQ scores were $R^2=0.53$ and $R^2=0.32$, respectively, at the PFC and ACC.

CONCLUSION: The results suggested that right DMN in the cLBP patients occur dysfunction. In addition, hypofunction of the PFC and ACC which are both considered as the cerebral terminal of the descending pain inhibitory system might be induced in the cLBP patient

GP141

RELATION BETWEEN THE LOW BACK PAIN AND ROTATION RANGE OF MOTION OF THE HIP JOINT IN THE FEMALE PROFESSIONAL GOLFER

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that the low back pain (LBP) in the American male professional golfer is caused by the restricted internal rotation of the left hip joint. To the best of our knowledge, there have been no studies concerning the female professional golfer (FPG). The purpose of this study was to determine the relation between the LBP and rotation range of motion of the hip joint in the FPG.

METHODS: Thirty-two right-handed FPGs in our country (mean age, 31.6 years, mean height, 162.5 cm, and mean weight, 62.1 kg), who participated in our periodical physical check-up, were examined. Twenty of them had previous or present LBP (LBP group: LG) and 12 of them had been no LBP (NLBP group: NG). We measured the internal rotation angles (IRA) and external rotation angles (ERA) of the bilateral hip joints which were 90° flexed. All angles were compared between LG and NG, and between the right and left sides by Mann-Whitney U test. A P value < 0.05 was considered statistically significant.

RESULTS: The left IRA was significantly smaller in LG than in NG (Fig.).

There were no significant differences between LG and NG concerning the right IRA, the left ERA, and the right ERA. The left IRA was significantly smaller than the right IRA in LG (Fig.). However, there were no significant differences between the right and left sides in regard to the IRA in NG, the ERA in LG, and the ERA in NG.

INTRODUCTION: There has been reported

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Figure. Mean angles which compared between LG and NG (upper), and between the right and left sides (lower)

	LG (n=20)	NG (n=12)	P value (*P<0.05)
Left IRA	:47.3±4.7°	51.7±6.2°	0.021*
Right IRA	:54.0±5.5°	53.3±5.7°	0.481
Left ERA	:53.5±6.3°	53.3±4.4°	0.576
Right ERA	:53.0±6.4°	54.2±7.3°	0.754

	Right	Left	P value (*P<0.05)
IRA in LG	:54.0±5.5°	47.3±4.7°	0.013 *
IRA in NG	:53.3±5.7°	51.7±6.2°	0.369
ERA in LG	:53.0±6.4°	53.5±6.3°	0.824
ERA in NG	:54.2±7.3°	53.3±4.4°	0.256

Values are expressed as mean ± sd.

LG : low back pain group NG : no low back pain group

IRA: internal rotation angle ERA: external rotation angle

DISCUSSION: From the results of this study, only the left IRA was restricted in right-handed FPG who had previous or present LBP. We think that the restricted internal rotation of the left hip joint prevents the weight shift to the finish position, then the FPG compensates those by the lumbar extension which can lead to LBP. These findings suggest that it is important to pay attention to the IRA in FPG and the flexibility of the hip rotation is called for the prevention of LBP.

GP142

THE ASSOCIATION OF BENIGN JOINT HYPERMOBILITY WITH SPINAL INSTABILITY AND ITS CLINICAL IMPLICATION IN ACTIVE YOUNG MAN

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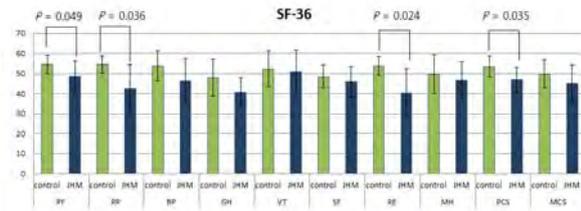
INTRODUCTION: In spite of the similarity in definition between JHM and spinal instability, there have been few studies clarifying the association between two entities. Furthermore, the clinical significance of the spinal instability in the young men with JHM still remains unknown. Therefore, the purpose of this study was to firstly, to evaluate spinal intervertebral mobility in patients with joint hypermobility (JHM) and matched controls without JHM, and secondly, to investigate the influence of JHM on back pain, disability, and general health status in the young man with a retrospective case-control analysis of prospectively collected data.

METHODS: The JHM group included 32 subjects who had Beighton scale of 4 or more according to nine-degree Beighton scale. The age-matched 32 young men without JHM were selectively included in the control group. In both groups, Oswestry Disability Index (ODI), Visual Analog Pain Scale (VAS) for back pain, and Short Form-36 (SF-36) was assessed. Radiological sagittal plane motions for each segment and whole lumbar spine were calculated as the difference between the Cobb angle measurements in the flexion and extension plain radiographs.

RESULTS: The JHM group showed significantly larger range of motion both at each matched segment and at whole lumbar spine (L1-S1) than the control group. The JHM group had significant increased VAS for back pain and ODI score, compared to con-

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trol group. The SF-36 physical function, role physical, role emotional, and physical component summary in the JHM group were significantly lower than in the control group.



DISCUSSION: In conclusion, the present study shows that the young man with JHM has the symptomatic spinal instability correlated to significant low back pain, disability and limited physical activity. Future study regarding spinal instability should be taken into account this benign JHM.

GP143

THE INFLUENCE OF PAIN SENSITIVITY ON THE SYMPTOM SEVERITY IN PATIENTS WITH LUMBAR SPINAL STENOSIS

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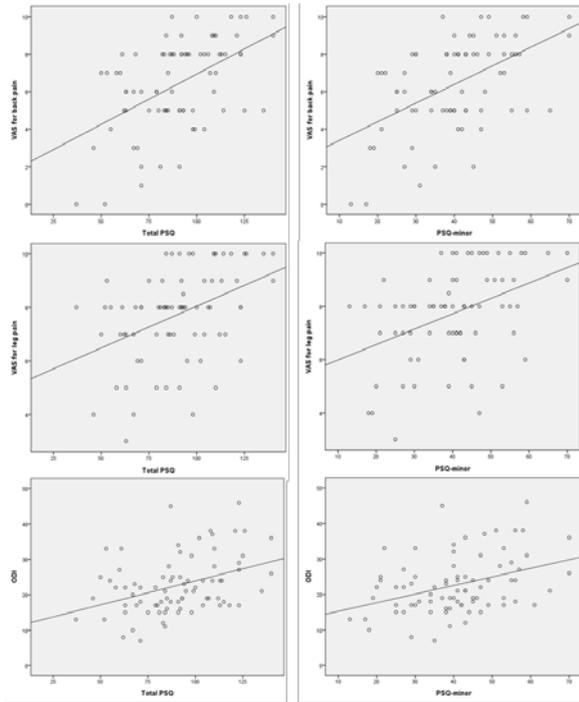
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INTRODUCTION: The symptom severity of back pain/leg pain is not correlated with the severity of degenerative changes and canal stenosis in lumbar spinal stenosis (LSS). Considering the individual pain sensitivity might play an important role in pain perception, this discordance between the radiologic findings and clinical symptom in the LSS might originate from the individual difference of pain sensitivity. Therefore, the aim of this study was to determine the relationship among the clinical symptom, radiologic findings, and the individual pain sensitivity in the patients with degenerative LSS.

METHODS: In 94 patients who had chronic back pain and/or leg pain caused by degenerative lumbar spinal stenosis, a medical history, a physical examination, and completion of a series of questionnaires, including pain sensitivity questionnaire (PSQ) [total PSQ and PSQ-minor], Oswestry Disability Index (ODI), Visual Analog Pain Scale (VAS) for back pain, and Short Form-36 (SF-36) were recorded on the first visit. Radiologic analysis was performed using the MRI findings. The grading of canal stenosis was based on the method by Schizas, and the degree of disc degeneration was graded from T2-weighted images with the Pfirrmann classification. The correlations among variables were statistically analyzed.

RESULTS: VAS for leg and back pain was highly associated with the total PSQ and the PSQ-minor. Total PSQ and PSQ-minor were also significantly associated with ODI. Among SF-36 scales, the PSQ minor had significant correlations with SF-36 BP, RE, and MCS after control of confounding variables such as BMI, age, and the grade of canal stenosis/disc degeneration. Total PSQ was significantly associated with the SF-36 RP, BP, and RE. There was no significant association between the grade of canal stenosis/disc degeneration and symptom severity.

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DISCUSSION: The current study suggests that the pain sensitivity could be a determining factor for symptom severity in the degenerative spinal disease.

GP144

VARIATIONS IN CLINICAL OUTCOME IN THE CLINICAL PRACTIC GUIDELINE-BASED TREATMENT OF PATIENTS WITH ACUTE LOWER BACK PAIN: AN INTENTION TO TREAT ANALYSIS OF THE CHIROPRACTIC HOSPITAL-BASED INTERVENTIONS RESEARCH OUTCOMES (CHIRO) STUDY.

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INTRODUCTION: To conduct an intention-to-treat analysis of data on the consistency of outcomes between patient groups treat-

ed by four different non-operative spine clinicians administering best evidence clinical practice guideline-based treatment that included chiropractor-administered lumbar spinal manipulative therapy.

METHODS: Design: prospective nonrandomized trial. Inclusion: ages 19-59; Quebec Task Force categories 1 and 2; pain duration of 2-4 weeks. Exclusion: “red flag” conditions; contraindications to high velocity low amplitude (HVLA) spinal manipulation therapy (SMT). Treatment: standardized clinical practice guidelines-based care including ≤ 4 weeks of lumbar HVLA SMT administered by a chiropractor. Comparison groups: based on 4 attending non-operative spine clinicians. Outcomes: change in Roland Disability Questionnaire (RDQ) scores at 24 weeks (primary), and in SF-36 bodily pain (BP) and physical functioning (PF) scores at 8, 16 and 24 weeks (secondary). **RESULTS:** In adjusted models, nearly significant overall differences between groups was detected on RDQ ($P=0.10$) and PF ($P=0.16$), but not BP ($P=0.41$) change scores at 24 weeks. Significant differences were observed between groups on both RDQ ($P=0.02$), and PF ($P=0.008$) change scores at 8 weeks, but not at 16 or 24 weeks. No significant differences in BP change scores occurred at any time points. Generally, improvements on all outcomes occurred within all patient groups over time.

DISCUSSION: Early statistically and clinically important differences in RDQ and PF change scores at 8 weeks are not maintained at 16 and 24 weeks. Outcomes are almost universally positive over time irrespective of treating clinician.

GP145

FACET JOINT TROPISM AND DEGENERATIVE SPONDYLOLISTHESIS – A STUDY FROM THE AOSAP RESEARCH COLLABORATION

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tralia

INTRODUCTION: Orientation of lumbar facet joints (FJ) may be associated with the pathogenesis of degenerative spondylolisthesis (dSpl). However, the role of FJ tropism (i.e. asymmetry between facet joint orientations at the same level) in dSpl is undetermined. This study addresses the role of FJ tropism in relation to dSpl.

METHODS: A multi-national, cross-sectional study was performed in 34 institutions in the Asia Pacific region. Lateral standing radiographs and axial MRIs and/or CT scans were obtained for subjects with single level lumbar dSpl. Imaging was analyzed to assess lumbar levels with L4-5 dSpl (Group A) or without dSpl (Group B). FJ tropism was defined as a ≥ 7 degree angulation difference and also assessed on ROC curve analysis to identify critical values. Subject demographics were also noted.

RESULTS: The study included 351 patients (36.9% males, 63.1% females) with a mean age of 61.8 years. There were 267 patients (76.1%) in Group A and 84 individuals (23.9%) in Group B (control). A significant difference was noted in FJ angulations between Group A (mean right: 57.5 degrees; left: 55.4 degrees) and Group B (mean right: 48.4 degrees; left: 46.5 degrees) ($p < 0.001$). Based on FJ tropism of 7 degrees, there was no statistically significant difference between Groups. ROC analysis identified FJ angulation difference of 15 degrees or greater associated with dSpl. Based on age and FJ angulation-adjusted multivariate analysis, FJ tropism with a critical value of ≥ 15 degrees noted an odds ratio of 2.43 (95% CI: 1.20 - 4.91; $p = 0.014$) associated with dSpl. Slippage was noted with increased FJ tropism, but the effects could not be discerned.

DISCUSSION: Greater sagittal FJ orientation was associated with dSpl, as was joint tropism. A critical value of 15 degrees FJ angle difference produced a two-fold increased

likelihood of dSpl. Our study broadens the understanding of FJ morphology and its role in degenerative sagittal plane instability.

GP146

HIP FLEXION CONTRACTURE AND OUTCOME OF CORRECTIVE SURGERY FOR ADULT SPINAL DEFORMITY WITH SAGITTAL IMBALANCE

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INTRODUCTION: Hip flexion contracture might be a potential risk for fixation failure and loss of correction in surgical treatment of sagittal imbalance. This study aimed to evaluate preoperative hip flexion contracture and to investigate the effect of perioperative physical therapy on the outcomes of corrective surgery sagittal imbalance.

METHODS: Fourteen patients who underwent corrective surgery for adult spinal deformity with sagittal imbalance were included in this study. The mean age was 68 years (54-78 years). Surgical procedures were posterior or transforaminal lumbar interbody fusion (PLIF/TLIF) in eight patients, pedicle subtraction osteotomy (PSO) in five patients, and posterior vertebral column resection (PVCR) in one patient. Hip range of motion (ROM) was measured preoperatively in all patients. Improvement of ROM was also assessed in patients with physical therapy intervention for hip contracture. "Remaining sagittal imbalance" was defined as more than 10 cm deviation of C7 plumb line even after surgery.

RESULTS: Ten patients achieved improvement of sagittal balance (successful correction group), but sagittal imbalance remained in four patients (poor correction

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group). Hip flexion contracture (hip extension < -5 degree) was observed in 7 of 14 patients. Hip extension ROM was -8 degrees in poor correction group, and was 1 degree in successful correction group. Perioperative physical therapy was done in three patients; hip extension ROM was improved from -15 degrees to 8 degrees. C7 plumb line deviation was improved from 14.8 cm to 6.0 cm in the patients with physical therapy intervention, but was worsen from 5.1 cm to 13.2 cm in those without physical therapy.

DISCUSSION: Hip flexion contracture was frequently observed in patients with adult spinal deformity and sagittal imbalance. Perioperative physical therapy improved hip extension ROM, and might have a favorable effect on postoperative sagittal spinal balance.

GP147

INTRAOBSERVER AND INTEROBSERVER RELIABILITIES IN ULTRASONOGRAPHIC MEASUREMENT OF THE LATERAL ABDOMINAL MUSCLE THICKNESS WITH USE OF THE BONE INDEX IN THE IMAGE

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INTRODUCTION: There have been reported that the lateral abdominal muscle was important to stabilize the spine. However, it has been difficult to measure accurately the muscle thickness without the index using the ultrasonography. The purpose of this study was to establish a new method to measure the lateral abdominal muscle thickness and to investigate the reliability of our method.

METHODS: Informed consents to inclusion in this study were obtained from 13 healthy men (mean age, 24.5 years) who did not have any previous back nor lumbar disor-

ders, and the study was approved by the internal review board. The muscle thicknesses of external oblique (EO), internal oblique (IO), and transversus abdominis (TA) were measured using the ultrasonography (Fig.). The muscle thicknesses were measured twice independently and averaged. The observer A (OA) and observer B (OB) remeasured the bilateral muscle thicknesses of the four of the 13 subjects one week later, and the intraobserver reliabilities (IARs) of the two days' measurements were determined by the intraclass correlation coefficient (ICC). Also, interobserver reliability (IER) between OA and OB was calculated.

RESULTS: IARs between the two days were high in both observers and in all muscles (OA: ICC=0.953 in EO, 0.919 in IO, and 0.970 in TA, OB: ICC=0.830 in EO, 0.915 in IO, and 0.864 in TA). IERs between OA and OB were also high in all muscles (ICC=0.928 in EO, 0.906 in IO, and 0.908 in TA).

DISCUSSION: From the results of this study, IAR and IER were high and evaluated to be "almost perfect" according to Ladis ('77, Biometrics). We think this is because that we could reemerge accurately the lateral abdominal muscles using the bone index in the image and using the probe which was placed perpendicularly to the fasciae. These findings suggest that our new method may be useful for the follow-up study of the same subject and for the comparison of the muscle thicknesses which were measured by the other observers.

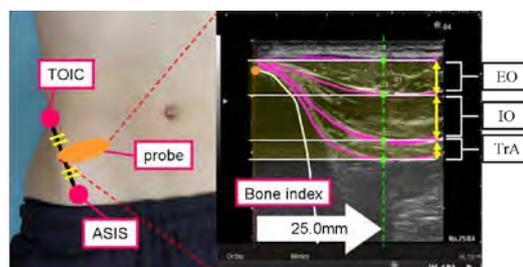


Fig. The probe was placed at the midpoint of the anterior superior iliac spine (ASIS) and the top part of the iliac crest (TOIC) of the subject at supine end-expiratory resting position (left). We measured the bilateral muscle thicknesses at the point of 25mm towards the navel from the tip of the iliac crest (Bone index) with use of the ultrasonography (right).

GP148

THE EFFICACY OF LP-IDOPE AS A NEAR-INFRARED PROBE IN THE MANAGEMENT OF PAIN CAUSED BY SPINAL METASTASIS

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INTRODUCTION: The cause of and mechanism underlying pain due to spinal metastasis, despite severe and refractory therapy, is unclear. No standard therapy has yet been established for the management of pain due to spinal metastatic tumors. In a recent study, we have reported that liposomally formulated 1,2-dioleoyl-*sn*-glycero-3-phosphoethanolamine(LP-iDOPE) along with indocyanine green as a near-infrared(NIR) probe accumulates near fragile vascular tissue. LP-iDOPE accumulates near various tumors and inhibits tumor growth after NIR irradiation. However, to our knowledge, no studies have reported whether it plays a role in relieving pain caused by spinal metastasis. The aim of this study was to determine the efficacy of LP-iDOPE as an NIR probe for alleviating pain due to spinal metastatic tumors.

METHODS: Rat breast tumor cell-line cluster transplanted at the L6 vertebral body was used as the spinal metastasis model. Seven days after surgery, the L6 vertebra was intravenously injected with LP-iDOPE and subjected to NIR irradiation. Then, in-vivo fluorescence imaging of the L6 was performed after 24, 48, and 168 h. Further, the bilateral dorsal root gangliaon(DRGs) at the L1–L6 levels were resected and immunohistochemically evaluated using calcitonin gene-related peptide(CGRP)

induction with TRPV1 as a capsaicin receptor. The percentages of TRPV1-immunoreactive (IR) DRG cells and CGRP-IR DRG cells were statistically compared between the groups.

RESULTS: Tumor growth was inhibited in the region showing spinal metastasis after NIR irradiation. The percentage of CGRP- and TRPV1-IR DRG cells was lower in the NIR-irradiated group than in the non-NIR-irradiated.

DISCUSSION: Spinal metastasis is associated with acid and pH fluctuation. We found that the levels of TRPV1, a sensor of acid and pH fluctuation, and CGRP, a nociceptive neurotransmitter, decrease after NIR irradiation. Therefore, LP-iDOPE, as an NIR probe, is effective in managing the pain caused by spinal metastasis.

GP149

HEALTH, SOCIAL AND ECONOMIC CONSEQUENCES OF NECK INJURIES: A CONTROLLED NATIONAL STUDY EVALUATING SOCIETAL EFFECTS ON PATIENTS AND THEIR PARTNERS

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INTRODUCTION: Despite neck injuries cause significant socio-economic burdens, there is insufficient information about the time course, as well as the effect on their partners. The aim was to estimate health-care costs of neck injuries, except fractures, in patients and their partners, both follow-

ing and preceding the injury.

METHODS: In a case-control study, using records from the Danish National Patient Registry 1998-2009, all patients with a diagnosis of neck injury and their partners were identified and compared with randomly chosen controls matched for age, gender, geographic area and civil status. Direct costs included frequency of primary and hospital sector contacts, procedures and medication. Indirect costs included the effect on labour supply. Social transfer payments were included to illustrate the effect on national accounts.

RESULTS: The register contributed 94,224 patients, and 372,341 matched controls were identified. Approximately 47.5% were married or cohabiting in both groups. Neck injury patients had significantly higher rates of health-related contacts, medication use and higher socio-economic costs than controls. To a lesser extent, they also had lower employment rates, and those employed generally had lower incomes. Furthermore, the patients had already presented negative social- and health-related status up to 11 years before the first diagnosis, which became more pronounced for those with the highest costs. The health effects on costs were present regardless of age group and gender, and it was also seen for the patients' partners.

DISCUSSION/CONCLUSION: Neck injuries are associated with major socio-economic consequences for patients, their partners and society. However, the increased expenses during subsequent years cannot be explained by the injury alone, because these patients already had elevated expenses prior to the injury. This indicates some selection of increased vulnerability for both patients and their partners.

GP150

CT CLASSIFICATION OF VACUUM PHENOMENON FOR THE LUMBAR INTERVERTEBRAL DISC

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INTRODUCTION: Vacuum phenomenon in the intervertebral disc has been well-recognized phenomena in disc degeneration process. However, the clinical significance as well as the comprehensive analysis has not been assessed. Our objective was to clarify characteristics of vacuum phenomenon in lumbar disc.

METHODS: The study involved 120 lumbar discs from 24 patients (mean 70.4 years) with existence of vacuum phenomenon detected by reconstructed sagittal CT images. Vacuum phenomenon was classified into 5 grades: Grade 1, dot-like change 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 annulus fibrosus (AF); and Grade 5, linear cleft through the disc. Disc height was measured by CT. Segmental instability was evaluated by flexion/extension radiographs. Correlation of vacuum phenomenon grades with MRI Pfirrmann degeneration grades and Modic change type was investigated.

RESULTS: Vacuum phenomenon was detected in 49% of 120 discs (L1/2, 3%; L2/3, 6%; L3/4, 10%; L4/5, 17%; and L5/S, 13%), which were classified into Grade 1, 6%; Grade 2, 8%; Grade 3, 8%; Grade 4, 14%; and Grade 5, 13%. Disc height was significantly decreased in Grade 5. In comparison between vacuum phenomenon grades and Pfirrmann grades, while no disc with Pfirrmann Grade 1-2 was observed, and 77% of discs with Grade 4 vacuum were

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identified as Pfirrmann Grade 4, and 100% of discs with Grade 5 vacuum were classified as Pfirrmann Grade 5. Type 2 Modic change was observed in 73% of vacuum Grade 5 discs. In functional radiographs, 10% of segments with vacuum Grade 3 disc and 18% of segments with vacuum Grade 4 disc showed translation over 3mm.

DISCUSSION: Our grading system for vacuum phenomenon facilitates classifying discs with advanced degeneration in MRI. Even in Pfirrmann Grade 4-5 discs, vacuum Grade 3-4 discs with massive defect from NP through AF may have the potential to induce segmental instability.

GP151

TRUE POSITIVE CONDUCTION TESTS OCCUR RARELY IN CLINICAL PRACTICE

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INTRODUCTION: Conduction tests are a necessary component of the low back pain (LBP) physical examination. This study compares conduction test findings with location of dominant pain to establish false positives from true positives.

METHODS: This was a prospective observational cohort study of low back pain (LBP) cases (n=2196) treated non-operatively at 40 spine care rehabilitation clinics across four provinces between January 2008 and June 2010. All patients had mechanical LBP as determined by the Saskatchewan Spine Pathway triage methodology.

Level test	#positive (back)	#positive (leg)	total
L4 knee reflex	65	5	70
L4-5 ankle dorsiflexion	58	14	72
L5 trendelenberg	14	0	14
L5 ext. hallucis longus	60	9	69
S1 ankle reflex	82	5	87
S1 plantar flexion	57	12	69
S1 gluteus maximus	14	4	18

RESULTS: The Table displays seven conduction tests evaluated in this study and the frequency of occurrence based on location of dominant pain. There was a statistically significant difference between conduction tests that were positive among those with back pain vs those with leg pain ($p < 0.05$).

DISCUSSION: Positive tests in those without leg dominant pain or with the reproduction of LBP only are highly unlikely to be associated with the current clinical problem. They may represent a pre-existing neurological deficit or, more frequently an error in examination. True positive conduction tests occur only in those with leg dominant pain; thus, the 'positive back' column is considered false positives while the 'positive leg' column are the true positives. Clinicians need to cross reference test results with location of dominant pain to ensure accurate diagnoses and avoid false positives.

GP152

ANALYSIS OF THE S1 SACRAL FORAMINAL LOCATION USING A THREE-DIMENSIONAL CT RENDERING TECHNIQUE

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INTRODUCTION: Nerve root blocks (NRBs) have been widely performed under fluoroscopic guidance. Because of the lack of three-dimensional (3D) anatomical information, an S1 NRB is more difficult than a lumbar NRB. The purpose of the present study was to investigate the location of the S1 foramen using a 3D computed tomographic (3D CT) rendering technique, ray-sum projection.

METHODS: We retrospectively assessed 60

patients (30 female, 30 male; age 22–84 years, average 54.4 years) with lumbar degenerative disease. Spiral CT was performed using a multi-detector CT scanner in the axial plane. Images were networked to imaging software Synapse Vincent V3.0.0003(Fujifilm Medical, Japan) for 3D imaging. On axial CT imaging, we marked the center of the posterior sacral foramina (PS1). The marked point (PS1) was displayed by 3D CT with ray-sum projection as a substitute for fluoroscopic radiography. Ray-sum projection is a 3D rendering technique in which the attenuation value of each voxel is summed along a projection line. A ray-sum image resembles a conventional radiograph. The center of the L5 pedicle (PL5) was also marked on a ray-sum image. The distances between PS1 and PL5 were measured in the vertical and lateral directions, respectively.

RESULTS: PS1 was located 39.3 ± 7.0 mm caudally and 3.5 ± 3.7 mm laterally from PL5.

DISCUSSION: The present findings demonstrate the excellent feasibility of the 3D-CT rendering technique for assessing the 3D anatomy of the S1 foramen. Quantitative analysis indicates that a fluoroscope should be aimed 39.3 ± 7.0 mm caudal and 3.5 ± 3.7 mm lateral from the center of the L5 pedicle to perform an S1 NRB under fluoroscopic guidance. The present findings may be useful when performing an S1 NRB.

GP153

CLINICAL EVALUATION OF PREGABALIN FOR LUMBAR CANAL STENOSIS PATIENTS WITH PERIPHERAL NEUROPATHIC PAIN

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INTRODUCTION: Lumbar spinal stenosis (LSS) patients may experience neuropathic pain (NeP) that is refractory to existing analgesics. Pregabalin (PGB), a novel analgesic developed for NeP management, suppresses the secretion of pain-related mediators in the synapses by binding to $\alpha 2\delta$ subunits of Ca^{2+} channels. PGB has already been reported to be effective for post-therapeutic neuralgia and diabetic neuropathy; however, its efficacy in LSS patients with NeP has not yet been evaluated. The present study aimed to investigate whether PGB has an effect on NeP management in LSS patients.

MATERIALS AND METHODS: The subjects were LSS patients with NeP identified using a screening tool, Pain DETECT. Individuals who experienced leg pain (Visual Analog Scale [VAS] score > 30) and intermittent claudication (< 300 m) refractory to NSAIDs for more than a month were included. They were administered PGB at a dose of 25 mg/d, which was gradually increased to 150 mg/d for 6 wk according to their pain intensities. VAS scores and Japan Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) responses were assessed before and 1 mo after the PGB treatment was initiated. JOABPEQ is a novel, validated method for evaluating the degree of low back pain (LBP) based on the Roland-Morris Disability Questionnaires and Short Form 36 containing the following 5 subscores: pain-related disorders (PD), gait disturbance (GD), lumbar spine dysfunction (LD), social life disturbance (SD), and psychological disorders (PD).

RESULTS: Fifty-seven LSS patients were assessed (ave. 71.0 yo). The use of PGB significantly decreased their VAS scores ($P < 0.01$). With respect to JOABPEQ, PD ($P < 0.01$), LD ($P = 0.031$), GD ($P = 0.028$), and PD ($P = 0.014$) showed significant improvement after PGB treatment. Complications such as dizziness or nausea were not observed dur-

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ing the study.

CONCLUSION: PGB can alleviate the pain and improve LBP-related factors such as PD, LD, GD, and PD in LSS patients with NeP symptoms.

