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ORAL PRESENTATIONS

O01

INTRADISCAL ADMINISTRATION OF TUMOR NECROSIS FACTOR-ALPHA INHIBITOR, ETANERCEPT, CLINICALLY IMPROVES INTRACTABLE DISCOGENIC LOW BACK PAIN: A PROSPECTIVE RANDOMIZED STUDY

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INTRODUCTION: Discogenic low back pain (LBP) has been clinically considered to be one of the sources of intractable LBP. Tumor necrosis factor-alpha (TNF-a) is one of the well-known pain-related proinflammatory mediators in the degenerative intervertebral disc (IVD). However, it is unclear whether its inhibition leads to any analgesic outcomes. In this study, we aimed to examine the effect of intradiscal TNF-a inhibitor administration in discogenic LBP patients.

METHOD: Discogenic LBP patients were diagnosed on the basis of physical and radiographic (X-ray and magnetic resonance imaging) findings. Sixty patients were divided randomly into 2 groups: etanercept group (n = 30; bupivacaine 2 ml with etanercept 10 mg) and control group (n = 30; bupivacaine 2 ml). Visual analog scale (VAS) scores for LBP before and 1, 2, and 4 weeks after the injection and Oswestry Disability Index (ODI) score before and 4 weeks after the injection were evaluated. In addition, complications after the injection were evaluated.

RESULTS: While both groups experienced considerable pain relief, the VAS score significantly decreased in the etanercept group at every time point after the injection (P < 0.05). The ODI score decreased 4 weeks after the injection only in the etanercept group (P < 0.05). There were no compli-

cations in either group.

DISCUSSION: Single intradiscal administration of TNF-a inhibitor showed a greater analgesic effect without any complications lasting for 4 weeks, thereby implying that TNF-a may be profoundly involved in the pathogenesis of chronic discogenic LBP. The present study indicates that intradiscal administration of TNF-a inhibitor can be useful for intractable discogenic LBP treatment in humans.

O02

DOES UNDERLYING SPINAL PATHOLOGY AFFECT THE OUTCOME OF CLINICAL PRACTICE GUIDELINE-BASED TREATMENT FOR ACUTE LOWER BACK PAIN? A SUBGROUP ANALYSIS OF THE CHIRO STUDY OUTCOMES

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INTRODUCTION: Clinical practice guideline-based treatment (CGT) is effective for patients with acute lower back pain (ALBP). However, ALBP patients may be heterogeneous with respect to clinically significant or insignificant underlying spine pathology. Our goal was to determine if the outcome of CGT for ALBP is independently affected by diagnostic imaging-identified underlying pathology.

METHODS: Design: combined randomized and observational cohorts. Inclusion: ages 19-59 years; Quebec Task Force criteria grades I and II; and back pain duration <4 weeks. Exclusion: "red flag" conditions, comorbidities contraindicating CGT. Out-

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comes: change from baseline in Roland Disability Questionnaire (RDQ) scores (primary), and SF-36 Bodily Pain (BP) and Physical Functioning (PF) scores (secondary) at 24 weeks. Patients were classified as having either: 1) spinal stenosis (SS), 2) Thompson grade \geq 3 disc degeneration (DD), 3) facet arthropathy (FA), or 4) no identifiable pathology (NP) on computerized tomographic, magnetic resonance imaging or technetium bone scan. Hospital and University Ethics approval was obtained.

RESULTS: 105 patients were enrolled. In adjusted models, significant overall differences between groups were observed in RDQ ($P < 0.0001$) and BP ($P = 0.013$), but not PF ($P = 0.36$), change scores. Improvements were greatest in the NP group and least in the DD group. RDQ change scores were significantly better in the NP group and significantly worse in the DD group than in each of the other groups. Also, BP change scores were significantly worse in the DD group compared to the NP and FA groups.

DISCUSSION: The presence and type of underlying spine pathology affects the outcome of non-operative CGT treatment for ALBP. Patients with no identifiable pathology improve the most while patients with underlying disc degeneration improve the least. Future outcome studies of ALBP should control for the presence of diagnostic imaging-identified underlying spine pathology.

003

DOES LUMBAR PARASPINAL MUSCLE FAT-TY DEGENERATION CORRELATE WITH AEROBIC INDEX AND OSWESTRY DISABILITY INDEX?

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INTRODUCTION: We sought to analyze whether the amount of paraspinal fatty

degeneration correlates with a patients measured aerobic index to determine if findings on lumbar MRI scans can help predict physical fitness and functional outcomes.

METHODS: A retrospective review was performed on 172 patients. Inclusion criteria involved being seen by a spine surgeon for low back pain, and having a measured aerobic index, BMI, ODI, body fat percentage, and a recent lumbar MRI scan. The percentage of fatty muscle degeneration was graded by three reviewers using T2 weighted axial images at L3 and L5 using a newly proposed system that was validated independently. The system is graded as follows: Grade 1: 0-24%, Grade 2: 25% to 49%, Grade 3: 50% to 74%, Grade 4: 75% to 100%. An independent t-test was used for comparisons.

RESULTS: The average aerobic index (AI) was 34.87, and the cohort was divided up into two groups: above average AI (89 patients) and below average AI (83 patients). For all paraspinal fat measurements and body fat percentage, the difference between the above and below average AI groups were statistically significant ($p < 0.05$), with the least amount of paraspinal fatty degeneration and body fat in the greater AI group. Weight alone and BMI were not found to be significantly different between those with above average AI when compared to those below ($p = 0.491$ and $p = 0.122$, respectively). There was a trend for lower ODI scores in the above average AI group (41.9 versus 46.1), but this did not reach statistical significance between the two groups ($p = 0.075$).

DISCUSSION: We were able to show that patients with a higher AI have lower body fat percentages and lower amounts of fatty degeneration in their lumbar paraspinal musculature. The amount of paraspinal fatty degeneration therefore correlates with physical fitness. Patients with higher AI also showed a trend towards having a lower ODI

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score.

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004

ENHANCED THERAPEUTIC ALLIANCE MODULATES PAIN INTENSITY AND MUSCLE PAIN SENSITIVITY IN PATIENTS WITH CHRONIC LOW BACK PAIN: A RANDOMIZED DOUBLE-BLIND CONTROLLED TRIAL.

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BACKGROUND: Mechanisms through which treatment influences chronic pain includes both the specific ingredient of an intervention as well as contextual factors inherent to clinical encounters including the provider, patient and setting. Although well documented in other areas, the impact of contextual factors in treatment of low back pain (LBP) is unknown.

METHODS: 117 chronic LBP participants were randomly divided into 4 groups: active limited (AL) included the application of active interferential current (IFC) in a limited therapeutic encounter (i.e. limited patient-practitioner interaction), sham limited (SL) included sham IFC in a limited therapeutic encounter, active enhanced (AE) included active IFC in an enhanced therapeutic encounter (i.e. supportive patient-practitioner relationship, encouragement), and sham enhanced (SE) included sham IFC in an enhanced therapeutic encounter. Outcomes

included pain intensity (PI-NRS) and muscle pain sensitivity (PPT). Analysis included MANOVA and clinical significance through the effect size and global rating scale.

RESULTS: Baseline demographics data were similar ($p>0.05$). There were statistically significant differences between groups on PPT's and PI-NRS (baseline and after treatment) ($p<0.05$). Mean differences in PI-NRS were 18.3 mm, 10.0 mm, 31.4 mm, and 22.2 mm, for the groups AL, SL, AE, and SE respectively. Clinically important effect sizes were found. Mean differences in PPT's were 1.2 kg, 0.3 kg, 2.0 kg, and 1.7 kg for the group AL, SL, AE, and SE respectively. Again, clinically important effect sizes were found.

CONCLUSION: Results highlight the important role of contextual (i.e. non-specific) factors in the treatment of patients with chronic LBP. Specially, enhanced therapeutic relationship was associated with meaningful improvement in clinical outcomes.

005

INDICATORS PREDICTING SUCCESSFUL CLINICAL OUTCOME ONE YEAR AFTER AN INTENSIVE PAIN MANAGEMENT PROGRAM FOR CHRONIC LOW BACK PAIN

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INTRODUCTION: Chronic low back pain (CLBP) is a heterogeneous condition. The results of surgical interventions are often unsatisfactory. Combined physical and psychological (CPP) programs are widely recommended in international guidelines, but

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not often implemented. A two-week CPP program including exercises and a cognitive behavioral approach is used in our unit in collaboration with Orthopaedic Spine surgeons. The purpose is to determine the proportion of CLBP patients who are restored to a functional status within the normal range and those indicators that predict a successful outcome one year.

METHODS: A prospective cohort of 524 consecutive CLBP patients is followed. Potential predictive indicators were included: demographic characteristics, disability, experienced pain intensity and psychosocial factors. Successful outcome is defined as one-year improvement in functional status to a value as seen in healthy populations (≤ 22) measured with the Oswestry Disability Index (ODI).

RESULTS: Patients with longstanding CLBP (mean 13 years) participated. More than 40% patients reached a successful outcome. Multivariate logistic regression revealed pretreatment 'employed' (OR 3.609 [95%CI 1.795-7.256]), and 'disability' (OR 0.943 [95%CI 0.921-0.965]) as significant predictive factors for a successful outcome in functional status at one-year followup. Despite a small association between psychological distress and an unsuccessful outcome (Pearson's $r = -0.23$, $p < 0.001$), no predictive value is shown.

DISCUSSION: Employment and mild to moderate disability are predictive indicators for a successful functional outcome in CLBP patients, who participated in the RealHealthNL program. These indicators are easily identified and this implies that it might speed up assigning priority for program entry. We expected measures of distress to be predictive of failure. Even patients who are highly distressed with prolonged symptoms can respond positively to the program.

O06

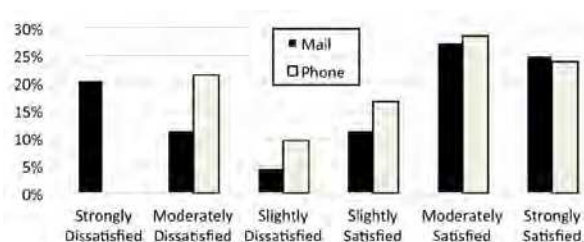
THE IMPORTANCE OF CONTEXT WHEN EVALUATING PATIENT SATISFACTION

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INTRODUCTION: In 2007 a poster our group presented at ISSLS reported that 43.5% of patient's reported satisfaction with their back pain symptoms was explained by patient reported goal achievement. The purpose of this paper to reevaluate these results taking into consideration that patients' reported satisfaction was captured in two different ways: through a paper form returned by mail and via telephone interview by clinical staff after return by mail failed. It is hypothesized that the how satisfaction was obtained (mail vs. phone interview) would reduce the variability in satisfaction scores in the phone group and bias satisfaction scores upward, reducing the explained variance (R^2) in satisfaction.

METHODS: Compare differences in patient reported satisfaction and explained variance between patients who mailed in their surveys with those who completed their surveys by phone.



RESULTS: Of the 89 patients who completed the survey 51% were mailed and 49% were by phone survey. Demographic differences between these two groups indicated patients who mailed in the survey were older ($p < .02$), but differed in gender ($p < .46$) and workers' comp status ($p < .76$) were not significant. In comparing the mailed vs. phone groups, means and (standard deviations) for reported satisfaction were 3.8 (1.9) and

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4.3 (1.5), $p < .20$, and the R2 were 62.6% vs. 37.9%, respectively.

DISCUSSION: The current “wisdom” in some clinical circles is to focus on patient satisfaction as a key outcome for assessing treatment success. These results provide clear evidence that patient satisfaction can be too easily manipulated by context effects to be considered a good key outcome candidate. Face validity is good but unstable satisfaction estimates make construct validity weak. This should not be surprising given that satisfaction is, in essence a “mood” variable and mood is reasonably considered a weak steady state, meaning that satisfaction can change rapidly and repeatedly over short time spans.

007

VALIDATION OF ADMINISTRATIVE CODING ALGORITHM TO IDENTIFY BACK-RELATED DEGENERATIVE DIAGNOSES.

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Administrative healthcare claims have been used as observational data to evaluate utilization, costs and quality of care for back pain. However, concerns persist that billing codes and algorithms may be inaccurate for classifying patients into clinically-meaningful lumbar degenerative diagnoses.

METHODS: We identified Current Procedural Terminology (CPT) and International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes related to back pain. We grouped these codes into a clinically meaningful hierarchy including, in order: degenerative disc disease, herniated disc, spinal stenosis, spondylolithesis, and scoliosis. For patients older than age 65 years enrolled in the Spine Patient Outcomes Research Trial, we obtained Medicare claims and compared the administratively-derived diagnosis to the

diagnosis assigned by rigorous clinical evaluation.

RESULTS: Medicare claims were obtained for 377 surgical patients in SPORT. Sensitivity, and specificity, respectively, for the administratively derived algorithm compared to the surgeon indication in SPORT are as follows: disc herniation (SENS 76.2% , SPEC 98.0%), spinal stenosis (SENS 79.2%, SPEC 90.7%), and degenerative spondylolisthesis (84.4%, SPEC 89.2%).

DISCUSSION: Our administrative claims algorithm for classifying back surgery patients by diagnosis had sensitivity and specificity for three common back pain diagnoses: disc herniation, spinal stenosis, and degenerative spondylolisthesis. Similar validation would be useful for classifying back surgery procedures and safety outcomes.

008

LUMBAR FACET JOINT SUBCHONDRAL BONE DENSITY IS HIGHER IN LOW-BACK PAIN PATIENTS

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INTRODUCTION: Osteoarthritis (OA) is a degenerative joint disorder that affects synovial joints, such as the facet joints (FJ). Subchondral bone density (SBD) is a parameter to evaluate OA measured with CT-osteodensitometry, a method that has load-distribution specificity. This study aims to describe SBD in a cohort of controls and low back pain (LBP) subjects.

METHODS: This IRB-approved study obtained CT scans of the L1-S1 region in supine position for 56 control and 33 LBP subjects aged 20-59. The resulting DICOM data of the FJ surfaces was further subdivided into 5 anatomical topographic zones: center, superior, inferior, medial and lateral. FJ SBD was reported in Hounsfield units (HU) from

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the joint surface down to a depth of 5.5 mm below the surface in 0.5 mm increments. Statistical comparisons were carried out with ANOVA and Student's t-test.

RESULTS: Data from 1,780 FJ surfaces shows that the SBD was higher in LBP subjects, center zones, and upper levels. SBD was lower in asymptomatic subjects, caudal zones, and lower levels (Fig. 1).

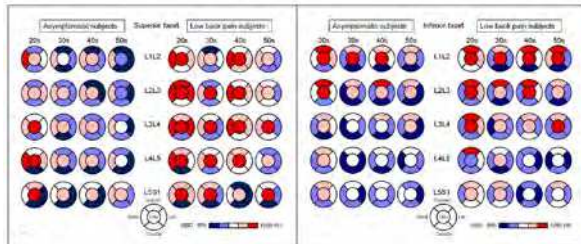


Fig. 1. SBD distribution by age and spinal level. Left: superior FJs, Right: inferior FJs.

Aside from center zone vs. cranial zone in inferior facet surfaces, the SBD of each zone of superior and inferior facet surfaces was significantly different from that of each other. The mean SBD of low back pain subjects (1074.3 ± 201.4 HU) was significantly higher ($p < 0.0001$) than that of asymptomatic subjects (1040.3 ± 211.7 HU). In low back pain subjects, the SBD of superior facet joints was significantly higher ($p < 0.0001$) than that of inferior facet joints.

DISCUSSION: Previous reports show that subchondral bone plates are thinner with uniform thickness in other joints with convex surface geometry and the subchondral plates are thicker, especially in the center region of joints with concave surface geometry. This work provides detailed and non-invasive in vivo information on FJ SBD distribution, deemed useful to estimate facet loads and their relation to OA progression.

O09

DOES CUMULATIVE LOADING OF THE SPINE CONTRIBUTE TO LOW BACK IMPAIRMENT?

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INTRODUCTION: Cumulative loading of the spine has been assumed to be a risk factor for low back disorders (LBDs) for years but has never been quantitatively assessed in field-based in vivo studies. Periodic loading is also known to strengthen tissues, which can limit the value of in vitro studies. This prospective field study considered the degree to which different measures of low back cumulative load exposures (CLE) were associated with impairment of the lumbar spine.

METHODS: Worker anthropometric information, psychosocial factors, and numerous quantitative real-time physical exposure measures were collected among 446 distribution center workers performing repetitive lifting tasks. LBD health measures were quantitatively measured for workers performing each of the jobs using kinematic measures of function. Multiple logistic regression models were developed to describe which combination of factors and CLEs best predicted LBD impairment measure changes over time.

RESULTS: Few univariate measures of physical exposure were associated with low back impairment decrements over time. However, multivariate models of daily job CLEs resulted in excellent models of job risk (sensitivity=90% / specificity=87.5 percent) and reasonable predictions of individual worker risk (sensitivity=74% / specificity=74%). Models that considered weekly or job career CLEs were unable to predict low back impairment.

DISCUSSION: Collectively, this analysis indicates that CLEs defined as the integration of daily cycles of tissue loading and rest were able to predict low back impairment. These findings indicate that tissue damage in vivo is more a function of daily load exposure/rest cycles than long-term loading/rest cycles.

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O10

COMPARISON OF LUMBAR DISC DEGENERATION CHARACTERISTICS BETWEEN PATIENTS WITH LOW BACK PAIN AND SCIATICA RESULTS OF CLINICO-RADIOLOGICAL ANALYSIS OF 224 PATIENTS

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INTRODUCTION: Though Disc degeneration (DD) and disc prolapse (DP) manifest differently, existing studies on DD have included patients with both these features leading to ambiguity. The possible relationship or dis-affect between DD and DP is not fully evaluated. The present study aims to analyse the characteristics of disc degeneration in patients with chronic back pain and DD, and those with acute DP.

METHODS: Two groups of patients (age: 20-50 years) were prospectively studied. Group 1 included patients requiring a single level microdiscectomy for acute DP. Group 2 included patients with chronic low back pain with DD. Discs were assessed by MRI. Pfirmann's grading, Schmorl's nodes, Modic changes and the Total end plate damage score were calculated for each disc.

RESULTS: Group 1 (DP) had 91 patients and Group 2 (DD) had 133 patients. DP and DD patients differed significantly in the number, extent and severity of DD. DD patients had a significantly higher number of degenerated discs than DP patients. The incidence of multi-level and Pan lumbar DD was also significantly higher in DD group. The pattern of DD also differed in both the groups. DD patients had predominant upper lumbar DD whereas DP patients had mainly lower lumbar DD. Modic changes were more common

in DP patients (37% of prolapsed levels versus 9.9% of normal discs) ($p < 0.00$). TEPS had a positive correlation with DD in both the groups. The mean TEPS score at prolapsed level was also significantly higher.

CONCLUSION: This is the first study in literature to identify significant differences in patterns, extent and severity of DD in patients with DD and DP. A probable mechanical etiology in single level DP was indicated by the predominance of non-degenerate discs with significant end plate damage. A possible genetic/ biologic etiology in DD patients was indicated by more disc degeneration, multi-level DD and upper lumbar involvement.

O11

SKIP SEGMENT DISC DEGENERATION AFTER LUMBAR FUSION

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INTRODUCTION: The occurrence of adjacent segment pathology after lumbar fusion has been well described. However, subsequently less has been documented about the skip segment degeneration. A retrospective radiological study was performed to determine the occurrence of skip (non-adjacent) segment disc degeneration after lumbar fusion in comparison with adjacent segment degeneration.