GP154

EPIDEMIOLOGY, DETERMINANTS, AND FUNCTIONAL STATUS OF SCIATICA: A LARGE-SCALE POPULATION-BASED STUDY IN CHINESE

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INTRODUCTION: The prevalence, risk factors, and outcomes of sciatica have been sporadically reported in the literature, largely patient-based and mainly related to Caucasians. The following study addressed the epidemiology, determinants, and functional status of sciatica within a Chinese population.

METHODS: A cross-sectional population-based study of 2,597 Southern Chinese was performed assessing sagittal T2-weighted lumbar MRIs for the presence of radiographic findings from L1-S1 (e.g. HIZ, Modic changes, Schmorl's nodes). A summated disc bulge/extrusion (DBE) score was obtained of all levels. Self-reported sciatica during the past year was assessed. Subject demographics, environmental/lifestyle factors, and functional status (i.e. SF-36, ODI) were also assessed.

RESULTS: There were 60% females and 40% males (mean age: 42 years). The overall prevalence of sciatica was 39.4%, which increased with progression of each age category ($p=0.005$). An elevated DBE score was found in subjects with reported sciatica (mean: 0.80) compared to those without (mean: 0.63) ($p<0.001$). DBE was most prevalent

at L5-S1 (31.3%) and L4-L5 (24.3%). Based on an adjusted multivariate model, DBE (OR: 1.36; 95% CI: 1.15-1.60), females (OR: 1.38; 95% CI: 1.17-1.64), obesity (OR: 1.68; 95% CI: 1.25-2.24), and moderate/heavy workload (OR:1.74; 95% CI: 1.11-2.74) were associated with sciatica. Subjects with sciatica reported worse SF-36 and ODI functional outcomes ($p<0.05$).

DISCUSSION: This is one of the largest population-based studies to assess demographics, environmental/lifestyle, functional, and imaging factors in relation to the development of self-reported sciatica. DBE, females, obesity, and moderate/heavy workload were significant determinants associated with sciatica. Decreased functional status was also more prevalent in sciatica subjects.

GP155

CHANGES IN OBJECTIVELY MEASURED WALKING CAPACITY OVER A 2 YEAR PERIOD IN INDIVIDUALS WITH LUMBAR SPINAL STENOSIS

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INTRODUCTION: Walking capacity is recognized as a key outcome in people with lumbar spinal stenosis (LSS). The majority of studies investigating walking in LSS have used inaccurate self-report tools. Little is known about long term changes in objectively measured walking.

OBJECTIVE: Assess changes in objectively measured walking capacity over 2 years in people with LSS. Methods: Of 49 subjects enrolled in a study of walking in LSS, we were able to follow 26. All subjects had LSS diagnosed by a spine surgeon, confirmed on imaging. At baseline and 2 yrs subjects completed a Self-Paced Walking Test, and a questionnaire. At follow-up they indicated treatments accessed over the 2 yr period.

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For analysis subjects were divided into surgical, non-surgical treatment, and no treatment groups.

RESULTS: The 26 subjects had a mean baseline age of 68.4(9.2) and 65% were female; 11 had surgery over the 2 year period, while 8 had some form of non-surgical treatment and 7 had no treatment of any kind. The only significant difference between groups for baseline walking was between the surgery and no treatment groups. Over the 2 yrs, the surgery group had a non-significant increase in capacity from 871m(867) to 1402(1009), the non-surgical treatment group had a significant decrease from 1868m(907) to 960(783), and subjects who had no treatment showed no change (1463m(839) to 1301(974)).

DISCUSSION: Individuals who elected to have surgery had lower baseline walking capacity compared to those who had no treatment. A significant decrease in walking was observed for the 8 subjects who had non-surgical intervention, yet despite a similar baseline capacity, the 7 subjects who had no treatment showed relatively stable walking capacity over 2 years. Given the observational nature of this study, we can make limited conclusions regarding comparison of treatments. However, these results may aid us in better understanding the nature of walking limitation in LSS.

GP156

OPIOID SENSITIVITY AFFECTS POSTOPERATIVE OUTCOME IN LUMBAR SPINE SURGERY

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INTRODUCTION: Opioid sensitivity altered

by the A118G polymorphism in the opioid receptor Mu 1 gene is reported to affect postoperative outcome. However, it is unclear whether this is true for lumbar spine surgery. The purpose of this study was to prospectively evaluate whether preoperative opioid sensitivity alters postoperative outcome in patients undergoing lumbar spine surgery.

METHODS: Subjects included 22 patients suffering from low back pain (LBP) and radiated leg pain who were treated with opioids (fentanyl or tramadol) at our hospital from September 2009 to August 2012. Cases included 4 lumbar disc herniation and 18 lumbar spinal stenosis patients who underwent posterior lumbar discectomy and posterior lumbar decompression accompanied by instrumented posterolateral fusion, respectively. We evaluated their LBP and leg pain improvement rate on the visual analog scale (VAS) in response to opioids before and after surgery. Patients were divided into two groups according to their response to presurgical opioid administration: higher improvement rate on VAS (>50%; HR group) and lower improvement rate (<50%; LR group). Symptoms are indicated by a subscript "LBP" or "LEG" (leg pain).

RESULTS: For LBP, the HRLBP group showed 58.6% postsurgical improvement, while the LRLBP group experienced 28.3% improvement; this difference was statistically significant ($P<0.05$). For leg pain, the HRLEG group showed 64.3% postsurgical improvement, while the LRLBP group experienced 32.7% improvement; this difference was not statistically significant.

DISCUSSION: Higher opioid sensitivity was indicative of significantly higher postsurgical improvement in LBP, while no such association was observed for leg pain. The results of the present study suggest that the intensity of LBP derived from lumbar disorders can be associated with altered opioid sensitivity. This implies that preoperative opioid sensitivity can be a potential predictive fac-

tor for postsurgical outcome.

GP157

CHARACTERISTICS OF PAIN-RELATED SENSORY INNERVATION ON OSTEOPOROTIC LUMBAR VERTEBRAE WITH OVARIECTOMIZED RATS.

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INTRODUCTION: Osteoporotic patients without fractures sometimes experience chronic low back pain of unknown origin. We have previously reported that the expression of calcitonin gene-related peptide (CGRP), a marker of inflammatory pain, is increased in dorsal root ganglia (DRG) neurons innervating lumbar vertebrae of osteoporotic rats. However there is few evidence what is happening in the osteoporotic spinal dorsal horn where microglia is activated in a state of chronic neuropathic pain. The present study aimed to examine the characteristics of pain-related sensory innervation in rat osteoporotic lumbar vertebrae in their DRG and spinal dorsal horn.

MATERIALS AND METHODS: As an osteoporosis group (OVX group), we used 21-week-old female rats ovariectomized at 5 weeks (n=20). As the control group, sham-operated rats without ovariectomy were used (n=20). Fluoro-Gold (FG), retrograde neurotracer, was applied into the myeloid of L3 to label DRG neuronal cells innervating the vertebra. Four weeks after the FG-labeling, the animals were killed to resect

bilateral L1 to L6 DRGs and spinal cord. The CGRP expression in FG-labeled DRG neurons, Iba-1 (a marker of microglia) expression in spinal dorsal horn were statistically examined between the two groups using immunofluorescence.

RESULTS: The proportions of FG-labeled CGRP immunoreactive (-ir) DRG neurons in the OVX group were significantly elevated compared with the control (p < 0.05). Furthermore, the proportion of Iba-1-ir neurons in the dorsal horn of spinal cord were also significantly increased in the OVX group (p < 0.05).

DISCUSSION: The result of the present study suggested that osteoporotic state might increase CGRP expression in DRG neurons innervating L3 vertebrae and microglial activation in spinal dorsal horn, implying that the central nervous system may be activated as well as peripheral in osteoporosis rats. That should be lead to clarify the pathology of osteoporotic pain.

GP158

SEVERE SCOLIOSIS DURING ADULTHOOD: IS SURGERY THE ONLY POSSIBLE TREATMENT?

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INTRODUCTION: Surgery is generally considered the only approach for worsening adult scoliosis. Nevertheless there are patients who cannot undergo surgery for poor general health condition or who are willing not to be fused. An evidence based treatment for these patients is necessary. In our facility we treat adult scoliosis patients with specific exercise to avoid/stop progression. The aim of this study is to report our results in a cohort of patients

METHODS: Population: Thirty one patients (3 males) of 38 ± 11 years and 55 ± 14° Cobb

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scoliosis, treated for 3 (range 1–18) years because of progression subjectively perceived (17 patients), or objectively documented (14 patients: subgroup A, previous observation of 10 years, range 1–27), have been included. 6 patients (sub-group B) were observed also after stopping treatment for 6 (3–10) years. Patients were treated according with a scoliosis specific exercise protocol (SEAS).

RESULTS: Exercises caused a statistically significant decrease of $3.6 \pm 5^\circ$ of scoliosis ($-3.2 \pm 4.3^\circ$ per year): 1 patient progressed, 45% improved; in sub-group A results were identical, after a previous worsening of $9.7 \pm 6.8^\circ$ ($+2.1 \pm 4.3^\circ$ per year); in sub-group B stopping exercises caused a progression of $8.3 \pm 3.8^\circ$ ($+1.4 \pm 0.5^\circ$ per year). The best results were observed in patients exercising since, even if some patients continued to decrease their curve during the years.

CONCLUSION: SEAS exercises revert the progression of adult scoliosis, and a prospective study is already under way. The different results according to length of treatment could be due to a plateau of correction or to an increase of quality of the protocol applied (SEAS changes continuously according to new knowledge in the literature). These results question the immediate need for surgery when facing progression of deformity in adulthood.

GP159

A STUDY ON DIFFUSION WEIGHTED IMAGING FOR LUMBAR DISEASES ~ITS USEFULNESS AND LIMIT ~

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Funabashi Orthopedic Hospital*

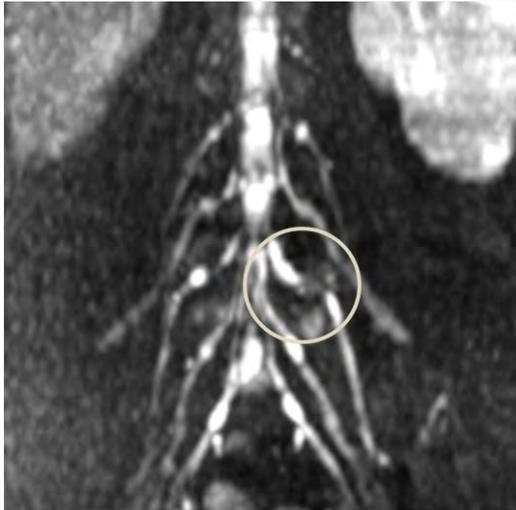
INTRODUCTION: Conventional MRI is very useful for lumbar diseases, but it is often not sensitive for intra- and extra foraminal lesions. Since Jun.2011, we are trying to picturize the nerve root lesions by using

diffusion weighted imaging (DWI), which can be examined within a short time, in addition to conventional MRI. The purpose of this study was to evaluate the usefulness and the limit of DWI for lumbar diseases.

METHODS: One-hundred fifty two consecutive patients, who were performed MRI and DWI (1.5-T, b-value 400, imaging time 86seconds) in Jan 2012 for lumbar diseases were included. One spine surgeon and one radiological technician interpreted DWI and recorded the abnormality findings of nerve root as follows; swelling, stoppage and deviation of the runway of nerve root. In addition, the high intensity of tissues around nerve was recorded. When both viewers' findings coincided, they were defined to be DWI positive. Neurological symptoms and diagnosis were checked by a medical record and MRI, so that its sensitivity and specificity were evaluated.

RESULTS: One-hundred forty four patients were able to be interpreted (84 men and 60 women). Mean age was 56 (range: 14 to 84). There were 56 lumbar disc herniation patients (lateral type 5 patients), spinal canal stenosis 25, spondylolisthesis 20, compression fracture 13, foraminal stenosis 5, spondylolysis 5, and normal findings were 20 patients. 100 patients had unilateral or bilateral sciatica. DWI positive were 33 patients. The sensitivity of DWI positive to sciatica was 36% and specificity was 20%, therefore it was not useful. However, as to lateral disc herniation and foraminal lesions, sensitivity was 86% and specificity was 80%. In addition, 2 spondylolysis and 2 metastatic tumors were detected.

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DISCUSSION: DWI in our hospital is able to be performed for short time enough to be added to conventional MRI examination. It was useful for intra- and extra foraminal lesions but not for in spinal canal les

GP160

LOW BACK PAIN IN YOUNG ATHLETES AND THEIR EXAMINATION FINDINGS

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INTRODUCTION: Many young athletes come to our hospital suffering low back pain (LBP). Their etiology is often different from that of adult's, of which over 80% is non-specific; on the contrary, young athletes' LBP is considerably due to lumbar spondylolysis.

OBJECTIVES: The purpose of this study was to investigate the etiology of young athletes' LBP and to evaluate the usefulness of examination findings.

METHODS: From 2010.1, we prospectively investigated a total of 94 young athletes with LBP (54 men and 40 women; mean age; 14.9 years; range 12 to 18). We evaluated them at their first visit with following findings; LBP 1) on flexion and 2) on extension in standing position, 3) tenderness on facet joint, 4) straight leg raising (SLR) test. We restricted their sport activities for one

week, and if they still had LBP, we performed CT and/or MRI. Spondylolysis were divided into three stages; early, progressive, terminal stage.

RESULTS: Of the 94 subjects, 68 athletes remained LBP. The number of spondylolysis was 42 (44.7%), lumbar disc herniation was 18 (19.1%), fatigue fracture of sacrum was 1 (1.1%), and 6 (3.2%) were unable to be diagnosed. Of 42 spondylolysis, early stage was 26, progressive 10, terminal 6. The number of the subjects who became pain free after rest, was 28, and they resumed athletic training with no difficulty. As to the clinical findings, when there were both LBP on extension and facet joint tenderness, the sensitivity and specificity for spondylolysis was 95.2% and 53.8% respectively. For lumbar disc herniation, LBP on flexion was 88.9% and 60.5% respectively.

CONCLUSION: In this study, spondylolysis caused LBP in 44.7% of young athletes. The findings of LBP on extension and tenderness on facet joint were very important for diagnosis of spondylolysis. When you examine young athletes with low back pain, you have to think of spondylolysis and record these findings.

GP161

FACTORS ASSOCIATED WITH PARASPINAL MUSCLE ASYMMETRY IN A GENERAL POPULATION SAMPLE OF MEN.

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INTRODUCTION: Paraspinal muscle asymmetry in cross-sectional area (CSA) and composition (e.g. fatty infiltration) have been associated with low back pain (LBP) and pathology. Yet, substantial multifidus asymmetry has also been reported in

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asymptomatic men and little is known about other factors influencing asymmetry. The goal of this study was to identify a range of behavioral, environmental and constitutional factors associated with paraspinal muscle asymmetry.

METHODS: A cross-sectional study of a general population sample of 202 adult male twins was conducted. Data were collected through a structured interview, physical examination and MRI. Multifidus and erector spinae CSA (muscle size), and the ratio of fat-free CSA to total CSA (muscle composition) measurements were obtained from T2-weighted axial images at L3-L4 and L5-S1 spinal levels.

RESULTS: In multivariable analyses, greater asymmetry in multifidus CSA (size) at L3-4 was associated with less occupational physical demands and disc narrowing. No factors studied were associated with multifidus CSA asymmetry at L5-S1. For erector spinae, greater age and disc narrowing were associated with CSA asymmetry at L3-4 and sports activity, disc narrowing and familial aggregation at L5-S1. In multivariable analyses of asymmetry in muscle composition, familial aggregation was associated with side to side differences in multifidus and erector spinae at both levels measured, explaining 9-17% of the variance. Sports activity and pain severity also entered the model for erector spinae asymmetry at L5-S1, and disability and disc narrowing for multifidus at L5-S1.

CONCLUSION: Few of the factors investigated were associated with paraspinal muscle asymmetry, and associations were generally modest, explaining little of the variance in paraspinal muscle asymmetry. With the exception of familial aggregation, and disc narrowing to a lesser degree, associated factors were not consistent across muscles or spinal levels.

GP162

THE USA FUNGAL MENINGITIS OUTBREAK AFTER EPIDURAL STEROID INJECTIONS: THOUGHTS ON EPIDEMIOLOGY AND FUTURE PATIENT SAFETY

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Co-Chairman NASS Patient Safety Committee

INTRODUCTION: The September 2012 outbreak of fungal meningitis in the United States following epidural steroid injections (ESI) has raised a number of issues concerning the epidemiology of the infection and future patient safety.

METHODS: The Patient Safety Committee of the North American Spine Society (NASS) has liaised with the US Centers for Disease Control (CDC) through the outbreak. CDC and various state department of health websites were monitored to follow the investigation. Literature on complications of ESI's was reviewed.

RESULTS: Recent CDC data indicates 461 cases of meningitis from approximately 14,000 injections/exposures. This translates to an infection rate of approximately 3%. There have been 32 deaths. The CDC has suggested that the epidemiology is inoculation of the epidural space from an ESI, compromise of the immune system from the systemic steroid effect and the fungus eventually "boring" through the dura to infect the CSF causing meningitis.

DISCUSSION: Questions arise whether there is an alternate explanation to the epidemiology suggested by the CDC. A literature review indicates that the accepted rate of inadvertent intrathecal injection is about 3%. This is similar to the rate of meningitis infection after ESI with tainted methylprednisolone. Thus, one explanation for the epidemiology of the meningitis would be that we are seeing infections develop as a result of the expected incidence of transdural injection with ESI's. Other technical issues include whether there is a higher rate of

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infections using a sharper Quincke needle versus a duller Tuohy, if use of fluroscopy allows more precise needle placement, whether multiple ESI's are a risk factor to infection and whether a transforaminal ESI has a lower rate of infection compared to translaminar. These questions will hopefully be clarified as the investigation proceeds. The answers will assist in deciding on the safest injection techniques for our patients into the future.

GP163

REDUCTION OF SURGICAL REVISION RATES AND ECONOMIC ANALYSIS OF USING AN INTRAOPERATIVE CT-BASED NAVIGATION SYSTEM FOR PEDICLE SCREW PLACEMENT

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INTRODUCTION: Incidence of pedicle screw breach varies based on anatomic location, body habitus, surgeon experience, spinal deformity, and surgical technique. Pedicle breaches have been reported to occur in up to 40% of screws. The purpose of the current study was to compare the rates of returning to the operating room for revision of pedicle screw placement when using C-arm versus O-arm assessment of pedicle screws.

METHODS: A retrospective study was performed to determine the rates of returning to the operating room for revision of a breached pedicle screw when using C-arm versus O-arm visualization. An economic analysis was also performed based on estimated cost of return to the operating room for revision of the pedicle screws.

RESULTS: There were 4 (1%) of 386 control cases that required a return to the operating room for pedicle screw revision for a breached pedicle screw not identified with intraoperative C-arm fluoroscopy. In the study group none of the 331 patients were

returned to the operating room when using the O-arm to assess the placement of pedicle screws. Based on the 1% rate of returning to the operating room for pedicle screw revision in the control group, the annual rate of cases nationwide requiring pedicle screw revision would be approximately 2300 with a cost of approximately \$40,595,000.

DISCUSSION: These results suggest that the use of intraoperative CT can reduce the need for return to the operating for revision of a breached pedicle screw. This can potentially lead to a major cost savings.

GP164

ROD BREAKAGE AFTER LONG CONSTRUCT FUSION IN SPINAL DEFORMITY: CLINICAL AND RADIOGRAPHIC RISK FACTORS

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INTRODUCTION: The aim of this study was to analyze clinical and radiographic risk factors of rod breakage after long construct fusion in spinal deformity.

METHODS: The survey subjects were 155 cases who were diagnosed with spinal deformity and underwent correction and fusion surgery with long construct instrumentation (>3 levels, average 10.3 levels) between July 2004 and June 2010. The subjects comprised 32 males and 123 females with a mean age of 19.0 (range 8-78) years. The mean follow-up period was 46.1 months (range: 24-94 months). All patients were examined for rod breakage in x-rays at a follow-up visit. Univariate analysis and logistic regression analysis were performed.

RESULTS: Rod breakage occurred in 8 of 155 cases (5.2%). The mean period from surgery

to rod breakage was 18.1 months (range 2-37). Six patients had breakage near the fused lower end and two patients had it at the thoracolumbar junction. The clinical symptoms were pain in 2 patients and a breaking sound of a crack in 2 patients. There was no symptom in 4 patients. Univariate analysis revealed that non-ambulatory status, preoperative kyphosis, small diameter rods, multiple surgeries, and use of iliac screws were significant risk factors in rod breakage. Sex, obesity, severity of preoperative scoliosis, and rod material were not significant risk factors. Logistic regression analysis revealed that the following were risk factors for rod breakage: use of iliac screws (odds ratio: 81.9, 95% confidence interval: 7.2-935.0, $p < 0.001$) and small diameter rods (diameters of less than 6 mm) (odds ratio: 16.3, 95% confidence interval: 1.7-152.6, $p = 0.015$).

DISCUSSION: The incidence of rod breakage after long construct fusion in spinal deformity was 5.2%. Iliac screw fixation and small diameter rod were risk factors for rod breakage.

GP165

GOOD FUSION RATE AND CLINICAL RESULTS OF LESS INVASIVE FACET FUSION WITH SEXTANT PEDICLE SCREW SYSTEM FOR DEGENERATIVE LUMBAR SPONDYLOLISTHESIS

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INTRODUCTION: After a long 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 SEXTANT pedicle screw system for DLS. In this study,

we assessed fusion rate and clinical results of FF.

METHODS: Forty-eight patients who underwent FF for single-level DLS were retrospectively reviewed at a minimum one year follow-up. They consisted of 27 women and 21 men with an average age of 68.4 years. In our surgical method, we added 5cm skin incision, bilateral laminar fenestration and FF with autologous bone harvested from spinous process. Then, pedicle screws were inserted bilaterally by minimum access technique.

We evaluated facet fusion rate by computed tomography (CT), range of motion (ROM) at the fused level on a flexion-extension lateral X-ray preoperatively and at the final follow-up, and therapeutic effectiveness of FF using Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ).

RESULTS: The facet fusion rate was 83.3% of patients. ROM at fused level was less than two degrees at the final follow-up in all the patients whose facets were sufficiently fused on CT. In eight patients whose facet fusion wasn't sufficient, the average ROM significantly decreased to 3.8 degrees, whereas it was 13.4 degrees preoperatively. The percentage of the patients who showed therapeutic effectiveness in JOABPEQ were 92.7% in Walking ability and 75.0% in Low back pain.

DISCUSSION: Park et al reported FF alone is an effective surgical option for DLS. However, in their method, a bone graft was harvested from the iliac crest and conventional pedicle screw system was used. We devised less invasive FF using local bone graft and SEXTANT system. The fusion rate and the clinical results of FF compared well with those of conventional PLF. Thus, FF is a useful technique for DLS.

GP166

INTEROBSERVER RELIABILITY OF CT SCANS TO ASSESS RADIOGRAPHIC FUSION CRITERIA WITH A NOVEL TITANIUM INTERBODY DEVICE

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INTRODUCTION: The accuracy of CT scans of titanium implants to assess lumbar interbody fusion has been questioned in the past. Published reports have focused on older cage technologies. Radiologists report difficulty assessing fusion bone due to artifact and small graft windows. A new titanium interbody implant has been developed with a large footprint and wide aperture for graft. Purpose: To determine the interobserver reliability of CT scans to assess radiographic fusion variables with a new titanium interbody device.

METHODS: Patients underwent ALIF at L3-S1 as part of a separate clinical outcomes study. All patients received the same implant type (Endoskeleton TA[®]; Titan Spine.). Each cage was packed with 2 sponges of InFuse[®] (Medtronic) plus 1-3 cc of HA/TPC (MasterGraft[®]). CT scans with reconstructed images were performed randomly at 6, 9, or 12 months. Two independent radiologists reviewed the scans and were blinded to the other's interpretation. Interobserver reliability was calculated using the kappa statistic.

RESULTS: 33 patients/ 56 spinal fusion segments were analyzed. 17 had CT at 6 months, 9 at 9 months, 7 at 12 months. No differences in results were noted between time points. Kappa coefficient was calculated separately for each variable. The kappa for the overall study was 0.88 (p<.001) demonstrating agreement between the 2 radiologists in 345 of the 392 data points reviewed. The agreement for fusion formation was 0.77 (p<.001). Other criteria are

in Table. All measurements reached statistical significance.

Table: Other Fusion Assessment Criteria/ Interobserver Reliability

Reviewer	Artifact			Subsidence		Trabecular Bone Through Cage	
	Grade 0	Grade 1	Grade 2	Yes	No	Yes	No
A	43 (77%)	12 (21%)	1 (2%)	0 (0%)	56 (100%)	54 (96%)	2 (4%)
B	54 (96%)	2 (4%)	0 (0%)	3 (5%)	53 (95%)	56 (100%)	0 (0%)
Reliability (Kappa)	0.80			0.95		0.96	

Legend: Artifact Grade 0: Mild; Grade 1: Moderate; Grade 2: Non-diagnostic

DISCUSSION: Clinicians have been reluctant to rely on CT scans with titanium devices due to concerns that the interpretation of the images may be inaccurate. This device demonstrated minimal artifact, minimal subsidence, and trabecular bone was easily identified through the implant in the majority of cases. Our study confirms radiographic fusion criteria can be assessed with high interobserver reliability with this new titanium implant.

GP167

MICROENDOSCOPIC DISCECTOMY FOR LUMBAR DISC HERNIATION: DOES THE INSTABILITY AFFECT THE LOW BACK PAIN?

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INTRODUCTION: This study was undertaken to determine the influence of instability on low back pain (LBP) after microendoscopic discectomy (MED) for lumbar disc herniation (LDH).

METHODS: MED was used to treat LDH in 42 patients, and the intensity of their leg pain, leg numbness, and LBP measured on a visual analogue scale (VAS) was recorded before and after MED. The degree of improvement (DOI) was calculated by the following formula: preoperative score - postoperative score, and the patients were classified into two groups based on the DOI in LBP concerning VAS: a group whose DOI was more than twenty (M group) and a group whose DOI was less than twenty (L

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group). Clinical outcomes were evaluated using the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ). Lateral radiographs in maximal flexion and extension, and in neutral position were obtained before and after MED to measure the intervertebral angle and horizontal displacement (translation) in flexion and extension, and to measure the disc height of the affected intervertebral space. Using MRI, disc degeneration was also graded. All measurements and DOIs were statistically compared by unpaired t test between the M and L groups.

Fig. Preoperative and postoperative radiographic results

	M group (n=19)	L group (n=23)	P value (*P<0.05)
Preoperative intervertebral angle in flexion	2.61±5.7°	1.96±5.5°	0.710
Postoperative intervertebral angle in flexion	-0.29±5.7°	-0.98±4.8°	0.673
Preoperative intervertebral angle in extension	7.79±6.0°	10.2±5.5°	0.181
Postoperative intervertebral angle in extension	10.7±4.2°	9.46±4.5°	0.349
Preoperative intervertebral range of motion	5.45±4.0°	8.41±5.8°	0.0657
Postoperative intervertebral range of motion	11.1±5.5°	10.5±5.3°	0.720
Preoperative slipping in flexion	-0.37±2.9mm	-2.54±2.5mm	0.0127*
Postoperative slipping in flexion	-0.47±2.3mm	-2.41±2.8mm	0.0187*
Preoperative slipping in extension	1.68±2.7mm	3.61±2.1mm	0.0133*
Postoperative slipping in extension	1.92±2.6mm	3.48±2.4mm	0.0488*
Preoperative difference in slipping between flexion and extension	2.05±1.6mm	1.54±1.1mm	0.242
Postoperative difference in slipping between flexion and extension	1.71±1.4mm	1.50±1.2mm	0.605
Postoperative/preoperative disc height	0.84±0.1	0.86±0.1	0.549
Preoperative grade of disc degeneration	2.95±0.8	2.96±0.6	0.964

Values are expressed as mean ± sd.

RESULTS: The DOIs in LBP concerning VAS and JOABPEQ were significantly greater in the M group (n=19) than in the L group (n=23). There were no statistically significant differences between the two groups in DOI in leg pain or leg numbness concerning VAS, nor in DOIs in the other four functional scores concerning JOABPEQ. Preoperative

and postoperative translation in flexion and extension in the L group had slipped significantly posteriorly in comparison with the M group (Fig.)

DISCUSSION: From the results of this study, the large posterior translation in flexion and extension could lead to poor improvement in LBP after MED. These findings suggest that posterior translation in flexion and extension may be a cause of LBP in LDH.

GP168

INFECTION RATE AND COMPLICATIONS FOLLOWING ASSOCIATED WITH EPIDURAL STEROID PASTE USED IN POSTERIOR LUMBAR SURGERY - A CASE-CONTROLLED REVIEW

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INTRO: The use of various epidural agents to reduce postoperative pain and inflammation following lumbar surgery is common. These agents are typically administered as steroid and/or analgesic laced paste, sponges, or foams. Studies have shown the efficacy in reducing pain and narcotic usage acutely with minimal adverse effects. However, Kramer found a nearly 8-fold increase in surgical site infections (SSI) after laminectomy when a morphine-prednisolone nerve paste was used. We tested the hypothesis that a steroid containing epidural pain paste, applied after laminotomy, does not increase risk of acute SSI.

METHODS: A case-controlled retrospective review of patients treated by lumbar decompression, either with or without analgesic steroid paste, was done. Demographic characteristics including age, gender, BMI, smoking and alcohol status, and type of operation were analyzed.

Acute SSI were defined as any infection within the first six weeks postoperatively.

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Late infections were not encountered. SSI was coded as superficial, deep-suprafascial, or deep-subfascial.

RESULTS: We analyzed 62 consecutive patients with no paste, and 61 patients receiving pain paste. Male patients represented 57.4% in the paste group and 66.1% in the no paste group ($p=0.32$). The average age of patients in the two groups was 49.8 and 46.1 respectively ($p=0.15$). There were four suspected or documented infections, (6.7%) in the paste group, and one (1.67% [0.03%, 8.7%]) in the no paste group ($p=0.21$). One additional patient in the paste group had a slow healing wound. There were no wound complications in the no paste group.

DISCUSSION: Our data does not demonstrate a statistical difference in the rates of infection with the use of an epidural steroid paste, but the observed three-fold increase in the rate is concerning. This trend necessitates a larger review, currently ongoing, which will allow better statistical certainty. For the moment we use no steroids in our paste.

GP169

EPIDEMIOLOGICAL TRENDS IN THE USE OF BONE MORPHOGENIC PROTEIN IN SPINAL FUSIONS FROM 2002-2009

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INTRODUCTION: The use of bone morphogenic proteins (BMP) as an adjunct to spinal fusion has increased since first approved for use in anterior lumbar interbody fusions in 2002. The purpose of this study was to analyze a population-based database to describe national trends of BMP use in terms of incidence, demographics, costs and mortality.

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing anterior or posterior cervical fusions (ACF/PCF), anterior or posterior lumbar fusions (ALF/PLF), or thoracic fusions were identified and BMP use was examined by year. Demographics, co-morbidities, costs (adjusted for inflation), and mortality were assessed. Statistical analysis was performed using Pearson's correlation to assess for trends with a p -value <0.01 to denote significance.

	2002	2003	2004	2005	2006	2007	2008	2009	Total	p-value
Total Count										
Weighted	1,734	18,473	37,601	54,155	74,328	84,652	105,030	106,168	482,141	<0.0005
Unweighted	366	3,843	7,687	11,281	15,410	17,553	21,407	20,997	98,544	<0.0005
Frequency of BMP Use										
Weighted	0.7%	6.6%	13.9%	18.5%	23.8%	26.2%	28.0%	27.3%	19.2%	<0.0005
Unweighted	0.3%	2.1%	4.6%	4.9%	8.2%	10.8%	9.2%	8.5%	6.2%	0.002
ACF										
Weighted	313	2,735	5,420	6,029	10,568	14,203	12,923	12,570	64,852	<0.0005
Unweighted	66	569	1,108	1,256	2,131	2,945	2,634	2,486	13,255	0.001
Frequency	0.2%	3.5%	7.6%	11.5%	15.5%	17.4%	17.5%	18.9%	11.5%	<0.0005
PCF										
Weighted	14	356	915	1,301	1,881	2,185	2,963	2,677	12,481	<0.0005
Unweighted	3	74	187	271	390	453	604	569	2,551	<0.0005
Frequency	0.2%	3.5%	7.6%	11.5%	15.5%	17.4%	17.5%	18.9%	11.5%	<0.0005
Thoracic										
Weighted	62	572	1,414	2,314	2,701	2,985	4,617	6,017	20,602	<0.0005
Unweighted	13	119	289	482	560	619	941	1,190	4,213	<0.0005
Frequency	0.5%	4.6%	9.7%	13.6%	17.5%	18.0%	22.7%	27.0%	15.7%	<0.0005
ALF										
Weighted	616	5,682	10,424	11,243	13,616	15,688	17,687	18,901	93,959	<0.0005
Unweighted	130	1,182	2,131	2,342	2,823	3,253	3,605	3,738	19,204	<0.0005
Frequency	3.5%	29.3%	47.4%	44.9%	50.2%	53.9%	51.9%	50.2%	44.1%	0.02
PLF										
Weighted	730	9,129	19,429	33,267	45,562	49,592	66,839	65,803	290,237	<0.0005
Unweighted	154	1,899	3,972	6,930	9,446	10,283	13,623	13,014	59,321	<0.0005
Frequency	0.7%	8.6%	18.7%	28.6%	35.3%	37.3%	41.1%	39.5%	28.3%	<0.0005
LOS (days)										
ACF	4.1	4.3	4.6	4.3	4.2	4.1	4.0	4.2	4.2	0.35
PCF	1.7	2.4	2.8	2.7	2.3	2.4	2.4	2.7	2.5	0.26
Thoracic	9.3	6.2	7.3	5.4	6.2	6.1	6.0	6.3	6.2	0.12
ALF	9.1	9.3	8.7	7.9	8.7	8.6	8.4	7.9	8.3	0.05
PLF	3.9	4.1	4.8	4.5	4.3	4.0	4.1	4.3	4.3	0.96
	4.8	4.6	4.7	4.3	4.3	4.2	3.9	4.0	4.1	<0.0005
Costs (adjusted)	\$25,961	\$28,844	\$29,119	\$30,746	\$29,787	\$31,005	\$30,583	\$31,836	\$29,529	<0.0005
ACF	\$17,995	\$16,337	\$17,891	\$19,767	\$18,831	\$19,606	\$18,261	\$18,357	\$18,011	0.28
PCF	\$43,158	\$25,532	\$28,919	\$27,802	\$30,577	\$33,023	\$33,062	\$33,840	\$30,852	0.87
Thoracic	\$53,638	\$59,347	\$48,378	\$53,222	\$51,328	\$53,842	\$55,769	\$57,788	\$53,110	0.61
ALF	\$23,850	\$27,802	\$32,427	\$34,670	\$33,049	\$33,985	\$36,286	\$38,831	\$33,028	0.001
PLF	\$28,318	\$29,456	\$29,096	\$30,093	\$29,878	\$31,943	\$29,755	\$30,520	\$29,284	0.06
Mortality (per 1000)	0.0	2.1	2.9	1.6	1.6	1.4	1.5	1.6	1.6	0.75
ACF	0.0	10.7	0.9	2.4	2.3	1.4	1.5	2.0	2.1	0.52
PCF	0.0	14.1	27.5	3.7	13.0	13.4	10.0	8.9	11.5	0.94
Thoracic	0.0	0.0	7.0	6.3	10.8	4.9	9.7	8.5	8.0	0.03
ALF	0.0	0.9	3.3	0.4	0.4	1.8	0.6	0.8	1.1	0.98
PLF	0.0	0.0	1.8	1.4	0.8	0.5	0.7	0.8	0.8	0.61

*ACF=anterior cervical fusion, PCF=posterior cervical fusion, ALF=anterior lumbar fusion, PLF=posterior lumbar fusion

RESULTS: An estimated 482,141 procedures utilized BMP from 2002-2009 in the United States (Table 1). The number of procedures per year that utilized BMP significantly increased from 1,734 in 2002 to 106,168 in 2009 ($p<0.0005$, $R=0.9$). ALF had the highest rates of BMP use, increasing to 53.9% of all ALFs in 2007 and then decreasing to 50.2% in 2009 (Figure 1). PLFs accounted for the majority of cases that used BMP with 290,237 cases from 2002-2009. There was a significant trend of older patients with increasing co-morbidities receiving BMP during this time period. Hospital costs significantly increased an average of \$5,875 from 2002-2009 (Table 2). Mortality did not change with utilization of BMP from 2002-

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2009.

DISCUSSION: Our study demonstrates that the use of BMP has dramatically increased from 2002-2009. Off-label use of BMP accounts for the vast majority of BMP utilization. The increase in costs from 2002-2009 is likely multi-factorial; older patients with more co-morbidities undergoing surgery as well as increasing use of BMP are likely to affect costs. Further studies are needed to identify long-term outcomes of BMP use in spinal fusions

GP170

EPIDEMIOLOGICAL TRENDS IN KYPHOPLASTY PROCEDURES BETWEEN 2004-2009

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INTRODUCTION: Kyphoplasty was introduced as a minimally invasive procedure to treat vertebral compression fractures with deformity. The purpose of this study was to analyze a population-based database to describe national trends of kyphoplasty procedures in the United States.

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2004-2009. Patients undergoing kyphoplasty for the diagnosis of pathologic fractures of the thoracolumbar spine were identified. Demographics (gender, age, and race), Charlson Co-morbidity Index (CCI), costs (adjusted for inflation), and mortality were assessed. Statistical analysis was performed using Pearson's correlation to identify trends. Logistic regression was performed to identify predictors of mortality.

RESULTS: The total number of patients undergoing kyphoplasty increased from 44,459 in 2004-2005 to 85,530 in 2006-2007 and then decreased to 76,583 in 2008-2009.

The mean pre-operative CCI increased from 4.59 in 2004 to 5.06 in 2009 ($p < 0.0005$) (Table 1).

Mean in-hospital costs significantly increased from \$12,815 in 2004 to \$16,853 in 2009 ($p = 0.006$). Mortality did not change across this time period ($p = 0.32$). Predictors of mortality in patients undergoing kyphoplasty were metastatic cancer, fluid/electrolyte disorders, congestive heart failure, pulmonary circulation disorders, renal failure, and weight loss.

	2004	2005	2006	2007	2008	2009	P-value	Correlation (R)
US Total Population	299,655,404	296,410,404	299,398,484	301,621,157	304,059,724	307,006,550		
Count (total-weighted)	7,049	37,410	39,861	45,849	42,320	34,263	0.21	
% of US Population undergoing kyphoplasty surgery	2.4×10^{-5}	12.6×10^{-5}	13.3×10^{-5}	15.2×10^{-5}	13.9×10^{-5}	11.1×10^{-5}	0.34	
Age (years)	75.2	75.9	76.5	76.4	76.3	76.3	0.10	
Female (%)	71.9	73.3	73.8	73.4	73.1	72.2	0.95	
LOS (days)	3.9	4.5	4.5	4.7	5.4	5.9	0.002	0.96
CCI Score	4.59	4.72	4.83	4.87	5.02	5.06	<0.0005	0.99
Costs adjusted (unadjusted)	\$12,815 (\$11,377)	\$13,719 (\$12,594)	\$13,754 (\$12,941)	\$13,947 (\$13,490)	\$16,012 (\$16,076)	\$16,853 (\$16,853)	0.006	0.94
Race (% Caucasian)	93.0	92.3	89.9	90.6	88.7	87.0	0.002	-0.96
Mortality (Count)	7	42	43	52	63	37	0.32	

DISCUSSION: Our study demonstrates that kyphoplasty procedures have increased in incidence from 2004-2009. We identified a trend of older patients with increasing co-morbidities undergoing kyphoplasty. Mortality has not changed despite the increasing co-morbidity of patients. This patient population also incurred increasing hospitalization days and costs which may be due to increasing chronic illnesses. Patients with mortality risk factors indicative of chronic illness should be carefully followed for complications in the peri-operative period after kyphoplasty procedures.

GP171

TRENDS IN COMPLICATIONS AFTER LUMBAR SPINE SURGERY FROM 2002-2009

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INTRODUCTION: The frequency of complications after lumbar decompressions (LD) and lumbar fusions (LF) varies widely in the reported literature. The purpose of this study was to analyze a population-based database to describe national complication trends of these two procedures.

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing LD or LF for degenerative etiologies were identified. Eight categories of complications were tabulated using ICD-9 codes including pulmonary embolism (PE), deep vein thrombosis (DVT), infection, cardiac complications, hematomas, CSF leaks, post-operative shock, and neurologic complications.

Total (Count)	2002	2003	2004	2005	2006	2007	2008	2009	Total	P-value	Rho
LD	42,839	44,213	36,723	38,601	34,330	34,564	32,370	28,437	292,177		
LF	29,323	30,934	31,005	33,628	35,580	36,927	44,038	44,845	286,280		
Overall											
LD	25.1	25.3	30.7	38.4	32.4	30.5	34.3	39.2		0.001	0.0
LF	46.7	46.8	50.0	52.2	49.0	49.4	45.8	47.7		0.92	
PE											
LD	0.8	0.8	1.1	0.8	1.1	0.8	1.0	1.7		0.16	
LF	2.3	2.0	3.0	2.9	2.2	2.7	2.8	3.0		0.27	
DVT											
LD	1.7	3.3	2.4	2.5	2.2	2.6	3.0	3.2		0.007	0.88
LF	3.6	4.2	4.3	4.5	4.4	4.3	4.5	4.5		0.02	
Infections											
LD	4.9	5.4	7.4	6.1	7.5	7.6	10.4	12.6		<0.0005	0.98
LF	7.7	9.1	8.2	8.1	8.8	8.9	8.0	8.2		0.89	
Cardiac (M.I.)											
LD	3.6	4.2	4.2	3.9	3.6	4.2	4.0	4.6		0.34	
LF	8.4	8.8	9.7	10.0	8.5	10.3	8.8	10.0		0.19	
Hematoma											
LD	5.9	4.5	5.9	6.2	6.7	6.5	7.3	8.3		0.001	0.93
LF	15.1	12.6	13.5	16.7	15.2	14.4	12.6	13.2		0.59	
CSF leak											
LD	1.2	1.2	0.8	1.4	1.3	1.2	1.2	1.8		0.23	
LF	1.8	1.6	1.6	1.5	1.1	1.3	1.5	1.6		0.20	
Post-operative shock											
LD	0.16	0.07	0.11	0.10	0.15	0.14	0.03	0.25		0.82	
LF	0.4	0.5	0.5	0.6	0.9	0.8	0.8	1.2		0.005	0.87
Neurologic Complications											
LD	6.7	6.9	8.8	7.4	9.8	7.6	7.5	6.8		0.61	
LF	6.9	8.0	9.1	7.7	7.9	6.7	6.8	6.1		0.58	

*All complications are listed as number of complications per 1,000 procedures; M.I.= myocardial infarction; PE= pulmonary embolism; DVT= deep venous thrombosis; CSF= cerebrospinal fluid.
 †Statistical analysis was performed using Spearman's Correlation to assess for significant trends.
 ‡Also reported only for significance at <0.01.
 §Grey highlighted areas designate Statistical Significance.

RESULTS: A total of 578,457 LDs and LFs were identified from 2002-2009 (Table 1). Both surgical groups demonstrated significant trends of increasing ages, co-morbidities, and costs during this time period. LFs had higher complication rates at all time points compared to the LD group. There were significant trends in the LD group of increasing overall complications: specifically increasing rates of DVTs, infections, hematomas ($p<0.01$). Increasing rates of post-operative shock from 2002-2009 was the only statistically significant trend in the LF group ($p=0.005$), while increasing rates of DVTs approached significance

($p=0.02$).

CONCLUSION: Our findings demonstrate that from 2002-2009, patients undergoing lumbar procedures had increasing trends of age and co-morbidities reflecting increases in surgical challenges and complexity. These changes in patient demographics may explain the increasing complication rates after LDs. Both groups demonstrated a trend of increasing costs, which may be explained by increasing ages and co-morbidities of patients as well as the increasing complication rates. The complication rate in the LF group was approximately double that of the LD group for all years. Despite a trend of increasing risk factors during this 8-year period, mortality did not change.

GP172

INCIDENCE AND MORTALITY OF THROMBOEMBOLIC EVENTS AFTER LUMBAR SPINE SURGERY

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INTRODUCTION: Pulmonary embolism (PE) and deep vein thrombosis (DVT) are potential complications of orthopaedic procedures. Incidences of these complications are not well characterized after lumbar spine surgery. A population-based database was analyzed to identify incidence, risk factors, and mortalities associated with lumbar decompression (LD) and lumbar fusion (LF).

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing LD or LF for degenerative etiologies were identified. Acute PE and DVT incidences and mortality rates were calculated. Co-morbidities were calculated using a modified Charlson Co-morbidity Index. Statistical analysis using a

p-value of <0.0005 was used to denote statistical significance. Logistic regression was used to identify independent predictors of thromboembolic events.

RESULTS: A total 578,457 LDs and LFs were identified from 2002-2009. DVT incidences were 2.4 and 4.3 per 1,000 cases in the LD and LF groups respectively (Table 1). PE incidences were 1.0 and 2.6 per 1,000 cases in the LD and LF groups (Table 2).

LF patients with thromboembolic events were younger, had less co-morbidity, and incurred higher costs than LD patients. Statistically significant predictors of DVT were pulmonary circulation disorders, coagulopathy, fluid/electrolyte disorders, anemia, obesity, teaching hospital status, and larger hospitals. Predictors for the development of a PE were pulmonary circulation disorders, fluid/electrolyte disorders, anemia, African-American ethnicity and teaching hospitals

Comparison Group	Lumbar Decompression (LD)		P-value	Lumbar Fusion (LF)		P-value	LD	LF	P-value
	No DVT	DVT		No DVT	DVT		DVT	DVT	
Total (n = count)	291,465	732		285,038	1,242		711	1,342	
Average Age (years)	55.0	66.7	<0.0005	55.1	61.6	<0.0005	66.7	61.6	<0.0005
Percentage									
0-44	29.5	9.1		25.7	11.6		9.1	11.6	
45-64	37.5	30.2	<0.0005	45.0	42.3	<0.0005	30.2	42.3	<0.0005
65-75	18.3	24.0		18.9	26.1		24.0	26.1	
>75	14.7	36.7		10.4	20.0		36.7	20.0	
Charlson Comorbidity Index	2.44	4.12	<0.0005	2.46	3.61	<0.0005	4.12	3.61	<0.0005
DVT Incidence (Per 1,000 cases)	2.4			4.3			2.4	4.3	<0.0005
Mortality (Per 1,000 cases)	0.8	14.1	<0.0005	1.4	21.8	<0.0005	1.4	2.2	0.229
LOS (days)	2.5	12.1	<0.0005	4.4	14.5	<0.0005	12.1	14.5	<0.0005
Costs (US dollars)	\$7,161	\$25,794	<0.0005	\$25,733	\$56,320	<0.0005	\$25,794	\$56,320	<0.0005

status.

DISCUSSION: Patients undergoing LD or LF are at inherent risk of thromboembolic events. DVT and PE are more common after LF procedures. Pre-operative pulmonary circulation disorders, fluid/electrolyte disorders, deficiency anemia, and teaching hospital status were significant risk factors for both DVT and PE. Preventive measures in patients at risk may decrease the incidence of thromboembolic events.

GP173

EPIDEMIOLOGICAL TRENDS IN LUMBAR SPINE SURGERY BETWEEN 2002-2009

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INTRODUCTION: Lumbar decompressions (LD) and lumbar fusions (LF) are routinely performed for lumbar degenerative pathology. The purpose of this study was to analyze a population-based database to describe national trends of these procedures in terms of incidence, demographics, co-morbidities, cost and mortality.

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing LD (i.e. laminectomy +/- discectomy) or LF for degenerative etiologies were identified. Co-morbidities were calculated using a modified Charlson Co-morbidity Index (CCI). Demographics, costs (adjusted for inflation), and mortality was also assessed. Statistical analysis was performed using Pearson's correlation to assess trends. A p-value of p<0.01 was used to denote significance.

RESULTS: The percentage of the population undergoing lumbar procedures did not change from 2002-2009 (p=0.789)(Table 1-adjusted for U.S. Census reported population). Patients undergoing LD decreased 33% while LF surgeries increased 50% throughout this time period (Figure 1).

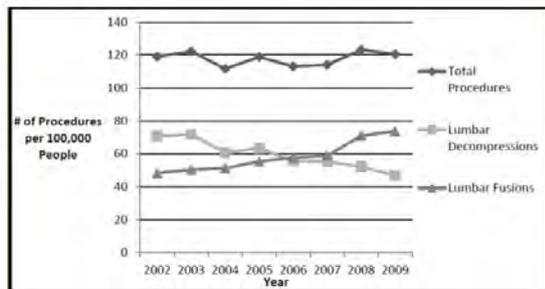
The mean age of patients increased by 4.0 years (p<0.0005). The mean pre-operative CCI increased by 0.5 points (p<0.0005). This co-morbidity increase was due to an increasing trend towards patients with collagen vascular disease, anemia, coagulopathy, diabetes, and hypertension. Hospital costs

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increased by \$8,296 over the 8-year period ($p < 0.0005$). In-hospital mortality did not change significantly for any cohort.

DISCUSSION: Our study demonstrates that the total number of lumbar procedures has not changed over the 8-year period. There was an overall trend towards more lumbar fusions and fewer decompressions performed. Mortality did not change despite an aging population with greater medical comorbidities. There was a trend towards increasing hospital costs despite decreasing hospitalizations in the lumbar fusion group which may be due to increased utilization of more expensive implants and biologics.

Figure 1: Trends in Lumbar Procedures



GP174

RISK FACTORS FOR HEMATOMAS AND NEUROLOGIC COMPLICATIONS AFTER LUMBAR SPINE SURGERY

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INTRODUCTION: Post-operative hematomas and neurologic complications are potentially catastrophic events that can occur after spine procedures. A population-based database was analyzed to identify incidence, mortality, and risk factors associated with these complications after lumbar decompression (LD) and lumbar fusion (LF).

METHODS: Data from the Nationwide Inpa-

tient Sample database was obtained from 2002-2009. Patients undergoing LD or LF for degenerative etiologies were identified. Incidences of hematomas, neurologic complications, and mortalities were calculated. Co-morbidities were calculated using a modified Charlson Co-morbidity Index. Statistical analysis was performed using p -value < 0.0005 to denote significance. Logistic regression was used to identify independent predictors of hematoma and neurologic complications.

Table 1: Patient Characteristics in Cases of Hematoma

Comparison Group	Lumbar Decompression (LD)		P-value	Lumbar Fusion (LF)		P-value	LD		LF		P-value
	No Hematoma	Hematomas		No Hematoma	Hematomas		Hematomas	Hematomas			
Total (n = count)	290,343	1,834		282,239	4,041		1,834	4,041			
Average Age (years)	55.0	62.2	< 0.0005	55.1	59.0	< 0.0005	62.2	59.0	< 0.0005		
Age Group (%)											
0-44	29.6	16.2		23.7	17.1		16.2	17.1			
45-64	37.5	33.0	< 0.0005	35.0	43.5	< 0.0005	33.0	43.5	< 0.0005		
65-75	18.2	24.0		18.9	24.2		24.0	24.2			
>75	14.7	26.8		10.4	15.2		26.8	15.2			
Charlson Comorbidity Index	2.43	3.40	< 0.0005	2.46	3.07	< 0.0005	3.40	3.07	< 0.0005		
Hematoma Incidence (Per 1,000 cases)	6.3			14.1			6.3	14.1	< 0.0005		
Mortality (Per 1,000 cases)	0.8	6.0	< 0.0005	1.4	10.2	< 0.0005	6.0	10.2	< 0.0005		0.113
LOS (days)	2.3	6.9	< 0.0005	4.4	8.7	< 0.0005	6.9	8.7	< 0.0005		
Cost (US dollars)	\$7,153	\$15,689	< 0.0005	\$25,649	\$40,838	< 0.0005	\$15,689	\$40,838	< 0.0005		

RESULTS: A total of 578,457 lumbar procedures were identified in the database from 2002-2009. Incidences of hematomas were 6.3 and 14.1 per 1,000 cases for LD and LF groups, respectively ($p < 0.0005$). Incidences of neurologic complications were 7.6 and 7.3 for LD and LF groups ($p = 0.152$). In both surgical groups, patients who suffered from both complications were older with more co-morbidities ($p < 0.0005$). Independent predictors of hematomas were emergent admissions, Native-American ethnicity, pre-existing coagulopathy, paralysis, and fluid/electrolyte disorders. Predictors for neurologic complications were emergent admission, female gender, pre-operative paralysis, obesity, and teaching hospital status.

DISCUSSION: Our results identified that older patients with more co-morbidity are at increased risks for hematomas and neurologic complications. Our findings suggest

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patients undergoing LF have greater hematoma risk, whereas LD patients are more prone to neurologic complications. Patients undergoing LD or LF procedures with pre-operative paralysis or obesity should be counseled regarding these risks and warrant careful post-operative monitoring.

GP175

INCIDENCE AND MORTALITY OF SURGICAL SITE INFECTIONS AFTER LUMBAR SPINE SURGERY

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INTRODUCTION: Surgical site infections (SSI) are a common complication after orthopaedic procedures. The incidence of SSI in lumbar spine surgery has not been reported in large patient populations. A population-based database was analyzed to identify incidence, mortality, and costs of SSIs associated with lumbar decompressions (LD) and lumbar fusions (LF).

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing LD or LF for degenerative etiologies were included. Cases of SSI were identified and associated mortality was assessed. Co-morbidities were calculated using a modified Charlson Co-morbidity Index. Statistical analysis was performed a p-value of <0.0005 to denote significance. Logistic regression was used to identify independent predictors of SSI.

RESULTS: A total 578,457 lumbar procedures were identified from 2002-2009 (Table 1). Incidences of SSI were 7.4 and 8.4 (per 1000 cases) for the LD and LF groups respectively. Patients with SSI had increased co-morbidity scores, hospitalizations, and costs (p<0.0005). SSI's were associated with increased in-hospital mortality of 18.9 and

16.4 (per 1000 cases) for the LD and LF groups (p<0.0005). An increased rate of SSIs, increased hospitalizations and costs was observed in LF patients over LD patients (p<0.0005). The most significant predictors of SSI were anemia, drug abuse, liver disease, fluid/electrolyte disorders, and weight loss.

	Lumbar Decompression (LD)		P-value	Lumbar Fusion (LF)		P-value	LD and LF		P-value
	Total (n=count)	2,170		283,884	2,396		2,170	2,396	
Comparison Group	No SSI	SSI		No SSI	SSI		SSI	SSI	
Age (years)	55.0	59.3	<0.0005	55.2	58.0	<0.0005	59.3	58.0	0.003
Age Group (%)									
0-44	29.6	16.6		25.7	18.4		16.6	18.4	
45-64	37.4	44.2		45.0	46.8		44.2	46.8	
65-75	18.2	21.4		18.9	21.2		21.4	21.2	
>75	14.8	17.8		10.4	13.6		17.8	13.6	
Charlson Comorbidity Index	2.43	3.62	<0.0005	2.46	3.33	<0.0005	3.62	3.33	<0.0005
SSI Incidence (per 1000 cases)	7.4			8.4			7.4	8.4	<0.0005
Mortality (per 1000 cases)	0.7	18.9	<0.0005	1.4	16.4	<0.0005	18.9	16.4	0.508
LOS(days)	2.4	14.8	<0.0005	4.3	17.9	<0.0005	14.8	17.9	<0.0005
Costs (US dollars)	\$7,045	\$28,013	<0.0005	\$25,603	\$57,290	<0.0005	\$28,013	\$57,290	<0.0005

DISCUSSION: Our study demonstrates a national incidence of 0.8% for SSI in patients undergoing lumbar spine surgery. SSI's in both surgical groups resulted in increased hospitalizations, costs, and mortality. The incidence of SSI is significantly higher after LF compared to LD. We conclude that patients undergoing lumbar surgery with specific co-morbidities are at an increased risk for SSI. Perioperative antibiotic protocols and pre-operative risk factors identified to decrease the incidence of SSI in patients at risk for infection

GP176

OUTCOMES OF LUMBAR TOTAL DISC ARTHROPLASTY REVISIONS AND ANTERIOR LUMBAR INTERBODY FUSION REVISIONS FROM 2002-2009

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INTRODUCTION: Lumbar total disc replacements (TDR) and anterior lumbar interbody fusions (ALIF) are both procedures for the treatment of lower back pain. Revisions of these procedures are less common

and little is known about their outcomes. This study aims to identify the epidemiology, complication rates and cost differences based upon revisions of these two procedures. To characterize these differences on a national level, a population-based database was analyzed with regards to patient demographics, complications, mortality and costs.