MATERIALS AND METHODS: Seventy-eight patients who had undergone spinal fusion (ALIF 38, PLF 40) for lumbar degenerative diseases and had taken MRI at the time of index treatment and at least 5-year follow-up were included. The control cohort involved 40 patients with non-fusion (decompression 20, conservative treatment 20). The MRI Pfirmann classification was used to grade disc degeneration at adjacent and skip segments preoperatively and at the

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time of follow-up. The occurrence of skip segment disc degeneration was compared with adjacent segment degeneration. The disc degeneration of fusion cohort was compared with that of non-fusion cohort.

RESULTS: The mean follow-up duration was 82.6 ± 22.1 months (range, 60~192 months). Disc degeneration at the adjacent level was found in 36.5% of PLF, 40.1% of ALIF, 22.5% of decompression, and 30.2% of conservative treatment ($P=0.105$). Skip segment disc degeneration was found in 32.1% of PLF, 27.9% of ALIF, 30.1% of decompression, and 25% of conservative treatment ($P=0.345$). The progression of disc degeneration was not different between adjacent levels and skip levels in each group ($P=0.106$ for PLF, 0.102 for ALIF, 0.09 for decompression, and 0.232 for conservative treatment). Both adjacent and skip segment disc degeneration were not different between fusion and non-fusion cohort ($P=0.303$ and 0.473, respectively)

DISCUSSION: Disc degeneration occurred similarly at both adjacent segment and skip segment regardless of spinal fusion. These results imply that natural degeneration rather than spinal fusion is a more important etiology for adjacent

O12

LUMBAR DISCS AND VERTEBRAE CHANGE IN CONCERT: A 15-YEAR FOLLOW-UP STUDY

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INTRODUCTION: We have 'always known' that we become shorter with aging due to disc narrowing. However, clear decreases in standing height are rare until late adulthood, although disc narrowing is common. Our goals were to measure changes in the shape and size of lumbar discs and vertebrae during a 15-year follow-up using quan-

titative MRI measures to better understand the process of degeneration and remodeling of the lumbar spine.

METHODS: Among 232 men, who had been examined 15 years earlier, 109 were re-examined. The mean age at follow-up was 63 years. Custom software (SpEx) was used to measure areas of mid-sagittal and mid-axial spine images (we used a Siemens Magnetom at baseline and an Avanto MR imager at follow-up). Segmentation of lumbar structures was done on proton density images. The inter-rater reliability ICC was 0.98 for sagittal and axial disc areas. The mean sagittal heights of vertebrae and discs were obtained by dividing their total area by their middle diameter.

RESULTS: Mean standing height decreased from 174.7 cm to 174.4 cm over 15 years. The T12-L1 L5-S1 spine block length decreased by 1.3% (2.0 mm; $p<0.001$). Vertebral height increased in mean by 2.7% in the upper lumbar region and by 4.1% in the lower ($p<0.001$ for each). Increases were observed in 88% of vertebrae in the upper lumbar region and 93% in the lower. Disc height decreased in mean by 7.8% in the upper and by 11.3% in the lower lumbar region ($p<0.001$) with disc height decreases observed in 83% of discs. Vertebra height increases were associated with disc narrowing in upper and lower lumbar regions ($P=0.001$). Upper lumbar lordosis increased by 0.9 degrees ($p<0.001$) and lower lumbar lordosis by 2.4 degrees ($p<0.001$).

DISCUSSION: An increase in vertebra height appears to accompany decreases in adjacent disc height. This would compensate to some degree for the effects of disc narrowing on lumbar spine shortening and support maintaining the status quo of the facet joint orientation.

O13

PRESSURE INCREASE IN ADJACENT DISCS DURING CLINICAL DISCOGRAPHY; QUESTIONS THE METHODS VALIDITY

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INTRODUCTION: Despite the introduction of pressure registration during discography the method's validity remains controversial. Discography in healthy pigs has shown that the pressure increase during disc injection propagates to adjacent discs. The aim of this study was to investigate if there is a pressure response in adjacent discs during clinical discography in subjects with discogenic pain.

METHODS: Discograms were performed at 25 discs in 9 consecutive patients. A 0.36mm fibre-optic pressure sensor was inserted through a 22G needle into nucleus pulposus in two adjacent discs. Contrast was injected with a twist manometer (approx. 0.03ml/s) in one of the discs while the intradiscal pressure was measured simultaneously in both discs. The adjacent discs were either non-injected (9 discs) or pre-filled (16 discs) with contrast from the previous discogram. Contrast was injected until one of following endpoints: concordant pain with intensity $\geq 5/10$ on a numerical rating scale, 80psi and/or 3.5ml contrast.

RESULTS: Intradiscal pressure was successfully measured in 22 adjacent discs in which 12 (54%) displayed a mean pressure increase of 13psi above baseline pressure (range 3-42psi). This pressure reaction was either a continuously rising pressure curve or pressure peaks synchronous with disc injection. 58% of the adjacent discs had degeneration grade ≥ 4 (Dallas Discogram Description). Maximum pressure in injected

discs averaged 35psi above opening pressure (range 10-69psi).

DISCUSSION: The propagation of intradiscal pressure to adjacent discs during clinical discography has not been reported earlier. The pressure increase was of clinically relevant magnitude and evident despite relatively low absolute pressures in the injected discs, thus constitutes a potential major source of false positive responses. Therefore discography could not anymore be seen as a diagnostic method provoking pain on a single disc level.

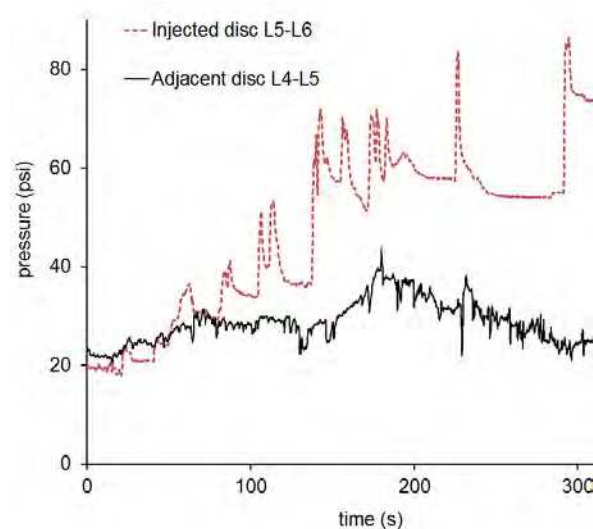


Figure 1. Example of pressure propagation from injected L5-L6 to adjacent pre-filled L4-L5. Degeneration according to Dallas Discogram Description was grade 4 and 5 respectively. Pressure increase above baseline was 64psi in the injected discs and 21psi in the adjacent.

O14

A FUNCTIONAL FLUOROPHORE FOR INTER-VERTEBRAL DISC DEGENERATION IMAGING

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INTRODUCTION: Recent advances in the development of novel biological therapies have shown potential in treating disc degeneration, although their success relies on the identification of IDD at its earliest stages. Molecular imaging has emerged as a valuable tool for the visualization of biological processes at the molecular/cellular levels, providing opportunities for early IDD imaging. In this study, we evaluate a novel targeted probe for IDD imaging.

METHODS: HYK52 was synthesized from an aldol condensation reaction incorporating a fluorescent styryl pyridinium moiety previously shown to have specificity for the intervertebral disc. To evaluate for cytotoxic effects and cellular uptake, AF and NP cells were exposed to 108-217 μ M HYK52, and cell viability was measured via XTT assay, compared to equimolar concentrations of gadolinium (Multihance). Normal intact rabbit intervertebral discs were soaked in 122 μ M HYK52 followed by cryosectioning at 10 μ m thickness and imaging.

RESULTS: Compared to gadolinium, HYK52 showed no significant cell cytotoxicity. Time and concentration-dependent cellular localizations were observed in both AF and NP. HYK52 was localized primarily to the cytosol of both AF and NP cells. In intact tissue, HYK52 binding in the AF highlighted the lamellar striations of the fibro cartilage structure, and stronger fluorescence was observed towards the disc's periphery (see Fig 1).

DISCUSSION: Overall, HYK52 appears to be a biocompatible and conjugable fluorescence marker that targets the IVD. Moreover, we designed HYK52 with a functional terminal carboxyl group to allow coupling with various signaling molecules for multimodal imaging applications. Such a tunable probe will have great potential in studying

disc morphology by providing disc-targeted image contrast through non-invasive means, and may have the potential to diagnose disc degeneration in vivo at an early stage.

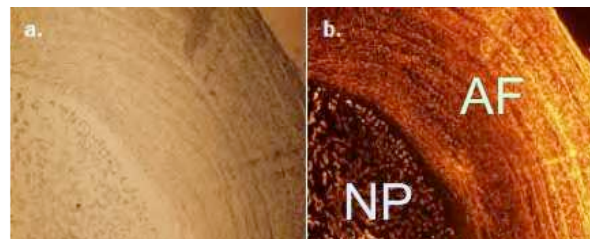


Figure 1. Rabbit disc tissue microscopy images. The dissected rabbit discs were soaked in media containing HYK52 (122 μ M or 56 μ g/mL) and incubated for 24 hr. After washing and fixation, frozen tissue was cryosectioned in 10 μ m thickness for imaging. a. Bright field and b. fluorescence images

O15

MORPHOLOGICAL CLASSIFICATION OF INTERVERTEBRAL DISC RUPTURE - ASSOCIATION WITH DEGENERATIVE LUMBAR DISEASES

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INTRODUCTION: Progression of intervertebral disc (IVD) degeneration is known to develop the rupture within IVD tissue. It is considered that IVD rupture leads to pathogenesis of degenerative spine disease, including low back pain and degenerative disc diseases. However, reports on the morphology of IVD rupture are few. The purpose of this study was to (1) assess and classify the morphology of IVD rupture using multi-detector computed tomography (MDCT) imaging, and (2) examine the association between morphological changes of IVD rupture and degenerative lumbar diseases.

METHODS: 99 patients with spinal diseases (48 male, 51 female; average age: 67.5 years), a total 587 discs (T12/L1 to L5/S1), were analyzed. IVD rupture was evaluated by the presence of vacuum phenomena

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using MDCT imaging. Shapes of rupture were classified into three types (spot, linear and island types) on sagittal imaging. The IVD was divided into 3 areas (nucleus pulposus: N; anterior annulus fibrosus: A; and posterior annulus fibrosus: P) on axial imaging. Then, the distribution of IVD rupture was classified into 4 groups (A-N: the rupture include both A and N, N: N only, N-P: include both N and P, A-N-P: all three area). Disc degeneration and Lumbar spinal stenosis (LSS) was evaluated by lumbar MRI grading.

RESULTS: IVD rupture was found in 37.8% of all discs, being most common at the L4/L5 level. In the distribution study, A-N was the most common group (42.4%), followed by N (31.7%), P-N (16.5%), A-N-P (9.4%). MRI and LSS grading was significantly higher in all the ruptured groups compared to the no ruptured group ($p < 0.01$). In the shape study (spot: 20.4%, linear: 27.0%, island: 52.6%), MRI and LSS grading was highest in the island type ($p < 0.01$).

DISCUSSION: The results of this study suggest that the morphology of IVD rupture is associated with disc degeneration and LSS. MDCT imaging of IVD ruptures would be clinically useful for predicting severity of degenerative lumbar diseases.

O16

SERUM METABOLOMIC BIOMARKERS AND LUMBAR DISC DEGENERATION

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INTRODUCTION: It has been suggested that altered metabolism may contribute to lumbar disc degeneration (DD). Quantitative high-throughput serum nuclear magnetic resonance (NMR) metabolomics has recently been introduced as a cost-effective way to obtain comprehensive data on systemic metabolism. Here we report our preliminary work on the identification of serum metabolomic biomarkers in relation to lumbar DD, with a primary focus on small molecules and lipid extracts.

METHODS: A radiographic and clinical cross-sectional study of 810 Southern Chinese volunteers was performed. A serum NMR metabolomics platform was utilized to assess the systemic metabolic profiles (~150 metabolic measures for each individual). Sagittal MRIs were utilized to assess DD (Schneiderman criteria) from L1-S1. A summed degenerative disc disease (DDD) score of the lumbar levels was obtained. Subject demographics and environmental/lifestyle factors were also assessed. ROC analysis and multivariate logistic regression analysis were performed to determine the strength and risk of various metabolomic biomarkers in relation to DD.

RESULTS: There were 315 male and 495 females (mean age: 51 years). DD was noted in 77% of the subjects. Multivariate model adjusted for age, sex, BMI, smoking status, triglycerides, ESR, and hs-CRP where appropriate. Serum tyrosine:lactate (OR: 1.60; 95% CI: 1.03-2.49) and leucine:isoleucine (OR: 2.65; 95% CI: 1.01-6.92) were significantly associated with the overall presence of DD. Elevated serum biomarker ratio of valine to histidine (critical value ≥ 3.8 ; DDD Score ≥ 5 ; OR: 1.74; 95% CI: 1.07-2.85) and lipid extracts (e.g. fatty acids; $p < 0.05$) were significantly associated with moderate to severe DD.

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CONCLUSIONS: This is the first study to report on a serum metabolomics approach in relation to DD. Novel serum biomarkers associated with early and moderate/severe lumbar DD were identified. Future studies are needed to validate the findings.

O17

EVALUATION OF LUMBAR INTERVERTEBRAL DISC DEGENERATION USING T1RHO MAPPING AND T2 MAPPING IN A RABBIT DISC INJURY MODEL

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INTRODUCTION: Intervertebral disc (IVD) pathology is one significant contributor to low back pain (LBP). The early signs of IVD degeneration are manifested by proteoglycan loss, dehydration, and collagen degradation. Recently, several quantitative MRI techniques for evaluation of cartilage tissue have been developed: T2 mapping is able to evaluate hydration and collagen fiber integrity within cartilage tissue, while T1rho mapping is useful to evaluate hydration and glycosaminoglycan content. The purpose of this study was to correlate T1rho/T2 values with degenerative grades and histological findings in a rabbit lumbar IVD injury model.

METHODS: Six 8-week-old male NZW rabbits were used. Annular punctures were performed 10 times at L2/3, 5 times at L3/4, and once at L4/5 IVD with an 18-gauge needle (n=3) or with a 21-gauge needle (n=3). Four and 8 weeks after surgery, MRI was performed using a GE Signa HDx 1.5-T,

which included T1rho and T2 sequences. The degree of IVD degeneration was assessed macroscopically using Thompson grading. All the specimens were sectioned and examined histologically. The degenerative grades and the histologic findings were compared with T1rho and T2 values for each IVD.

RESULTS: Both macroscopically and histologically, there was a decrease of disc height and degeneration of the annulus fibrosis in the injured IVDs compared to normal IVDs. Disc degeneration became more severe as the number of punctures increased and also as the needles grew larger. Regression analysis showed a positive linear relationship between Thompson grades and T1rho and T2 values ($p < 0.01$).

DISCUSSION: In this study, we controlled the degree of IVD degeneration and used T1rho and T2 quantitative MRI to detect small differences in cartilage degeneration. Our data suggest that T1rho and T2 mapping might be sensitive enough to detect early degenerative changes of IVDs and could potentially be used as a clinical tool to identify early IVD degeneration in discogenic LBP patient

O18

AN INTERVIEW STUDY OF PATIENTS' EXPERIENCE OF HEALTH AFTER A STRUCTURED PHYSIOTHERAPY TREATMENT MODEL OR SURGERY DUE TO LUMBAR DISC HERNIATION

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INTRODUCTION: In earlier studies evidence are formulated that surgery provides more rapid relief of leg pain than non-operative treatment. No differences can, however, be seen between treatments after two years, when using traditional outcome measures such as back-specific function and pain. However patients' experience of health is not earlier investigated with interviews using open-ended questions, which give the patients the opportunity to describe their experiences without being guided by standardized questionnaires. The aim of this study was to describe the experience of health among patients three years after treatment with a structured physiotherapy model or surgery due to lumbar disc herniation.

METHODS: Twenty patients who were eligible for surgery were treated with a structured physiotherapy model (n=10) or surgery (n=10). Open-ended interviews were tape-recorded, then transcribed verbatim and analyzed by content analysis. In the analysis the meaning units were coded according to its content. In order to better illustrate the two treatment groups, a choice was made to specify the amount of codes in each group. The codes with similar content were formed into subthemes. Finally, subthemes were formed into themes.

RESULTS: Findings emerged into two themes: feeling of well-being and feeling of ill-being. In the group treated with structured physiotherapy there were high number of codes in feeling of well-being. In the group treated with surgery there were high number of codes in feeling of ill-being.

DISCUSSION: These findings were surprising, as earlier studies have shown no differ-

ences between treatments after two years. One explanation could be that qualitative studies, reflecting the patients' own experiences, reveal results that cannot be obtained with standardized questionnaires. Another explanation could be the effect of the structured physiotherapy treatment that aims at increasing the patients' autonomy and give the patients tools to treat themselves.

O19

ADAMTS-5 MEDIATES TOBACCO SMOKING-INDUCED DISC AGGREGANOLYSIS

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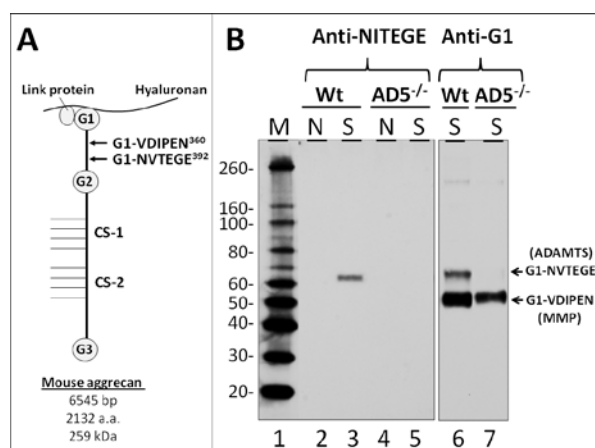
INTRODUCTION: Tobacco smoking is a major risk factor of intervertebral disc degeneration (IDD). Using the mouse model of chronic human tobacco smokers, we recently discovered that smoking resulted in a dramatic increase in the ADAMTS-mediated proteolysis within the aggrecan interglobular domain (IGD) in disc tissue. This proteolysis is extremely detrimental as it results in loss of the entire glycosaminoglycan-attachment region of aggrecan that is vital for disc biomechanical function. However, the specific ADAMTS responsible for this proteolysis was not known, and hence the goal of the current study is to evaluate the role of ADAMTS-5 in this critical proteolytic process.

METHODS: Three-month old Wt (C57BL/6) and ADAMTS-5 knockout (ADAMTS-5^{-/-}) mice were exposed to tobacco smoke by direct inhalation (4 cigarettes/day, 5 day/week for 6 months). ADAMTS-mediated cleavage of disc aggrecan IGD terminating in NITEGE-373 was analyzed by Western blot and immunohistochemistry from whole disc protein extract.

RESULTS: Western analysis demonstrated that exposure to tobacco smoke dramatical-

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ly increased ADAMTS-mediated proteolysis of disc aggrecan IGD in Wt mice but not in ADAMTS-5^{-/-} mice (Fig 1). This result was independently confirmed by immunohistochemistry showing the presence of NITEGE-373 breakdown aggrecan products in discs of Wt but not ADAMTS-5^{-/-} mice following exposure to tobacco smoking.



DISCUSSION: The discovery of smoke-induced proteolysis of disc aggrecan was novel and unprecedented. Disc aggrecan of ADAMTS-5^{-/-} mice was protected from this detrimental cleavage, indicating that ADAMTS-5 is the primary aggrecanase responsible for smoke-induced disc aggrecan analysis. Thus, ADAMTS-5 represents an important target for the development of therapeutic inhibitors aimed at delaying the onset or ameliorating the severity of IDD in chronic smokers.

O20

NUCLEUS PULPOSUS PROGENITOR CELL EXHAUSTION IN DISC AGEING AND DEGENERATION

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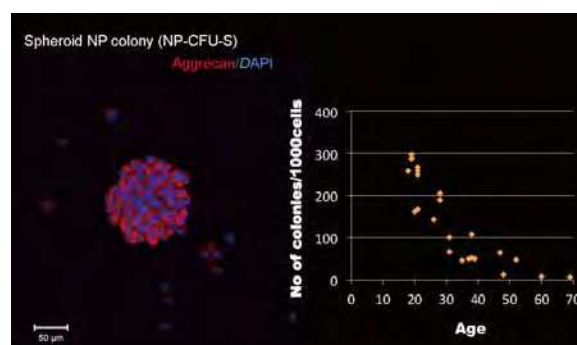
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INTRODUCTION: Stem/progenitor niche provides necessary factors for survival and maintenance of tissue specific

stem/progenitor cells. Lack of evidence of a functional stem/progenitor cell niche for nucleus pulposus (NP) cells is a major drawback for understanding disc degeneration and developing new treatment.

METHODS: To identify mouse and human NP stem and progenitor cells, we began with colony-forming assay using methylcellulose semi-solid medium. Various cell surface markers were analyzed to define spheroid colony generating NP cells. Following this prescreening, cells were evaluated for clonogenicity in vitro and for multipotency and self-renewal ability in vivo. Defined NP progenitor cells were analyzed for their correlation to Ageing and degeneration in human surgical specimens and also investigated for their functional niche.

RESULTS: We identified progenitor cells in populations purified from adult mouse and human NP cells using two markers: the tyrosine kinase receptor Tie2 (Tie2) and disialoganglioside 2 (GD2). These cells formed spheroid colonies (Fig.) that express type II collagen and aggrecan.



They were clonally multipotent and differentiated into mesenchymal lineages and induced reorganization of NP tissue when transplanted into NOD/SCID mice. The frequency of Tie2⁺ cells in human tissues decreased markedly with age and degeneration of the IVD, suggesting exhaustion of their capacity for regeneration. Tie2-Ang-1 niche played an important role in maintenance and survival of NP progenitor cells.

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DISCUSSION: The results of the study defined specific NP cell markers that show clonal stem/progenitor cell characteristics. Our study shows for the first time an experimental model of NP differentiation induced from functional NP progenitor cells in vivo and that one of the causes of ageing and degeneration correlating to exhaustion of NP progenitor cells. Identification of Tie2-Ang-1 niche offer insights for diagnostic and therapeutic development.

O21

INTRADISCAL INJECTIONS OF NFKB DECOY INTO RABBIT DISCS ABROGATED DEGENERATED DISC-INDUCED PAIN GENERATION IN THE XENOGRAFT RADICULOPATHY RAT MODEL

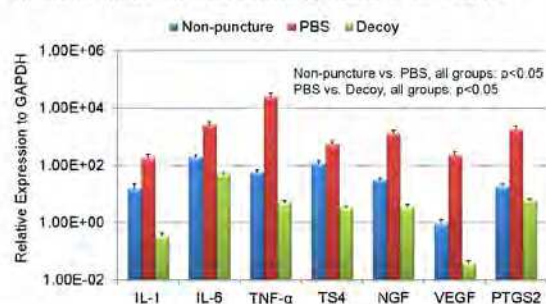
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INTRODUCTION: A two-step disc xenograft-radiculopathy animal model (rabbit/nude rat) was developed to assess treatment effectiveness of an injection therapy. Rabbit degenerated nucleus pulposus (NP) post-treatment with the therapeutic agent was implanted on nude rat DRGs to determine if the NP induces functional and sensory dysfunction. NF κ B decoy (Decoy) oligonucleotide was the tested therapeutic agent.

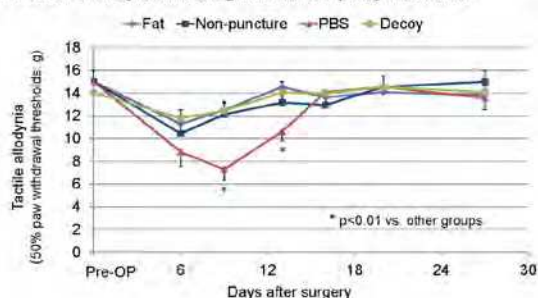
METHODS: 24 New Zealand white rabbits received anular puncture at L2/3 and L4/5, with L3/4 as non-puncture control. 4 weeks after puncture, Decoy (100 μ g/10 μ l PBS) or PBS only (10 μ l) was injected into punctured discs. Non-puncture discs served as the control. 4 weeks after injection, NPs were har-

vested for qPCR or implantation into nude rats. (A) Rabbit NP mRNA: mRNA levels of catabolic markers (IL-1, IL-6, TNF- α , ADAMTS4) and pain-related molecules (NGF, VEGF and PTGS2) in the rabbit NP were assessed by qPCR. (B) Rabbit NPs or fat (tissue control) were implanted on nude rat right L5 DRGs after partial laminectomy. Tactile allodynia was assessed by the von Frey test. Iba-1 and CGRP in rat DRGs were also evaluated by immunohistochemistry (n=8 each).

A: mRNA Expression in the Punctured Rabbit NP w/w/o Decoy



B: Tactile Allodynia in Xenograft Radiculopathy Rat Model



RESULTS: A: mRNA Expression (rabbit NP): Expression of all genes tested in the PBS-injected group was significantly higher than in non-punctured discs. IL-1, TNF- α , ADAMTS4, NGF, VEGF, PTGS expressions were significantly decreased in Decoy-injected discs compared to PBS-injected discs ($p < 0.05$). B: Allodynia in Xenograft Radiculopathy Rat Model: Rats in the PBS group experienced significant mechanical allodynia at days 9-13 after surgery ($p < 0.05$), which was significantly attenuated in the Decoy group ($p < 0.01$).

DISCUSSION: This novel combination of two animal models demonstrated that highly expressed cytokines induced by anular

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puncture were linked to pain generation; importantly, this phenomenon was significantly suppressed by the intradiscal injection of NF κ B decoy. This model can be used to assess treatments as a biosensor.

O22

THE RELATIONSHIP BETWEEN VITAMIN D STATUS AND SUCCESSFUL FUSION

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INTRODUCTION: Vitamin D insufficiency has been increasingly reported worldwide at alarming rates. Clinical findings indicate that vitamin D insufficiency, deficiency, and supplementation have a significant impact on bone health. However, there is no published experimental or clinical data on the causal effect of insufficient or deficient vitamin D levels on the success of establishing a solid bony union after a spinal fusion surgery.

METHODS: 50 male Sprague Dawley rats were randomized into four experimental groups based on vitamin D supplementation provided in their rat chow: controls (CD, 5 IU/g), deficient (DD, 0 IU/g), insufficient (ID, 2.25 IU/g), and hypervitamin D (HD, 40 IU/g). Diets were modified 4 weeks prior to surgery and maintained post-surgery through sacrifice. Fusion was performed using a tailbone autograft implanted into the L4/L5 transverse processes. Rats were sacrificed 3 months post-surgery and fusion was evaluated radiographically, via manual palpation, and microCT. Plasma was collected and 25(OH)D levels were determined via radioimmunoassay at surgery and sacrifice.

RESULTS: Manual palpation fusion rates were 83% for HD compared to 61% for CD, 58 % fused for ID, and 45 % for DD and were marginally related to Vitamin-D adjusted diet ($p=0.07$). Radiographic fusion and density of bone mass were significantly related

to the level diet ($p<0.05$). Vitamin D plasma levels were diet dependent and relatively stable from surgery to sacrifice (DD:9.3 \pm 1.6 ng/mL pre surgery to 6.3 \pm 1.0 sacrifice; ID:20.6 \pm 3.3 to 15.6 \pm 5.0; CD:28.3 \pm 4.6 to 19.6 \pm 5.6; HD:97.4 \pm 13.6 to 88.4 \pm 9.9, $p < 0.0001$).

DISCUSSION: Spinal fusion continues to be an important and increasing popular treatment for degenerative, deformation and traumatic spinal disorders. Data generated in this preliminary study suggest vitamin D modulates the consolidation of autograft bone after grafting for spinal fusion in a rat model.

O23

THE EFFECT OF HUMAN PARATHYROID HORMONE (1-34) ON SPINE FUSION IN AN OSTEOPOROTIC ANIMAL MODEL

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INTRODUCTION: It is difficult to achieve solid spine fusion in the osteoporotic spine. Several studies reported that PTH has been shown to enhance spinal fusion in normal animals. The purpose was to assess the effect of PTH on spine fusion in an osteoporotic animal model.

METHODS: Twenty-two female SD rats underwent either sham-operated (Sham) or bilateral ovariectomy (OVX). Eight weeks after the first surgery, animals underwent intertransverse fusion at L4-5. Then they received daily injection of vehicle (Control) or 20 μ g/kg/day of PTH (PTH) for 6 weeks. Animals were divided into three groups: Sham-Control: SC (N=7), OVX-CONTROL: OC (N=7), OVX-PTH: OP (N=8). The fusion mass was assessed with a soft x-ray apparatus, a pQCT device for the bone mineral density (BMD) and the cross-sectional area, a bone strength measuring apparatus in three-point bending. The specimens were also evaluated histologically.

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RESULTS: In the radiographic study the fusion mass of OC was thinner and smaller than that of SC and OP. In the pQCT study, the cross-sectional area of graft bone of BMD more than 267mg/cm³ (same as cancerous bone) is 2.9mm² in OC, 3.8mm² in OP respectively. That of BMD more than 690mg/cm³ (same as cortical bone) is 0.70mm² in OC, 0.82mm² in OP respectively. There is no significant difference of cross-sectional area between groups. In the three-point bending test, the stiffness was 18.9N/mm in OC and 32.6N/mm in OP. The ultimate load was 74.9N in OC and 117.8N in OP. The stiffness and ultimate load of OP were significantly higher than those of OC. In the results of histological analyses on the graft bone, excellent bone neogenesis around the grafted bone was observed in SC and OP compared to OC.

DISCUSSION: In this study, PTH formed large and dense fusion mass and increased the stiffness and ultimate load. Our results demonstrated that PTH was effective for radiological, biomechanical and histological successes of spine fusion in an osteoporotic animal model.

O24

DEVELOPMENT OF A NOVEL ANTIMICROBIAL-COATED BIOMEDICAL POLYMER

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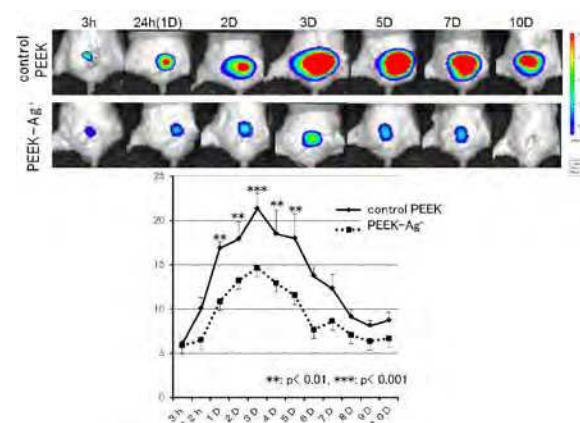
INTRODUCTION: In recent years, various biomedical polymers such as polyether-

ether-ketone (PEEK) cage and rod have been widely used in spine surgery. Meanwhile, implant-associated infection is increasing and brings on serious complications. To our knowledge, no bacteria-resistant polymers have been reported previously. The purpose of this study was to develop a novel antibacterial coated biomedical polymer.

METHODS: 1) Antibacterial polymer was fabricated: i) form the hydroxyapatite (HAp) film on PEEK's surface, ii) support inositol phosphate on HAp film, and iii) fix Ag⁺ ions on it.

2) Ag⁺ ions coated PEEK (PEEK-Ag⁺) or non-coated PEEK (control PEEK) were immersed into Staphylococcus aureus (*S. aureus*)-cultured solution for 24 hours, then, formation of bacterial biofilms was captured by IVIS[®] Lumina optical imaging system. The surface of PEEK was also analyzed by electron microscope (EM).

3) Either PEEK-Ag⁺ or control PEEK were inserted into superficial gluteus muscle of mouse with *S. aureus* (2x10⁷ CFU/ul). Bacterial photon intensity (PI) was sequentially measured by IVIS[®] at different time points. Gluteus muscle specimens were analyzed histologically in both groups.



RESULTS: In vitro, bacterial bioluminescent signal was detected by IVIS[®] on the surface of control PEEK, but not PEEK-Ag⁺. EM analyses also showed the formation of biofilms only on control PEEK. Sequential observa-

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tion of the luminescence revealed that the mean PIs in the PEEK-Ag+ group were significantly lower than those in the control PEEK at the early time points after surgery (Fig). Histologically, musculoskeletal infection were found significantly less frequently around PEEK-Ag+.

DISCUSSION: We have successfully developed the stable and uniformly-dense Ag+ ions coated polymer. To our knowledge, this is the first demonstration of antibacterial coating technique for polymer implants, and can be applied to various medical devices including PEEK cage and rod to prevent implant-associated infection.

O25

THE EFFECT OF DISC DEGENERATION ON ANTERIOR SHEAR FLEXIBILITY IN THE LUMBAR SPINE.

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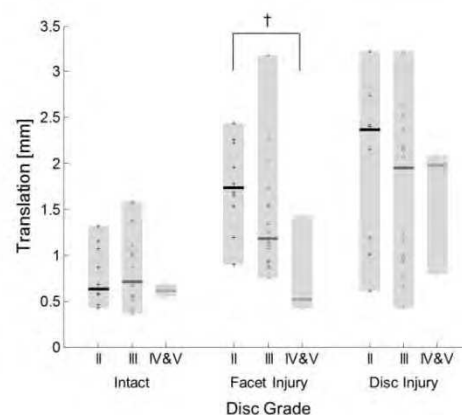
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INTRODUCTION: Disc degeneration (DD) is a risk factor for low back pain, and degenerative conditions are often treated with surgical stabilization. The effect of DD on spinal flexibility has been addressed by several groups in bending but not in shear; a highly relevant load direction is anterior shear. The objective of our study was to determine the effect of DD on anterior translation and specimen stiffness under shear loading in an

in vitro model of degenerative spondylolisthesis.

METHODS: Human cadaveric lumbar FSUs (N=30) were imaged, and the disc grade was determined from a five-point scale (Pfirrmann). Each specimen was tested in 3 sequential states: intact, facet destabilization and disc destabilization with the latter 2 states modeling the clinical scenario of degenerative spondylolisthesis. The specimens were loaded with a 300 N axial compressive force combined with a cyclic anterior shear force (5-250 N). Translation was tracked with a motion capture system. Kruskal-Wallis ANOVA and multiple comparison Dunn's tests were performed to determine the effect of DD on anterior translation and specimen stiffness.

RESULTS: DD had no effect on anterior translation or specimen stiffness for the intact and disc destabilization conditions (Fig. median and range). In the facet destabilization condition, specimens with disc grade II translated more than those with disc grades IV and V ($p=0.03$). Stiffness increased with DD in the facet destabilization condition (ANOVA $p=0.04$; Dunn's test was not significant).



DISCUSSION: There was a trend to reduced anterior translation in shear with advancing degeneration only in the facet destabilization condition. These results suggest that shear stiffness of an intact specimen is not affected by overall degeneration, except in

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the case where the facets are not competent to resist load. A more comprehensive characterization of degeneration may allow us to tease out possible effects of DD on anterior translation.

O26

15 DAYS MICROGRAVITY CONDITION INDUCED DISC HEIGHT LOSS AND BONE MORPHOLOGICAL CHANGES OF THE MOUSE LUMBAR SPINE

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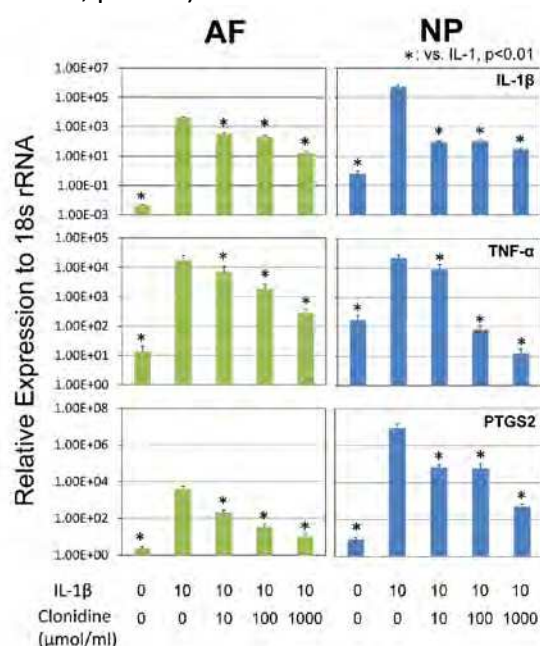
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INTRODUCTION: Intervertebral disc (IVD) degeneration and bone remodeling occur during space flight. Mice lumbar spines from 15-days microgravity conditions (NASA Discovery space flight STS-131) were analyzed using a novel fully-automated micro-CT method to assess bone remodeling and disc height; region-dependent changes in bone morphological parameters were also evaluated.

METHODS: C57BL/6 mice (Flight: n=8) experienced microgravity (15-days); Control mice (n=8) remained on Earth. Post-flight, lumbar spines were imaged (micro-CT: Skyscan 1076) at 9um. The 3D micro-CT models were created to analyze 3D mean disc height using a C++ program. Bone volume/total volume (BV/TV), trabecular bone thickness (Tb.Th) and bone mineral density (BMD) were also determined. Trabecular bone volumes of interest (VOIs: 60% and 80%) were automatically defined in Matlab.

Effects of space flight and region-dependent BV/TV, Tb.Th, BMD and disc height were assessed using repeated ANOVA with Fisher LSD post hoc test.

RESULTS: Flight mice showed a loss of disc height (vs. Control; $p < 0.05$). Tb.Th showed a decrease in Flight mice (vs. Control, $p < 0.05$). Focusing on level effect, BV/TV at L5 and Tb.Th at L5 and L6 decreased in Flight mice in both VOIs (vs. Control, $p < 0.05$). For 80% VOI, BMD at L5 decreased in Flight mice (vs. Control, $p < 0.05$).



DISCUSSION: 15 days microgravity condition induced disc height loss of the mouse lumbar spine. Tb.Th in Flight mice was significantly lower than in Control mice. Level effect differences between groups in each bone parameter were mainly observed at L5 and L6. These findings suggest that biomechanical conditions for each lumbar vertebral body may have resulted in different responses to microgravity. The newly developed, fully automated VOI definition program could detect similar changes in micro-architecture deterioration in both VOIs, indicating this region-defined trabecular bone analysis can be used as an unbiased method for bone morphological analysis.

O27

THE PATHOGENESIS OF THORACOLUMBAR VERTEBRAL WEDGE FRACTURES

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INTRODUCTION: Senile kyphosis arises from anterior 'wedge' deformity of thoracolumbar vertebrae, often in the absence of trauma. It is difficult to reproduce these deformities in cadaveric spines, because a vertebral endplate usually fails first. We hypothesise that endplate fracture concentrates sufficient loading on to the anterior cortex that a wedge deformity develops subsequently under physiological repetitive loading.

METHODS: Thirty-four cadaveric thoracolumbar "motion segments", aged 70-97yrs, were overloaded in combined bending and compression. Physiologically-reasonable cyclic loading was then applied, at progressively higher loads, for up to 2 hrs. Before and after fracture, and again after cyclic loading the distribution of compressive loading on the vertebral body was assessed from recordings of compressive stress along the sagittal mid-plane of the adjacent intervertebral disc. Vertebral deformity was assessed from radiographs at the beginning and end of testing.