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing revision for either lumbar TDR or for ALIF were identified. Patient demographics, co-morbidities, major complications, hospitalization days, and costs were assessed. SPSS v.20 was used to calculate statistical significance using χ^2 tests for categorical data and Independent-Samples T tests for continuous data. A p-value of 0.001 was used to denote statistical significance.

	Lumbar TDR Revision	Revision ALIF	p-value
Total Procedures	390	2,899	-
Average Age (years)	51.4	50.6	0.281
Gender (% female)	54.1	54.9	0.775
Charlson Co-Morbidity Index	2.14	2.02	0.158
Race (%)			
White	74.7	85.1	<0.0005
Black	9.4	5.7	
Hispanic	8.1	6.0	
Asian / Pac. Islander	2.3	1.1	
Other	5.5	2.1	
Procedures Performed at Teaching Hospitals	56.6%	58.7%	0.411
Length Of Stay (days)	4.9	6.1	0.001
Hospital Costs	\$18,915	\$25,878	<0.0005
Overall Complication Rate*	102.6	107.5	0.321
Pulmonary Embolism	5.1	5.5	0.922
Deep Venous Thrombus	5.1	13.5	0.164
Infection	30.8	32.8	0.834
Cardiac	12.8	12.1	0.899
Hematoma	28.2	26.6	0.850
CSF Leak	0.0	3.1	0.271
Shock	0.0	1.7	0.412
Neurologic Complications	17.9	8.6	0.078
Mortalities	2.6	1.7	0.717

*Complication rates per 1,000 cases

RESULTS: There were 2,899 ALIF

revisions and 390 lumbar TDR revisions recorded in the NIS database from 2002-2009. There were no significant differences between groups when comparing average age, gender, and co-morbidity scores. Costs were significantly greater in ALIF revisions compared to TDR revisions ($p < 0.0005$). There were statistically significant longer hospitalizations ($p = 0.001$) and greater costs ($p < 0.0005$) in ALIF revisions compared to lumbar TDR revisions. There were no significant differences of complications between groups.

DISCUSSION: Our study demonstrated a larger amount of ALIF revisions than revision lumbar TDRs from 2002-2009. Patient's age, gender, and co-morbidities were not significantly different between groups. Patients undergoing revision ALIF had longer hospitalizations and greater costs compared to the TDR revision cohort. In the acute setting, there appears to be minimal differences in complications between these two procedures.

GP177

OUTCOMES OF LUMBAR TOTAL DISC REPLACEMENT AND ANTERIOR LUMBAR INTERBODY FUSION FROM 2002-2009

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INTRODUCTION: Favorable outcomes have been reported using anterior lumbar interbody fusion (ALIF) and total disc replacement (TDR) for lumbar disc degeneration. Epidemiology, complication rates and cost differences based upon these surgical approaches are not well known. To characterize these differences on a national level, a population-based database was analyzed with regards to patient demographics, complications, mortality and costs.

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METHODS: Data from the Nationwide Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project was obtained for each year from 2002-2009. Patients undergoing lumbar TDR and primary ALIF were identified. Patient demographics, co-morbidities, hospitalization days, costs, major complications, and mortalities were assessed. SPSS v.20 was used to calculate statistical significance using the χ^2 test for categorical data and Student's T-test for continuous data. A p-value of 0.001

Table 1: Comparison of Outcomes between Lumbar TDR and Primary ALIF			
	Lumbar TDR	Primary ALIF	P-VALUE
Total Procedures	2,255	51,778	-
Average Age	40.4	48.2	<0.0005
Percent Female	45.6	54.5	<0.0005
Charlson Comorbidity Index	0.83	1.77	<0.0005
Race (%)			
White	84.5	82.4	0.069
Black	4.4	5.8	
Hispanic	6.2	7.1	
Asian / Pac. Islander	1.0	0.9	
Other	3.9	3.8	
Teaching Hospital (%)	47.8	51.6	<0.0005
Length of Stay (days)	2.8	5.0	<0.0005
Hospital Costs	\$19,015	\$31,782	<0.0005
Overall Complication Rate	19.1	64.5	<0.0005
Pulmonary Embolism	0.0	3.3	0.007
Deep Vein Thrombosis	0.4	7.6	<0.0005
Infection	1.3	16.0	<0.0005
Cardiac	5.3	10.6	0.015
Hematoma	8.4	17.2	0.001
CSF Leak	0.4	1.0	0.429
Shock	0.0	1.1	0.109
Neurologic Complications	2.2	3.9	0.205
Mortalities	0.4	2.05	0.093
<i>Complication rates are presented as per 1,000 cases</i>			

was used to denote statistical significance.

RESULTS: There were 51,778 ALIFs and 2,255 lumbar TDRs identified from 2002-2009 in the United States. Patients undergoing ALIF were significantly older with more co-morbidities ($p < 0.0005$). Females underwent significantly more ALIFs, whereas males underwent more TDRs ($p < 0.0005$). Hospitalization duration and costs were significantly increased in the ALIF group ($p < 0.0005$). ALIFs demonstrated statis-

tically significant greater complications including infections, hematomas, and DVTs.

DISCUSSION: Our study demonstrates that ALIFs were performed much more frequently than lumbar TDRs in the United States from 2002-2009. The data demonstrates that patients undergoing ALIF are more susceptible to developing complications including infections, hematomas, and DVTs. We suggest that older age and increased co-morbidities of the patient population undergoing ALIFs may explain this discrepancy in complication rates as there is a similar approach to both procedures.

GP178

OUTCOMES OF LUMBAR SPINE SURGERY IN TEACHING AND NON-TEACHING HOSPITALS

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INTRODUCTION: Lumbar decompression (LD), and Lumbar fusion (LF) are commonly performed procedures in both academic and private settings. Perception biases exist on outcomes based upon the hospital environment. A population-based database was analyzed to characterize differences regarding teaching-hospital status on the national level.

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing LD (i.e. laminectomy and discectomy), or LF for degenerative etiologies were identified and separated into cohorts (Teaching and Non-teaching hospitals). Demographics, hospitalization days, costs, complications, and mortality were assessed for both groups. Statistical analysis was performed using a p-value of < 0.0005 to denote significance. Logistic regression was used to assess independent

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predictors of mortality.

RESULTS: A total of 578,457 lumbar procedures were identified from 2002-2009 (Table 1). Patients treated in teaching hospitals were younger, more likely to have African-American ethnicity, and Medicaid or private insurance ($P < 0.0005$). The incidence of procedure-related complications was higher at teaching hospitals across both surgical groups. DVTs, pulmonary embolisms, surgical site infections, and cardiac complications were increased in LF patients in the teaching hospital cohort. Mortality did not significantly differ between teaching and non-teaching hospitals. Regression analysis revealed that significant predictors of mortality were male gender, congestive heart failure, coagulopathy, and neurologic disor-

ders, and weight loss. hospitals for lumbar spine surgery were younger, had longer hospitalizations, but equivalent costs and mortality compared to patients treated in non-teaching hospitals. Incidences of several complications were identified as higher in teaching hospitals. Our analysis confirmed that teaching-hospital status is not a significant predictor of mortality.

GP179

RISK FACTORS FOR URINARY COMPLICATIONS AFTER LUMBAR SPINE SURGERY

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	Lumbar laminectomy & discectomy			Lumbar Fusion		
	Teach	Non-teach	Sig.	Teach	Non-teach	Sig.
Count (n)	154,836	136,941	<0.0005	147,446	137,659	<0.0005
% Male	55.0	54.1	<0.0005	43.6	44.4	<0.0005
% Female	45.0	45.9	<0.0005	56.4	55.6	<0.0005
Average Age (years)	54.5	55.7	<0.0005	55.0	55.3	<0.0005
Age Group (%)						
0-44	30.5	28.4		25.7	25.5	
45-64	38.2	36.7		45.4	44.5	
65-74	17.4	19.2		18.7	19.2	
>75	13.9	15.8		10.2	10.8	
Charlson Co-morbidity Index	2.39	2.49	<0.0005	2.47	2.47	0.792
Race (%)						
Caucasian	82.5	86.0	<0.0005	82.6	85.0	<0.0005
African American	7.2	4.6		7.4	5.2	
Hispanic	5.6	5.7		5.9	6.3	
Asian/Pacific Islander	1.5	1.1		1.0	1.0	
Native American	0.4	0.3		0.4	0.4	
Other	2.8	2.3		2.8	2.2	
Payer (%)						
Medicare	31.3	35.5	<0.0005	31.3	33.3	<0.0005
Medicaid	4.6	3.4		4.9	3.7	
Private/Other	64.1	61.0		63.8	63.0	
Admission Type (%)						
Emergent	7.9	6.8	<0.0005	3.9	2.7	<0.0005
Urgent	8.5	8.9		5.6	6.3	
Elective	83.6	84.3		90.2	90.9	
LOS (days)	2.52	2.46	<0.0005	4.69	4.11	<0.0005
Costs	\$7,208	\$7,204	0.888	\$25,807	\$25,892	0.212
Disposition after Discharge (%)						
Routine	86.0	84.7	<0.0005	70.5	69.3	<0.0005
Transfer short term hospital	0.2	0.2		0.4	0.5	
Skilled nursing	7.7	7.7		16.6	15.2	
Home health	5.9	7.2		12.2	14.8	
AMA	0.1	0.1		0.1	0.1	
In-hospital Mortality	0.1	0.1		0.2	0.1	
Unknown	0.0002	0.007		0.04	0.009	
Complications (per 1000)	32.1	27.9	<0.0005	53.9	42.4	<0.0005
Pulmonary Embolism	1.1	0.8	0.005	3.1	2.2	<0.0005
DVT	3.0	1.8	<0.0005	5.6	3.0	<0.0005
Infections	7.9	6.9	0.004	10.2	6.3	<0.0005
Cardiac	4.4	3.6	0.001	10.2	8.4	<0.0005
Hemorrhage/hematoma	6.2	6.3	0.666	14.6	13.5	0.014
CSF leak	1.1	1.4	0.023	1.5	1.5	0.712
Neurologic	8.5	6.9	<0.0005	7.9	6.8	0.001
Post Op Shock	0.1	0.1	0.972	0.8	0.7	0.447
Mortality (per 1000 cases)	0.86	0.77	0.425	1.7	1.3	0.003

ders, and weight loss.

DISCUSSION: Patients treated in teaching

INTRODUCTION: Complications of the urinary-renal system are common after orthopaedic procedures. In order to characterize the national burden of urinary complications, a population-based database was analyzed to identify incidence, mortality, and costs associated with lumbar decompression (LD) and lumbar fusion (LF).

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing LD or LF for degenerative conditions were included. Urinary complications were identified as urinary tract infections (UTI) and renal complications (e.g. anuria/oliguria, acute renal failure). Co-morbidities were assessed using a modified Charlson Co-morbidity Index (CCI). Mortality associated with urinary complications was also assessed. Statistical analysis was performed using a p-value of <0.0005 to denote significance.

RESULTS: A total 578,457 lumbar procedures were identified from 2002-2009. The incidence of UTIs (per 1,000 cases) was 14.8 and 24.6 for the LD and LF groups respectively ($p < 0.0005$)(Table 1). The incidence of renal complications was 9.9 and 9.7 for the

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LD and LF groups ($p < 0.0005$) (Table 2). Patients who developed either urinary complication were significantly older with more co-morbidities ($p < 0.0005$). Women were significantly more likely to have a UTI, while men were more likely to have a renal complication ($p < 0.0005$). Hospital stays, costs, and mortality were significantly greater in patients with urinary complications.

Comparison Group	Lumbar Decompression (LD)			Lumbar Fusion (LF)			LD	LF	p-value
	No UTI	UTI	p-value	No UTI	UTI	p-value			
Total (n=count)	287,851	4,326		279,225	7,055		4,326	7,055	
Incidence (per 1,000 cases)		14.8			24.6		14.8	24.6	<0.0005
Mean Age (years)	54.9	66.4	<0.0005	54.9	62.3	<0.0005	66.4	62.3	<0.0005
Age Group (%)									
18-44	29.7	12.7		25.9	13.4		12.7	13.4	
45-64	37.7	22.4	<0.0005	45.2	36.2	<0.0005	22.4	36.2	<0.0005
65-74	18.1	26.6		18.7	27.8		26.6	27.8	
>75	14.4	38.3		10.2	22.5		38.3	22.5	
% Female	45.0	72.3	<0.0005	55.5	74.5	<0.0005	72.3	74.5	0.01
CCI	2.42	4.01	<0.0005	2.44	3.51	<0.0005	4.01	3.51	<0.0005
Mortality (per 1000 cases)	0.7	5.8	<0.0005	1.4	7.4	<0.0005	5.8	7.4	0.32
LOS(days)	2.4	8.5	<0.0005	4.3	9.2	<0.0005	8.5	9.2	<0.0005
Costs (US dollars)	\$7,075	\$15,847	<0.0005	\$25,603	\$36,165	<0.0005	\$15,847	\$36,165	<0.0005

DISCUSSION: Our study identified that older, female patients with greater co-morbidities are at significantly increased risk of developing UTIs, whereas male patients are at increased risk for renal complications. Urinary complications in both surgical groups increased hospitalizations, costs, and mortality. Early removal of Foley catheters and careful monitoring of fluid status in patients at risk may help decrease the rate of urinary complications after lumbar spine surgery.

GP180

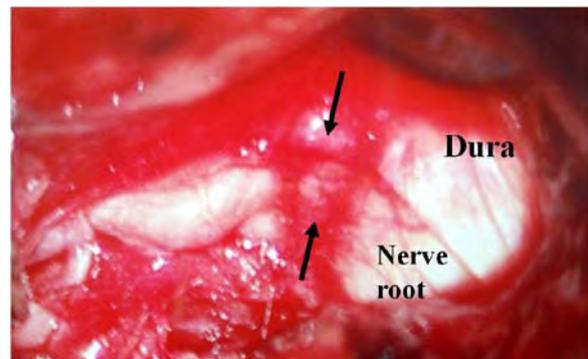
EFFECTIVENESS OF DECOMPRESSION ALONE WITH PROPER MANAGEMENT OF EPIDURAL MEMBRANE AND PERIRADICULAR SHEATH FOR LUMBAR SPINAL STENOSIS AND ITS LIMITATION

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INTRODUCTION: Decompression alone under microscopy or endoscopy has been developing into a reliable option for lumbar spinal stenosis (LSS) with degenerative spondylolisthesis (DS). Proper management of epidural membrane (EM) and periradicular sheath (PS) has been reported to be useful for successful decompression. The purpose of this prospective study was to report how to successfully perform decompression alone for LSS, its outcomes and limitation.



METHODS: With a more than 2 year-follow up period, 122 patients with LSS who underwent decompression alone at the L4-5 under microscopy were evaluated. Patients were classified into three groups: Group A as a control without DS had < 10% slip, B had 10 to 20% slip and C had \geq 20% slip. The remarkable EM and PS (Fig.): obstructing dural tube expansion and compressing the nerve root were recorded and detached. The clinical outcomes were compared among the 3 groups with JOA score. **RESULTS:** The age at surgery averaged 68.5 years; 60 males and 62 females. Among the 3 groups: A (n = 63), B (n = 39) and C (n = 20), there was no difference in the age at surgery, symptom duration, follow-up period or preoperative JOA score ($p = 0.29$, 0.98, 0.21 and 0.98, respectively). The % slip increased significantly in Group B and C ($p < 0.01$). The remarkable EM and PS were observed in 7 and in 35 patients, respectively; the latter was more frequently in Group C

than in A ($p < 0.05$). However, the JOA score of each group increased significantly ($p < 0.01$) without any significant difference in the recovery rate ($p = 0.66$). Eight patients (6.6%) had secondary surgery due to stenosis: 2 at the same level (one each in A and B) and 6 at the different levels.

DISCUSSION: Despite slip progression after surgery, decompression alone is effective for LSS patients with DS. However, re-stenosis due to degeneration at the decompressed level requires re-operation in a tiny number of patients, which is the limitation of decompression alone.

GP181

SURGICAL RESULTS OF PAINLESS FOOT DROP CAUSED BY DEGENERATIVE LUMBAR DISEASES

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PURPOSE: Foot drop can be seen by several etiologies and claudication caused by foot drop is known as steppage gait. Foot drop caused by lumbar degenerative disease often involves radiating leg pain. However, we have patients who has foot drop without leg pain. In these cases, it is questionable if we have to have the operation to expect neurologic improvement. We retrospectively studied recoveries after surgeries for painless drop foot caused by degenerative lumbar diseases. We also studied the factors which influence on recovery from drop foot.

METHODS: This study consisted of 19 patients presented foot drop without leg pain preoperatively who underwent lumbar spine surgery for degenerative lumbar diseases. Foot drop was defined as motor weakness of tibialis anterior (TA) by MMT less than 3 of 5. Mean age at surgery was 51 years. Mean follow-up period was 2.2 years. Mean duration of palsy before surgery was

130 days. Surgical outcome was evaluated "excellent" when muscular strength of TA recovered to 4 or 5, "good" when it reached to 3 or 3+, "fair" when it recovered but within less than 3, and "poor" when there was no improvement in palsy of TA. The preoperative factors we studied were diagnosis, number of involved segment, age, severity of palsy and duration of palsy.

RESULTS: Surgical result was "excellent" in 8 patients, "good" in 4, "fair" in 3 and "poor" in 4. 63% of all cases showed excellent to good results after surgery. Looking at the results by dividing each factor, there was significant difference in duration of palsy. But the other factors have no significant difference.

DISCUSSION: There are a few reports of foot drop by lumbar degenerative diseases including our previous report. However, no report can be found which focused on painless foot drop. In current study, 63% of the patients had recovered from foot drop. As this surgery only aims recovery of palsy, we have to be careful with surgical intervention for patients with long duration period.

GP182

2-YEAR PROSPECTIVE COHORT STUDY FOR THE CHANGE OF BONE MINERAL DENSITY FOLLOWING LUMBAR SPINE SURGERY

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INTRODUCTION: Inactive patients may have a low bone mineral density (BMD) due to immobilization. Successful lumbar spine surgery improves the ADL. Thus, it might provide an increase in BMD. The purpose of this study was to determine whether or not lumbar spine surgery increases BMD of the body, and if in fact lumbar surgery is related to an increase of postoperative BMD, this study was further designed to analyze the factors involved in the BMD increase.

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MATERIALS AND METHODS: Forty-seven patients, aged more than 60 years old who had lumbar surgery in the period from Jan. to Dec. 2009, were participated. BMD of the vertebral body and the femoral neck was measured by DEXA preoperatively, at 1 year and 2 years after surgery. The surgical results were evaluated by JOA score. Walking ability was evaluated using the Nurick scale.

RESULTS: The average preoperative BMD gradually decreased postoperatively. Despite the age-related loss of BMD, 11 patients had increased BMD of the lumbar spine at 2 years postoperatively. There were also 9 patients who showed increased BMD of the femoral neck. The % decrease of BMD was lower in excellent and moderate groups compared to that in poor group evaluated by the postoperative Nurick scale. According to the analysis of repeated measures ANOVA, there were significant differences in the % change of BMD among the groups by postoperative Nurick scale. The % decrease of BMD in excellent and moderate groups was significantly less compared to that in poor group.

CONCLUSIONS: Postoperative BMD was affected by postoperative walking ability. The postoperative Nurick scale was the most significant factor regarding the % change of both BMDs. These results indicate that postoperative activity, especially walking ability, might directly effect on the change of postoperative BMD. Successful lumbar spine surgery might increase BMD of the femoral neck. Thus, it might be useful for the prevention of hip fracture.

GP183

ANALYSIS OF LIFE PROGNOSTIC FACTORS IN HEMODIALYSIS PATIENTS AFTER LUMBAR SPINE SURGERY

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INTRODUCTION: The purpose of this study

was to perform a retrospective analysis of a series of varied lumbar spine surgeries on hemodialysis patients determine and to risk factors for life prognostic factors after lumbar spinal surgery.

METHODS: Between 4/2003 and 7/2012, 30 lumbar spinal surgeries for hemodialysis patients were performed at our institution. Perioperative (life prognostic) risk factors were compared between the death group and the survival group. This study was a follow-up study using medical records and telephone. The mortality rate was calculated using the Kaplan-Meier method. For each factor, the comparison between the two groups was used Student's t-test.

RESULT: The 15 patients were operated on the herniotomy & the laminectomy, and 15 patients were operated on the anterior or the posterior spinal instrumentation. Of these patients, already 13 patients (43.3%) died after the surgery. The perioperative complication ratio was 40%. Survival rate after the surgery was 89.6% one year later and 77.4% five years later. Perioperative risk factors, which were compared in the death group and survival group, almost have no significant difference. But in the total protein and the albumin, the survival group data were higher than the death group data ($p < 0.05$).

	all patients		survive	death	P Value
	Minimum —Maximum	Average	Average	Average	
Age at surgery (years)	52-91	65	63.9	66.6	0.2
Age of starting dialysis (years)	29-89	53.7	52.5	54.6	0.355
Maintenance dialysis period(years)	0.17-29	12.4	12.6	11.9	0.427
Preoperative weight(Kg)	37.9-104.9	61.78	62.87	60.9	0.353
Ejection Fraction(%)	47-80	63.8	64.75	63	0.291
Hemoglobin(g/dl)	6.4-15.1	10.66	11.03	10.37	0.123
Total protein(g/dl)	3.5-8.1	6.48	6.95	6.11	0.012*
Albumin(g/dl)	2.2-4.5	3.75	3.97	3.6	0.034*
Calcium <phosphorus	17.7-71.7	50.08	49.54	50.54	0.439
Duration of operation(min)	115-468	251.1	255.5	247.4	0.421
Duration of anesthesia(min)	175-600	361	345	383	0.171
Total intraoperative fluid replacement volume (ml)	500-6500	1092.4	1622.5	1870	0.365
The total amount of perioperative bleeding(ml)	176-3840	962.5	1123.3	831.7	0.168
The total amount of fluid removed during the first week after surgery(ml)	3240-9740	5387.8	5316.9	5442	0.435

* Student's t-test $p < 0.05$

DISCUSSION: In spinal surgery, it has been reported that many complications on hemodialysis patients happen to compared with healthy patients. After the start of hemodialysis, 1-year survival rate was 87.7%

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and the 5-year survival rate was 60.3% in the year 2010 in Japan. By comparison, the results of this study were good. Ejection fraction, Ca × P and intact PTH data, which is known to relation to survive on the hemodialysis patients, were no significant difference in survival. But total protein and albumin were involved in the survival of dialysis patients after lumbar spinal surgery. So perioperative dialysis management was important to lumbar spinal surgery patients, especially nutritional management.

GP184

COMPARISON OF CORTICAL BONE TRAJECTORY METHOD TLIF AND WILTSE APPROACH TLIF AIMING AT LESS INVASIVENESS

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INTRODUCTION: Cortical bone trajectory (CBT) is a method of placing a pedicle screw using a more medial-to-lateral path than the conventional one. The trajectory follows a caudocephalad path sagittally and a laterally directed path in the transverse plane. As the entry point is on the medial side of the facet joint, it likely decreases the need for muscle stripping during exposure and the possibility of damaging the medial branch nerve of the dorsal rami. The CBT method is assessed aiming at less invasiveness compared with the Wiltse approach.

METHODS: Twenty-one single level TLIF patients (CBT group (C) : 11, Wiltse group (W) : 10) were examined retrospectively. The survey items included operation time, intraoperative blood loss, VAS score of the low back on the first postoperative day, length of hospital stay and CPK, CRP and WBC of the first, third and seventh postoperative day.

RESULTS AND DISCUSSION: The mean operation time (C: 127, W: 163 min) and the mean intraoperative blood loss (C: 164, W:

377 g) were significantly less in the CBT group. The VAS score of the low back on the first postoperative day (C: 48.6/100, W: 56.8/100) tended to be less in the CBT group but was not significant. There was no difference in the length of hospital stay (C: 11.1, W: 10.0 days). The CPK decreased significantly in the CBT group of every postoperative day. There were no differences in CRP and WBC.

The operation time and the blood loss were less and CPK decreased in the CBT group, so the CBT method is probably less invasive than the Wiltse approach. The operation time was shorter than the Wiltse approach, which indicates there is no learning curve in the CBT method whereas the learning curve is one of the issues to solve in order to perform MIS procedures. Some of the merits of MIS procedures especially in percutaneous screwing are less muscle injury and denervation. The CBT method will probably involve less muscle injury and denervation and there is no learning curve.

GP185

MINIMALLY INVASIVE PERCUTANEOUS ENDOSCOPIC LUMBAR DISCECTOMY FOR ATHLETES

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INTRODUCTION: Percutaneous endoscopic discectomy (PED) was first reported in 2002 and showed good clinical outcome for normal subjects. However, there are few reports for athletes. Since the PED is minimally invasive for the back muscles, the technique must be suitable for athletes. The purpose of this report is to understand the effectiveness of PED for athletes.

METHODS: Ten male athletes with herniated nucleus pulposus underwent PED surgery under local anesthesia. Magnetic resonance imaging (MRI) revealed HNP (herniated nu-

cleus pulposus) in the lumbar spine in all cases. The affected level was L2–L3 (n=1), L3–L4 (n=1), and L4–L5 (n=8). One patient had far-lateral disc herniation at L4–L5, and the remaining nine patients showed intracanal type HNP. Operation time, blood loss, and surgery-related complications were recorded. Time to return to play (RTP), RTP rate, and recurrence were also evaluated. Changes in visual analog scale (VAS) scores for low back pain and leg pain before and after surgery were reviewed.

RESULTS: Herniated fragments were successfully removed endoscopically with local anesthesia. Mean operation time was 53.5 min, blood loss during operation was negligible, and no surgery-related complications such as dural tear, nerve root injury, hematoma, or surgical site infection were observed. Subjects returned to their sport 6 to 8 weeks after surgery. The mean VAS score (out of 10) for low back and leg pain was 0.5 and 0, respectively at the final follow-up, compared with 6.5 and 4.5 before surgery. Of the patients, 9 (90%) had complete RTP, and one (10%) showed recurrence.

CONCLUSION: The minimal invasiveness and good clinical outcome of PED favor it as a gold standard for disc surgery in athletes with HNPs.

GP186

COMPARISON OF POSTERIOR FIXATION WITH OR WITHOUT VERTEBRAL REDUCTION FOR THORACOLUMBAR BURST FRACTURE

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INTRODUCTION: In order to evaluate the efficacy of transpedicular reduction with anterior column reconstruction without posterior fusion for thoracolumbar burst fracture, we compared the surgical outcome of patients with AO classification type A or B

thoracolumbar burst fracture treated by posterior fixation with or without vertebral reduction.

METHOD: Among thirty-three patients, 12 patients with type A and 11 patients with type B fractures were treated with posterolateral fusion (L). Five patients with type A and 5 patients with type B fractures were treated with transpedicular reduction using the Schanz system combined with vertebroplasty by hydroxyapatite blocks (S). Operative time, blood loss, radiographic analysis including vertebral wedge deformity and segmental kyphosis were evaluated at 1-year follow-up.

RESULT: All cases achieved fusion. Operative time was shorter and less bleeding was found in cases treated by S ($p < 0.05$). In type A fractures, differences were not seen in wedge deformity (L: pre-op 36.9% post op 25.6%, S: pre-op 30.8% post op 22.1%) and kyphosis (L: 6.3° S: 6.5°). However, in type B fractures, wedge deformity was significantly reduced and maintained in cases treated with S (L: pre-op 43.4% post op 36.5%, S: pre-op 52.3% post op 24.1%) ($p < 0.05$). Interestingly, in type B fractures treated with S tended to increase kyphosis 1-year post operation (L: 7.0° S: 10.3°).