RESULTS: Initial overload usually fractured a vertebral endplate, at 2.31 kN (STD 0.85). There was minimal anterior wedging, but pressure in the nucleus of the adjacent disc was reduced by 65.2% on average, and this was associated with relative increases in compressive stress in the annulus and neural arch. Subsequent cyclic loading in combined flexion and compression then caused anterior wedge deformity of the vertebral body, with the height of the anterior and

posterior cortex decreasing by 34.3% (13.2) and 12.7% (7.5) respectively, and wedge angle increasing from 5.0° (3.8) to 11.4° (3.9) (all $p < 0.001$).

DISCUSSION: Our hypothesis is supported: initial minor damage facilitates progressive anterior wedge deformity by concentrating compressive loading on to the anterior cortex during flexion. Detecting initial endplate damage is important to minimise subsequent vertebral deformity in patients with osteoporosis.

O28

THE EFFECT OF PEDICLE SCREW REDIRECTION FOLLOWING LATERAL WALL BREACH – A BIOMECHANICAL STUDY USING HUMAN LUMBAR VERTEBRAE

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INTRODUCTION: Currently, pedicle screw segmental fixation of the spine is considered a standard of care for a number of conditions. Despite continued improvements in technique, pedicle breach remains a frequent occurrence. Once a breach is detected intra-operatively, the most common corrective maneuver is to redirect the pedicle screw medially into the pedicle. To our knowledge, the biomechanical impacts of medially redirecting a pedicle screw medially after a lateral pedicle breach has not been examined.

METHODS: Ten cadaveric human lumbar vertebrae were used. Each vertebra was instrumented with a monoaxial pedicle screw into each pedicle using two different techniques. On one side a perfect screw path was created and a pedicle screw was inserted. On the contralateral side, an intentional lateral pedicle wall breach was

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created at the pedicle-vertebral body junction using a guide wire, a cannulated tap, and pedicle probe. This path was then redirected into a center-center position, developed, and instrumented with a screw. For each screw, we measured: 1) maximal insertion torque; 2) seating torque; 3) screw loosening; and 4) post-loosening axial pullout force. A digital torque driver was used for torque measurements and an MTS machine for loosening and screw pullout.

RESULTS: The biomechanical costs of redirecting a pedicle screw after a lateral pedicle breach are: 1) 28% drop ($p < 0.002$) in maximal insertion torque and 25% ($p < 0.049$) in seating torque; 2) 25% drop ($p < 0.040$) in resistance to screw loosening; and 3) 11% drop ($p < 0.047$) in axial pullout force.

DISCUSSION: As compared to a lumbar pedicle screw placed center-center, a lumbar pedicle screw that has been redirected after a lateral wall breach is significantly weaker. These significant decreases in biomechanical properties would be important when redirected pedicle screws are placed at the cephalad or caudal end of a long construct. In these situations the surgeon may want to consider screw or construct augmentation.

O29

THE EFFECTS OF STRAIN AND DISPLACEMENT RATE ON NERVE ROOT INJURY TOLERANCE TO STRETCH

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INTRODUCTION: Nerve root injuries occur in roadway accidents, sports, surgical procedures and birth deliveries. There is very little published data on injury tolerance of nerve roots at high strain rates. This study investigated conduction changes of lumbar

nerve roots at low to high strain rates.

METHODS: Sixty-five L5 dorsal nerve roots in anesthetized adult male rats were pulled at strains of 1-30% at displacement rates of 20, 200 or 800 mm/sec. Video recordings at 2000 or 10,000 frames/s were used to determine regional strains on the roots. Compound action potentials (CAP) of the nerve roots were obtained at the proximal and distal ends of the root before and after stretch over 6 hours. CAP amplitude loss and recovery was analyzed using repeated measures ANOVA.

RESULTS: In sham group, nerve conduction over the 6 hours was not significantly less than 0 time point (One Way ANOVA, $p > 0.5$). In 20, 200, and 800 mm/s groups, CAP amplitude over the time was significantly less than baseline. The 800 mm/s rate caused greater decrease of CAP amplitude than 20 mm/s and 200 mm/s rates. At 800 mm/s with strains $> 10\%$, no functional recovery occurred over 6 hours after stretch. At low strains ($< 10\%$) and low stretch rate (20 mm/s), nerves showed CAP amplitude recovery over 6 hours. There was no statistical difference of CAP amplitude between 20 mm/s and 200 mm/s rates (GLM, Univariate, $p < 0.05$). The strain distribution along the roots was not uniform and in most cases the strain at the proximal end of root was greater than at the distal end of root (t test, $p < 0.05$).

DISCUSSION: These studies demonstrated that nerve roots recover from stretch at low rates and strains $< 10\%$. However, at high stretch rates seen in accidental trauma, recovery is only partial, and if the strain exceeds 20%, there is no recovery. These data can provide guidance in computer modeling of spinal trauma and in surgical procedures involving nerve roots.

O30

MALE SPINE MOTION DURING COITUS: IMPLICATIONS FOR THE LOW BACK PAIN PATIENT

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INTRODUCTION: Qualitative studies investigating the sexual activity of people with low back pain (LBP) found a substantial reduction in the frequency of coitus and have shown that pain during coitus due to mechanical factors, such as movements and postures, are reported as the primary reason for the decreased frequency. The objective of this study was to describe male spine motion during coitus and compare this motion across four common positions.

METHODS: Ten healthy males (29.3 ± 6.9 years, 176.5 ± 8.6 cm, 84.9 ± 14.5 kg) and ten healthy females participated in this study. Each couple performed four coital positions for 20 seconds – female quadruped/male kneeling behind, female side-lying/male side-lying behind, and female supine/male prone on top with either elbow or hand support – while spine kinematic signals were recorded.

RESULTS: Maximum male lumbar spine flexion (-) and extension (+) for all coital positions, expressed as a percentage of maximum active range of lumbar spine flexion/extension motion (%aROM), are as follows: kneeling -27.9 ± 18.3 to 8.4 ± 31.8 %aROM; prone with hand support -30.0 ± 27.6 to 21.6 ± 53.5 %aROM; prone with elbow support -52.3 ± 21.8 to 10.4 ± 31.5 %aROM; side-lying -66.4 ± 14.5 to -27.2 ± 16.4 %aROM.

DISCUSSION: Since highly repetitive lumbar spine flexion/extension has been shown to consistently produce intervertebral disc herniation under load and full flexion reduces the ability of the spine to bear compressive load, side-lying and prone-with-elbow-support coital positions are not rec-

ommended for patients with existing LBP exacerbated by flexion. Kneeling was the most spine-conserving with respect to both range and percentage of spine flexion. Varying the prone position from elbow to hand support reduced both of these characteristics. This biomechanical analysis of coitus provides initial recommendations for patients with LBP concerned with exacerbating their injury during coitus and maintaining their frequency of sexual activity.

O31

FUSION DID NOT IMPROVE OUTCOME IN DECOMPRESSIVE SURGERY FOR LUMBAR SPINAL STENOSIS A 2-YEAR FOLLOW-UP STUDY OF 5390 PATIENTS FROM SWESPINE

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INTRODUCTION: The risk of postoperative instability after decompression has been debated for decades and concomitant fusion in surgery for lumbar spinal stenosis (LSS) remains a controversial procedure. The objective of this study was to determine whether the addition of fusion results in better outcome in decompressive surgery for LSS in patients with or without degenerative spondylolisthesis.

METHODS: The National Swedish Register for Spine surgery (Swespine) was used for the study. Data were obtained for all patients in the register that were operated for LSS on one or two adjacent lumbar levels before July 1st 2008. In all, 5390 patients fulfilled the inclusion criteria and completed a 2-year follow-up. The results of patients operated on with decompression only (n=4259) and decompression with fusion (n=1131) were compared. The consequence of preoperative olisthesis (n=1306) in operated segments was additionally considered.

RESULTS: Overall significant improvements were seen in both groups on all outcome

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measures at the 2-year follow-up when compared with preoperative data. After 2 years, no significant differences were identified between the two treatment groups for any of the outcome measures (back pain, leg pain, EQ-5D, Oswestry Disability Index, walking ability and overall satisfaction), regardless of any preoperative olisthesis. After multivariable adjustment, the odds ratios (ORs) regarding improved walking ability and overall satisfaction between patients treated with concomitant fusion compared with decompression only was 1.01 (95% confidence interval (CI) 0.85-1.19) and 1.08 (95% CI 0.94-1.24) respectively. The frequency of repeated surgery for LSS was 7.0% after decompression and 8.1% after decompression with fusion.

DISCUSSION: This large prospective cohort analysis indicate that adding fusion to decompressive surgery does not improve outcome in lumbar spinal stenosis, regardless of the presence of preoperative degenerative olisthesis.

O32

FIVE-YEAR OUTCOMES FOLLOWING MINIMALLY INVASIVE TRANSFORAMINAL LUMBAR INTERBODY FUSION FOR SPONDYLOLISTHESIS AND DEGENERATIVE LUMBAR DISEASE

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INTRODUCTION: Over five-year outcomes have not been reported after minimally invasive transforaminal lumbar interbody fusion. The purpose of this study was to report the surgical outcomes with a five-year follow-up.

METHODS: A consecutive series of 124 patients with low-grade spondylolisthesis and degenerative lumbar diseases who underwent minimally invasive transforaminal

lumbar interbody fusion was evaluated at regular intervals. The prospectively collected data from the preoperative and two- and five-year follow-up were analyzed. The data included demographic data, Oswestry Disability Index, numeric-rating scales for back and leg pain, a radiographic fusion status, and adverse events.

RESULTS: Eight three (67%) patients had complete five-year follow-up. Substantial improvements from baseline were noted in all clinical measures at two-year and five-year intervals. The mean improvement in the Oswestry Disability Index score was 35.5 points at two years and 36 points at five years. At two years after surgery, an improvement in the Oswestry Disability Index scores of >10 points was achieved in 96% (102) of 106 patients and maintained in 95% (79) of 83 patients at five years postoperatively. Radiographic fusion success at five years was 81% (67) of 83 patients and 89% (64) of 72 single-level surgeries in this analysis. Perioperative complications occurred in 9% (11 patients). Second surgery rate was 6.5% (8 patients) involving the index level, and 5.6% (7 patients) at the adjacent levels.

DISCUSSION: The five-year follow-up data in the present study demonstrates a substantial improvement for patients with spondylolisthesis and lumbar degenerative diseases treated with minimally invasive transforaminal lumbar interbody fusion. We conclude that this procedure is a reasonable treatment option for properly selected patients with spondylolisthesis and degenerative lumbar diseases.

O33

MIS-TLIF REDUCES AN INCIDENCE OF ADJACENT DISC DISEASE IN THE PATIENT WITH DEGENERATIVE SPONDYLOLYSTHESIS – COMPARATIVE STUDY WITH CONVENTIONAL TLIF

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INTRODUCTION : Although TLIF has been a standard procedure for patient with unstable degenerative spondylolisthesis (DS), an adjacent disc disease (ADD) often occurs as a complication after the surgery. Here we have assessed the radiographic and clinical outcomes in the patients with DS who underwent either one-level conventional TLIF or minimally invasive TLIF (MIS-TLIF) to investigate the incidence of ADD.

METHODS: Seventy-eight patients who underwent one-level interbody fusion for DS at L4-5 were retrospectively reviewed. There were 28 men and 50 women with a mean age of 61.5 years. Conventional TLIF and MIS-TLIF were performed in 38 and 40 patients, respectively. The mean follow-up (f-u) period was 46.8 months (Minimum 2Y f-u). Various parameters obtained from L3-4 and L4-5 levels were measured using the plain lumbar radiographs before surgery and during f-u period. Degenerative change of L3-4 disc was evaluated by MR images. The JOA scores, the recovery rate, and questionnaires were used for clinical evaluation.

RESULTS: There were no significant differences in ages, gender, or preoperative translation, disc height, ROM at L3-4 level, and JOA scores between two groups. The mean height of cage in conventional TLIF and MIS-TLIF were 10.4 and 10.2mm, respectively (N.S.). Although patients in both groups provided significantly postoperative improvements in JOA scores and VAS (N.S.), conventional TLIF was associated with significantly higher L3-4 translation (2.5 vs 1.3mm), lower L3-4 disc height (9.7 vs 10.3mm), and higher L3-4 ROM (10.9 vs

5.6°) at the final f-u ($P<0.05$ each). Degenerative change of L3-4 disc in MR images was frequently observed in conventional TLIF. MIS-TLIF provided significantly better improvements in 2Y- ODI and RMDQ and JOA recovery rate at the final f-u (83.4 vs 79.3%, $P<0.05$), compared with conventional TLIF.

DISCUSSION: MIS-TLIF may preserve the paraspinal muscles and facet joints, thereby reducing the incidence of ADD.

O34

SHORT-SEGMENT FIXATION WITH OUT FUSION FOR THORACOLUMBAR BURST FRACTURES WITH NEUROLOGICAL DEFICIT CAN PRESERVE THORACOLUMBAR MOTION WITHOUT RESULTING IN POST-TRAUMATIC DISC DEGENERATION. A 10-YEAR FOLLOW-UP STUDY.

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INTRODUCTION: Early clinical results of short-segment fixation without fusion for thoracolumbar burst fractures were satisfactory. However, the long term results have not been reported, and post-traumatic disc degeneration and preservation of thoracolumbar motion have not been elucidated.

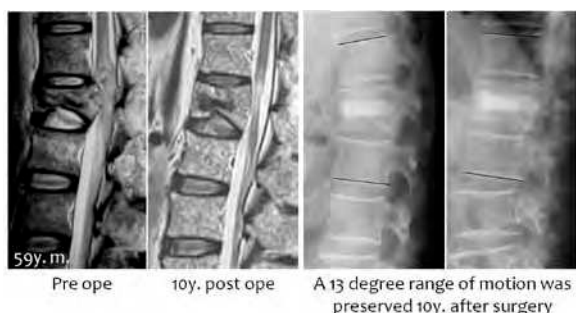
METHODS: Twelve patients who had thoracolumbar burst fractures and associated incomplete neurologic deficit, operatively treated within 4 days of admission and had their implants removed within one year, were prospectively followed for at least 10 years. Following indirect reduction and pedicle screw fixation, transpedicular intracorporeal HA grafting to the fractured vertebrae was performed.

RESULTS: Sagittal alignment was improved

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from a mean preoperative kyphosis of 17° to -2° (lordosis) by operation, but was found to have slightly deteriorated to 2° at the final follow-up observation. With respect to back pain, eight patients did not report back pain. Three reported occasional minimal pain, and one reported moderate pain. None reported severe pain or needed daily dosages of analgesics.

Regarding disc degeneration, the shape of the disc adjacent to the fractured vertebra had not changed from the preoperative to the 10-year postoperative MRI. Although signal intensity of the disc had decreased by one grade from the preoperative to the 2-year postoperative MRI, the intensity had not changed from the 2-year postoperative MRI to the 10-year postoperative MRI. At the 10-year follow-up, flexion-extension radiographs revealed that a mean range of motion at the disc adjacent to the fractured vertebra was 12 degrees (range; 5-19) (fig.).



DISCUSSION: This unprecedented 10-year follow-up study demonstrated that posterior indirect reduction, transpedicular HA grafting, and pedicle screw fixation does not require fusion to a segment, thereby preserves thoracolumbar motion without resulting in post-traumatic disc degeneration.

O35

A SYSTEMATIC REVIEW OF LUMBAR FUSION RATES WITH AND WITHOUT THE USE OF RHBMP-2

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INTRODUCTION: Recombinant human bone morphogenetic protein-2 (rhBMP-2) has been increasingly used for anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF)/ transforaminal lumbar interbody fusion (TLIF), and posterolateral spine fusion (PSF). Perception among surgeons that rhBMP-2 improves fusion rates motivates its use. The present review assesses fusion rates associated in these procedures.

METHODS: A systematic review of the literature published between May 2000 and May 2012 comparing fusion rates with and without rhBMP-2 in ALIF, PLIF/TLIF, and PSF was performed.

RESULTS: Nineteen studies (15 prospective and 4 retrospective) consisting of 1901 patients (1066 with rhBMP-2 and 835 without) were identified. Average fusion rate at 24 month follow-up for the rhBMP-2 group was 97.4% for ALIF, 97.3% for PLIF/TLIF, and 93.9% for PSF and 83.4%, 77.8%, and 83.5%, respectively, for the control group. Five of 5 studies for PLIF/TLIF (including 299 of 299 patients, 100%), 3 of 6 for ALIF (including 303 of 725 patients, 42%), and 5 of 8 for PSF (including 411 of 877 patients, 47%) did not demonstrate statistically significantly improved fusion rates with rhBMP-2 at longest follow-up investigated.

DISCUSSION: The present literature does not statistically significantly support the use of rhBMP-2 in ALIF, PLIF/TLIF, and PSF to improve fusion. While there is a non-significant trend in the data, future studies should elucidate whether benefits outweigh risks and costs to justify use in these operations.

O36

EARLY VERSUS LATE INITIATION OF REHABILITATION AFTER LUMBAR SPINAL FUSION – ECONOMIC EVALUATION ALONGSIDE A RCT

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INTRODUCTION: In a previously reported RCT, we assessed the impact of timing of rehabilitation after a lumbar spinal fusion and found that a fast-track strategy led to poorer functional ability. Before making recommendations, the societal perspective including return to work, quality of life, and costs seems relevant to address. The aim of this study was to examine the cost-effectiveness of initiating rehabilitation 6 weeks after surgery as opposed to 12 weeks after surgery.

METHODS: Economic evaluation was conducted alongside a randomized controlled trial with 1-year follow-up. 82 patients undergoing instrumented lumbar spinal fusion

due to degenerative disc disease or spondylolisthesis (grade I or II) were randomised to an identical protocol of four sessions of group-based rehabilitation and were instructed in home exercises focusing on active stability training. Outcome parameters included functional disability (ODI) and quality-adjusted life years. Health care and productivity costs were estimated from national registries and reported in Euros (EUR). Costs and effects were transformed into net benefit. Bootstrapping was used to estimate 95% confidence intervals (95% CI).

RESULTS: The fast-track strategy tended to be more costly by 6,869 EUR (95% CI -4,640;18,378) while at the same time leading to significantly poorer outcomes of functional disability by 9 points (95% CI 1;16) and a tendency for a reduced gain in quality-adjusted life years by -.04 (95% CI -.11;.03). The overall probability for the fast-track strategy being cost-effective does thus not reach 10% at conventional thresholds for cost-effectiveness.

DISCUSSION: The net societal benefit of early initiation of rehabilitation after lumbar spinal fusion was found to be negative. The uncertainty of this result did not seem to be sensitive to methodological issues, and clinical managements who have already adapted fast-track rehabilitation strategies have reason to reconsider their choice.

O37

EPIDEMIOLOGY OF LUMBAR CANAL STENOSIS: A POPULATION-BASED STUDY IN JAPAN

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INTRODUCTION: The purpose of this study was to clarify the incidence of leg symptoms such as pain and numbness, and the lumbar spinal stenosis (LSS) estimated by the LSS diagnostic supporting tool (Konno S et al: BMC Musculoskelet Disord, 2007) in a random sample of all registered residents of Japan between the ages of 40-79 years.

METHODS: The local ethics committee approved this research. Subjects were selected using a 2-stage, stratified, random sampling. Each of the 9 geographic regions of Japan was divided into strata according to 5 categories of population density. Each stratum was assigned a number of sampling areas, which reflected the distribution of population as recorded in the 2010 national census. The total number of potential participants was 4400. Trained employees of a survey research company went to the potential participants' homes, delivered the questionnaires, and returned within 2 weeks to collect the completed questionnaires. From the questionnaire, people with LSS peculiar leg symptoms such as pain and numbness were identified. In these people, the persons showing 13 points or more in the LSS diagnostic supporting tool were suspected as having LSS.

RESULTS: Responses were received from 2666 people (60.6%). The average age was 60.6±10.9 years, and 47.4% (1264) were men. The LSS peculiar leg symptoms were seen in 500 people (18.1%). People suspected as having LSS were 153. The incidence of LSS was 5.7% with no difference between men and women, although the incidence increased with age. Over 10% of patients between 70-79 years old had LSS. There were no significant differences in the incidence of LSS between geographic re-

gions, or between categories of population density. When standardizing the number according to the distribution of population as recorded in the 2010 national census, 3650000 people are suspected as having LSS in Japan.

DISCUSSION: This is the first report of nationwide epidemiologic research for LSS incidence.

O38

THE PREVALENCE OF RADIOGRAPHIC LUMBAR SPINAL STENOSIS AND ITS ASSOCIATED CLINICAL SYMPTOMS IN A POPULATION-BASED COHORT: THE WAKAYAMA SPINE STUDY

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INTRODUCTION: Little information is available regarding the epidemiology and prevalence of radiographic lumbar spinal stenosis (LSS) in the general population. In addition, it is well known that many subjects with radiographic LSS are asymptomatic, but the prevalence of symptomatic subjects among those with radiographic LSS is not known. The purpose of this study was to clarify the prevalence of radiographic LSS and its associated clinical symptoms in a population-based cohort.

METHODS: In this cross-sectional study, 938 participants (men/women, 308/630; mean age, 67.3 years, range, 40–93 years) from the Wakayama Spine Study were examined, and MRI was performed on them on the same day. The severity of radiographic LSS including central stenosis was assessed by qualitative measurements and rated on a 4-grade scale. The diagnostic criteria for clinical symptoms were based on the LSS definition as per the North American Spine Society (NASS) guidelines.

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RESULTS AND DISCUSSION: In all, 77.9% (731/938) of the participants had more than moderate central stenosis and 30.4% (285/938) had severe central stenosis. The prevalence of symptomatic persons was 12.9% (94/731) among those with moderate or severe stenosis, 17.5% (50/285) among those with severe stenosis, 16.1% (25/155) among those with severe single stenosis, and 19.2% (25/130) among those with severe multiple stenoses. There was no significant difference in the prevalence of symptoms in persons with single vs. multiple stenoses. ($p = 0.47$, Chi-square test) In conclusion, although radiographic LSS was prevalent in our cohort resembling the general Japanese population, related clinical symptoms were rather uncommon.

O39

PREVALENCE AND DISTRIBUTION OF INTERVERTEBRAL DISC DEGENERATION IN THE SPINE IN A POPULATION-BASED COHORT: THE WAKAYAMA SPINE STUDY

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INTRODUCTION: Intervertebral disc degeneration (IDD) is known to be an indicator of degenerative spinal change and is typically followed by gradual osteophyte formation, disc narrowing, and spinal stenosis. However, the prevalence of IDD and its distribution along the spine are unknown. We aimed to describe the prevalence and distribution of IDD in the spine by using magnetic resonance imaging (MRI) in a population-based cohort and examine IDD-related factors at each spinal level.

METHODS: Out of the 1011 subjects who participated in the Wakayama Spine Study (a population-based cohort established in 2008), 975 residents (men, 324; women, 651) were included in this study. The degree

of disc degeneration on MRI was classified on the basis of Pfirrmann's classification system, and cases showing "multilevel disc degeneration" were defined by the existence of 2 or more degenerative discs in the cervical, thoracic, and lumbar spinal regions, respectively.

RESULTS: The prevalence of IDD was the highest at C5/6 (men: 51.5%, women: 46%), T6/7 (men: 32.4%, women: 37.7%), and L4/5 (men: 69.1%, women: 75.8%) in the cervical, thoracic, and lumbar regions, respectively. In addition, a high prevalence of IDD was found near the apex of each curvature. Age was significantly related to the prevalence of multilevel disc degeneration in each region. The prevalence of multilevel disc degeneration in the cervical region was significantly higher in men ($p < 0.005$; $p = 0.83$ and 0.95 , respectively, for the thoracic and lumbar regions). BMI significantly influenced multilevel disc degeneration in the thoracic region ($p < 0.0001$).

DISCUSSION: IDD prevalence was the highest near the apex of each curvature in the cervical, lumbar, and thoracic regions. This could be due to the distribution of compressive forces. Furthermore, gender significantly influenced cervical IDD and BMI influenced thoracic IDD.

O40

THE PREVALENCE OF CONCOMITANT OSTEOPOROSIS AND LUMBAR SPINAL STENOSIS AND ITS ASSOCIATION WITH LOW BACK PAIN AND HEALTH-RELATED QUALITY OF LIFE

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BACKGROUND: Lumbar spinal stenosis (LSS) and osteoporosis (OP) are both important clinical conditions that affect elderly persons. However, little is known about the coexistence of these disorders. The purpose of this study was to investigate the prevalence of concomitant OP and LSS, and its association with low back pain and health-related quality of life (QOL) in a population-based cohort.

METHODS: This cross-sectional study was performed as part of a large-scale population-based cohort study in Japan. A total of 1,011 residents (335 men, 676 women, mean age 66.1±13.3 years) were recruited. We assessed the magnetic resonance images (MRI) of the entire spine, bone mineral density (BMD), visual analog scale (VAS) for low back pain, health-related QOL (SF-8), and neurological status. Femoral neck OP, vertebral compression fractures (VCF) at T9–L5 and symptomatic LSS were diagnosed. Descriptive statistics and multivariate statistics were used for analysis (significance level, 0.05).

RESULTS: The prevalence of OP was 15% (49/326) and 31% (202/650) in men and women, respectively. The prevalence of VCF (all were old fractures) was 36% (113/316) in men and 35% (224/631) in women. Multiple (>2) VCF were present in 17% of men (55/316) and 20% of women (126/631), and LSS was present in 10% of men (33/326) and 9% of women (61/653). The prevalence of these conditions significantly increased with age. In the LSS-affected men and women, the prevalence of concomitant OP was 15% (5/33) and 44% (27/61), respectively. Multivariate statistics showed aging alone to be a related factor in the physical component summary scale of SF-8. Factors that were

strongly associated with VAS were aging ($\beta = 0.19$), male gender (3.21), multiple VCF (3.29), and LSS (16.60).

DISCUSSION: This study revealed the prevalence of concomitant OP with LSS. LSS and multiple VCF are both associated with low back pain but did not affect the health-related QOL in the population-based cohort.

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THE FATE OF PROSPECTIVE SPINE STUDIES POSTED ON CLINICALTRIALS.GOV

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INTRODUCTION: Research ethics concerns include withholding study results. ClinicalTrials.gov is available for posting clinical trials, originally created to help patients find trials for treatment. The internationally used site offers basic study information (enrollment goal, study design, outcome measures, protocol changes, etc.). The purpose of this study was to investigate the fate of spine-related studies posted on ClinicalTrials.gov, particularly the publication rate of completed trials.

METHODS: ClinicalTrials.gov website was searched for trials on these common spine conditions: herniated disc, degenerative disc, stenosis, and spondylolisthesis. For studies completed more than 18 months prior to this review, literature searches were conducted to determine publication status.

RESULTS: ClinicalTrials.gov searches found 263 spine-related studies classified on the site as: 72 completed, 70 active, not recruiting (in follow-up), 74 recruiting, 11 recruiting by invitation, 13 not yet recruiting, 18 terminated, 4 withdrawn, and 1 suspended. Among 72 completed trials, only 21 were posted before initiation or shortly after. Studies posted long after initiation were excluded from publication analysis due to potential bias in posting. Of 21 completed trials, 8 (38.1%) were published. Mean time

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to publish was 2.1 yrs after study completion. Publication rate did not vary by country of study origin, but was lower for industry-sponsored trials.

DISCUSSION: The 38.1% publication rate for spine trials appears low, but is similar to 22.8% for arthroplasty (Smith, *J Arthropl*, 2012) and 43.2% for trauma (Gandhi, *BMC Musculo Disord*, 2011). ClinicalTrials.gov provides patients information and allows tracking publications rates, protocol changes, matching of outcome measure reported to those collected, etc. and raise questions about not publishing what appear to be well-designed trials. Posting studies before initiation can increase transparency and evaluation of spine trials.

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WHAT SCORE ON THE OSWESTRY DISABILITY INDEX INDICATES A SATISFACTORY SYMPTOM STATE?

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INTRODUCTION: The achievement of a given change-score, e.g. a 15-point reduction on a 0-100-scaled instrument, is often used to indicate clinically-relevant change after spine surgery. However, the achievement of such a change 1) depends on the initial pre-operative score and 2) does not indicate whether a satisfactory symptom state is ultimately reached. The achievement of an absolute score equivalent to a satisfactory symptom state may be a more stringent measure of success; we quantified this score for the Oswestry Disability Index (v2.1).

METHODS: 532 patients undergoing lumbar spine surgery completed the ODI and the Core Measures Outcome Index (COMI) at various times up to 4y after surgery. The

COMI item: “if you had to spend the rest of your life with the symptoms you have right now, how would feel about it?” was responded to on a 5-point Likert scale from “very satisfied” to “very dissatisfied”. Two receiver operating characteristics (ROC) analyses were used to derive cut-off scores for ODI that best predicted being 1) at least “satisfied” and 2) “very satisfied” with the symptom state.

RESULTS: 114/532 (21%) patients were “≥satisfied” and 43 (8%) “very satisfied” with their symptom state. The ROC area under the curve was 0.89 (95% CI, 0.86-0.92) for “≥satisfied” and 0.94 (95% CI, 0.92-0.96) for “very satisfied” indicating the ODI discriminated well. The ODI-score cut-off predicting a “≥satisfied state” was ≤ 29 points (sens, 88% and spec 75%) and a “very satisfied state”, ≤ 14 points (sens, 86% and spec 89%).

DISCUSSION: Whilst change scores show the achievement of improvement after surgery, they may give a more optimistic view than when the proportion of patients achieving a satisfactory state is examined. In the absence of valid “norm values” for condition-specific questionnaires, the % patients reaching an ODI score equivalent to a satisfactory/very satisfactory state might represent a more appropriate criterion when assessing the success of surgery.

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ADVERSE EVENTS IN SPINE SURGERY: A 9 MONTH PROSPECTIVE ANALYSIS

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INTRODUCTION: Studies on spine adverse events have typically been retrospective and have utilized hospital administrative data. Street et al prospectively identified a high rate of postoperative complications by utilizing the SpineAdVerse Events Severity

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system AE (SAVES V2) abstraction tool. Our objective is to determine the incidence, severity and effect on length of hospital stay (LOS) for adverse events (AEs) for patients undergoing spine surgery at an American university.

METHODS: AE data were prospectively collected by a nurse practitioner daily for nine months using SAVES V2 AE form. The severity of each AE was graded and estimated effect on LOS was calculated. We calculated the total number of AEs, average number of AEs per patient, the incidence of AEs and each severity grade, and the estimated effect on LOS.

RESULTS: 91% (561/613) of patients were recorded in the AE database. 60% of patients experienced at least one AE (478 total AEs). Of patients with at least one AE, the average number was 1.43 (range 1-5). The incidence of intraoperative complications was 3.4%. The incidence of postoperative adverse events was 60% (pain control, 26.4%; pneumonia, 3.4%; delirium, 1.8%; wound complications, 7.6%). Of the patients who had at least one AE, 21% had no effect on LOS, 49% had 1-2 day increase in LOS, 20% had 3-7 day increase in LOS, and 10% had 8 day or longer LOS. Of the total number of documented AEs, 126 were grade 3 or 4 (26%)-requiring either return to OR or ICU care, 3 were grade 6 (0.6%)-mortality.

DISCUSSION: Spine surgeries are associated with a high rate of perioperative adverse events. Increased LOS and increased level of care affect patient outcomes and overall hospital costs. This study will help define our current baseline of AEs will aid in development of protocols for preemptive management.

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ANALYSIS OF PROSPECTIVE MULTICENTER SURVEILLANCE DATA ON SPINE SURGERY SURGICAL SITE INFECTION

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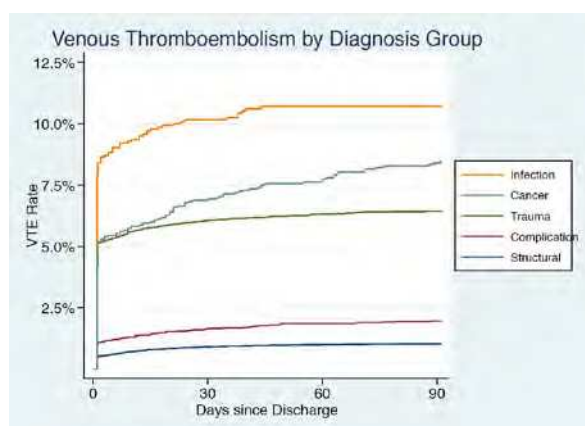
INTRODUCTION: Surgical site infection (SSI) is a significant complication of spinal surgery. SSI leads to higher morbidity, higher healthcare costs, and poor patient outcomes. The accurate identification of risk factors is essential in developing strategies to prevent these potentially devastating infections. Collection and analysis of SSI data in a multicenter prospective study may lead to the identification of reliable risk factors.

METHODS: We performed a prospective study of patients who underwent spinal operations at 11 hospitals between July 2010 and June 2012. Clinical and surgical

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data were collected through electronic databases.

RESULTS: In 4166 procedures, 58 patients (1.4%) were found to have a SSI, with 42 having a deep infection. Cefazolin was the most frequently used prophylactic antibiotic (3831 patients). Staphylococcus was the predominant pathogen (60.3%; methicillin-sensitive staphylococcus aureus in 12 patients, methicillin-resistant staphylococcus aureus in 10, and coagulase-negative staphylococcus in 14). There was no statistically significant difference in the incidence of SSI between cervical and thoracolumbar surgery. The incidence of SSI was 18/2081 (0.86%) in posterior decompression surgery, 36/1567 (2.3%) in posterior fusion surgery, and 3/26 (11.5%) in single-stage anterior and posterior fusion surgery. SSI occurred in each of these 3 groups but did not occur in anterior spine surgery (0/160). Statistically significant ($p < 0.03$) patient risk factors for infection included an ASA score of > 1 , diabetes with insulin use, and steroid use. Long operation times, large blood loss, and unclean operating rooms were significant surgical risk factors.



DISCUSSION: The incidence of SSI tends to increase with more invasive surgery and the utilization of spinal instrumentation. The risk factors identified in this study may allow us to design protocols to decrease the risk of SSI.

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VENOUS THROMBOEMBOLISM AFTER SPINE SURGERY

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INTRODUCTION: Deep vein thrombosis and pulmonary embolism are serious complications that can occur after spine surgery. Current literature on this topic does not address the heterogeneity of spine procedures, is underpowered, and may inaccurately measure the true VTE rate due to methodological design. This study measured the VTE rate while addressing the potential weaknesses on this topic in the current literature.

METHODS: We used administrative databases from California and Florida from 2005 through 2010, which contain 100% of patient records, and can track patient utilization of inpatient hospitalization, ambulatory surgery, and the emergency department. We identified patients who received spine decompression or fusion using procedure codes. Patients were grouped by primary diagnosis (1) structural (scoliosis, stenosis, spondylolisthesis), (2) complication of prior spine surgery, (3) trauma, (4) infection, and (5) cancer. Patients were tracked for a diagnosis of VTE during the index hospitalization or within 90 days of discharge.

RESULTS: We identified 363,825 patients who underwent a spine procedure (36.9% decompression alone, 63.1% fusion). The overall rate of VTE was 1.32%, but there was significant variation depending on primary diagnosis (Figure 1). Overall 52.8% ($n=2541$) of events occurred during the index hospitalization; 47.2% ($n=2270$) occurred after discharge, of which almost half were diagnosed at a different hospital than where the index spine surgery was performed. Revision procedures, multiple procedures during one admission, spine location, and surgical approach each showed

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independent risk for VTE.

DISCUSSION: The strengths of this study are the large patient population and the ability to identify VTE events that occurred outside the original hospital. We found significant differences across primary diagnosis. Detailed information from this study may help risk stratify spine surgery patients regarding the use and timing of chemoprophylaxis.

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IS SURGICAL SPECIALTY ASSOCIATED WITH 90-DAY RE-OPERATIONS FOLLOWING LUMBAR SPINE FUSION? FINDINGS FROM MEDICARE

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INTRODUCTION: Lumbar spine fusions are high-risk procedures that may be performed by orthopedic, neuro-, and spine surgeons. Little is known about whether rates of complication vary by surgical specialty. We aimed to identify differences in 90-day re-operations and counts of lumbar spine fusions by surgical specialty. We used a retrospective claims-based cohort of Medicare patients undergoing fusions.

METHODS: We examined Medicare Part A (inpatient) claims for patients 65+ in 2003 and 2004, with a 1-year look-back period and follow-up data until 2009. We used an ICD-9-CM and CPT coding algorithm for surgery definitions and exclusions. Additional variables were linked from Medicare Part B, Medicare denominator files, American Medical Association, and American Hospital Association data. The operating surgeon was defined as an orthopaedic, neuro-, or spine surgeon. A secondary analysis placed the spinal surgeons into their initial specialty of orthopaedic or neurosurgeons. We adjusted for hospital and other factors using clustered robust standard errors.

RESULTS: In 2 years, 87,121 index lumbar

fusions were performed. After removing beneficiaries based on exclusion criteria, our data comprised 40,735 lumbar spine fusions. Orthopaedic, neuro-, and spine surgeons performed 15,097 (37.1%), 15,487 (38.0%) and 10,151 (24.9%) respectively. When not considering spine surgeon status, orthopaedic and neurosurgeons performed 57.6% and 42.4% of fusions. 867 beneficiaries (2.1%) underwent a re-operation. Surgeon specialty was not associated with re-operations following a lumbar fusion. However, increasing years from medical school graduation were associated with lower rates of re-operation, with beneficiaries using older surgeons less likely to have a re-operation (OR 0.69, 95% CI 0.50 – 0.95, P = 0.02).

DISCUSSION: Surgical specialty was not associated with 90-day re-operations following lumbar spine fusion using Medicare data. Older surgeons were associated with fewer re-operations.

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COMPLICATIONS OF ANTERIOR AND POSTERIOR LUMBAR FUSION WITH BONE MORPHOGENIC PROTEINS

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INTRODUCTION: The use of bone morphogenic proteins (BMP) as an adjunct to spinal fusion has increased since FDA approval in 2002. The incidence of post-operative complications with the use of BMP is not well characterized after lumbar fusions. A population-based database was analyzed with regards to patient demographics, costs, complications, and mortality.

METHODS: Data from the Nationwide Inpatient Sample database was obtained from

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2002-2009. Patients undergoing 1-2 level anterior or posterior lumbar fusion (ALF/PLF) for degenerative etiologies were identified and separated into cohorts ("BMP" and "No BMP"). Patient demographics (e.g. age, gender), co-morbidities, hospitalization days, costs, complications, and mortality were assessed. Student T-test and χ^2 -test were used to assess for significant differences. A p-value of <0.0005 was used to denote significance.