DISCUSSION: Result showed that thoracolumbar burst fractures treated with Schanz system offer less operative time and blood loss compared to PLF. For wedge deformity and segmental kyphosis, type A fractures showed no differences between procedures. However, in type B fractures with posterior ligament complex disruption, wedge deformity was superiorly reduced with Schanz system, but segmental kyphosis was increased. Results of the current study suggest that type B thoracolumbar burst fractures, surgical treatment with Schanz system assisted with posterior bone graft may be ideal.

GP187

CLINICAL OUTCOMES AND COMPLICATIONS OF MINIMALLY INVASIVE POSTERIOR LUMBAR INTERBODY FUSION: COMPARISON OF MINIMALLY INVASIVE AND TRADITIONAL OPEN SURGERY.

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INTRODUCTION: Minimally invasive posterior lumbar interbody fusion (MIS-PLIF) has rapidly been spreading because of lower tissue damage. This procedure can deliver similar clinical outcomes when compared to a traditional approach. There has been also reported some complications by using MIS instruments. The purpose of this study was to investigate the clinical outcomes and complications of MIS-PLIF.

METHODS: A retrospective study was performed with 144 cases treated for more than one level fusion between March 2007 and February 2012. 74 cases received MIS-PLIF (group M), while another 70 cases underwent through a traditional open approach (group T). The clinical outcomes were assessed with following questionnaires: Oswestry Disability Index (ODI), the Short Form of the Medical Outcome Study (SF-36), and pain scales in 63 cases who answered the questions. In all 114 cases, we investigated complications associated with both spinal fusion surgeries. In particular, the accuracy of pedicle screw placement was evaluated by using computed tomography scan.

RESULTS: There was no significant difference in ODI, SF-36 and pain scales between the two groups. In group M, there were 2 cases that had reoperations because of severe frank penetration of pedicle screws, 2 fractures of transverse process and 2 cage retropulsions. In group T, 2 reoperations

because of penetration of pedicle screws, 2 cage retropulsions and 1 reoperation because of pseudoarthrosis. The overall rate of screw perforation rate was 12% in group M, and 6% in group T.

DISCUSSION: We retrospectively compared 114 cases who underwent instrumented PLIF using either MIS systems or open traditional approach. The results indicate that MIS-PLIF could achieve similar clinical results as conventional procedures, and on the other hand this is technically demanding because of the higher screw misplacement rate.

GP188

SELECTIVE DECOMPRESSION AND LONG SEGMENTAL FUSION OF DEGENERATIVE LUMBAR SCOLIOSIS

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INTRODUCTION: To analyse the surgical results of selective decompression and long segmental fusion for degenerative lumbar scoliosis (DLS).

METHODS: 19 patients with DLS were treated surgically. 7 males and 12 females were included, aged from 56 to 78 years old. The selective decompression and long segmental fusion with pedicle screws were employed and fusion levels exceed scoliosis curves. The follow-up time was 1.5 to 3.5 years. We evaluated preoperative and postoperative Cobb angle, lumbar lordotic angles, Visual Analog Pain Scale (VAS) and Oswestry Disability Index (ODI), and statistical difference was analysed.

RESULTS: Mean number of fusion range from 5 to 9 vertebral bodies. Preoperative VAS score was 4 to 9, averaged 6.3 ± 2.1 , and final follow-up VAS score was 1 to 7 points, averaged 3.3 ± 2.3 . Preoperative ODI score was 21 to 43 points, averaged 32.5 ± 13.9 , and final follow up ODI score was 5 to 33, averaged 18.2 ± 13.5 . The statis-

tical difference between preoperative and follow-up VAS score was significant, and statistical difference was also found between preoperative ODI scores and final follow-up scores. Preoperative Cobb angle of lumbar spine was between 26° and 43°, averaged 31.2°±5.6°. Final follow up Cobb angle of lumbar spine was between 7° and 22°, averaged 10.1°±6.9°. Lumbar spine lordotic angle was between 9° and 36°, averaged 19.1±10.2°, and postoperative lumbar spine lordotic angle was between 21° and 48°, averaged 31.4±11.6°. The significant difference was found between preoperative and follow-up Cobb angles. Early complication occurred to 47.4 percent of patients, including urinary infection, ileus et al.

DISCUSSION: Selective decompression and long segmental fusion is an effective way to treat degenerative lumbar scoliosis with main symptom of lower back pain and lower limbs discomforts, large coronal Cobb angle, coronal or sagittal imbalance.

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CORRELATION OF PELVIC PARAMETERS WITH PATIENT REPORTED CLINICAL OUTCOMES—A FOLLOW-UP STUDY OF THE MRC SPINE STABILISATION TRIAL

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INTRODUCTION: It is claimed there is a predictive relation between pelvic parameters (Pelvic Incidence (PI), Sacral Slope (SS) and Pelvic Tilt (PT)) and patient reported clinical outcomes in spinal fusion.

METHODS: We calculated PI, SS and PT on a recent radiograph in a cohort from the MRC Spine Stabilisation Trial previously randomised to either operative management or intensive rehabilitation for chronic low back pain. 10-year follow up data imaging are available for 131 patients. This was related

to Oswestry Disability Index (ODI), EQ-5D and Visual Analogue Scores (Back and Leg). Results of first 39 patients are included. 26 patients had operative intervention and 13 had non-operative rehabilitation. In the operative group we found no strong correlation between any of the angles and outcome scores (r ranged from 0.002 to 0.05). In the non-operative group there was evidence of a stronger correlation between some of the variables but this did not reach statistical significance. Pelvic Tilt had a positive correlation with ODI ($r = 0.2$) and a negative correlation with EQ-5D ($r = 0.08$). Sacral slope had a negative correlation with ODI ($r = 0.17$) and a positive correlation with EQ-5D ($r = 0.05$). Pelvic Incidence did not have any correlation to outcome scores in the non-operative group.

DISCUSSION: The preliminary results in this study appear to support the limited evidence available on the correlation of pelvic parameters with patient reported outcome measures. Lazennec reported that those with a larger pelvic tilt were more likely to experience residual back pain following surgery. Lafage had similar findings in a more heterogeneous group and no differentiation was made between operative and non-operative cases. Our results have shown that a larger degree of pelvic tilt has a less favourable outcome. Pelvic incidence and sacral slope do not appear to be strong indicators of patient reported outcomes.

GP190

TREATMENT OF NEUROPATHIC PAIN BY SENSORY NERVE STIMULATION OF THE LUMBAR EXITING NERVE DRG USING A PERCUTANEOUS TRANSFORAMINAL APPROACH

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INTRODUCTION: Epidural Spinal column

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stimulation (SCS) is used to salvage FBSS. This study investigated the advantages of direct nerve placement of a wirelessly powered Sensory Nerve Stimulator (SNS) placed transforaminally by the DRG of the painful spinal segment.

METHOD: Five FBSS patients with back and leg pain were implanted with a SNS lead containing four electrodes. A 14 gauge Tuohy needle guided the lead percutaneously to the axilla of the exiting and traversing nerve by the DRG. After functional verification of pain relief stimulation, the needle is removed and the lead's tubing is anchored subdermally. The SNS lead is not anchored. Patients continue the stimulation at home for up to 30 days before explantation. Anterior-posterior and lateral X-rays were used every three days to monitor lead migration.

RESULTS: All five patients reported successful stimulation as defined by at least 50% reduction of VAS and 50% paresthesia coverage of the pain distribution area. Baseline VAS score averaged 8.5 to 2.3 by the end of the trial period. Lead migration ranged from 1.1 mm to 5.4 mm after 30 days.

DISCUSSION: Placement of a SNS directly to the DRG is closer to the pain source compared to traditional epidural SCS. Patients with bilateral pain that received only one SNS lead on one side of the dorsal column only reported one-side coverage of their total pain area. This suggests that optimal treatment and complete coverage may require multi-level or bilateral stimulator placements. The patient with dual lead placement had close to 100% pain relief coverage. Although lead migration was observed in all patients, the SNS electrode coverage area overcompensated for any migration effects.

Wirelessly powered SNS enables direct transforaminal implantation of the lead closer to the pain generator in FBSS patients. Wireless SNS is a practical and simplified therapy that may provide a viable, min-

imally invasive treatment option for chronic low back and/or leg pain from FBSS.

GP191

THE MINIMALLY INVASIVE TRANSFORAMINAL ENDOSCOPIC APPROACH IS EFFECTIVE FOR THE TREATMENT OF FBSS DUE TO RECURRENT HNP AND LATERAL STENOSIS

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INTRODUCTION: Treatment of Failed back surgery syndrome due to recurrent herniation and foraminal stenosis can be as successful as the index procedure, but revision surgery often incorporates more extensive decompression necessitating fusion.

METHODS: 40 consecutive patients with FBSS from recurrent HNP and lateral stenosis elected to undergo percutaneous transforaminal endoscopic discectomy and foraminoplasty. Outcome data at each visit included MacNab, VAS and ODI. All patients requested the non-fusion procedure first, even if fusion is indicated in the face of Isthmic or grade I spondylolisthesis. All procedures were performed at an ambulatory surgical center under local anesthesia. The average follow up time was, average 40 months, Minimal 12 months.

RESULTS: Average pre-operative VAS improved from 7.2 to 4.0, and ODI 48% to 31%. Endoscopic foraminoplasty was performed to either decompress the bony foramen for foraminal stenosis, and allow for endoscopic visual confirmation of the decompressed traversing and exiting nerve. While temporary dysesthesia occurred in 4 patients in the early post-operative period, all were happy with to avoid "open" decompression or fusion surgery.

DISCUSSION: The transforaminal endoscopic approach is effective for FBSS due to recurrent HNP and lateral stenosis. Failed index surgery may involve failure to recognize

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pathoanatomy in the axilla of the foramen housing the traversing and the exiting nerve, including the DRG. The transforaminal endoscopic approach effectively decompresses the foramen and does not further destabilize the spine. It avoids going through the previous surgical site. Residual axial back pain may be improved further with dorsal endoscopic rhizotomy performed dorsally or from the foramen. Foraminal endoscopic decompression is a MIS technique that does not “burn bridges” for a more conventional approach. Endoscopic foraminal decompression will at least add to the surgical armamentarium of FBSS.

GP192

A COMPARATIVE OUTCOME EVALUATION OF LUMBAR TRANSFORAMINAL ENDOSCOPIC DISCECTOMY VERSUS MICRO-LUMBAR DISCECTOMY FOR LUMBAR DISC HERNIATION

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INTRODUCTION: The outcome of MIS techniques for lumbar disc herniation treated by transforaminal endoscopic discectomy (SED) versus micro-lumbar discectomy were compared.

METHOD: 250 consecutive patients who underwent transforaminal “selective endoscopic discectomy” (SED) and 50 consecutive patients who underwent micro-lumbar discectomy (MLD) were compared using (VAS) and (ODI). The procedure MLD vs SED was a shared patient/surgeon decision. Data was collected and recorded at each office visit and at final follow up before discharge from care. All procedures were performed in a spine ambulatory surgical center owned by the practice. Average follow up was, minimum 12, average 38 months.

RESULTS: 50 Cases of MLD: L4-5=15, L5-S1=35. Average VAS=6.5-1.7, Average ODI

44%-30%. Complications=1 seroma, 1 durotomy. Patients receiving MLD was for extruded, migrated, or sequestered HNP believed better for MLD and not appropriate for SED. Patients in this spine practice, known nationally for SED usually chose SED over MLD when given a both choices by the operating surgeon. SED included extruded, migrated, sequestered HNP at all levels felt possible by the operating surgeon. The SED group numbered 250, with 309 total levels. Average VAS was 6.6-2.5 and ODI was 46%-32%. 37 patients (15%) developed temporary dysesthesia in the 2 week post-operative period. Improvement in VAS and ODI was comparable to MLD. Patient satisfaction in the endoscopic group was high in spite of dysesthesia, usually occurring and predicted when furcal nerves were identified and occasionally sacrificed.

DISCUSSION: In spite of dysesthesia not usually experienced by MLD patients, patient satisfaction remained high, as the patient’s ultimate results were similar. The more difficult extruded herniations where access was not possible or limited due to anatomic considerations were encouraged to chose MLD.

GP193

ENDOSCOPICALLY GUIDED DORSAL RHIZOTOMY IS MORE EFFECTIVE THAN PULSED RADIOFREQUENCY LESIONING FOR NON-DISCOGENIC AXIAL BACK PAIN.

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INTRODUCTION: Pulsed Radiofrequency lesioning of the medial branch, dorsal ramus, a standard technique to treat facet pain, is compared to an endoscopic visually guided technique.

METHOD: A prospective non randomized study of 50 initial patients assessed the efficacy of endoscopic rhizotomy. Patients with lumbar spondylosis and facet arthrosis who

had at least 50% pain relief by medial branch blocks met the inclusion criteria. The initial 50 patient study expanded to over 400 patients by May 2012. The surgical technique was guided by cadaver dissections that revealed variable locations of the media branch, thus the need for visualized rhizotomy.

RESULTS: At one year follow-up, VAS improved 6.2-2.5, and ODI 48-28. All patients had VAS improvement equal or greater than injection. The results remained constant with additional surgical cases. Approximately 10 percent returned at one year follow-up with mild recurrence of their axial back pain. Rhizotomy of the upper lumbar facets provided additional relief in selected patients.

DISCUSSION: The cadaver studies demonstrated considerable variability in the location of the medial and lateral branches. Variability was most common cephalad to L3-4. The dorsal ramus can be visualized ventral to the intertransverse ligament. Neuromas of the dorsal ramus have been identified endoscopically, and may also contribute to axial back pain. In the upper lumbar spine, we were not able to find the medial branch to the facet consistently. The nerve to the facet joint did not cross the transverse process. Nerve Ablation at these two levels may require lesioning of the dorsal ramus or targeting the innervation on the facet wall or capsule.

Discussion: Endoscopically guided facet rhizotomy provides more consistent ablation of the medial and lateral branches of the lumbar dorsal ramus than radiographically guided pulsed radiofrequency. The variations in the location of facet innervation dictate a need for visually guided MIS procedure.

GP194

CLINICAL AND RADIOLOGICAL OUTCOMES OF MINI-TLIF VIA PARASPINAL APPROACH USING CAGE FILLED WITH MORSELIZED LOCAL EXCISED BONE AS AUTOGRAFT AND ADDITIONAL ALLOGRAFT: MINIMUM 2-YEAR FOLLOW-UP

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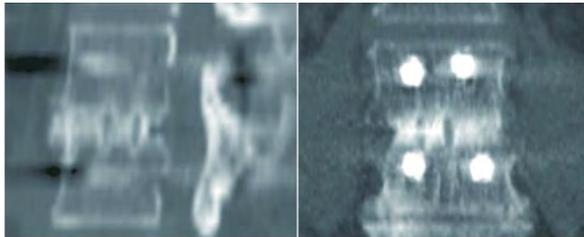
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INTRODUCTION: Paraspinal Mini-TLIF has become a favored surgical treatment for the management of lumbar degenerative diseases. Autologous iliac bone is more suitable for biologic bone healing ability although there may be some questions such as donor site morbidity. The purpose of this study was to evaluate the clinical and radiological outcomes of paraspinal Mini-TLIF using cage filled with morselized local excised bone.

METHODS: Retrospectively, 46 patients who underwent paraspinal Mini-TLIF using cage filled with local excised bone graft and additional allograft at single hospital were evaluated with minimum 2-year follow-up. Clinical outcomes were assessed with preoperative and postoperative Oswestry Disability Index (ODI) and visual analogue scale (VAS) for leg and low back pain. Radiological fusion was evaluated using dynamic plain radiographs and computed tomography (CT) scan with coronal and sagittal reconstructions.

RESULTS: Of the 46 patients, there were 37 females and 9 males, with a mean age of 62.22 years (range, 44-80). The mean fol-

low-up period was 32.6 months (range, 26-39). The mean preoperative and last follow-up ODI, leg pain VAS and back pain VAS were 28.1/7.9, 7.7/1.6 and 5.2/1.6, respectively. Average improvement of ODI, leg pain VAS and back pain VAS were 20.1, 6.1 and 3.6 at last follow-up after surgery, respectively ($p < 0.001$). Excellent or good clinical improvement was seen in 93.5% (43/46) of the patients. Solid fusion was demonstrated on plain X-ray and reconstructed CT scan in 89.1% (41/46) of the patients at last follow-up. Reconstructed sagittal and coronal CT scan at last follow-up showed a continuity of the trabecular bone traversing the inferior and superior endplates both inside and around the cages (Figure 1).



DISCUSSION: In conclusion, paraspinal Mini-TLIF using cage filled with morselized local excised bone can provide satisfactory clinical outcomes and high fusion rates without harvesting autologous iliac bone graft.

GP195

THE COMPRESSION FRACTURE WITH THE VACUUM CLEFT SHOW MORE INTRAVERTEBRAL INSTABILITY AND SEVERE SYMPTOMS COMPARED WITH THE SIMPLE OSTEOPENIC COMPRESSION FRACTURE

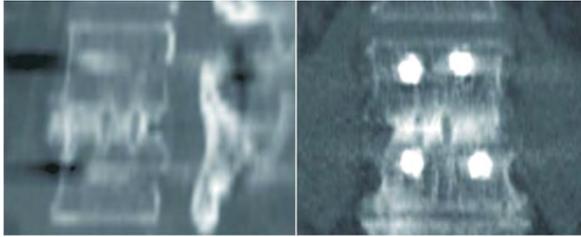
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INTRODUCTION: While the vertebral fractures have been the focus of extensive studies, little is known about the difference between the compression fracture with vacuum cleft and without that. We hypothesized that the compression fracture with the vacuum cleft showed more intra-vertebral instability and severe symptoms, while vertebroplasty for that would have more favorable clinical outcomes compared with the simple osteopenic compression fracture.

METHODS: Eighty-three patients who underwent vertebroplasty for the treatment of vertebral compression fracture were participated. Patients were divided into two groups; the vacuum group with the intra-vertebral vacuum cleft (IVC) (n=45, mean age: 74.2 [61-87]) and the non-vacuum group without IVC (n=38, mean age: 72.5 [53-86]). The intra-vertebral instability was identified by analyzing the kyphotic angle and the body height of 6 different dynamic plain radiographs: the combinations of (1) neutral, extensional, and flexional, (2) supine and standing. Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI) for pain were measured before surgery and at 1-month follow-up.

RESULTS: The range of the change of single vertebra kyphotic angle was higher in the vacuum than the non-vacuum group ($p < 0.05$). The mean percentage of the vertebral body height (standing flexional to standing neutral) was significantly lower in the vacuum group (88.5 ± 13.4) than the non-vacuum group (95.2 ± 9.0) ($p = 0.038$). At 1-month follow-up, the mean improvement of VAS and ODI were significantly higher in vacuum group compared to those of non-vacuum group ($p < 0.05$).

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DISCUSSION: The compression fracture with the vacuum cleft show more intra-vertebral instability and severe symptoms compared with the simple osteopenic compression fracture. After the vertebroplasty, there was a marked improvement in the vacuum group. Therefore, the compression fracture with the vacuum cleft should be treated with vertebroplasty earlier and actively.

GP196

A PROSPECTIVE STUDY OF A UNIQUE TITANIUM INTERBODY FUSION IMPLANT; CLINICAL AND RADIOGRAPHIC OUTCOMES AT 1 AND 2 YEAR FOLLOW UP

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INTRODUCTION: Acid etched titanium is used extensively in dental implants. Published research found acid etched Ti induces better osteoblast differentiation and BMP than PEEK or smooth Ti. Purpose: assess the outcomes of patients having ALIF with an acid etched Ti implant.

METHODS: Prospective consecutive enrollment between 2008-2010. Surgical technique: ALIF interbody cage (Titan Spine) + Infuse (Medtronic) 3 mg/ cage. Pedicle screw fixation/ decompression at the discretion of the surgeon. Visual Numerical Scale (VNS) and Oswestry Disability Index (ODI) scores were collected 0, 6, 12, and 24 months. Fusion assessed by independent radiologist review of X-rays and CT scans.

RESULTS: 77 patients; 42 male and 35 female. Ave age 46 years (range 23-67). Diag-

nosis: DDD n= 52 (67%); Spondylolisthesis n=19(25%); Nonunion n=6 (8%). 48 (63%) had ALIF + decompression + pedicle screw fixation, 24 (31%) had ALIF + percutaneous pedicle screw fixation, 5 patients (6%) had stand-alone ALIF. VNS and ODI scores improved significantly at 6, 12, and 24 months (Table). Clinical outcomes at 6 months were statistically unchanged at 12 and 24 months. Radiographic analysis revealed 94 % fusion rate between 6-12 months and no appreciable subsidence or lysis. 1 case of retrograde ejaculation (2.3%) resolved by 3 months.

	Pre-op	6 mo.	12 mo.	24 mo.
VNS Back	7.1	3.7*	3.6*	3.4*
VNS Leg	5.1	2.3*	2.1*	2.4*
ODI	55	36*	32*	30*

DISCUSSION: This study confirms the acid etched Ti cage with BMP is safe and effective in achieving excellent outcomes in lumbar disc degeneration. Meaningful Clinical Improvements (ODI >15 and VNS >3) were noted in the majority of cases. Clinical outcomes did not change significantly after the 6 mo data point. We postulate this is due to rapid bone-implant incorporation and lack of subsidence. Further study (without BMP) is underway to determine if a less expensive biologic can be used without sacrificing clinical results.

GP197

UNI- AND BI-LATERAL INSTRUMENTED POSTEROLATERAL FUSION OF THE LUMBAR SPINE WITH LOCAL BONE GRAFTING: A PROSPECTIVE STUDY WITH A 2-YEAR FOLLOW-UP.

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INTRODUCTION: The iliac crest bone graft technique for lumbar posterolateral fusion surgery is widely used; however, donor site problems such as pain and sensory disturbance have been reported. Local bone has been used for bilateral multi-segment fusion surgery; however, outcomes have been poor because of insufficient amounts of local bone used. The current study evaluated unilateral and bilateral posterolateral fusion at 3 levels using a local bone graft.

MATERIALS AND METHODS: Forty-two patients diagnosed with degenerated spondylolisthesis at 3 levels were divided into 2 groups. All underwent decompression and bilateral instrumented posterolateral fusion. However, a unilateral local bone graft was used in 22 patients and bilateral local bone graft was used in 20 patients. The amount of bone grafting, proportion of patients with bone union, duration of bone union, visual analog scale (VAS) score, Japanese Orthopedic Association (JOA) score, and Oswestry Disability Index (ODI) were evaluated before and 2 years after surgery.

RESULTS: VAS score, JOA score, and ODI were not significantly different between the 2 groups before and after surgery ($P > 0.05$). The amount of local bone graft used for each segment was significantly less in the bilateral group ($P < 0.05$). The rates of bone union and instability were 86% and 9% respectively in the unilateral group, but significantly poorer at 60% and 34% in the bilateral group.

DISCUSSION AND CONCLUSION: If multi-segment fusion (3 level fusions) is performed, bilateral local bone grafting results in a poor rate of bone union because of an insufficiency of local bone. Unilateral bone grafting is recommended because better rates of bone union and stability are achieved.

GP198

REDUCING BLOOD LOSS USING A BIPOLAR SEALER IN LUMBAR POSTEROLATERAL FUSION: A RANDOMIZED CONTROLLED TRIAL

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INTRODUCTION: Although a bipolar sealer, which provides hemostasis at lower temperatures than conventional electrocautery, was an effective coagulation alternative for total hip and knee arthroplasties, it is still unknown if this device reduces blood loss and tissue damage in lumbar posterolateral fusion (PLF). The purpose of this study was to analyze the efficacy of this device in affecting blood loss during exposure of the lumbar spine for PLF and postoperative pain.

METHODS: A randomized controlled trial was conducted. Thirty-five patients, who underwent PLF, were prospectively enrolled between October 2011 and August 2012. Eighteen patients were randomized to the bipolar sealer (BS) group, and 17 patients were assigned to a standard electrocautery (control) group. Demographic data, the number of fusion levels, time and blood loss during exposure of posterior bony elements including the transverse process for PLF, visual analog scale (VAS) of postoperative pain and the period from the surgery to hospital discharge were compared. Data were analyzed and $P < 0.05$ was considered significant.

RESULTS: There were no differences in demographic data, the number of the fusion level, time and blood loss during the exposure between two groups. Time and blood loss during the exposure one per level were significantly lower in the BS group than those in the control group (exposure time:

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15 vs 24 min, blood loss: 37 vs 72 ml) There was a tendency towards lower VAS at post-operative 1 week and shorter hospitalization from the surgery in the BS group than the control group (VAS: 26 vs 47 mm, hospitalization: 15 vs 26 days).

DISCUSSION: We found that a bipolar sealer is effective in PLF to reduce time and blood loss during the exposure for the PLF. A tendency toward less postoperative pain and shorter hospitalization might result from a less invasiveness against soft tissue. Collectively, these results suggest that the bipolar sealer is an effective coagulation alternative for PLF.

GP199

MIDTERM RESULTS OF THE YELLOW LIGAMENT FLOATING METHOD FOR LUMBAR SPINAL CANAL STENOSIS

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INTRODUCTION: We found our yellow ligament floating method (YFLM) useful for decompression of lumbar spinal canal stenosis without disc herniation because of less incidental dural tears, less postoperative hematoma disorders, and good short-term results (J. Spine. Res 2010). However, midterm results have not yet been reported.

METHODS: The Japanese Orthopedic Association score (JOAS); Oswestry disability index (ODI); numerical rating scale (NRS) for low back pain and other variables; satisfaction rate; and the appearance of radiological instability were measured in patients followed for more than three years.

RESULTS: We evaluated 55 patients (average age 71.2 years) from 77 consecutive cases treated with the YFLM. We excluded 5 patients because they had no preoperative record, 6 patients with other disease that made evaluation difficult, and 12 patients

without follow-up. The average follow-up was 50 months (range 36-75 mo). There was significant improvement in average JOAS (16.1 to 22.6), in ODI (39.3 to 20.1), and NRS scores for low back pain (3.7 to 2.1), leg pain (5.3 to 1.6), and leg numbness (6.4 to 3.8). Satisfaction rate was 91%. Radiological instability (including more than 3 mm slip-page and $>3^\circ$ wedge disc, as defined by Ohtani) appeared in 30 of 76 spinal segments (39.4%).



DISCUSSION AND CONCLUSIONS: Because the deep layer of the yellow ligament and epidural fat are preserved in the YFLM, and the dura is rarely seen during surgery (figure), this technique is relatively safe for nerve tissue. The midterm results are comparable with our previous results using conventional methods (JOAS improvement from 14.6 to 22.9). Weinstein et al. reported an ODI improvement from 43.2 to 22.7 and 68.2% satisfaction rate (NEJM 2008). Ohtani reported an appearance of instability of 34% in wide fenestration. Thus, the midterm results of the YFLM are comparable with results using conventional methods. We recommend the YFLM as more useful because of its safety.

GP200

VERTEBRAL ENDPLATE CYST AS A PREDICTOR OF NONUNION AFTER LUMBAR INTERBODY FUSION: TITANIUM ALLOY CAGE VS PEEK CAGE

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INTRODUCTION: We reported the clinical significance of vertebral endplate cyst formation as an early predictor of nonunion after lumbar interbody fusion (LIF) at the annual meeting of ISSLS in 2011. One of the limitations of that study was the lack of data on the effects of different cage materials. PEEK has gained significant popularity as the biomaterial of choice for interbody fusion because of its radiolucency and low elastic modulus, similar to that of cortical bone. A prospective comparative study of the titanium alloy (Ti) cage and the PEEK cage in LIF was performed to clarify the different effects of the two materials.

METHODS: Nineteen patients treated with 22 PEEK cages were compared with 76 patients treated with 93 Ti cages. The relationship between vertebral endplate cyst formation and bony union was assessed with CT preoperatively, three months postoperatively, and one year postoperatively. Cases of the de novo appearance of endplate cyst or a progression in cyst size after surgery were defined as cyst positive. Cases with no development of an endplate cyst or a regression in cyst size were defined as cyst negative.