RESULTS: A total of 18,554 ALFs and 160,970 PLFs were identified from 2002-2009. 51.7% of ALFs and 34.1% of PLFs utilized BMP (Table 1). Patients receiving BMP in both surgical groups were significantly younger with less co-morbidities ($p < 0.0005$). Both surgical groups had short-

er hospitalizations and greater costs when BMP was utilized ($p < 0.0005$). The average hospital cost increased by \$1,038 with BMP in ALFs and increased \$5,271 in PLFs. Both surgical groups with BMP utilization experienced significantly lower infection rates ($p < 0.0005$).

	ALF			PLF		
	No BMP	BMP	p-value	No BMP	BMP	p-value
Count	8,967	9,587		106,104	54,866	
Frequency (%)	48.1	51.7		65.9	34.1	
Age	48.0	46.5	<0.0005	56.5	55.9	<0.0005
%Female	54.1	55.1	0.17	56.5	56.0	0.82
CCI	1.77	1.50	<0.0005	2.61	2.34	<0.0005
LOS (days)	4.2	3.5	<0.0005	4.0	3.9	<0.0005
Costs	\$24,318	\$25,356	<0.0005	\$22,380	\$27,651	<0.0005
Complications (per 1000)	52.0	42.4	<0.0005	49.3	46.1	0.004
Pulmonary Embolism	2.0	1.7	0.58	2.1	2.0	0.50
DVT	7.6	4.1	0.002	2.9	2.4	0.25
Infection	15.9	7.6	<0.0005	5.9	4.2	<0.0005
Cardiac (M.I.)	7.8	6.5	0.38	7.8	7.3	0.38
Hemorrhage/Hematoma	14.6	10.3	0.008	11.3	11.3	0.88
CSF Leak	0.7	0.2	0.18	1.9	1.4	0.49
Neurologic	2.6	1.8	0.08	7.3	6.9	0.22
Post-op Urinary	0.8	0.5	0.02	0.5	0.4	0.60
Mortality (per 1000)	1.8	1.1	0.188	1.1	0.8	0.088

er hospitalizations and greater costs when BMP was utilized ($p < 0.0005$). The average hospital cost increased by \$1,038 with BMP in ALFs and increased \$5,271 in PLFs. Both surgical groups with BMP utilization experienced significantly lower infection rates ($p < 0.0005$).

DISCUSSION: Our results confirm that BMP is commonly used in lumbar fusions. Patients in the BMP cohorts incurred greater in-hospital costs despite having shorter hospitalizations, which may be attributed to the direct cost of BMP. Interestingly patients receiving BMP had fewer infections. This study cannot definitively determine whether use of BMP, a healthier patient population, or other factors were responsible for the decreased infection rate. Further investigations are needed determine if utili-

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POST-TRAUMATIC STRESS SYMPTOMS FOLLOWING ELECTIVE LUMBAR ARTHRODESIS ARE ASSOCIATED WITH REDUCED CLINICAL BENEFIT

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INTRODUCTION: Post-operative Post-traumatic Stress Disorder (PTSD) symptoms can occur among elective lumbar fusion patients. While adverse impact of pre-operative depression and psychiatric distress has been described, no reports have assessed the impact of post-operative PTSD symptoms on clinical outcomes following lumbar arthrodesis. We assessed the impact of post-operative PTSD symptoms on clinical outcomes following lumbar arthrodesis.

METHODS: 73 undergoing elective lumbar spinal arthrodesis patients completed the PTSD Checklist-Civilian version (PCL-C) at 3,6,9 and 12 months post-operatively. Short Form 36 and the Oswestry Disability Index (ODI) were completed pre-operatively and at 12 months post-operatively. Impact of post-operative PTSD symptoms, pre-operative psychiatric diagnoses, and Mental Composite Scores (MCS) on clinical outcome scores and likelihood of reaching Minimal Clinically Important Difference (MCID) for ODI and Physical Composite Score (PCS) was evaluated.

RESULTS: PTSD symptoms were reported in 22% of the cohort, with significantly reduced surgical benefit measured by final ($p < 0.0001$ and $p = 0.003$) and total change ($p = 0.013$ and $p = 0.032$) in ODI and PCS scores, respectively. Likelihood of reaching

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MCID for both ODI and PCS was also reduced for patients reporting PTSD symptoms ($p=0.009$ and $p=0.001$, respectively). Pre-operative psychiatric diagnosis correlated only with final ODI score ($p=0.008$). Pre-operative MCS scores were significantly correlated with final ODI and PCS scores, with total change and likelihood of reaching MCID for PCS, but not for ODI score.

DISCUSSION: Post-operative psychological distress was strongly correlated with reduced clinical benefit among elective lumbar arthrodesis patients, and was a stronger predictor than either major psychiatric diagnosis or pre-operative MCS scores. Efforts to reduce post-operative psychological distress may enhance patient reported clinical outcomes from elective spine surgery.

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ADJACENT SEGMENT DISEASE AFTER INSTRUMENTED POSTEROLATERAL FUSION FOR SINGLE LEVEL DEGENERATIVE LUMBAR SPONDYLOLISTHESIS: IS LOCAL SAGITTAL ALIGNMENT ASSOCIATED WITH ITS DEVELOPMENT?

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INTRODUCTION: Conflicting results have been reported regarding sagittal malalignment as a potential risk factor associated with adjacent segment disease (ASD) after lumbar fusion. In this study, we evaluated the correlation between local alignment at the fused segment and development of ASD after instrumented posterolateral fusion (iPLF) for single level degenerative lumbar spondylolisthesis (DLS).

METHODS: A total of 47 patients who underwent iPLF for single-level unstable DLS were reviewed after a minimum follow-up of 5 years. Radiographic ASD was defined by

a decrease in disc height more than 2 mm, development of sagittal translation more than 8%, or increase in disc range of motion greater than 5 degrees. The patients were divided into 2 groups according to the final local alignment at the fused segment. Group I comprised 30 patients with lordosis, and Group II showed kyphosis (17 patients).

RESULTS: The disc angle at the fused segment eventually became the same as that in the neutral position before surgery. No patient showed local kyphosis exceeding 5 degrees. The incidence of radiographic ASD was as follows: disc narrowing 29.8%, sagittal translation 14.9%, and signs of instability 4.3%. The incidence of these changes was not significantly different between Groups I and II. Symptomatic ASD developed in 2 (4.3%) patients. Only one patient in Group I underwent additional decompression surgery for ASD. There was no significant intergroup difference in the severity of low back pain and functional disability assessed using the Roland-Morris Questionnaire at the final follow-up.

DISCUSSION: The incidence of both radiographic and symptomatic ASD after iPLF was considerably lower than reported rates after posterior lumbar inter-body fusion with cages. The local alignment at the fused segment was not related to the incidence of ASD and clinical outcomes, questioning the need for restoration of local lordosis in a single level fusion for unstable DLS.

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A COMPARISON OF BIOFILM FORMATION IN VARIOUS METAL MATERIALS

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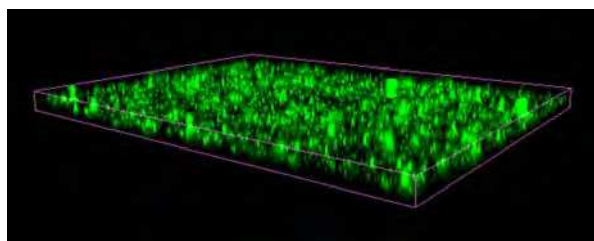
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INTRODUCTION: Implant-associated infection (IAI) caused by biofilm formation is serious complication after surgery. Especially, metal materials have been widely used in the field of the spinal reconstruction surgery. In spite of the prevalence of advanced precaution and treatment for IAI, little is known about the pathogenesis of IAI. The purpose of this study was to evaluate bacterial adhesion and quantify the biofilm formation on various metals in vitro.

METHODS: Metal plates including stainless (ST), pure titanium (TI), titanium alloy (TA) and cobalt chrome (CC) of 10mm diameter and 2mm thickness in size were prepared. Each metal was incubated in TSB culture medium including *Staphylococcus aureus* (*S. aureus*) (1×10^8 CFU/ μ l) for 3, 12, 24 hours at 37°C. Bacterial adherence to the metallic plates was quantitatively analyzed using LIVE/DEAD BacLight fluorescence (LD) staining. The density and the thickness of biofilm on each metal at each time point were calculated (N=5, 10). In addition, the biofilm configuration on the metal was observed through a scanning electric microscope (SEM).



RESULT: Adherence of *S. aureus* was found at 1 hour after the incubation and biofilm was detected on all metals at each time

point by fluorescence microscope and SEM. The average of the density and thickness of each metal at three time points were shown as TA > SS > TI > CC ($p < 0.005$). Biofilm increased with time gradually in all metals ($p < 0.05$). The density and the thickness of biofilm on TA were significantly approximately 1.5 times higher and thicker than those observed on CC ($p < 0.005$).

DISCUSSION: In the present study, bacterial adherence and biofilm were observed on the surface of each metal at early phase. TA, which has frequently been used, presented with significantly higher *S. aureus* adhesion compared to SS, TI, and CC. Therefore, it is suggested that adherence of *S. aureus* on the metal during the surgery may be associated with the incidence of IAI.

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PREDICTORS OF FAILURE OF NONOPERATIVE MANAGEMENT OF SPINAL EPIDURAL ABSCESES

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INTRODUCTION: Spinal epidural abscess (SEA) is generally treated with urgent surgical decompression. The literature has suggested that antibiotic treatment alone can be successful in select patients. To date, independent variables that predict success of medical management of SEA patients have not been determined.

METHODS: A retrospective, case-control study analyzing the management of SEAs was performed. All hospitalized patients with a SEA from 1993 to 2011 were identified. Patients >18 years old and those with SEA documented by MRI or CT myelogram were included. Those with postsurgical SEAs or spondylodiscitis/osteomyelitis with phlegmon were excluded. Patients with less than 2 months follow-up or with paralysis greater than 48 hours were also excluded.

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Univariate and multivariate analysis were used to identify variables that led to success of medical management.

RESULTS: 355 patients (214 males, 141 females; mean age 60 years) met our inclusion criteria. 142 patients were initially intended to have medical management, 42 of whom were considered failures had surgery. 73 patients were successfully treated medically while 54 failed. Overall mortality for the entire cohort was 8.7% during initial hospitalization and 11.3% within 90 days of admission. *S. aureus* was identified in 78% of cases. Univariate analysis identified age, neurology, diabetes, SEA above the level of the conus medullaris and circumferential abscess as significant risk factors for failure of medical management. Multivariate analysis eliminated spinal level and circumferential abscess.

DISCUSSION: SEA treated with medical management alone has a high likelihood for failure in at-risk individuals. Age > 65 years, diabetes, MRSA infection and neurologic compromise were independent risk factors for failure. In the absence of these risk factors, medical management has a probability of failure of only 12%.

O52 ISSLS PRIZE - BIOLOGY

LINK PROTEIN PEPTIDE (LPP) STIMULATES CHONDROCYTE MATRIX SYNTHESIS BY HUMAN INTERVERTEBRAL DISC CELLS WITH MINIMAL EFFECT ON OSTEOGENIC GENES.

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INTRODUCTION: Growth factors such as BMP-2 and BMP-7 increase disc matrix production but also significantly increase osteogenic gene expression. Link protein peptide (LPP) is the N-terminal 16 amino peptide of Link Protein. The regulatory ef-

fects of LPP on human disc cells expression of cartilage matrix, catabolic regulators, and bone markers remain unclear. The objectives of this study were to 1) determine the effect of LPP on disc matrix (sGAG, aggrecan, and collagen II) and catabolic regulators (IL-1 β , TNF α , the MMPs, and the ADAMTSs); 2) compare the effect of LPP vs BMP-2 and BMP-7 on bone markers (osteocalcin and alkaline phosphatase).

METHODS: Human nucleus pulposus cells were cultured in alginate beads with a chemically synthesized LPP (25, 50, 100, and 200 ng/ml), negative control peptide, or untreated for three weeks. The levels of aggrecan and collagen II mRNAs were measured by real-time PCR. Sulfated glycosaminoglycan (sGAG) content was assayed using the DMMB method. The protein levels of collagen II and catabolic regulators were determined by ELISAs and Western blots. The relative osteoinductive potential of LPP was evaluated by comparing the effect of LPP, BMP-2 and BMP-7 on in vitro markers of osteoinductivity (osteocalcin and alkaline phosphatase).

RESULTS: LPP upregulates cartilage matrix in a dose-dependent manner to a peak of 150% (aggrecan), 120% (collagen II), and 50% (sGAG) above baseline ($p < 0.05$). LPP inhibits expression of the catabolic regulators IL-1 β and MMP1, and LPP has no effect on the other catabolic regulators TNF- α , ADAMTS1, ADAMTS4, ADAMTS5, MMP3, and MMP9. LPP has no significant increase in osteocalcin or alkaline phosphatase activity in sharp contrast to BMP-2 and BMP-7 which caused increases of over 200% ($p < 0.05$).

DISCUSSION: LPP has desirable properties (increases disc matrix and decreases catabolic regulators without significant osteoinductive effect) which makes it worthy of further investigation.

O53 ISSLS PRIZE -

CLINICAL/BIOMECHANICS

THE ANATOMY OF FAILURE IN LUMBAR DISC HERNIATION - AN IN-VIVO, MULTI-MODAL, PROSPECTIVE STUDY OF 181 SUBJECTS

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INTRODUCTION: Although in-vitro mechanical disruption studies have implicated both the end plate junction and the annulus fibrosus as the site of failure in Lumbar Disc Herniation (LDH), there are no in-vivo human studies to document the exact anatomy of failure. This knowledge is important in understanding the pathology of LDH and developing preventive steps. The present study aimed to document in-vivo, the site of anatomical failure in LDH and validates the findings of the published biomechanical failure studies on the lumbar disc.

METHODS: 181 consecutive patients requiring microdiscectomy at a single level formed the study group. The status of the end plate and annulus fibrosus in the operated level (study discs) and the other discs (control) were evaluated by plain radiograph, thin slice CT, plain and contrast MRI, intraoperative examination and histopathological analysis.

RESULTS: LDH due to End plate Junction Failure (EPJF- Type I herniation) was more common (117; 65%) than annulus fibrosis rupture. Herniated discs had a significantly higher incidence of EPJF than control discs (p <0.0001) The EPJF was evident radiologically as vertebral corner defect in

30 patients, rim avulsion in 46, frank bony avulsions in 24 and avulsion at both upper and lower EP in four. 13 discs with normal EP radiologically had cartilage or bone avulsion intraoperatively. 64 discs (35%) had intact EP of which annular HIZ was found in 21(11%) suggesting a disruption of AF (Type II herniation). Post contrast MRI in 20 patients showed dye leak at the EPJ proving EPJF as main cause of LDH.

CONCLUSION: Our study provides the first in-vivo proof that LDH in humans is more commonly the result of EPJF than AF rupture and offers clinical validation of previous in-vitro mechanical disruption studies. Future research must focus on the EPJ as a primary area of interest in LDH.

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A COMPARISON OF SPINAL FUSION AND NON-OPERATIVE TREATMENT IN PATIENTS WITH CHRONIC LOW BACK PAIN: AN AVERAGE 11-YEAR FOLLOW-UP OF THREE RANDOMIZED CONTROLLED TRIALS

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INTRODUCTION: Chronic LBP (cLBP) is a complex and poorly understood problem and its management represents a major challenge to our healthcare systems. The relative efficacy of surgery over non-operative care for the treatment of cLBP remains controversial, and little is known of the long-term outcomes. This study compared the clinical outcome at long-term follow-up (LTFU) (average 11.4 (range 8-15) years) of patients who were randomized to either spinal fusion or non-operative treatment in three multicentre randomized controlled trials.

METHODS: Participants were 473 patients with cLBP of at least 1 year's duration who

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were all considered candidates for spinal fusion. Treatment comprised lumbar spine fusion (instrumented or non-instrumented) or non-operative treatment (multidisciplinary cognitive-behavioral and exercise rehabilitation program). The primary outcome was the Oswestry Disability Index (ODIv2.1a) score measured at LTFU. Secondary outcomes included VAS pain scales, pain frequency, pain medication use, work status, quality of life (EQ-5D), satisfaction with care, and global treatment outcome.

RESULTS: 140/242 patients randomized to receive surgery and 121/231 randomized to receive non-operative care were available for LTFU. The intention-to-treat analysis showed no statistically or clinically significant differences between treatment groups for ODI scores at LTFU (adjusted for age, sex, smoking habit, previous surgery, duration of LBP and baseline ODI): the mean adjusted treatment effect of fusion was -1.4 points on the 0-100 ODI scale (95% confidence interval, -6.2 to 3.4). An as-treated analysis similarly demonstrated no advantage of surgery (treatment effect, -0.6 points on the ODI (95% CI, -5.8 to 4.5). There were no significant group differences for any of the adjusted values for the secondary outcomes.

DISCUSSION: After an average of 11 years follow-up, there was no difference in patient self-rated outcomes between fusion and non-operative treatment for cLBP. The results suggest that, given the increased risks of surgery and the lack of deterioration in non-operative outcomes over time, the use of lumbar fusion in cLBP patients should not be favored in healthcare systems where combined physical and psychological programs are available.

O55

NUTRITIONAL STATUS IN PATIENTS UNDERGOING ELECTIVE SPINE PROCEDURES

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INTRODUCTION: Poor nutritional status can have an effect on the overall recovery of patients undergoing major orthopedic procedures. Studies have estimated the rate of malnutrition to be 50% in surgical patients. Nutrition markers can help assess nutritional status and stratify risk. There is limited data on these markers in patients undergoing spine surgery. Our goal is to establish baseline nutritional data in a spine surgery population.

METHODS: This is a prospective cohort study involving a consecutive series of patient undergoing elective spine procedures in a one month period. Serum prealbumin and albumin levels were drawn on all patients in the post-operative period.

RESULTS: Nutrition markers were collected in 73 patients (48 female, 25 male; average age 53.2, range 25-93). All were elective cases including 61 degenerative, 9 deformities, 2 traumas, and 1 tumor. Average BMI of this cohort was 28.2 (range 14.6-46.4). Average albumin level was 3.2 g/dL (range 2.2-4.5 g/dL) with 76% of patients had level < 3.5 g/dL and 30% <3.0 g/dL. There was a statistical difference in age (55.2 vs. 47, $P<0.05$) between patients with levels >3.5 g/dL and <3.5 g/dL but not in BMI (28.5 vs. 27.24, $P=0.2$). Average prealbumin level was 19.8 mg/L (range 7-35 mg/L) with 33% of patients < 18 mg/L, 14% 11-15 mg/L, 4% <11 mg/L. Statistical difference in age was found between patients with prealbumin <18 mg/L and >18 mg/L (59.8 vs. 50.2, $P<0.05$) but not BMI (28.5 vs. 27.8, $P=0.3$).

DISCUSSION: Our study found 76% of patients with low albumin levels with 30% malnourished (<3.0g/dL). Based on prealbumin risk stratification by Bernstein

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et al, 14% of patients (11-15 mg/L) were at increased risk of morbidity and mortality and 4% at significant risk (5-10.9 mg/L). This highlights a potentially modifiable risk factor for patients undergoing elective spine surgery. This study may provide a basis for future clinical evaluation and preemptive treatment before surgery.