RESULTS: In the PEEK group at three months, the patients were cyst positive at three levels and cyst negative at 19 levels. The union rate was 77.3% after one year. The sensitivity of cyst positivity/negativity at three months to subsequent bony union at one year was 60%, the specificity was 100%, the positive predictive value was 100%, and

the negative predictive value was 89.4%. The results for the PEEK group were almost identical to those of the Ti group.

DISCUSSION: Our radiological findings concerning bony union and vertebral endplate cysts were almost identical in the Ti and PEEK groups. Regardless of the material used, vertebral endplate cyst formation in the early period after surgery was confirmed as a significant predictor of nonunion. We also found no advantage in using the PEEK cage rather than the Ti cage for LIF.

GP201

DISCOGRAPHY FOLLOWED BY DISCOBLOCK ENSURES SUCCESSFUL SURGERY FOR DISCOGENIC LOW BACK PAIN.

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INTRODUCTION: Discogenic low back pain (LBP) is usually diagnosed by magnetic resonance imaging and discography. However, the reliability of discography is still controversial. Recently, the usefulness of discoblock for diagnosis was reported. The purpose of the current study was to evaluate the results of surgery for discogenic LBP which was diagnosed by discography and discoblock.

METHODS: This study was based on a prospective cohort of 14 consecutive patients with a chief complaint of low back pain who responded to the diagnostic procedures; discography (1.5 mL of contrast medium) and discoblock (intradisc injection of 0.75 mL of 1% lidocaine.) for intervertebral disc to confirm pain provocation and reduction were done. All patients underwent one level fusion using cages which was performed at L4/5 in 6 patients and at L5/S in 8 patients.

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Clinical and radiologic findings were examined preoperatively and 1-year after surgery.

RESULTS: Low back pain improved from the mean visual analogue scale score of 48mm (25-73) preoperatively to 18mm (5-25) postoperatively ($P<0.05$). The mean Roland and Morris Disability index also improved from 12.5 preoperatively to 2.1 postoperatively ($P<0.05$). Radiologically, the mean angle of lumbar lordosis (L1-S1) improved from 37.9° (28.7-56.3°) preoperatively to 40.3° (28.2-54.7°) postoperatively, and the mean lordotic angle of the fused segment changed from 14.0° (9-25°) to 15.7° (0-22°), respectively.

Based on patient satisfaction, excellent and good results were obtained in all patients.

DISCUSSION AND CONCLUSIONS: Inflammatory cytokines are expressed in the pathological human intervertebral disc. Additional discoblock following discography should ensure the diagnosis of discogenic pain, leads to success of the surgery.

GP202

RETROPERITONEAL OBLIQUE WINDOW TO THE L2-S1 INTERVERTEBRAL DISCS IN THE LATERAL POSITION: AN ANATOMIC STUDY

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INTRODUCTION: Access to the intervertebral discs from L2-S1 in one surgical position can be challenging. The lateral transpsoas

minimally invasive surgical (MIS) approach is preferred by many surgeons. The direct lateral transpsoas approach does however pose potential risk to neural structures of the lumbar plexus as they course through the psoas. The lumbar plexus and overlap of the iliac crest cause access to the L4-5 disc to be more complex. The L5-S1 level has not been a viable option from a direct lateral perspective.

METHODS: Twenty fresh frozen cadaveric specimens (11 female, 9 male; 31-103 yrs; BMI 15.0-39.7) with peritoneal contents intact were dissected while in a right lateral decubitus position. An oblique anatomic window to access the L2-S1 discs was examined. Measurements were taken in a static state and then with mild retraction of the psoas. The access window was defined at L2-3, L3-4, and L4-5 as the left lateral border of the aorta (or iliac artery) and the anterior medial border of the psoas. The L5-S1 window of access was defined transversely from the mid-sagittal line of the inferior endplate of L5 to the medial border of the left common iliac vessel and vertically to the first vascular structure that crosses midline.

RESULTS: The mean static/retracted access window was as follows; L2-3 = 17.8mm/24.6mm, L3-4 = 18.7mm/26.3mm, L4-5 = 14.5mm/23.8mm. The L5-S1 disc space means were 15.1mm between midline and left common iliac vessel, and 24.6mm from the first midline vessel to the inferior endplate of L5.

DISCUSSION: The MIS oblique window allows access to the L2-5 discs as well as L5-S1 while keeping the patient in a lateral decubitus position. Minimal psoas retraction without significant tendon disruption allowed for a generous corridor to the disc space. This study supports the potential of an MIS oblique retroperitoneal approach to the L2-S1 discs.

GP203

PSYCHIATRIC DISORDERS AND MAJOR SPINE SURGERY: EPIDEMIOLOGY AND PERIOPERATIVE OUTCOMES

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INTRODUCTION: Psychiatric comorbidity is a known risk factor for impaired health-related quality of life and poor long-term outcomes following spine surgery, yet little is known about its impact in the perioperative spine surgery setting. The purpose of this study was to evaluate the influence of preoperative depression, anxiety, schizophrenia or dementia on in hospital (1) adverse events, (2) mortality and (3) non routine discharge in patients undergoing major spine surgery.

METHODS: Using the National Hospital Discharge Survey database for the years 1990 through 2007, all patients undergoing either spinal fusion or laminectomy were identified and separated into groups with and without psychiatric disorders. Multivariable binary logistic regression analysis was performed for each of the outcome variables.

RESULTS: Between 1990 and 2007, an estimated 5,382,343 spinal fusions and laminectomies were performed. The prevalence of diagnosed depression, anxiety and schizophrenia among the study population increased significantly over time. Depression, anxiety, schizophrenia and dementia were associated with higher rates of non routine discharge. Depression, schizophrenia and dementia were associated with higher rates of adverse events. Dementia was the only psychiatric disorder associated with a higher risk of in hospital mortality.

DISCUSSION: Patients with a psychiatric comorbidity undergoing major spine surgery are at increased risk for perioperative adverse events and post hospitalization care.

Pre-surgical psychological screening of spine surgery candidates might ultimately lead to the enhancement of perioperative outcomes in this growing segment of the US population.

GP204

CLINICAL OUTCOMES OF SPINOUS PROCESS-SPLITTING LAMINECTOMY FOR LUMBAR SPINAL CANAL STENOSIS.

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INTRODUCTION: Spinous process splitting lumbar laminectomy (SPL) for the treatment of one or two levels of lumbar spinal canal stenosis has been reported to be less invasive than conventional laminectomy (CON). However, no studies have evaluated the invasiveness of SPL in multilevel decompression. The aim of this study is to evaluate the invasiveness of SPL and CON.

METHODS: This study comprised 102 patients (male, 57; female, 45; mean age, 73 years) with lumbar spinal canal stenosis treated by lumbar laminectomy retrospectively. CON was performed from January 1995 to December 2004, and SPL was performed from January 2005. Intra-operative time, intra-operative blood loss and Japanese Orthopaedic Association (JOA) score were evaluated. The serum level of C-reactive protein (CRP), white blood cell (WBC) count and creatine phosphokinase (CPK) were evaluated preoperatively and on postoperative day (POD) 1, 7 and 14. Patients were grouped according to whether decompression was performed at one, two, three or four levels.

RESULTS AND DISCUSSION: For each number of decompression levels, no differences were observed between groups for the intra-operative blood loss, JOA score, WBC count and CRP levels. SPL intra-operative

time was shorter than that with CON when one or two levels of decompression were performed. The level of CPK on POD 1 was lower after SPL than after CON when one level of decompression was performed, but when two or more levels of decompression were performed, the level of CPK on POD 1 was not significantly different between groups. In conclusion the SPL approach for lumbar laminectomy is less invasive for one or two levels of decompression. However, in multilevel decompression, the extent of invasion is not significantly different than with the CON approach.

GP205

EFFECTIVENESS OF MIS-TLIF AS REVISION SURGERY

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INTRODUCTION: To evaluate short- to middle-term clinical and radiographic outcomes of minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) and conventional open TLIF as revision surgery for patients who previously had undergone discectomy or decompression surgery.

METHODS: A total of 33 patients (19 males, 14 females) who underwent 1-level MIS-TLIF (MIS: n=17, mean 65.4±11.7 years) or conventional open TLIF (Open: n=16, mean 53.6±14.0 years) as revision surgery were retrospectively reviewed. Follow-up period averaged 18.3±12.6 months. Previous surgeries performed were discectomy (n=13), laminectomy (n=12), and fenestration (n=8),

respectively. MIS-TLIFs were performed by one spine surgeon and open TLIFs by three experienced spine surgeons. Operation time, blood loss, complications, ODI, and VAS for low back pain and leg pain at pre-operative and final follow-up period were assessed.

RESULTS: Significant differences were found in operating time (MIS/Open: 127±38/186±57 min, p=0.002), blood loss (135±131/362±240ml, p=0.004), final ODI (14.6±3.8/23.6±4.4, p=0.01), and final VAS for low back pain (23.5±15.9/38.8±14.9, p=0.006). Significant improvements were obtained in ODI (MIS: 53.3±15.6 to 14.6±3.8, p<0.001; Open: 45.5±15.2. to 23.6±4.4, p=0.02) and VAS for leg pain (MIS: 68.8±15.6 to 17.9±7.7, p<0.001; Open: 74.1±15.3 to 22.8±14.0, p<0.001). Improvement of VAS for low back pain in MIS was significant (63.6±19.4 to 23.5±15.9, p<0.001), while in Open not significant (45.0±19.7 to 38.8±14.9, p=0.35). Complications in MIS group included transient leg pain due to epidural hematoma in two patients. In Open group, there were two cases of deep wound infection. Dural tear occurred in two cases each in MIS and Open groups.

DISCUSSION: MIS-TLIF can yield better improvement in low back pain than conventional TLIF in revised patients with less surgical invasiveness, although it is associated with several complications including dural tear and epidural hematoma.

GP206

Empty

GP207

CORRELATIONS BETWEEN SELF-REPORT, LABORATORY, AND ACCELEROMETRY MEASURES 6-MONTHS FOLLOWING DE-COMPRESSION SURGERY FOR LUMBAR SPINAL STENOSIS

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INTRODUCTION: Accelerometers record free-living physical activity and recently gained the attention of spine researchers. An objective and quantifiable outcomes tool has obvious advantages, yet the role of accelerometry in spine research remains undefined. The aim of this study was to evaluate, in patients undergoing lumbar stenosis surgery, correlations between interval changes in accelerometry and those in laboratory and self-reported outcomes.

METHODS: A prospective observational study of 16 patients scheduled for lumbar stenosis surgery. Baseline and 6mo post-op evaluations included accelerometry for 7 consecutive days (Actigraph GT3x+), self-reported measures (ODI, NCOS, SF-36 and SSS), and laboratory evaluation with a self-paced walking test (SPWT) and Short Physical Performance Battery (SPPB). Accelerometry data was computed as daily count thresholds and activity bouts. Spearman Correlations were used to investigate the relationships between interval changes in accelerometry and those in laboratory and self-reported measures.

RESULTS: Overall, stronger correlations were observed between accelerometry and self-reported outcomes than laboratory

measures. Strong correlations were observed between moderate/vigorous range activity and the SF-36 physical component score ($r=0.5$ to 0.7) and the SSS physical function subscale ($r=0.6$ to 0.7). Moderate correlations were observed for light/moderate range activity and the NCOS ($r=0.4$ to 0.6) and the ODI ($r=0.4$ to 0.5). Light range activity demonstrated moderate correlations to the SPWT ($r=0.4$ to 0.6) and strong correlations to the balance portion of the SPPB ($r=0.6$ to 0.8). Overall, bout-based accelerometry measures appeared more sensitive to change than daily count thresholds.

DISCUSSION: In patients with lumbar stenosis, post-surgical improvements in free-living physical activity, especially activity bout lengths, are more sensitive to change linked to self-reported measures than laboratory assessments of function.

GP208

RISK FACTORS FOR ADJACENT SEGMENT DISEASE AFTER POSTERIOR LUMBAR INTERBODY FUSION AND EFFICACY OF SIMULTANEOUS DECOMPRESSION SURGERY FOR SYMPTOMATIC ADJACENT SEGMENT DISEASE.

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INTRODUCTION: Posterior Lumbar Interbody Fusion (PLIF) increases mechanical stress and can cause degenerative changes at the adjacent segment. However, the precise causes of ASD after PLIF are not known, and it is unclear whether simultaneous decompression surgery for symptomatic ASD is effective. The aim of this study is to investigate, radiographically and symptomatically, the risk factors for adjacent segment disease (ASD) in the lumbar spine

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following L4/5 PLIF and to examine whether decompression surgery for the adjacent segment (L3/4) reduces the occurrence of symptomatic ASD.

METHODS: Fifty-four patients who underwent L4/5 PLIF for L4 degenerative spondylolisthesis and could be followed for at least 2 years were included. Of these, 37 were treated simultaneously with decompression surgery at L3/4. We measured radiographic changes and assessed symptoms from the cranial adjacent segment.

RESULTS: Thirty-one patients (57.4%) met radiological criteria for ASD. The length of follow-up ($p=0.004$) and simultaneous decompression surgery at L3/4 ($p=0.009$) were statistically significant factors for radiologic diagnosis of ASD. Seven patients (13.0%) had symptomatic ASD: 6 in the decompression group (16.2%) and one in the PLIF-only group (5.9%). Simultaneous decompression surgery did not reduce the incidence of symptomatic ASD ($p=0.256$). Local lordosis at the fused segment ($p=0.005$) and the sagittal angle of the facet joint at L3/4 ($p=0.024$) were statistically significant predictors of symptomatic ASD, which was accompanied by postoperative anterior listhesis above the fused segment (S group, $8.4 \pm 8.0\%$; NS group: $-0.7 \pm 5.0\%$, $P=0.024$).

DISCUSSION: Patients whose facet joint at the adjacent segment had a more sagittal orientation had postoperative anterior listhesis, which caused symptomatic ASD. Simultaneous decompression surgery without fusion at adjacent level was not effective for these patients, but rather there was a possibility that it induced symptomatic ASD

GP209

A PROSPECTIVE RANDOMIZED CONTROLLED STUDY COMPARING SUPINE POSITION AND LATERAL POSITION FOR POSTOPERATIVE POSITIONING; WHICH POSITION IS COMFORTABLE AFTER SURGERY FOR LUMBAR DEGENERATIVE DISEASE?

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INTRODUCTION: Patients are usually placed in a supine position after lumbar surgery; however, a considerable number of patients are unable to maintain that position. To date, there have been no studies comparing postoperative pain and discomfort between the two positions. A prospective randomized study was conducted to determine which position is more comfortable for patients.

METHODS: Patients with lumbar degenerative disease ($n=45$) treated by decompression surgery ($n=23$) or fusion surgery ($n=22$; <2 levels) were randomly assigned to receive either supine ($n=24$) or lateral ($n=21$) postoperative positions. Patients were asked to maintain that postoperative position until a day after surgery; those unable to do so were allowed to change their position. A day after surgery, postoperative back pain and discomfort were evaluated using a visual analogue scale (VAS; 0-100 mm). Rates of patients able to maintain their position were also evaluated.

RESULTS: VAS scores for postoperative back pain (supine: 64.4; lateral: 54.7) showed no significant difference. VAS scores for the supine group did reflect a non-significant trend to experience more severe discomfort (74.1), compared to the lateral group (63.7, $p=0.08$). In the supine group, significantly fewer patients were able to maintain their position (29.2%) than in the lateral group (58.3%). When limited to patients that received decompression surgery, there was no significant difference in the rate of patients who maintained their position between the supine (45.5%: 5/11) and lateral (75.0%: 9/12) groups. When limited to fu-

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sion surgery, there was a non-significant trend of a difference ($p=0.07$) between the supine (15.4%: 2/13) and lateral groups (55.6%: 5/9).

DISCUSSION: A difference in patients' post-operative back pain and discomfort between the supine and lateral postoperative positions has been demonstrated. Particularly, patients receiving fusion surgery may have difficulty maintaining the postoperative supine position.

GP210

THE EFFECT OF PLATELET-RICH PLASMA ON INVASIVE PARASPINAL MUSCLES DURING SPINAL SURGERY

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INTRODUCTION: We examined the effect of platelet-rich plasma (PRP) on spinal muscle pain and inflammation in a rat model of a posterior surgical approach.

METHODS: Rats were divided into three groups: a sham group, a surgery group, and a surgery with PRP group. In the sham group, only an incision was made. In the surgery group, bilateral lumbar back muscles were separated and the neurotracer FluoroGold (FG) applied between the separated muscles. In the surgery with PRP group, the same surgery was performed applying PRP in the same area. One and two weeks after treatment, a Catwalk system was used to evaluate back pain, and back muscles were resected and evaluated histologically using hematoxylin and eosin staining. In addition, dorsal root ganglia were resected to evaluate inflammation using immunohistochemistry with CGRP as a marker.

RESULTS: The platelet concentration in PRP was 4.3 times higher than that in normal

blood. The concentration of growth factors in PRP was more than 10 times higher than that in normal blood. The Catwalk analysis showed that contact pressure by the hind paws was decreased and the duration of paw contact was shortened in the surgery and surgery with PRP groups compared with the sham group ($P<0.05$). No significant difference was found between the surgery and surgery with PRP groups. The proportion of FG-labeled and CGRP-immunoreactive DRG neurons was increased in the surgery group compared with the sham group, and was significantly lower in the surgery with PRP group compared with the surgery group. The histology showed that the numbers of neutrophils and lymphocytes were increased in the surgery group. The increase was significantly suppressed in the surgery with PRP group.

DISCUSSION: Local inflammation of back muscles was suppressed by adding PRP, but no significant difference was found in behavior suggesting the presence of back pain. PRP did not significantly reduce low back pain resulting from surgical damage.

GP211

ANATOMICAL EVALUATION OF THE LUMBAR SPINAL NERVE ROOTS WITH DIFFUSION TENSOR TRACTOGRAPHY: PRESURGICAL IMAGING FOR DIRECT LATERAL INTERBODY FUSION

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INTRODUCTION: Direct lateral interbody fusion (DLIF) has been reported as a new surgical procedure with a minimally invasive lateral transpsoas approach. Although real-time electromyography (EMG) is recommended to avoid complications related to lumbar spinal nerve and lumbosacral plexus injury, the risk of such complications remains high. Diffusion tensor imaging (DTI) and diffusion tensor tractography (DTT) have been reported as novel imaging tools with which to evaluate and visualize highly anisotropic peripheral nerve fiber tracts. Several authors have reported the course of lumbar spinal nerves and the lumbosacral plexus, but these were all in cadavers. The purpose of this study is to provide an anatomical evaluation of the spinal nerve course using DTT, to investigate its efficacy for presurgical imaging.

METHODS: Thirty-five patients underwent DTT with 3.0T MR imaging. Tractography of L3 and L4, and the location on each spinal nerve root at the L3-4 and L4-5 levels were evaluated. The location of the nerve roots was categorized into one of six zones (1 through 4, A, P), defined as: 1 through 4 denote the disc space divided into quartiles from anterior to posterior, A denotes anterior to the disc space, and P denotes posterior to the disc space.

RESULTS: L3 nerve roots were found in zone 4 and P at L3-4. A quarter of L3 nerve roots were found in zone 3 at L4-5. L4 nerve roots were found in zone 4 and P at L4-5. At L3-L4 nerve roots were located in the most posterior quarter of the vertebral body and dorsally, and at L4-L5 nerve roots were located in the mid posterior and dorsally.

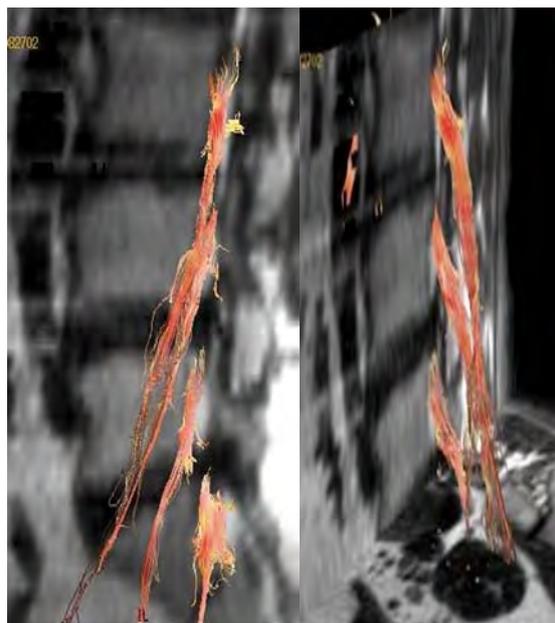


Fig. Diffusion tensor tractography merged with T2-weighted images

DISCUSSION AND CONCLUSION: DTT can visualize lumbar spinal nerve roots. The nerve distribution we found was similar to that found in previous cadaveric studies. It is safe to access the anterior half of the disc space during DLIF, but there is risk of the nerve injury for the posterior half. The risk of nerve injury during DLIF may be decreased by using DTT for presurgical imaging.

GP212

IS THE POSITIVE NERVE ROOT SEDIMENTATION SIGN IN PATIENTS WITH LUMBAR SPINAL STENOSIS REVERSIBLE AFTER DE-COMPRESSION SURGERY?

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INTRODUCTION: The Nerve Root Sedimentation Sign (SedSign) has been established as a new radiological sign in the diagnosis of lumbar spinal stenosis (LSS). In patients without LSS, on supine Magnetic Resonance Imaging (MRI) lumbar nerve roots sediment to the dorsal part of the dural sac. In patients with LSS, this nerve root sedimentation is not always seen. The absence of nerve root sedimentation has been defined as positive SedSign. As patients with a positive SedSign may benefit from surgical decompression the Sign might assist the spine surgeon to determine the indication for surgery. The aim of this study was to investigate if in patients with LSS the positive SedSign will turn negative after lumbar decompression.

METHODS: Retrospective cohort study of consecutive spine patients with an initial MRI of the lumbar spine in whom a follow-up MRI was performed after decompression surgery. Comparison of the primary MRIs with the follow-up MRIs in regard to the presence of nerve root sedimentation (negative SedSign).

RESULTS: Fifty-seven of 118 LSS patients had a positive SedSign, of these 39 had undergone spine surgery. In this group, 12 patients were identified who had a post-op MRI of the lumbar spine (7 male, 5 female, mean age 69 yrs [range 52-83]). Eight patients demonstrated a negative SedSign, 3 patients had a positive SedSign associated with a newly occurred stenosis in another previously not affected segment. One patient had an arachnoiditis with a positive SedSign but without stenosis.

DISCUSSION: Despite several limitations of this study the reversibility of a pre-op positive SedSign was demonstrated after decompressing the affected level; except for a case of arachnoiditis which could not be differentiated from spinal stenosis due to the parietal clumping of nerve roots. Further research is required to investigate in a prospective representative patient sample if

the reversibility of a positive SedSign is correlated with an improved clinical outcome.

GP213

INVERTED Y APPROACH TO LUMBOSACRAL REGION- ANALYSIS OF 525 CASES OVER 10 YEARS.

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INTRODUCTION: Traditional approach to lumbosacral region utilizes midline incision, which often requires long incision to get sufficient exposure. We describe our experience with inverted Y approach to lumbosacral junction.

OBJECTIVE: To analyze the surgical steps, complications and results of inverted Y incision to approach lumbosacral region in a tertiary care referral center (Amrita Institute of Medical Sciences, Kochi) by file review.

MATERIALS AND METHODS: Total of 525 patients were included in the study with the range of age from 17 to 75 years and mean age being 51.24 years. Mean follow-up period was 26 months, with a range from 10 to 64 months. The surgeries included PLF, PLIF, TLIF and Iliolumbar fixations.

RESULTS: 522 patients had primary wound healing and 3 patients had wound breakdown. Of these 3 patients, two had previous radiation treatment to lumbosacral region and one patient had multiple surgeries for spondylodiscitis earlier.

Discussion: Inverted Y Approach to lumbosacral region is a simple and safe technique with minimal wound complications.

GP214

ADJACENT SEGMENT PATHOLOGY AFTER THORACOLUMBAR FUSION IN THORACOLUMBAR FRACTURE: AN AGE AND SEX MATCHED-COHORT STUDY WITH LOWER LUMBAR FUSION

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INTRODUCTION: Although numerous studies have reported the adjacent segment pathology (ASP) after lumbar fusion, little attention has been paid to the ASP after thoracolumbar fusion. The purpose of this study was to investigate the ASP after thoracolumbar fusion as compared with lower lumbar fusion.

METHODS: Forty-four patients with thoracolumbar (T10-L2) fracture treated with posterior fusion using pedicle screw instrumentation that had taken MRI at the time of index treatment and at least 2-year follow-up were included. A matched cohort of 47 patients that underwent lower lumbar (L3-S1) fusion with pedicle screw instrumentation was identified. The ASPs including disc degeneration, disc herniation, spinal stenosis and spondylolisthesis between the 2 groups were compared with MRI.

RESULTS: There was no difference regarding the patients' age ($P=0.066$), gender ($P=0.152$), and the duration of follow-up MRI ($P=0.150$) between thoracolumbar fusion group and lower lumbar fusion group. The mean instrumentation level was 3.5 ± 0.9 in thoracolumbar fusion and 1.6 ± 0.7 in lower lumbar fusion ($P < 0.001$). Adjacent disc degeneration was found in 11 of thoracolumbar fusion and 14 of lower lumbar fusion ($P=0.567$). Adjacent disc herniation was found in 4 of thoracolumbar fusion and 6 of lower lumbar fusion ($P=0.201$). Spinal stenosis was found in 5 of thoracolumbar fusion and 7 of lower lumbar fusion

($P=0.427$). Spondylolisthesis was found in 1 of thoracolumbar fusion and 2 of lower lumbar fusion ($P=0.328$).

DISCUSSION: The occurrences of ASPs after thoracolumbar fusion were not different with those of lower lumbar fusion. The limitation of this study was devoid of including thoracolumbar fracture without fusion.

GP215

DO RISK FACTORS MATTER IN PROPHYLACTIC ANTIBIOTICS REDUCTION AFTER SPINAL SURGERY?: A PROSPECTIVE COMPARATIVE STUDY

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INTRODUCTION: Prophylactic antibiotics duration after spinal surgery remains controversial, especially for patients with risk factors. We designed a prospective comparative study to evaluate whether risk factors affect the occurrence of surgical site infection (SSI) and the changes of host immune responses depending on the duration of prophylactic antibiotics.

MATERIALS AND METHODS: This study involved 150 consecutive patients who had undergone a spinal surgery and were administered first generation cephalosporin as prophylactic antibiotics. The duration of antibiotics administration had been altered for each fifty consecutive patients as 5-day, 3-day, and 1day. Preoperative antibiotics prophylaxis was commonly administered for the 3 groups within 1 hour prior to surgical incision with the same trial antibiotics. Intraoperative bacterial culture on the surgical site was performed. The occurrences of SSI were evaluated as described by National Nosocomial Infection Surveillance guideline. SSI was considered as acute if it occurred within postoperative 1 month, subacute for < 3 months, and chronic for > 3

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months. Serial changes of hematologic inflammatory markers and DIC profiles were compared until postoperative 2 weeks. Risk factors such as age, sex, body mass index, estimated blood loss, diabetes mellitus, smoking, nutritional status, baseline laboratory values, catheter indwelling, the duration of drain, and type of surgery were analyzed.

RESULTS: Incisional SSI was found in 2, 3, and 3 patient with 5-day, 3-day, and 1-day administration, respectively ($P=0.887$). Organ/space SSI occurred in 1 patients in all the three groups. All SSIs were acute infection. There was no difference for intraoperative bacterial culture. Laboratory results revealed that postoperative changes of hematologic inflammatory markers and DIC profiles were not different among the three groups (all $P>0.05$). The occurrence of SSI was not affected by having risk factors.

DISCUSSION Prophylactic an

GP216

THE LUMBO-PELVIC SAGITTAL ALIGNMENT AND EARLY ADJACENT SEGMENT DISORDER AFTER PLIF IN PATIENTS WITH LUMBAR DEGENERATIVE SPONDYLOLISTHESIS .

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PURPOSE: Spondylodesis is indicated for a number of patients with lumbar degenerative spondylolisthesis (SD); however, its influence on early onset adjacent segment disorder is a concern. The purpose of this study was to evaluate the early onset adjacent segment disorder (ASD) after PLIF and lumbo-pelvic sagittal alignment.

SUBJECTS AND METHODS: Subjects were 69 patients with unstable DS who underwent PLIF and postoperative follow-up for 3 years or longer. Subjects were classified into 2 groups; namely, an adjacent segment disorder

which occurred within one year after surgery (early ASD) and an adjacent segment disorder which occurred in the later periods (late ASD). Intervertebral height, range of motion, slip, and sagittal alignment were measured by preoperative XP and intervertebral joint angle by CT, and then adjacent vertebral narrowing, absence or presence of instability, and an increase or decrease of range of motion with time during postoperative follow up were examined.

RESULTS AND DISCUSSION: Adjacent vertebral narrowing occurred in 15 of 69 patients (21.0%), including ten in the early ASD and five in late ASD, showing that more ASD occurred within one year. In the early ASD, L3/4 disorder occurred in three patients by L4/5 PLIF + L3/4 fenestration, L2/3 disorder occurred in four. Regarding to the onset of ASD, there were no significant difference about the facet angle. However, sagittal plane was affected to the onset of ASD. Table showed the results of sagittal alignment. In early ASD group, the trunk tilted forward more severely, and the pelvis tilted more forward. before the operation. In general, DS has posterior rotated pelvis in order to compensate for lumbar slip. However, if the pelvic anterior rotation was severe before surgery, the LLA should be correct enough. Otherwise, because the postoperative change of pelvic rotation is small, the mechanical stress above PLIF segment would be increased.

GP217

VERTEBROPLASTY FOR VERTEBRAL PSEUDOARTHROSIS IN PATIENTS WITH SECONDARY OSTEOPOROSIS: COMPARATIVE STUDY WITH PRIMARY AND SECONDARY OSTEOPOROSIS

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INTRODUCTION: Osteoporosis has been classified as either primary or secondary. Although secondary osteoporosis is less common, it is becoming more frequently diagnosed. The purpose of this study was to compare the clinical outcomes of vertebroplasty (VP) for patients with primary and secondary osteoporosis.

METHODS: In our hospital we perform VP using calcium phosphate cement (CPC) for the treatment of vertebral pseudoarthrosis. We reviewed 45 patients (Pts) undergoing 49 VPs with more than 1 year follow up. There were 7 men and 38 women with an average age of 76.0. We divided these patients into patients with primary osteoporosis (P-group) and patients with secondary osteoporosis (S-group). Outcomes including pain, complications, frequency of new fractures and radiographic changes (anterior vertebral height restoration) in S-group were compared with P-group.

RESULTS: Fourteen Pts were included in S-group. The causes of secondary osteoporosis were followed. Long-term corticosteroid therapy for the treatment of the coexisting illness such as rheumatologic diseases was 7, Diabetes mellitus was 7, gastrectomy patient was 2, and Liver cirrhosis was 1. There was no significant difference between the two groups in pre- and post- operative JOA score and VAS. The frequency of new fractures was not significantly different between the two groups. The 23.0% of the anterior vertebral body height correction was lost in S-group, but 13.5% in P-group. Number of cases of height loss > 10% were significantly higher in the S- group than P-group

DISCUSSION: VP performed for vertebral pseudoarthrosis as a result of secondary osteoporosis is as safe and effective in relieving pain as those of primary osteoporosis. However, patients with secondary osteoporosis showed higher risk in loss of cor-

rection in the treated vertebrae.

GP218

SURGICAL DECOMPRESSION OF THE THORACIC SPINAL CANAL IN ACHONDROPLASIA; INDICATION AND OUTCOME

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INTRODUCTION: The achondroplastic spinal canal is narrow due to short pedicles and a small interpediculate distance. Compression of neural structures passing through this canal is therefore regularly encountered, but scarcely described. Symptomatology, radiologic evaluation, and treatment of 20 achondroplasts that underwent decompression of the thoracic medulla is described and outcome is correlated to the size of the spinal canal and the thoracolumbar kyphotic angle.

METHODS: The modified JOA score, Nurick score, European Myelopathy Score, Cooper myelopathy scale for lower extremities, and Odom criteria before and after surgery were compared. MR imaging was evaluated for the size of the spinal canal, medullary compression, and presence of myelomalacia. The thoracolumbar kyphotic angle was measured on fluoroscopy.

RESULTS: Symptomatology included deterioration of walking pattern, pain, cramps, spasms, and incontinence. MRIs of all patients demonstrated medullary compression due to degenerative changes. Surgery resulted in (slight) improvement on all aforementioned ranking scales. Surgery at the wrong level occurred in 15%, but no serious complications occurred. The mean thoracolumbar kyphotic angle was 20 degrees, and no correlation was established with outcome after surgery. No post-operative increase in this angle was reported. Neither

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was there a correlation between size of the spinal canal and outcome.

DISCUSSION: Decompressive surgery of the achondroplast thoracic medulla can be performed safely if anatomical details are taken into account. Spondylodesis did not appear obligatory. Special attention should be paid to the method of surgery, how to identify the level of interest and follow up of the thoracolumbar kyphotic angle.

GP219

DORSAL VENTRAL DORSAL THREE STAGE CORRECTION SURGERY FOR LUMBAR KYPHO-SCOLIOSIS DEFORMITY

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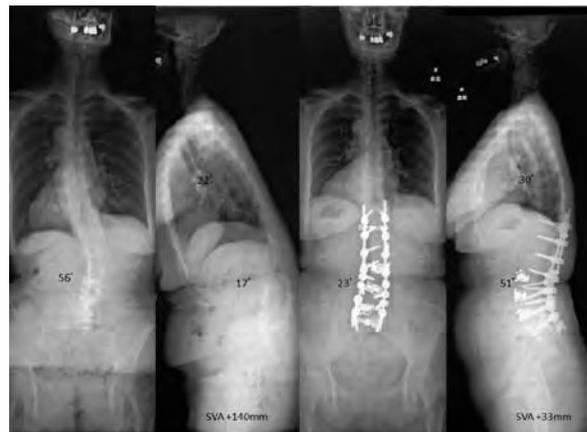
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INTRODUCTION: Sagittal balance restoration is essential in achieving positive outcomes in correction of adult spinal deformities. We have performed dorsal ventral dorsal (DVD) three-stage correction for patients with maximum kyphosis correction required. The aim of the study was to determine the efficacy of the DVD procedure for patients with severe lumbar kyphosis deformity.

METHODS: Retrospective review of 82 patients (8 male and 74 female). Mean age 66 years (46-78). Mean follow-up period 3.7 years (1-12). Facetectomy at 2-3 levels performed in first stage, followed by anterior release and interbody fusion at same level; posterior fusion with instrumentation performed in final stage. Mean fused levels 5.4 (range 3-11). Clinical assessment performed using JOA score and visual analog scale for low back pain. Radiological measurement performed using pre-operative, post-operative and final films.

RESULTS: The mean pre-operative JOA

score of 16.4 changed to 24.4 at final follow-up, with a recovery rate of 64.1%. The mean pre-op VAS of 62.7mm was reduced to 20.6mm at final follow-up. Re-operation was performed on 4 patients (proximal junctional kyphosis in 2 cases; disc herniation at L5/S in 2 cases). The fusion rate was 89% with 8 of 9 non-union cases were those at L5/S. Subsequent vertebral fracture was observed in 14.6% of the patients. The pre-op lumbar lordosis (L1-S) of 2.5° changed to 48.8° at post-op and 34.8° at follow-up. The obtained lordosis at the fusion area was 48.6° at post-op and 35.2° at follow-up. The single level obtained lordosis at DVD correction level was 17.6° at post-op and 15.1° at follow-up. The pre-op sagittal vertebral axis of 98.0mm changed to 49.2mm at follow-up.



DISCUSSION: The DVD procedure was useful in the correction of kyphosis and provided good clinical results. The remaining challenges are how to determine the fusion area and how to avoid L5/S pseudarthrosis, subsequent vertebral fracture and proximal junctional kyphosis.

GP220

ASSOCIATION BETWEEN VERTEBRAL ENDPLATE SIGNAL CHANGES AND LOW BACK PAIN IN PATIENTS WITH CURRENT OR PREVIOUS SYMPTOMS OF SCIATICA

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BACKGROUND: Patients with current or previous symptoms of sciatica frequently experience low back pain (LBP). One of the proposed causes for LBP is Vertebral Endplate Signal Changes (VESC) visualized by Magnetic Resonance Imaging. We investigated the association between VESC and LBP in patients with current or previous symptoms of sciatica.

METHODS: The study population consisted of 283 patients who were randomized to surgery or to prolonged conservative care with surgery if needed. Participants underwent MRI both at baseline and after 1 year. The presence of VESC was correlated to LBP (defined as a visual-analogue scale of at least 40mm on a scale of 0-100) using Fisher's exact tests and logistic regression.

RESULTS: VESC were observed in 43% of the patients at baseline. Of the patients with VESC at baseline 40% had LBP compared to 38% of the patients with no VESC (P=0.70). The prevalence of type 1 VESC increased from 1% at baseline to 35% one year later in

the surgical group compared to an increase from 3 to 11% in the conservative group. The prevalence of type 2 VESC decreased from 39 to 29% in the surgical group while remaining comparable in the conservative group. The prevalence of LBP at one year was 12% in patients with no VESC, 16% in patients with type 1 VESC, 11% in patients with type 2 VESC and 3% in patients with mixed type 1 and 2 VESC (P=0.34). Patients who showed an increase in the amount of VESC after one year did not significantly report more LBP compared to patients who did not (OR 1.21, 95% CI 0.57-2.58, P=0.61). Undergoing surgery was associated with progression in the amount of VESC (OR 8.56, 95% CI 4.67-15.67, P<0.001).

DISCUSSION: Surgery highly accelerates the development of VESC. However, in this group of patients with current or previous sciatica no association existed between the presence or progression of VESC and LBP. Therefore, VESC cannot be responsible for remaining or new LBP after surgical or conservative treatment for sciatica.

GP221

PREDICTION OF SURGERY FOR SCIATICA WITH MRI

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BACKGROUND: A randomized trial showed

that surgery compared to a prolonged conservative care strategy for patients with 6 to 12 weeks sciatica yields similar functional recovery rate results by one year. However, 39% of the patients assigned to prolonged conservative care underwent surgery during the first year after randomization. Previously we reported that sequestered herniations and the level of the disc herniation on Magnetic resonance imaging (MRI) were not predictive for delayed surgery. The objective of this study was to evaluate the predictive value of a more detailed qualitative and quantitative MRI assessment for delayed surgery.

METHODS: MRIs of the 142 patients who were assigned to receive conservative care were assessed, both qualitatively (by two neuroradiologists and one neurosurgeon who were not previously involved in earlier published papers) and quantitatively (by an independent investigator also not previously involved). Logistic regression model and Receiver operating characteristic (ROC) curve analysis were used to determine the predictive value of qualitative and quantitative MRI measurements on the occurrence of surgery during the first year. Area under the ROC curve (AUC) above 0.7 was considered acceptable.

RESULTS: MRI variables such as the probability of definite nerve root compression, location and form of the disc herniation, and baseline size of the disc herniation did not have any predictive value for delayed surgery. Size of the dural sac spinal canal did predict delayed surgery (per 25 mm² increment in size odds ratio 0.80 [95% CI 0.67-0.96] and 0.82 [95% CI 0.71-0.95] respectively). Using the size of the dural sac and spinal canal to predict delayed surgery revealed an AUC of 0.62 (95% CI 0.53-0.72) and 0.62 (95% CI 0.53-0.72) respectively.

DISCUSSION: MRI is not acceptably able in assisting clinical decision making for surgical or non-surgical management in patients who suffer from sciatica for 6 to 12 weeks.

GP222

SURGICAL OUTCOME OF DROP FOOT CAUSED BY DEGENERATIVE LUMBAR DISORDERS; FOCUSED ON THE RECOVERY OF MOTOR DEFICITS AND THE IMPROVEMENT OF LOW BACK AND LOWER EXTREMITY SYMPTOMS.

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INTRODUCTION: Drop foot, sometimes caused by degenerative lumbar disorders, is a neuromuscular condition in which patients are unable to dorsiflex the ankle. It is important to advise patients as to how much motor function will improve after surgery, and whether low back and lower extremity symptoms will resolve, but there are no reports describing surgical outcomes such as residual pain and numbness in patients with lumbar degenerative disorders complicated by drop foot. We conducted a retrospective study to evaluate these outcomes.

METHODS: Between April 2010 and September 2011, 20 patients (12 men, 8 women) with degenerative lumbar disorders and drop foot underwent lumbar spine surgery. We evaluated patient age, the causative disorder, and the duration from symptom onset to surgery. We measured preoperative and 1 year postoperative tibialis anterior (TA) strength using the manual muscle test (MMT). Low back and lower extremity symptoms were evaluated with a visual analogue scale (VAS), and activities of daily living (ADL) by Oswestry Disability Index (ODI).

RESULTS: Twelve patients had lumbar disc herniation (LDH) and 8 had lumbar spinal stenosis (LSS). TA strength was improved in LDH patients (pre-op, post-op: 2.46±0.77, 4.23±1.09) to a significantly greater degree than in LSS patients (1.43±0.79, 3.14±1.77).

The age at onset was negatively correlated with the TA strength recovery rate ($p < 0.01$). There was also a negative correlation between this rate and the duration from onset to surgery ($p < 0.05$). Following surgery, significant improvement in low back pain, lower extremity pain, and numbness was observed by both VAS and ODI in patients with both unfavorable ($MMT < 4$), and favorable ($MMT \geq 4$) motor recovery.

CONCLUSIONS: Causative disorder, age, and duration to surgery are prognostic factors for surgical outcome in patients with drop foot. ADLs, low back pain, and lower extremity symptoms were improved after surgery even when motor deficits remained.

GP223

VERTEBROPLASTY FOR PATIENTS WITH NEUROLOGICAL DEFICITS CAUSED BY INSUFFICIENT UNION FOLLOWING OSTEOPOROTIC VERTEBRAL FRACTURE

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INTRODUCTION: We have previously reported that intravertebral instability is a significant factor in neurological deficits following insufficient union after osteoporotic vertebral fracture (OVF). On the basis of this finding, we prospectively performed vertebroplasty without decompression in patients with neurological deficits. The purpose of this study was to clarify the usefulness and limitations of vertebroplasty for insufficient union of OVF with lower limb neurological symptoms.

METHODS: Twenty-eight patients (7 males and 21 females) underwent vertebroplasty for neurological deficits caused by insufficient union following OVF. Twenty-one patients who underwent posterior decompression and fusion surgery with instrumentation were selected as controls (group-PDF). Neurological improvement (modified Frankel classification), invasiveness of surgery, surgical complications, and radiographic results were evaluated between the 2 groups.

RESULTS: The neurological function determined using the modified Frankel classification were as follows: C1, 2; C2, 4; D1, 10; D2, 1; and E, 11 preoperatively and C1, 0; C2, 0; D1, 2; D2, 10; and E, 16 at the final follow-up. The symptoms improved in all patients with sensory disturbances or bladder and rectal disturbances. The mean operation time was 120 min, mean blood loss was 119 mL, and transfusion rate was 3.6%; these were significantly lower than corresponding values in group-PDF. Subsequent adjacent vertebral fracture rate was 32% (9 patients). Among these 9 patients, 2 with adjacent vertebral collapse in the early postoperative period developed severe thigh pain. In the kyphotic angle, there were no significant differences between the 2 groups.

DISCUSSION: We obtained satisfactory results of vertebroplasty for insufficient union of OVF with lower limb neurological symptoms. Advanced collapse of the adjacent vertebral body in the early postoperative period caused poor results.

GP224

INSTRUMENTATION AND EQUIPMENT RELATED INEFFICIENCY IN SPINE SURGERY: POTENTIAL FOR COST SAVINGS

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INTRODUCTION: Spine procedures represent a large portion of healthcare expenditure in the orthopedics specialty. Studies have shown that intra-operative waste has exacerbated the high cost of surgeries. Our objective is to identify and quantify the incidence of pre- and intra-operative equipment related events that generate inefficiency.

METHODS: Data was collected over a 9-month period. A data collection instrument was developed to record procedure related details and instrument/equipment related issues. Administrative records of equipment issues were also obtained for the same period. For each case with equipment related issues, estimates of cost increase and time delay was made. Operating cost of OR time is based on hospital financial data (\$1061.03/hour).

RESULTS: 53% of the spine procedures (325/613) were recorded in the database. Equipment related issues occurred in 43.5% of cases. Issues included missing equipment (19.2%), improperly packaged pans (7.1%), improperly maintained equipment (16.2%), and other (1.0%). Unanticipated extra pans were opened in 18.6% of the cases (total of 91 pans, range 1-5). In cases requiring extra pans, the average cost increase was \$135.6 (range \$26.05 to \$742.75). Comparing cases with pre-operative equipment issues and those without: the difference in the first cases of the day is 15 minutes (\$265.26, 29 vs. 14 minutes, $P < 0.05$), the difference in the rest of the cases is 7.8 minutes (\$137.9, 48 vs. 40.2 minutes, $P = 0.06$). Examining the administrative record of the cases in our study, hospital record captured 46 (14%) equipment related issues.

DISCUSSION: Perioperative inefficiency in spine surgery can be material or temporal. Material inefficiency is demonstrated by the high incidence of equipment related issues. Indirect costs such as delay in OR start time can be a contributor to overall hospital waste. Our method was more capable of

capturing equipment issues than administrative process (43.5% vs. 14%).

GP225

RISK FACTORS FOR RECOLLAPSE OF THE TREATED VERTEBRAE IN PATIENTS WITH VERTEBRAL PSEUDARTHROSIS AFTER VERTEBROPLASTY

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INTRODUCTION: Recollapse of the treated vertebra after vertebroplasty (VP) is one of the severe complications. Pre-operative vertebral pseudoarthrosis has been reported as predisposing factor. However, which characteristics of vertebral pseudoarthrosis increase the risk of recollapse remains unclear. The purpose of this study was to investigate the risk factors for this complication using uni- and multivariate regression analysis.

METHODS: A total of 49 vertebral pseudoarthrosis treated with VP using calcium phosphate cement were included in this study. Demographic data, comorbidities and all complications were analyzed. Morphological variables, including posterior/anterior wall injury, endplate injury and anterior vertebral height restoration (AVH) of treated vertebrae were also analyzed. In this study, we made a new scoring system based on the extent of damage to the vertebral wall (Vertebral wall injury severity score. 1: only anterior wall injury, 2: anterior and posterior walls injury without endplate injury, 3: both anterior and posterior walls injury with upper or lower endplate injury, 4: both anterior and posterior wall injury with both upper and lower endplate injuries)

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RESULTS: Recollapse was occurred in 14 vertebrae (28.6%). In univariate analysis, hemoglobin level, bone metabolic marker, ASA physical classification system (ASA), posterior wall injury, lower endplate injury, vertebral wall injury severity score, and AVH were significantly associated with the incidence of recollapse. In multivariate analysis, ASA (odds ratio, 6.2; $p=0.065$) and vertebral wall injury severity score (odds ratio, 6.8; $p<0.05$) were significantly associated with recollapse.

DISCUSSION: Recollapse after VP is common in patients with vertebral pseudoarthrosis and the residual bone condition (vertebral wall injury severity score) was the most important predictive factor for this complication than other predictive factors such as age and bone mineral density.

GP226

COMPARISON OF PULMONARY FUNCTION IN ADULTS YOUNGER AND OLDER THAN AGE 60 UNDERGOING SPINAL DEFORMITY SURGERY

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INTRODUCTION: The objective of this study was to determine differences in pulmonary function in adult patients who are either younger (Y) or older (O) than age 60 following spinal deformity surgery.

METHODS: 128 consecutive adult deformity patients with idiopathic scoliosis undergoing surgical treatment were evaluated at a single institution with minimum 2 yr follow-up. Prospectively collected PFTs, clinical records and radiographs were analyzed.

RESULTS: There were 102 patients in Y

group (avg age $39.3+14.1$ yrs) and 26 in O group (avg age $63.7+2.7$ yrs), with similar F/U ($Y=2.9$ v $O=2.6$ yrs, $p=0.27$). There were no differences in avg preop main thoracic (MT) curve magnitude ($Y=50.0$ deg, $O=54.8$ deg, $p=0.27$), however O patients had significantly greater # of lumbar (5.9 v 4.2 , $p=0.00$), thoracic (9.1 v 7.3 , $p=0.00$), and total (15.0 v 11.5 , $p=0.00$) levels fused. We also found O patients had significantly lower absolute pre-op FEV1 (2.1 v 2.6 L, $p=0.02$) and FVC (2.7 v 3.3 L, $p=0.05$), but no differences in %pred PFTs. This relationship remained at 2 yrs, with lower absolute FEV1 (1.9 v 2.5 L, $p=0.00$) and FVC (2.5 v 3.1 L, $p=0.00$). A clinically significant decline in PFTs (greater than 10% pred FEV1) occurred in 8 (31%) O patients and 26 (25%) Y patients, which was not statistically different. ($p=0.63$). We also observed pre-op PFT impairment (less than 65%pred FEV1) in 1 (4%) O patient, which significantly increased to 6 (23%; $p=0.02$) postoperatively, compared to Y group experiencing no change in the number of patients ($n=12$, 12%) with PFT impairment postoperatively.

DISCUSSION: Despite age related reduction in PFTs, older patients (over age 60) had no significant difference in %pred PFTs compared to younger patients following spinal deformity surgery and no differences in the rate of clinically significant PFT decline ($\geq 10\%$ pred FEV1). However, older patients more frequently (23% v 12%) experience PFT impairment ($<65\%$ pred FEV1) after spinal deformity surgery.

GP227

RETURN TO SPORTS AFTER SURGERY TO CORRECT ADOLESCENT IDIOPATHIC SCOLIOSIS

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INTRODUCTION: Participation in sports and athletic activities by children and adolescents has become an important aspect of society, and is a frequent question following surgery for adolescent idiopathic scoliosis. No studies in the last decade using modern posterior spinal implants have provided recommendations on when surgeons' should allow patients' to return to athletic activities following spinal fusions for deformity surgery.

METHODS: A survey was administered to members of the Spinal Deformity Study Group (SDSG). The survey consisted of surgeon demographic information, 6 clinical case scenarios and three different construct types (hooks, pedicle screws, and hybrid).

RESULTS: Twenty-three (23) surgeons completed the survey, with 43% being orthopaedic spine surgeons and 57% being pediatric orthopaedic surgeons. Respondents were all experienced, expert deformity surgeons, supported by 50% performing an average of 21-50 AIS cases per year with 44% of surgeons with >20 years in practice. Most patients were allowed to return to both non-contact and contact sports within 3-6 months, and collision sports within 6-12 months postoperatively. We also found pedicle screw instrumentation allows earlier return to contact & non-contact sports. For all construct types, approximately 20% of respondents never allow return to collision sports, whereas all surgeons allow eventual return to contact & non-contact sports regardless of construct type. Of all surgeons surveyed, there was only 1 reported catastrophic failure in a patient with implant pullout after snowboarding 2 weeks postoperatively.

DISCUSSION: Our study found that modern posterior instrumentation allows surgeons to recommend earlier return to sports following fusion for AIS, with the majority allowing non-contact and contact sport at 6 months and collision sports at 12 months.

There was only one reported catastrophic construct failure after return to sports postoperatively.

GP228

THE RELIABILITY OF THE THORACOLUMBAR INJURY CLASSIFICATION AND SEVERITY SCORE AMONG ORTHOPEDIC SURGEONS AT DIFFERENT LEVELS OF TRAINING

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INTRODUCTION: Despite the increased use of Thoracolumbar Injury Classification and Severity Score (TLICS), it has not yet gained universal acceptance. Our objective was to examine the reliability of TLICS between orthopedic physicians from intern to staff level surgeons.

METHODS: Ten cases of thoracolumbar spine fractures were reviewed and scored using TLICS by eight evaluators: intern (n=2), junior level resident (n=3), senior level resident (n=2), spine surgeon (n=1). Each participant evaluated the same cases on three different occasions. Statistical analysis with Intraclass Correlation Coefficient (ICC) was calculated assessing the inter- and intra-observer reliability of the TLICS classification.

RESULTS: Interobserver reliability yielded moderate to excellent agreement between evaluators in all three rounds of testing. Neurologic injury produced the highest ICC values, ranging from 0.820 to 0.902. Fracture morphology demonstrated the lowest interobserver ICC scores with moderate agreement of 0.449 and 0.423. Intraobserver ICC scores improved with increasing levels of training. The intern evaluators recorded the lowest intraobserver ICC values, while the staff surgeon scored the highest. Staff surgeon ICC values all

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ranked above 0.800 for excellent intraobserver agreement. Fracture morphology produced the lowest intraobserver ICC values, ranging 0.586 to 0.683. The total severity score yielded the highest intraobserver ICC values of 0.768 to 0.920 for interns through senior residents.

CONCLUSIONS: The use of TLICS demonstrated moderate to excellent intra- and inter-observer reliability among all training levels. Senior residents and Staff demonstrated improved ICC scores in higher training levels, however, interns and Junior Residents were able to reliably classify spinal trauma injuries. This suggests that the TLICS scheme is a reliable way to successfully communicate thoracolumbar injury information.

GP229

CLINICAL OUTCOME OF UNILATERAL DECOMPRESSION WITHOUT FUSION FOR UNILATERAL RADICULOPATHY DUE TO LUMBAR SPINAL STENOSIS

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INTRODUCTION: It is still controversy that unilateral decompression without fusion for unilateral radiculopathy due to lumbar spinal stenosis (LSS) is sufficient or not. The purpose of this study was to assess the clinical outcome of unilateral decompression without fusion for unilateral radiculopathy due to LSS.

PATIENTS AND METHODS: From 2001 to 2008, 258 patients with LSS caused by spondylosis (SP) or degenerative spondylolisthesis (DS) received the initial operation at the University hospital. Repeat operation was excluded. At those periods, there were no fusion and no bilateral de-

compression for symptomatic unilateral radiculopathy. 37 patients with unilateral radiculopathy were received unilateral decompression without fusion and 30 patients were followed more than 3 years (SP: 25 pts, DS: 5 pts). Contralateral symptom of the initial operation level and new symptom due to the different site from the initial operation level were assessed.

RESULTS: 1) Six of 30 patients (20%) showed contralateral symptom at the same of the initial operation level. Five of 6 patients received the additional operation.

2) Three of 5 patients who received the additional operation showed that the different level from the initial operation was the responsible level for the new symptom.

3) One of 5 patients with DS showed new symptom but did not receive the second operation. On the other hand, five of 25 patients with SP received the additional operation.

DISCUSSION AND CONCLUSION: From the current study, there could not detect the prognostic factors for the occurrence of the contralateral symptom. So it is concluded that unilateral decompression is the first choice of operation procedure for unilateral radiculopathy due to LSS, and when contralateral radiculopathy occurs, the additional operation should be considered. Preventative operation for the contralateral side might not be necessary at the initial operation.

GP230

COMPLICATIONS FOLLOWING ANTERIOR LUMBAR SPINAL FUSION IN PATIENTS WITH A HISTORY OF PRIOR INTRA-ABDOMINAL SURGERY

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INTRODUCTION: With different approaches available for lumbar interbody grafting, it is

unclear whether a history of prior abdominal/ pelvic surgery confers an increased risk of approach related complications when undergoing anterior lumbar interbody fusion via an anterior retroperitoneal approach.

METHODS: We present a retrospective chart review of 104 patients who underwent an infra-umbilical retroperitoneal approach to the anterior aspect of the lower lumbar spine. There was a minimum 1 year follow-up. Data collected included age, gender, procedure performed, levels fused, intraoperative blood loss, length of hospital stay, duration of surgery, preoperative diagnosis, blood transfused, intraoperative and peri-operative complications, and resolution of any complications.