O56

LONG-TERM EVALUATION OF RE-OPERATION RATES FOR LUMBAR TOTAL DISC REPLACEMENT AND FUSION: ANALYSIS OF 1,237 PATIENTS

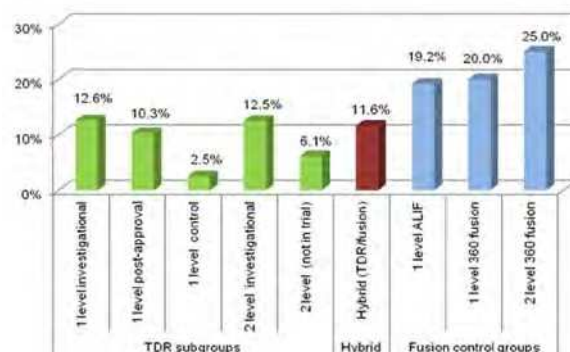
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INTRODUCTION: Re-operation rates are important in evaluating spine surgery. The purpose of this study was to analyze re-operations in a large consecutive series of TDR patients, beginning with the first case, and compare it to fusion procedures performed as part of randomized, prospective trials.

METHODS: Analysis was conducted on a database of all TDRs performed at a spine center participating in 5 trials, beginning in March 2000, and also used TDRs post-approval. TDR patients were divided into subgroups based on number of levels operated and those randomized to a TDR investigational group, randomized to TDR as control group, or received TDR post-approval. Fusion patients were randomized to anterior lumbar interbody fusion (ALIF) or 360 fusion control groups in TDR trials. Patients with combined TDR/fusion hybrids were also included. Patients operated less than 24 months prior to this report were excluded. The longest follow-up was 134 months. Patient selection criteria were similar in all studies with a primary indication of painful disc degeneration unresponsive to mini-

mum 6 months non-operative care. All re-operations were reported including those for wound infection and spinal cord stimulator implantation.



RESULTS: Re-operation rates were 10.4% (110/1,058) for TDRs; 11.6% (13/112) in hybrids, and significantly higher in fusions, 20.9% (14/67; $p < 0.05$). Re-operation rates in the TDR subgroups were not significantly different (see figure). Age, gender, body mass index, or number of levels operated were not related to re-operation ($p > 0.20$). To evaluate the timing of re-operations, the 343 patients with minimum 60 month follow-up were analyzed separately. In fusion and TDR groups, re-operation occurred most often within 24 months, with a re-operation rate of $< 5\%$ after 60 months.

CONCLUSION: TDR had a significantly lower re-operation rate than fusion. TDR re-operation rate did not vary with study status or post-approval, nor increase with long-term follow-up.

O57

THE IMPACT OF DIFFERENT HEALTH DIMENSIONS ON OVERALL QUALITY OF LIFE RELATED TO KYPHOPLASTY AND NON-SURGICAL MANAGEMENT

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OBJECTIVE: The objective was to quantify the impact of different health dimensions on overall quality of life using the patient reported outcome measurements (PROMs) collected in the Fracture Reduction Evaluation (FREE) trial.

MATERIALS AND METHODS: The analysis was based on the patients included in the two year long randomised controlled Fracture Reduction Evaluation (FREE) trial that studied the efficacy and safety of balloon kyphoplasty (BKP) compared to non-surgical management (NSM). The PROMs included in the FREE trial was EQ-5D, SF-36, VAS-pain and the Roland-Morris Disability Questionnaire (RMDQ). The quality adjusted life year (QALY) improvement over two years was calculated by assuming that improvements over the baseline utility were solely due to treatment received. The dimensional contribution to the overall QALY was analysed by isolating the impact each dimension has on quality of life. A correlation analysis of the quality of life improvement was performed to investigate the relationships between the four instruments.

RESULTS: The contributions (%) to the QALY gained of BKP vs. NSM from changes in each EQ-5D dimension are shown in figure 1. Changes in pain explained 60% of the QALY gained of BKP vs. NSM followed by mobility, self-care and usual activities (EQ-5D dimensions). The results also indicate that health dimensions capturing the mental state do not seem to be an important factor for the QALY gained in this osteoporotic population. The SF-36 dimensional analysis showed similar results. The correlation analysis showed that the correlation of VAS-pain, RMDQ and QALY improvement were relatively weak.

CONCLUSIONS: Changes in the pain dimension of health are the most important driver

for overall quality of life in patients treated with BKP or NSM. However, ignoring the impact of other dimensions would lead to an underestimation of the actual improvement in overall quality of life.

O58

THE APPROPRIATENESS OF SURGERY FOR LUMBAR DEGENERATIVE SPONDYLOLISTHESIS

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INTRODUCTION: Spine surgery rates are increasing worldwide, but there is little consensus on many indications for surgery. With an aging population, more patients with lumbar degenerative spondylolisthesis (LDS) will present for surgery. We developed criteria for the appropriateness of surgery (AoS) in LDS, using the RAND-UCLA Appropriateness Method (RAM).

METHODS: The risks/benefits of treatment were summarised in a systematic review. Clinical scenarios comprising combinations of signs, symptoms and other clinical parameters in LDS were then generated. The AoS for decompression only (D), decompression with fusion (F), and decompression with instrumented fusion (IF) for each scenario was rated on a 9-point scale by 13 international, multidisciplinary experts; AoS for each scenario was "appropriate", "uncertain" or "inappropriate", based on the median ratings and disagreement.

RESULTS: 744 hypothetical scenarios were generated; overall, surgery was considered appropriate in 27% (16% when considering only F and IF), uncertain/equivocal in 41% (43%) and inappropriate in 31% (41%). Frank disagreement was low (7% of scenari-

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os). For the category “back pain (LBP) only and no instability”, experts were reticent to consider any surgery (appropriate in only 7% of scenarios); with instability, the AoS (most often IF) increased slightly (12%), mostly for severe disability. For “radicular pain without LBP (\pm instability)” surgery was appropriate in 29% of the scenarios. AoS (especially IF) was markedly reduced for all categories when psychosocial “yellow flags” were present. Surgeons gave significantly higher AoS ratings than physiatrists/rheumatologists ($p < 0.05$) for most categories.

DISCUSSION: For the first time, a multidisciplinary/international panel of experts has developed AoS criteria for LDS using a validated, standard method (RAM); this should facilitate their wide acceptance. The validity of the criteria should be further evaluated, prospectively, in the clinical setting.

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FIVE-YEAR FOLLOW-UP OF A PROSPECTIVE, RANDOMIZED FDA IDE TRIAL COMPARING TWO LUMBAR TOTAL DISC REPLACEMENTS: CLINICAL OUTCOME AND SERUM ION LEVEL ANALYSIS FOR A METAL-ON-METAL DEVICE

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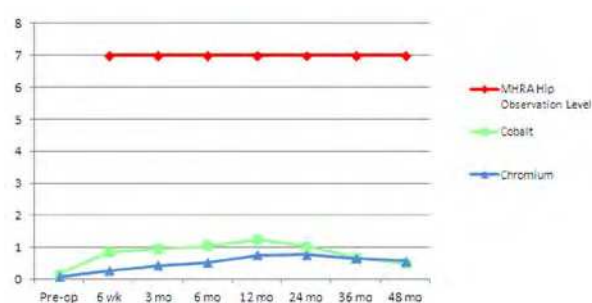
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INTRODUCTION: At 24-month follow-up in this prospective, randomized FDA IDE trial comparing two lumbar total disc replacements (TDR)s, both groups improved significantly, with no significant differences between them. The purpose of this study was

to compare the outcomes at 5-year follow-up and report the 4-year results of serum ion level analysis in a subgroup of patients receiving a metal-on-metal implant.

METHODS: The study included 204 patients receiving Kineflex-L (Investigational) and 190 receiving Charité (Control). In 32 Investigational patients, blood samples were evaluated for serum ion levels of cobalt and chromium, with 48-month follow-up available for 20 patients. This was compared to the Medicines and Healthcare Products Regulatory Agency (MHRA) value to merit following total hip replacement patients more closely for potential wear problems.

RESULTS: Mean Oswestry and VAS pain score in both groups improved significantly by 6 weeks and remained improved during 5-yr follow-up (scores in both groups of approximately 60 pre-op vs. 20 at 2 and 5 yr; $p < 0.01$). Approximately 11% of both groups underwent re-operation by 5-year follow-up. Serum ion level analysis in the Investigational group found the greatest mean value at any time during 4-yr follow-up was $< 20\%$ of MHRA recommended minimum value to merit following hip replacement patients more closely for potential wear problems (see Figure).



By 48 months, values were $< 10\%$ of the recommended monitoring threshold.

CONCLUSIONS: This prospective, randomized study comparing 2 TDRs found no significant differences in outcomes during 5-yr follow-up. Both provided statistical improvement by 6 wk follow-up which were maintained. This supports multiple studies

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finding TDR provides significant improvement with stable multi-year outcomes. Although there may be concern about wear in metal-on-metal hip replacements, serum ion levels in TDR patients were well below the recommended threshold level to merit closer monitoring.

O60

7-10 YEAR FOLLOW-UP OF 2-LEVEL PRODISC-L VS. FUSION AT ONE INSTITUTION

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INTRODUCTION: Previously the results of the prospective, randomized multicenter 2-level Prodisc-L versus fusion were reported. This study is the continuation of this FDA study at one institution.

METHODS: A total of 237 patients were treated in a randomized controlled trial designed as a non-inferiority study for regulatory application purposes. Blocked randomization was performed with use of a 2:1 ratio of TDR to circumferential arthrodesis. Clinical results were evaluated from patient derived questionnaires. Roentgenographic results were evaluated independently. Patients at 7-10 years were evaluated by ODI and in some cases, x-ray.

RESULTS: At 24 mos., 58.8% (87) of 148 patients in the TDR group were classified as a statistical success, compared with 47.8% (32) of 67 patients in the arthrodesis group; non-inferiority was demonstrated. The mean Oswestry Disability Index (ODI) in both groups significantly improved from baseline ($p < 0.0001$); the mean percentage improvement for the TDR group was significantly better than that for the arthrodesis group ($p = 0.0282$). At 7-10 years ODI and Visual Analog Pain Scores were maintained

for Prodisc-L. Of 21 2-level Prodiscs there were no revisions of prosthesis or adjacent level surgeries. Of 8 fusions there were 3 revision surgeries at the index level.

DISCUSSION: At 7-10 years 2-level Prodisc-L continued to perform well. Fusion performance diminished in keeping with historical patterns.

O61

POTENTIAL RISK FACTORS OF PERSISTENT LOW BACK PAIN DEVELOPING FROM MILD LOW BACK PAIN IN JAPANESE WORKERS

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INTRODUCTION: Although psychosocial factors are strongly indicated as yellow flags of low back pain (LBP) leading to disability, the association between aggravated LBP and psychosocial factors has not been well assessed in Japanese workers.

METHODS: At baseline, 5,310 participants responded to a self-administered questionnaire including questions about individual characteristics, ergonomic work demands, and work-related psychosocial factors (response rate: 86.5%), with 3,811 respondents completing the 1-year follow-up questionnaire. The target outcome was aggravation of mild LBP into persistent LBP during the follow-up period. Incidence was calculated for the participants with mild LBP during the past year at baseline. Logistic regression was used to explore risk factors associated with persistent LBP.

RESULTS: Of 1,675 participants who had mild LBP during the preceding year, 43 (2.6%) developed persistent LBP during the follow-up year. Multivariate analyses adjusted for individual factors and an ergonomic factor found statistically significant or almost significant associations of the following psychosocial factors with persistent LBP:

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interpersonal stress at work [adjusted odds ratio (OR): 1.96 and 95% confidence interval (95%CI): 1.00-3.82], job satisfaction (OR: 2.34, 95%CI: 1.21-4.54), depression (OR: 1.92, 95%CI: 1.00-3.69), somatic symptoms (OR: 2.78, 95%CI: 1.44-5.40), support from supervisors (OR: 2.01, 95%CI: 1.05-3.85), previous sick-leave due to LBP (OR: 1.94, 95%CI: 0.98-3.86) and family history of LBP with disability (OR: 1.98, 95%CI: 1.04-3.78).

DISCUSSION: Psychosocial factors are important risk factors for persistent LBP in Japanese workers. It may be necessary to take psychosocial factors into account, along with physical work demands, to reduce LBP related disability.

O62

RELATIONSHIP BETWEEN DEPRESSION AND ACUTE LOW BACK PAIN AT FIRST MEDICAL CONSULTATION, THREE, AND SIX WEEKS OF PRIMARY CARE

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INTRODUCTION: Depression and low back pain are among the most common diseases that health practitioners encounter today. They are both related to each other; however, their relationship has not been fully explored, yet. The aim of this study was to test lagged reciprocal effects of depression and acute low back pain across the first weeks of primary care.

METHODS: In a prospective inception cohort study, 221 primary care patients with acute or subacute low back pain were assessed at the time of initial consultation and then followed up at three and six weeks. Key measures were depression measured by the modified Zung Self-Rating Depression Scale and pain assessed by the three sub-

scales (sensory pain, present pain index and visual analogue scale) of the Short-Form McGill Pain Questionnaire.

RESULTS: When only cross-lagged effects of six weeks were tested, a reciprocal positive relationship between pain and depression was shown in a cross-lagged structural equation model ($\beta = 0.15$ and 0.17 , $p < 0.01$). When lagged reciprocal paths at three- and six-week follow-up were tested depression at the time of consultation predicted higher low back pain severity after three weeks ($\beta = 0.23$, $p < 0.01$). Low back pain after three weeks had in turn a positive cross-lagged effect on depression after six weeks ($\beta = 0.27$, $p < 0.001$).

DISCUSSION: Results suggest that reciprocal effects of depression and low back pain depend on time under medical treatment. Depression at first consultation of general practitioners seems to threat successful pain relief during the following three weeks and sustained pain after three weeks of treatment seems to contribute to sustained depression after six weeks. Health practitioners should screen for and treat depression at the first consultation of patients to bring forward the low back pain treatment.

O63

THE RELATIONSHIP OF WORKERS COMPENSATION STATUS, PSYCHOLOGICAL PROFILES, AND CLINICAL OUTCOME: RESULTS OF A PROSPECTIVE, MULTICENTER STUDY

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INTRODUCTION: Multiple studies have found Workers Compensation (WC) patients have less favorable outcomes after spinal surgery than those not receiving this benefit

(Non-WC). Psychological factors are also related to surgical outcomes. The purposes of this study were to compare personality and emotional characteristics of WC patients and Non-WC spine surgery candidates using the MMPI-2-RF and investigate the potential relationship of WC status and psychological factors to clinical outcome after surgery.

METHODS: This prospective study included 112 WC and 241 Non-WC patients who completed presurgical psychosocial screening consisting of a structured interview with a psychologist, psychological testing including MMPI-RF-2, and chart review. Pre- and post-operatively, patients completed the Oswestry Disability Index (ODI) and numerical rating scale (NRS) evaluating pain intensity. Preliminary outcomes reported are at a mean of 4.7 mo follow-up.

RESULTS: Pre-operatively, WC patients had significantly higher scores than Non-WC on MMPI-2-RF scales: low ability to experience positive emotions, cynicism, antisocial behavior, ideas of persecution, and aberrant experiences (e.g., thought disorder, somatic delusions). After surgery, WC patients had increased fearfulness, while Non-WC had less fearfulness ($p < 0.02$). WC patients were significantly more worried and depressed after surgery. The scores were not significantly different before surgery. Improvement in ODI scores was significantly less ($p < 0.01$) in WC compared with Non-WC (change from 48.0 to 43.7 vs. 46.2 to 31.5). WC also had significantly less improved pain scores ($p < 0.01$).

DISCUSSION: This study supports literature reporting reduced surgical outcomes in WC patients. This has often been attributed to WC patients seeking secondary gains. However, WC patients had greater pre-operative scores on multiple MMPI-2-RF scales, suggesting reduced outcomes may be related to psychological issues more prevalent in WC patients.

O64

PSYCHOSOCIAL STRESS IS ASSOCIATED WITH ONSET OF LOW BACK PAIN WITH DISABILITY IN COLLEGE STUDENTS: A LONGITUDINAL STUDY BEFORE AND AFTER THE DISASTER IN FUKUSHIMA

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INTRODUCTION: Few longitudinal studies have examined the likelihood of developing non-specific low back pain (LBP) with a designed psychosocial stressor. All participants were affected by the Great East Japan disaster after initiating our cohort study, which was conducted to assess the association between psychosocial stresses and the incidence, duration, and intensity of non-specific LBP.

METHODS: A longitudinal study was initiated among 188 students in Fukushima Medical University in January 2011. We reviewed LBP characteristics and assessed the psychosocial stress using the Perceived Stress Scale (PSS). A follow-up survey was conducted in July, in which 94 students were analyzed (50% follow-up rate). Students whose PSS scores decreased ≥ 5 points and with total scores ≥ 23 points were defined as the stress-aggravation group (S group, $n=29$); the others were defined as the no-change stress group (N group, $n=65$). The incidence, duration, and intensity of new-onset LBP were evaluated in both groups. Disabilities due to LBP were evaluated using the Brief Pain Inventory (BPI).

RESULTS: No significant differences were observed in gender, body mass index, smoking status, sleep time, past history of LBP, and physical activity between groups. No significant differences were observed in the incidence (37.9% vs. 32.3%), duration (7.7 vs. 6.2 days), and numerical rating scale

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scores (4.4 vs. 3.6) of LBP. However, the incidence of LBP with disability, defined as the fourth BPI score quartile, was significantly greater in the S group than in the N group (24.1% vs. 6.6%; $p = 0.0122$).

DISCUSSION: At 4 months after the disaster, about 30% of students perceived more severe psychosocial stress than before the disaster. Moreover, about 80% of new-onset LBP in students with unchanged stress levels did not cause any disability, while about 60% of new-onset LBP with aggravated stress levels caused disability. Thus psychosocial stress can increase the incidence of LBP with disability.

O65

EFFECT OF PREOPERATIVE FEAR AVOIDANCE BELIEFS (FABQ) ON TWO-YEAR POSTOPERATIVE OUTCOME IN LUMBAR SPINAL STENOSIS (LSS).

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INTRODUCTION: Outcome of surgery for chronic lumbar disorders varies considerably tending to deteriorate over time. There is a need to develop pre-screening tools to assist with patient selection for spinal surgery. Conservatively treated patients' higher FABQ-PA scores have been associated for higher disability, and provoke transition from acute to chronic low back pain.

STUDY DESIGN: Prospective clinical study. The aim of this study was to examine the effect of preoperative fear-avoidance beliefs on postoperative outcome in LSS. To our knowledge there are no previous studies on the effect of preoperative fear-avoidance beliefs on postoperative outcome in LSS patients.

METHODS: Patients (N=102, mean age 63 years) with symptomatic LSS underwent decompressive surgery. Preoperatively pa-

tients completed the Fear Avoidance Beliefs Questionnaire physical activity subscale (FABQ-PA). Physical functioning and pain were assessed with the Oswestry Disability Index (ODI), the Stucki Questionnaire, the Visual Analogue Scale (VAS) and self-reported walking ability. Patients completed the identical set of questionnaires preoperatively and 6-, 12- and 24 months postoperatively.

RESULTS: Preoperative FABQ-PA score was significantly associated with ODI scores of 6- (OR=2.526, $p=0.027$) and 24 (OR=2.979, $p=0.012$) months postoperatively, and with Stucki symptom severity scores 24 months postoperatively (OR=2.464, $p=0.037$).

CONCLUSION: Preoperative FABQ-PA was associated with postoperative disability in surgically treated LSS patients. FABQ-PA needs to be considered in clinical practice as a pre-screening tool in lumbar spine surgery patient selection. There is need for therapeutic interventions, eg cognitive psychotherapy with guided exercise, to impress fear-avoidance beliefs.

O66

DEPRESSION AS A PROGNOSTIC FACTOR OF LUMBAR SPINAL STENOSIS: A SYSTEMATIC REVIEW

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INTRODUCTION: The clinical syndrome of lumbar spinal stenosis (LSS) is one of the most commonly diagnosed lumbar pathologies and is associated with pain and disability. Psychological factors, including depression, also affect these and other health-related outcomes. Yet, the prognostic value of depression specifically in the context of LSS is unclear. The aim of this systematic review was to examine the literature on depression as a prognostic factor of outcomes in patients with LSS.