RESULTS: Out of 104 patients, 23 patients (23%) had 24 approach-related complications, either intraoperatively (9%), during the immediate postoperative period (5%), or within 1 year of surgery (10%). One patient had both an intraoperative or immediate postoperative complication in addition to a delayed complication. After controlling for other factors such as age, gender, diagnostic groups, and level of procedure, there was a statistically significant increase in the odds of having a complication when there was a history of abdominal or pelvic surgery (OR 1.35 P <0 .014). 19% of patients with a history of abdominal or pelvic surgery had a delayed complication; compared to only 4% who did not have abdominal or pelvic surgery in the past (p < .024)

DISCUSSION: Anterior lumbar interbody fusion via a midline incision and a retroperitoneal approach was associated with a 23% overall rate of complication. Many of these complications were minor and did not require intervention. However 5 (4.8%) patients did require revision procedures. Our study suggests that a history of prior abdominal or pelvic surgery puts the patients at a significantly higher risk for approach-

related complication.

GP231

LUMBAR STABILIZATION WITH A PARASPINOUS TENSION BAND DEVICE IN PATIENTS WITH DEGENERATIVE SPONDYLOLISTHESIS AND SPINAL STENOSIS: 24-MONTH DATA.

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INTRODUCTION: Segmental instability and recurrent symptoms can occur after surgical decompression in the presence of degenerative spondylolisthesis (DS), so surgeons often perform a segmental fusion. However, fusion can result in morbidity and adjacent segment degeneration. This study evaluated clinical and radiographic outcomes after implantation of a paraspinous tension band (PTB) device designed to control lumbar sagittal plane instability.

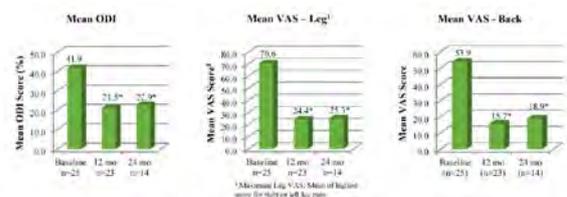


Figure 1. Clinical outcome measures (* p<0.001 vs. baseline)

METHODS: Patients with DS were enrolled in a single arm prospective study. Clinical and radiographic evaluations were performed preoperatively and at 3, 6, 12, and 24-months, and included evaluation of pain (VAS) and function (ODI), along with analyses of segmental rotation, flexion-translation, anterolisthesis, and device status.

RESULTS: Twenty-five patients (23f, 2m, mean age 69) were surgically decompressed and stabilized with the PTB at L4/5 (n=20)

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and at L3/4 (n=5). One device was explanted because of an epidural hematoma, and one patient died due to unrelated causes. One patient was lost to followup. Figure 1 shows statistically significant improvements ($p<0.001$) in VAS and ODI compared to baseline at 12 and 24 months. All patients with 12 or 24 month follow up were satisfied. Radiographic measurements showed the following changes (Δ):

	Baseline	Δ @ 12mo (n=21)	Δ @ 24mo (n=11)
Anterolisthesis (mm)	4.6 \pm 3.0	0.4 \pm 1.2 (p=0.07)	-0.6 \pm 1.7 (p=0.13)
Flexion-Translation (mm)	1.1 \pm 1.1	0.0 \pm 1.2 (p=0.90)	-0.5 \pm 0.8 (p=0.05)
Segmental Rotation	3.4 $^{\circ}$ \pm 3.5 $^{\circ}$	0.0 $^{\circ}$ \pm 3.2 $^{\circ}$ (p=0.99)	-1.5 $^{\circ}$ \pm 2.9 $^{\circ}$ (p=0.11)
Segmental Lordosis	8.2 $^{\circ}$ \pm 4.6 $^{\circ}$	1.2 $^{\circ}$ \pm 2.4 $^{\circ}$ (p=0.03)	-0.2 $^{\circ}$ \pm 4.6 $^{\circ}$ (p=0.89)

Qualitative radiography showed no change in device condition, no migration, no device-related spinous process fractures, and no bone-implant interface remodeling.

DISCUSSION: Clinical and radiographic outcomes at 1 and 2 years suggest that the PTB provides stability while preserving spinal function, and may be an alternative to fusion for patients with LSS and DS.

GP232

TECHNIQUE RELATED COMPLICATIONS OF CIRCUMFERENTIAL MINIMALLY INVASIVE SPINAL SURGERY (MISS) FOR CORRECTION OF SPINAL DEFORMITY - A 5 YEAR EXPERIENCE

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INTRODUCTION: MISS is intended to reduce approach related morbidities and complications. However, the novelty of the approach and the potential for complications has been a big concern for surgeons in adopting these techniques.

METHODS: A review of 102pts with >3 levels fusion indentified 11pts in 2007, 18pts in 2008, 28pts in 2009, 21pts in 2010, 20pts in 2011 and 4pts in 2012 including: Idiopathic Scoliosis(29), Degenerative Scoliosis(64), Iatrogenic Scoliosis(8), Kyphosis(1). All underwent a combination of 3MISS: Posterior instrumentation(100), DLIF(88) and AxialLIF(51).

RESULTS: Mean age was 63yrs(21-85). A total of 580levels were operated(5.7 levels/pt, 3-13). There were a total of 14technique-related complications in 14pts. In 2007 a total of 51 levels were operated (4.6/pt) and only there was 1quadiceps palsy that made a complete recovery within 6mths. Total of 92 levels were operated in 2008(5.2levels/pt) with 4complications: 1quadiceps palsy, 1retrocapsular renal hematoma with no untoward effect, 2wound dehiscence that underwent debridement. 148 levels were operated in 2009(5.3/pt) with 3complications: 1quadiceps palsy which made a complete recovery within 6mths, 1 pleural effusion who underwent thoracentesis, 1 screw loosening that needed reinstrumentation. 133 levels operated in 2010(6.3levels/pt) with 2 complications: 1pleural effusion that underwent thoracentesis and 1 sacral wound dehiscence that underwent debridement. 131levels were operated in 2011(6.5 levels/pt) with 4 complications: 1 foot drop post DLIF, 1 Uretero-pelvic injury with DLIF who underwent nephrostomy and paracentesis, 1screw loosening and cut out and 1hardware pull out that underwent posterior reinstrumentation. There was no complication in 2012.

CONCLUSIONS: This study documents a

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technique-related complication rate of 13.7%. Most were not life threatening and were easily treated with proper intervention. Understanding these possible complications can lead to effective adoption of MISS.

GP233

DOES MINIMALLY INVASIVE SURGICAL (MIS) TREATMENT OF ADULT SPINAL DEFORMITIES AFFECT THE INCIDENCE OF PROXIMAL JUNCTIONAL KYPHOSIS (PJK)?

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INTRODUCTION: PJK as a possible side effect of surgical treatment for spinal deformities is the result of trunk self-adjustment after surgery to achieve overall balance in the sagittal plane.

METHODS: A review of 176pts underwent MIS correction identified 105pts with >2 levels (age:21-84) including Degenerative Scoliosis(73), Idiopathic Scoliosis(22), Iatrogenic Scoliosis(8), Kyphosis(2). All underwent a combination of 3 MIS techniques: Post. instrumentation(103), DLIF(92) and AxialIF(45). PJK was defined as the sagittal Cobb angle between the lower endplate of the uppermost instrumented vertebra and the upper endplate of two vertebra supra-adjacent, which is >10° and at least 10° greater than the pre-op.

RESULTS: Mean FU was 33mths(10-59) with >1yr in 99pts. The mean pre-op Cobb was 27° and corrected to 11°. The pre-op Sagittal balance was 51.9mm(-47 to 160) and corrected to 11mm(-119 to 113.9). The pre-op lumbar lordosis which was 43°, maintained at 41.7° by the last FU. The incidence of PJK was 3.8%(4 of 103pts) and only 2pts needed revision surgery. In the

first pt, the pre-op angle changed from 8.1° to 28.9° at 5mths post-op. This pt underwent kyphoplasty with MIS extension of post. instrumentation 3 levels cephalad. In the 2nd pt the angle increased from 0.6° to 17.8° at 15mths post-op secondary to a compression fracture and it was corrected by kyphoplasty. In the 3rd pt, the pre-op angle was 10° and increased to 26.5° at 24mths post-op. In the 4th patient the pre-op angle increased from 1.7° to 13.7°, at 28mths post-op. Although theoretically this patient was placed in PJK group, she was asymptomatic and declined any revision. Last FU shows all pts were asymptomatic.

CONCLUSIONS: A combination of 3 novel MIS techniques offers excellent curve correction, maintains lumbar lordosis and appropriate kyphosis at thoracolumbar junction. The incidence of PJK in our study was 3.8% that is considerably less than the 26-46% rate quoted regarding surgery for spinal deformity.

GP234

THE SELECTION OF THE DISTAL INSTRUMENTATION LEVEL IN LENKE TYPE 1A CURVES USING SEGMENTAL SCREW FIXATION: THE NOTTINGHAM EXPERIENCE

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INTRODUCTION: To define the correct Lowest Instrumented Level (LIV) in Lenke Type 1A curves, in order to prevent the adding-on phenomenon.

METHODS: Over a 3 year period (May 2008 onwards), 35 Type 1A Lenke curves were operated upon. The average age was 17 years (range 13-20). The average thoracic spine curve was 45 degrees (range 40 to 95 degrees). Review of the pre- and post-operative radiographs was undertaken in order to determine potential risk factors for the 'adding-on' phenomenon.

RESULTS: The average correction obtained was 76%. We noted an average operative duration of 148 minutes (range 120 – 220) and an average operative blood loss of 653 mls (range 510-850).

The 'adding-on' phenomenon was noted in 5 cases early on. There was no correlation with the pre-operative Cobb angle, degree of curve correction or utilising the stable vertebra (SV) as the Lowest Instrumented Level (LIV). Selecting the End Vertebra (EV) as the LIV was associated with distal adding-on in most cases. We also noted an increased incidence of the adding-on phenomenon when the preoperative LIV had a greater than 10mm distance from the centre sacral vertical line (CSVL) to the mid-point of the vertebral body.

DISCUSSION: Selecting the Stable Vertebra minus 1 level or Neutral Vertebra plus 1 level as the LIV in Lenke Type 1A curves is less likely to result in the adding-on phenomenon. In addition, the LIV should be less than 10mm from the CSVL.

GP235

SPINO-PELVIC SAGITTAL ALIGNMENT IN PATIENTS WITH POSTOPERATIVE PERSISTENT LOW BACK PAIN

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INTRODUCTION: Postoperative spino-pelvic sagittal mal alignment causes persistent chronic low back pain and gait disorder in-patient with lack of lumbar lordosis, hip extension disorder, and gravity imbalance. The aim of this study was to analyze spino-pelvic sagittal alignment including a pelvic incidence (PI) and understand the relationship of postoperative low back pain and flatback deformity.

OBJECT AND METHOD: 59 patients who passed after two years or more from the

operation and who were able to measure spino-pelvic sagittal alignment before and after the operation were divided to two groups. The group of low back pain was more than seven at VAS score (LBP group: 16 persons, average of 72.7 years old). The group of no low back pain does not use painkiller (N-LBP group: 43 persons, average of 68.0 years-old). We measure lumbar lordotic angle(LLA), pelvic tilt (PT) , sacral slope(SS) and PI. Then we evaluated sagittal imbalance (SI) by using the SRS-Schwab classification (PI-LL > 20 degrees, SVA > 95mm, PT > 30 degree).

RESULT: The result of spino-pelvic sagittal alignment of LBP group and N-LBP group were SVA 93.8/55.3(mm), LLA 26.9/32.2 (°) PT 32.0/27.0 (°) SS 20.7/25.2 (°) PI 53.0/52.0 (°) respectively. The incidences of abnormal SI parameters in each group were PI-LL 68.8/44.2%, SVA 43.8/11.6%, and PT 68.8/43.9%. In results, the LBP group had significant large SVA, PI-LLA and large PT.

DISCUSSION: In recent years, PI has been reported which peculiar to an individual, made a large influence on a lumbar alignment and lumbar disease. When flatback is evaluated, PI should be included. The cause of postoperative low back pain is known as multifactorial factors, however, our results confirmed SI due to flat back and posterior rotated pelvis was an important element. Optimal LLA considered by PI would keep a suitable inclination of pelvis and prevent the forward inclination of trunk.

GP236

POSTERIOR LUMBAR INTERBODY FUSION OUTCOMES IN 17 PATIENTS WITH RHEUMATOID ARTHRITIS

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INTRODUCTION: Compared with the cervi-

cal spine, little attention has been paid to lumbar spine with rheumatoid arthritis(RA). Because of the instability and deformity of lumbar spine accompanied by lumbar spinal canal stenosis, we often need lumbar fusion for RA patients. But only a few articles have described the outcomes of lumbar fusion in RA patients. We performed posterior lumbar interbody fusion (PLIF) on seventeen patients with RA and evaluated the effectiveness.

METHODS: The subjects were 17 patients with RA who underwent instrumented PLIF , 1 man and 16 women, mean age 62.5 years old (range, 47 to 75 years), and the mean duration of RA was 22.3 years (range, 10 to 34 years). The mean duration of follow-up was 46 months (range, 11 to 74 months). As the clinical questionnaires we checked VAS, Zurich Claudication Questionnaires (ZCQ), and Oswestry Disability Index (ODI) at the time of preoperative and final follow-up and a student's t-test was used to compare them. We also evaluated radiographic assessment.

RESULTS: Statistically significant improvement was achieved in VAS, ZCQ, and ODI. Plain radiographics showed adjacent segment degeneration in 5 patients (29.4%), collapse of adjacent vertebra in 3 patients (17.6%), migration of pedicle screw in 1 patient (5.9%). Two patients required reoperation because of severe radiculopathy caused by adjacent segment disease (11.8%).

DISCUSSION: Because of osteoporosis and spondylosis, we were concerned about complications and poor results of lumbar fusion in RA patients . But little has been reported about that. In our cases postoperative radiographic assessment showed some complications related to osteoporosis and spondylosis which included two reoperation, but clinical outcomes at final follow-up showed an overall improvement. This results suggest that PLIF for RA patients can expect good clinical outcome and option for

surgical treatment.

GP237

PROSPECTIVE COHORT STUDY OF THE PERFORMANCE STATUS AND ACTIVITY OF DAILY LIVING IN PATIENTS WITH METASTATIC SPINE TUMORS

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INTRODUCTION: With the improvement of prognosis of malignant tumor, the patients with a spinal metastasis are increasing, which severely deteriorated the ability of life (ADL). The aim of this study was to clarify longitudinal transition of the ADL in spinal metastasis patients who received surgery or did not.

METHODS: Consecutive 37 patients with progressive paralysis due to metastatic spinal tumors were prospectively followed. 25 patients received spine surgery (Group S); 12 patients chose conservative treatment (Group C). At the day of surgical indication, 1 and 6 month later, final follow-up, ADL was evaluated by the Eastern Cooperative Oncology Group Performance Status (PS) and Barthel index. Neurological status was assessed by the Frankel classification.

RESULTS: 2 patients underwent laminectomy while 23 patients had it with instrumentation. The mortality was 12 cases (48%) in the Group S whereas 8 cases (67%) in the Group C; mean lifetime after the day of surgical indication was 202 and 211 days, respectively. Mean lifetime of survival patients was 460 days in both groups. Group S patients reduced PS with time (mean: 3.68

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at the day of surgical indication, to 1.89 at the final follow-up,) but Group C patients deteriorated PS (3.31 to 3.62). In the Group S, 92% of patients improved PS but 16% re-deteriorated at the final follow-up. Group S patients elevated Barthel index and retained it through the final follow-up (mean: 39.2→63.6→75.8→65.2) but Group C patients lost scores with time (50.3→33.1). 80% of Group S improved Barthel index but 12% re-deteriorated. 84% of Group S patients improved \pm scores for the Frankel classification but 8% re-deteriorated, while no patient in the Group C improved Frankel classification.

DISCUSSION: Surgery for metastatic spinal tumors elevated and maintained PS and Barthel index in more than 80% patients. This study suggests that surgical treatment can improve ADL as well as neurological deficit in patients with metastatic spinal

GP238

PERCEPTIONS OF SCOLIOSIS SURGERY FROM RADIOGRAPHS

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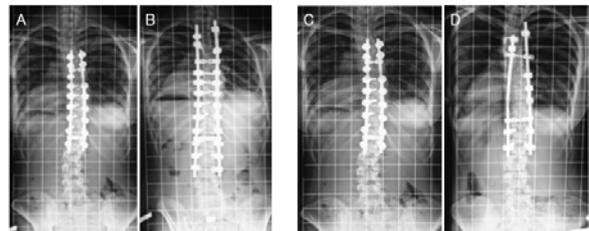
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INTRODUCTION: We investigated whether the length and density of instrumentation for scoliosis surgery could provide a preliminary determination of medical staff members' perceptions of pain, outcome, and desire for surgery.

MATERIALS: Subjects (N=52) completed a questionnaire containing 2 sets of 4 postoperative radiographic images with similar curve magnitudes and patterns. The first set included radiographs of instrumentation of 2 lengths: A. thoracic, B. upper thoracic, thoracic, and lumbar fusion. The second

included radiographs of instrumentation of 2 densities: C. segmental pedicle screws and D. hybrid instrumentation with wiring. We asked 4 questions for each set: Q1. Which procedure seems more painful? Q2. Which procedure seems better for correction? Q3. Which procedure seems more difficult? Q4. Which procedure would you choose?

RESULTS: For the first set, the probability of choice B was significantly greater than that of choice A when staff members were asked which images were associated with pain, good correction and difficulty. The probability of choice A was significantly greater than that of choice B when they were asked which procedure they preferred. For the second set, the probability of choice C was significantly greater than that of choice D when staff members were asked which images were associated with pain, good correction and difficulty. The probability of choice C was greater than that of choice D (but not significant) when they were asked which procedure they preferred.



DISCUSSION: Long fusion seemed painful and difficult, but was associated with good correction versus short fusion; subjects tended to prefer short fusion. Segmental pedicle screws seemed painful and difficult, but were associated with good correction, and twice as many subjects preferred segmental pedicle screws to hybrid methods. The perceptions of scoliosis patients should be investigated. These results may impact patient satisfaction.

GP239

LESS INVASIVE SURGICAL INTERVENTION CAN PREVENT THE LONG-TERM DEVELOPMENT OF LUMBAR DEGENERATIVE SCOLIOSIS. 10-YEAR-FOLLOWUP STUDY OF CONCAVE PLIF AT THE WEDGED DISC BELOW THE CAUDAL END VERTEBRA FOR DEGENERATIVE LUMBAR SCOLIOSIS

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INTRODUCTION: The objective of this study was to assess the efficacy of concave PLIF for lumbosacral hemi curve in treating patients with degenerative lumbar scoliosis.

METHODS: Twelve patients (53-72 years old) were operatively treated and prospectively studied. The surgical procedure was; following decompression of the affected nerve root, to correct the wedged disc below the caudal end vertebra, which allowed for the end vertebra to become horizontal, as well as restoration of lumbar lordosis by way of concave PLIF using cages filled with local autologous bone. The follow-up period was 10 years.

RESULTS: Mean VAS (100mm) was 77 before surgery, 19 at 2 years after surgery, and 18 at the final follow-up in leg pain, 68, 27, and 30, respectively, in low back pain, and 13, 6, and 8, respectively, in the disability score (Rolland-Morris). The mean Cobb angle was 24, 17, and 18 degrees, respectively, in scoliosis, 16, 8, and 10 degrees, respectively, in caudal end vertebral tilt, and 22, 28, and 26 degrees, respectively, in lumbar lordosis. In six patients with Cobb angle less than 30 degrees, the Cobb angle of the unoperated lumbar or thoracolumbar curve improved over time (fig.).



DISCUSSION: The results of this study suggest that this less invasive surgical intervention may prevent the long-term development of lumbar degenerative scoliosis.

GP240

DEGENERATIVE DISC DISEASE: A CASE OF MISTAKEN IDENTITY

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INTRODUCTION: Degenerative disc disease (DDD) is an important concept in the current diagnosis and care of common spinal disorders. It drives much diagnostic imaging and increasingly underlies decisions for spine surgery. Yet, DDD as a concept and term remains controversial and advances in its understanding have been modest since use of the term appeared in the scientific literature in 1947. The objective of this study was to investigate the current status of the concept of DDD through a systematic investigation of definitions of DDD used in recent genetic studies, where precise phenotype definitions are of particular importance.

METHODS: To get a sense of phenotypes currently representing DDD in genetic studies, a simple Medline search of publications from the year 2000 to the time of this review in 2012 (in the English language) using the terms "degenerative disc disease" and "gene*" was conducted.

RESULTS: The search yielded gene associa-

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tion studies of 11 independent samples from eight countries, representing phenotypes under the rubric of disc disease. The phenotype definitions varied greatly. Under the term “lumbar disc disease”, phenotypes ranged from “discogenic sciatica” with severe, unilateral pain radiating below the knee, to a complaint of back pain with radiological confirmation of lumbar disc disease on MRI, to a 4-point ordinal scale of disc signal on MRI regardless of back pain history. Phenotypes of “degenerative disc disease” showed a similar lack of consistency, with phenotypes of DDD varying from observations of disc signal loss, narrowing, bulging or osteophytes, irrespective of back symptom history, to chronic low back pain with a diagnosis of DDD for which spine surgery was planned.

DISCUSSION: Despite well over a half-century of increasingly common use of the term DDD, the research community has yet to agree on an underlying concept or definition. Until then, related research and knowledge are likely to remain underdeveloped and conflicting.

GP241

ROLE OF INTERVERTEBRAL DISCS IN THE SAGITTAL PLANE CORRECTION OF THORACO-LUMBAR ANGULAR KYPHOSIS AFTER SPINAL OSTEOTOMY

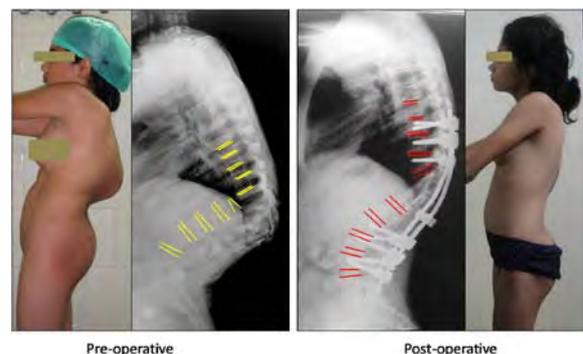
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INTRODUCTION: Pedicle subtraction osteotomies (PSO) for kyphosis correction in children result in better radiological and cosmetic correction compared to that of adults. PSO for thoraco-lumbar kyphosis results in better correction compared to thoracic kyphosis which can be attributed to the flexibility intervertebral discs. We analysed the role of lumbar and thoracic discs in surgical correction of thoraco-lumbar kyphosis.

METHODS: 15 patients with severe thoraco-lumbar kyphosis with normal pre-operative neurology undergoing PSO at or above L1 were included. Average age was 12.3 years (range 7 to 14). Relative sagittal angle correction at the osteotomy and at the five cephalad and caudal adjacent discs was measured to analyze the individual contribution. Radiological measurements were made utilizing pre & post-operative standing AP & lateral radiographs and measurement software.

RESULTS: There were no post-operative neurological deficits. Mean pre-op kyphosis was 107.3 degrees (range 93-133) which was corrected to 53.7 degrees. Mean percentage correction of kyphosis was 45.7% (SD=6.6). The proportion of sagittal plane correction contributed directly by the osteotomy was 49.3 degrees (range 42-55), whereas the five cephalad thoracic discs together contributed 10.1 degrees (Apex+1=4.50, Apex+2=2.30, Apex+3=1.30, Apex+4=1.0 and Apex+5=1.0) and five caudal lumbar disc segments contributed a total of 36.1 degrees of the correction (Apex-1=5.50, Apex-2=7.80, Apex-3=8.50, Apex-4=7.50, Apex-5=6.80).



CONCLUSION: The results document the significant contribution of lumbar disc in correction of thoraco-lumbar kyphosis after spinal osteotomy. Lower lumbar discs contributed more than the upper lumbar discs. Surgeons can take advantage of the flexibility of the lumbar spine in performing osteotomies at thoraco-lumbar level to obtain better radiological correction.

GP242

FREEDOM DISC VS. PRODISC-L FOR TREATMENT OF 1-LEVEL LUMBAR DISC DISEASE: RESULTS FROM ONE INVESTIGATIVE SITE OF THE USA FDA RANDOMIZED CLINICAL TRIAL

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INTRODUCTION: The Freedom Artificial Disc (FD) is studied in order to treat single-level lumbar disc disease L3 to S1. The design of the Freedom Artificial Disc allows potentially less range of motion in flexion, extension, axial rotation, and translation than does the comparison ProDisc-L (PD).

OBJECTIVE: To assess and compare the self-reported outcomes for patients treated for 1-level lumbar disc disease with the FD compared to PD. To report the two year results from one site participating in the RCT.

METHODS: USA-FDA approved prospective and randomized (1:1) clinical trial of the Freedom® Lumbar Disc (AxioMed Spine Corp., Cleveland, OH) versus ProDisc-L (Synthes, West Chester, PA). Self-reported inventories of Visual Analog Scale for back pain (VAS back pain) and VAS leg pain, Oswestry disability Index, physical exams, adverse events, and range of motion (ROM) were collected preoperatively and at 6 weeks, 3, 6, 12, 18, and 24 months annually postoperatively.

RESULTS: For FD treated patients (n=20 1-level), significant improvements of 80% in VAS back pain (7.3 pre vs 1.5 24mo), 86% in VAS leg pain (2.7 pre to 0.3 at 24mo) and 74% in Oswestry disability (59.5 pre vs. 14.2 24mo) were observed by 6 weeks and well maintained to 24 months (p< 0.05). For PD (n=19 1-level), significant improvements of 68% in VAS back pain (7.3 pre vs 2.5 24mo),

60% in VAS leg pain (3.9 pre to 1.8 at 24 mo) and 63% in Oswestry disability (57.1 pre vs. 21.2 at 24mo) were observed by 6 weeks and maintained to 24 months. There was slight earlier treatment benefit for Freedom by 6 wks [VAS back: 2.6 (FD) vs 4.2 (PD) at 6wks, p< 0.02; 2.3 (FD) vs 3.9 (PD) at 3 mo,p< 0.04, and 1.5 (FD) vs 3.8 (PD) at 6 mos p< 0.001; ODI: 19.3 (FD) vs 30.5 (PD) at 6 mos, p< 0.02] that disappeared at longer follow-up (NS)

CONCLUSIONS: Significant recovery was similarly reported by patients treated using either the ProDisc-L or Freedom ADRs with earlier recovery with Freedom.

GP243

SINGLE-LEVEL INSTRUMENTED POSTEROLATERAL FUSION VERSUS POSTERIOR LUMBAR INTERBODY FUSION FOR UNSTABLE LUMBAR SPONDYLOLISTHESIS

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INTRODUCTION: Surgery for lumbar spondylolisthesis is widely performed. However, few reports have compared outcomes between posterolateral fusion (PLF) and posterior lumbar interbody fusion (PLIF). This study retrospectively compared the clinical and radiographic outcomes of PLF and PLIF for L4 unstable spondylolisthesis.

METHODS: Patients with L4 unstable spondylolisthesis with Meyerding Grade II or more, slip of >10°or >4 mm upon maximum flexion and extension bending, and posterior opening of >5° upon flexion bending were studied. Patients were treated by

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L4-L5 level decompression and posterior instrumented fusion from January 2008 to January 2010. Patients who underwent PLF and PLIF (n = 11 per group) and were followed-up for >2 years were studied. The mean age and follow-up period of the PLF group were 71.3 years and 2.8 years, respectively, and those of the PLIF group were 70.0 years and 2.6 years, respectively. Radiographic findings and clinical outcomes evaluated by the Japanese Orthopaedic Association (JOA) score were compared between groups.

RESULTS AND DISCUSSION: JOA scores of the PLF group before surgery and at final follow-up were 11.6 ± 4.8 and 23.9 ± 3.7 , respectively; those of the PLIF group were 14.0 ± 4.8 and 21.2 ± 7.8 , respectively, with no significant difference between groups. Correction of slip estimated from postoperative slip angle, translation, and maintenance of intervertebral disc height was better in the PLIF group ($P < 0.05$); however, there was no significant difference in lumbar lordotic angle and slip angle and translation angle upon maximum flexion and extension bending. Fusion rates of the PLIF and PLF groups were 91.0% and 72.3%, respectively, showing no significant difference. These results suggest that L4-L5 level posterior instrumented fusion for unstable spondylolisthesis using both PLF and PLIF ameliorates clinical symptoms when local stability is achieved.

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