METHODS: A best-evidence synthesis was conducted, and included articles published between 1980 and May 2012. Each article meeting inclusion criteria, including a longitudinal design, was critically appraised on its methodological quality and validity by two of the authors independently. Only studies that were deemed scientifically admissible by both authors were included in the review.

RESULTS: Among the 19 articles that met the inclusion criteria, 12 were judged to be scientifically admissible and included in the review. All studies pertained to patients who elected surgery. Statistically significant associations were most consistent between preoperative depression and the outcomes of LSS-related symptom severity (pain, numbness, weakness and balance) and disability. The effect size for these associations was substantial, with regression coefficients of 2.30 and -2.01, and adjusted odds ratios ranging from 1.15 to 1.20 (e.g. in the case of the OR of 1.20, an increase of 5 points on a 60-point depression scale doubled the odds of being below the median in LSS-related symptom severity at follow-up). Depression as a predictor of walking capacity and pain severity alone was less consistent.

DISCUSSION: Findings support preoperative depression as an important prognostic factor for postoperative LSS-related symptom

severity (pain, numbness, weakness and balance) and disability at various follow-up points. Depression should be considered in the clinical care of this population.

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MORTALITY AND MORBIDITY FOR OPERATED AND NON-OPERATED VERTEBRAL COMPRESSION FRACTURE PATIENTS (OSTEOPOROTIC AND NON-OSTEOPOROTIC) IN THE U.S. MEDICARE POPULATION

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INTRODUCTION: Lower mortality risk has been reported for vertebral compression fracture (VCF) patients in balloon kyphoplasty (BKP) or vertebroplasty (VP) cohorts than non-surgically managed (NSM) cohorts, but differences in morbidity risks are unclear. We compared the mortality and morbidity risks for NSM, BKP, and VP VCF patients.

METHODS: Survival and morbidity of VCF patients in the 100% U.S. Medicare dataset (2005-2009) was estimated by the Kaplan-Meier method and the differences in outcomes were assessed by Cox regression. Propensity matching analysis was also used to account for potential bias. Subgroup analyses of osteoporotic VCF (OVCF) patients (overall, non-cancer, and those who survived 1+ years post-VCF diagnosis) were also performed.

RESULTS: 1,038,956 VCF patients were identified, including 141,343 BKP patients and 75,364 VP patients. At up to 5 years, the NSM cohort had a higher adjusted risk of mortality than the BKP and VP ones by 55%

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(propensity-matched: 62%) and 25% (propensity-matched: 30%), respectively ($p < 0.001$). The BKP cohort had a 19% (propensity-matched: 17%) lower adjusted risk of mortality than the VP cohort ($p < 0.001$). The NSM cohort had higher adjusted risk of death with pneumonia diagnosed than the BKP and VP cohorts ($p < 0.001$; non- and propensity-matched). The NSM and VP cohorts also had significantly higher risk of pneumonia after VCF diagnosis than BKP patients (< 0.001 ; non- and propensity-matched). Similar mortality differences were found for subgroups OVCF, non-cancer OVCF and 1+ year survivors OVCF (Table/Figure).

Subgroups	adj. HR of death	Non-matched		Propensity-matched	
		BKP	VP	BKP	VP
All OVCF Patients	NSM vs.	1.63 (1.61-1.66) $p < 0.001$	1.28 (1.26-1.31) $p < 0.001$	1.70 (1.67-1.74) $p < 0.001$	1.32 (1.29-1.35) $p < 0.001$
	BKP vs.	n/a	0.79 (0.77-0.80) $p < 0.001$	n/a	0.83 (0.80-0.87) $p < 0.001$
Non-Cancer OVCF Patients	NSM vs.	1.63 (1.60-1.66) $p < 0.001$	1.28 (1.25-1.31) $p < 0.001$	1.69 (1.64-1.74) $p < 0.001$	1.33 (1.29-1.38) $p < 0.001$
	BKP vs.	n/a	0.78 (0.76-0.81) $p < 0.001$	n/a	0.83 (0.79-0.88) $p < 0.001$
1+ years survivor OVCF Patients	NSM vs.	1.33 (1.30-1.36) $p < 0.001$	1.10 (1.08-1.13) $p < 0.001$	1.36 (1.31-1.41) $p < 0.001$	1.12 (1.08-1.17) $p < 0.001$
	BKP vs.	n/a	0.83 (0.80-0.86) $p < 0.001$	n/a	0.85 (0.80-0.91) $p < 0.001$

DISCUSSION: VCF patients in the Medicare population who are intervened, specifically BKP and VP, seem to experience lower mortality and overall morbidity than VCF patients who received conservative management.

068

SURVIVAL AND COST COMPARISON OF BALLOON KYPHOPLASTY (BKP) AND VERTEBROPLASTY (PVP) USING GERMAN CLAIMS DATA

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OBJECTIVES: Osteoporotic vertebral compression fractures (OVCFs) are associated with increased morbidity, mortality and thus reduced QoL. Vertebral augmentation has been shown to be effective in these fractures. The association between treatment and survivorship was analyzed in the Medicare Population (Edidin 2010). A subsequent study reported cost per life year gained for BKP compared to VP (Edidin 2012) in same setting (Edidin 2012). Replication of these analyses are warranted for confidence in findings. The purpose of this study was to examine the overall survival and treatment costs from a third payer perspective for OVCF patients treated by VP or BKP in Germany.

METHODS: Claims data from a major health insurance fund (AOK Niedersachsen, 2.4 million insurants in 2011) were used. Groups were established by propensity score matching adjusting for covariates. Mortality risk differences between operated (BKP, PVP) and non-operated were assessed by cox regression. For the matched OVCF-patients (2006-2010) survival and costs were estimated by the Kaplan-Meier method.

RESULTS: A total of 598 newly diagnosed OVCF patients were operated out of 3'607 OVCF and 298 remained after adjustment. The operated cohort were 43% less likely to die than non-operated one (HR=0.57; 0.48-0.70 $p < 0.001$). BKP patients had higher 60-month adjusted survival rate of 66.7% compared to 58.7% of VP ones ($p = 0.68$). Cumulative 4-year mean overall costs after first diagnosis were lower for the BKP-cohort (VP: 42,510€ vs. BKP: 39,014€). Initial up-front higher costs driven by surgical treatment for BKP patients are offset by considerable pharmacy costs in VP patients. Main difference was found for pain killers consumption (ATC N02; VP: 3,321€ vs. BKP: 2,224€).

CONCLUSIONS: Results suggest a higher overall survival for operated compared to

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non-operated OVCF. Total costs were lower after 4 years for patients who received BKP vs VP due to less consumption of pharmaceuticals.

O69

DIFFERENCES BETWEEN CASES WITH BONE UNION AND CASES WITH INTRAVERTEBRAL CLEFT FOLLOWING OSTEOPOROTIC VERTEBRAL FRACTURES

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STUDY DESIGN: Prospective multicenter study.

OBJECTIVE: To identify how OVF non-union influences the clinical results.

SUMMARY OF BACKGROUND DATA: Vertebral non-union, which displays as an intravertebral cleft on plain X-rays, was reported as a factor for prolonged severe pain following osteoporotic vertebral fracture (OVF). However, the differences between bone union and non-union cases remain unclear.

METHODS: A total of 324 OVF patients from 25 institutes in Osaka, Japan, who could be followed for 6 months were included in the study. At the 6-month follow-up, the patients were classified into bone union and nonunion groups based on plain X-ray findings and clinical results were evaluated respectively. The outcome assessments included VAS for back pain, SF-36 and severity of bed-ridden state for quality of life (QOL), MMSE for cognitive functions, and degree of vertebral body collapse on plain X-rays.

RESULTS: Overall, 280 patients were classified into the union group and 44 into the non-union group. The VAS score at 6 months was significantly worse in the non-union group ($P=0.01$). The scores of the physical functioning and bodily pain scores

in SF-36 at 6 months were significantly worse in the non-union group ($P=0.019$, $P=0.01$, respectively). The percentage of nearly or completely bed-ridden patients and that of newly developed cognitive impairment was significantly higher in the non-union group ($P=0.02$). Progression of vertebral collapse during the 6-month follow-up was more pronounced in the non-union group ($P<0.01$).

CONCLUSION: The present results revealed that non-union following OVF can be the cause of prolonged pain, QOL impairment, cognitive status deterioration and vertebral collapse progression.

O70

COMPARISON OF PEDICLE SCREW LOOSENING IN LUMBAR SPINAL FUSION SURGERY IN POSTMENOPAUSAL WOMEN WITH OSTEOPOROSIS AMONG TREATMENT OF TERIPARATIDE, BISPHOSPHONATE AND CONTROL. ASPECT FORM BONE QUALITY

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INTRODUCTION: Oral administration of bisphosphonate and intermittent injection of parathyroid hormone (PTH) treatment increase bone mass and reduce the risk for osteoporotic vertebral fractures, and may increase fusion rate after spinal surgery. However, clinical study using bisphosphonate or PTH for efficacy for loosening of pedicle screws (PSs) concerning bone quality of bone marrow and cortex of pedicle has not been reported.

METHODS: Sixty-two women with

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osteoporosis diagnosed with degenerated spondylolisthesis were divided into 3 groups (teriparatide group (n=20:subcutaneous injection daily of 20µg of teriparatide), bisphosphonate group (n=20: oral administration daily 2.5 mg of risedronate), and control (without medication for osteoporosis, n=22). All patients underwent decompression and 1- or 2-level instrumented posterolateral fusion with a local bone graft. Loosening of pedicle screws and surgical outcome were evaluated 12 months after surgery.

RESULTS: At 12 months follow-up, the percentage of loosening of PS was 7~13% in the teriparatide group, 13~ 26% in the risedronate group, and 15~25% in the control group, respectively. The percentage of loosening of PS in teriparatide group was significantly lower than those in risedronate and control group ($P < 0.05$). On the other hand the percentage of loosening of PS in risedronate group was not significantly different from control group ($P > 0.05$). However, there was no significant difference in pain scores at 12 months follow-up among 3 groups ($P > 0.05$).

DISCUSSION: The current study revealed that use of daily subcutaneous injection of teriparatide decreased loosening of PS after instrumented lumbar posterolateral fusion in postmenopausal women with osteoporosis compared with oral administration of bisphosphonate or control. These results may conclude that teriparatide increased bone quality of bone marrow and cortex of pedicle of lumbar spine.

071

ROLE OF WEEKLY ADMINISTERED TERIPARATIDE IN BONY UNION ENHANCEMENT AFTER POSTERIOR LUMBAR INTERBODY FUSION FOR OSTEOPOROSIS-ASSOCIATED LUMBAR DEGENERATIVE DISORDERS: A PROSPECTIVE, RANDOMIZED MULTICENTER STUDY

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INTRODUCTION: A recent study showed that teriparatide administration significantly enhanced spinal fusion in rats compared with saline control models (Spine 2012). In addition, daily subcutaneous teriparatide administration in osteoporotic women accelerated the rate of bone union after posterolateral fusion (Spine 2012). Further, posterior lumbar interbody fusion (PLIF) using polyetheretherketone (PEEK) cage has shown better fusion rates. Therefore, we examined radiological change and clinical scores for assessing the role of teriparatide before and after PLIF.

METHODS: This study comprised patients from 3 university hospitals and their affiliated hospitals. The patients were older than 50 years, had a young adult mean score of <80% or had previous spinal compression or femoral fractures, and had lumbar degenerative disease. These patients had a surgical indication of a single-level PLIF; however, multilevel surgeries were indicated for adequate decompression. Each case was submitted to the central office and randomly distributed into 2 groups: 1 in which teriparatide was subcutaneously administered after once a week after postoperative week 1, and the other in which no teriparatide was administered. This decision was reported to the hospital 1 week after surgery. Bony union was diagnosed using x-ray and 3D computed tomography scans at 2, 4, and 6 months postoperatively by independent doctors in a blinded manner by using the fusion grading system by Bridwell (Spine 1995).

RESULTS: Compared with the non-teriparatide group, the teriparatide group

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scans commonly showed fusion with remodeling and presence of trabeculae (Grade I) or showed intact grafts that were incompletely remodeled and incorporated but did not show lucency (Grade II).

DISCUSSION: Previous studies have shown that the complete fusion of local bone after PLIF using PEEK cage should be assessed 1 year postoperatively (Spine J 2011). Thus, weekly teriparatide treatment may promote bony fusion after PLIF.

072

EFFECT OF RH-PTH 1-34 VERSUS BISPHOSPHONATE ON THE UNION RATE OF OSTEOPOROTIC VERTEBRAL FRACTURES

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INTRODUCTION: Teriparatide (recombinant human PTH 1-34) has been increasingly used for severe osteoporosis, which stimulates bone formation and might have a potential advantage to enhance fracture healing. The objectives of this study are to compare the effect of rh-PTH 1-34 versus bisphosphonates on radiographic and clinical outcomes in the treatment of osteoporotic vertebral fracture, and to investigate whether or not rh-PTH 1-34 enhances the healing process of vertebral fracture.

METHODS: We reviewed 99 patients who underwent conservative treatment for a single-level fresh vertebral fracture related to osteoporosis. Thirty-nine patients were treated by daily subcutaneous injection of 20 micrograms of teriparatide (PTH group); 60 patients received bisphosphonates (BIS group). The same treatment protocol except pharmaceuticals was applied to both groups. Mean follow-up was 21 months. Clinical outcomes were evaluated using VAS of back pain. Radiographic parameters in-

cluded vertebral kyphosis angle, mid-vertebral body height, and fusion status.

RESULTS: Significant pain relief was observed in both groups; VAS decreased from 83/100 to 37/100 in the PTH group and from 75/100 to 38/100 in the BIS group. Vertebral kyphosis angle and body height at the final follow-up were 13 degrees and 13mm in the PTH group, and 15 degrees and 13mm in the BIS group. Union rate in the PTH group and BIS group was 90% versus 68% at 6 months($p=0.015$); 92% versus 85% at the final follow-up($p=0.355$)

DISCUSSION: Compared with bisphosphonate treatment, the use of PTH improves union rate in fresh vertebral compression fractures related to osteoporosis. Intermittent exposure to PTH stimulates osteoblast to enhance new bone formation.

073

THE IMPACT OF PAIN ON FUNCTION AND HEALTH RELATED QUALITY OF LIFE IN SPINAL STENOSIS SYNDROMES. A REGISTER STUDY OF 14.821 PATIENTS

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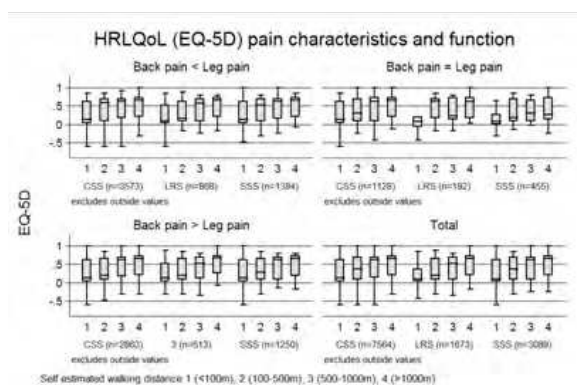
INTRODUCTION: Knowledge of what uniquely characterizes different morphological types of lumbar spinal stenosis in terms of symptoms, and imaging is limited. Little is also known about what characterizes different morphological stenosis types in terms of pain, HRQoL and function. Leg and back pain is known to show varied intensity and information on how this intensity impacts function and HRQoL should be of interest.

METHODS In a descriptive register study using the Swedish Spine Register we studied:

1.) the pain characteristics (leg and back VAS) of patients with central spinal stenosis (CSS), lateral recess stenosis (LRS) and spinal

stenosis with spondylolisthesis (SSS)
 2. how HRQoL (EQ-5D, Sf-36) and function (self estimated walking distance and the Oswestry disability index) correlate to the relationship between leg and back pain (back pain < leg pain, back pain > leg pain and back pain = leg pain). In total 14.821 patients operated between 2003-2010 were studied.

RESULTS More leg than back pain was the most common pain constellation (44%) followed by more back than leg pain (35%). 21% graded the same intensity of leg and back pain. The type of stenosis having the highest burden of back pain was SSS (ratio=0.93; [95%CI]=0.92-0.95), followed by CSS (ratio=0.88; [95%CI]=0.88- 0.89). LRS had the lowest burden of back pain (ratio=0.85; [95%CI]=0.83-0.87). The poorest HRQoL and function was found in SSS (back pain = leg pain group) where 54% ([95%CI]=50-59) of patients could not walk more than 100m. Patients having lateral recess stenosis had better self-estimated walking distance.



DISCUSSION Swedish spinal stenosis patients graded high levels of back pain in addition to leg symptoms. HRQoL was low in CSS, LRS and SSS but function was better in LRS. Patients who graded back and leg pain as like worthy demonstrated lowest scores of HRQoL and function. SSS patients had the highest back pain levels. More than 50% of the patients graded back pain as ≥ leg pain.

O74

IS THE SEDIMENTATION SIGN ASSOCIATED WITH SPINAL STENOSIS SURGICAL TREATMENT EFFECT IN SPORT?

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BACKGROUND: Cross-sectional spinal canal narrowing is an imaging hallmark of lumbar spinal stenosis (LSS), yet, there can be little correlation between anatomical narrowing and clinical symptoms or treatment outcomes. The sedimentation sign was introduced to facilitate the diagnosis of spinal stenosis. It is hypothesized that a positive sedimentation sign may predict poorer outcomes with non-operative treatment and thus a greater surgical treatment effect.

METHODS: 115/654 patients enrolled in the LSS cohort of the Spine Patient Outcomes Research Trial (SPORT) had complete MRIs available for blinded review by an independent spine surgeon. Patients underwent surgery (n=75) or received non-operative care (n=40) and were analyzed according to treatment received. Sedimentation sign was used to define subgroups for calculating the time-weighted average treatment effect over 4 years (TE=ΔOutcomesurgery-ΔOutcomenon-operative) for SF-36 bodily pain and physical function scales, the ODI, and the stenosis

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bothersome index. Statistical significance was defined as a subgroup-by-treatment interaction of $P < 0.05$.

RESULTS: Individuals with a positive sedimentation sign were more likely to have ≥ 2 stenotic levels (75% vs. 47%, $p = 0.01$), central stenosis (93% vs. 67%, $p < 0.001$), and severe stenosis (72% vs. 33%, $p < 0.001$). Surgical treatment effect was larger for the positive sedimentation sign group for all outcomes; statistically significant for ODI (-16 vs -7; $p = 0.02$); borderline for stenosis bothersomeness (-5.7 vs -3.2; $p = 0.09$); and not significant for SF-36 bodily pain (15.4 vs 11.5; $p = 0.44$) or physical function (17.7 vs 15.1; $p = 0.61$).

CONCLUSION: Patients with a positive sedimentation sign appear to have a somewhat greater treatment effect with surgery. These findings suggest that the presence of a sedimentation sign may be a useful adjunctive clinical diagnostic tool. These findings require confirmation in other cohorts.

075

DEFINING THE CLINICAL SYNDROME OF LUMBAR SPINAL STENOSIS: A RECURSIVE SPECIALIST SURVEY

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INTRODUCTION: Lumbar spinal stenosis (LSS) has evolved from an anatomical concept to a poorly defined clinical syndrome. Criteria for defining a syndrome should be informed by the experience of expert clinicians. We developed an innovative on-line survey technique to determine which factors are most important to clinicians in the diagnosis of LSS, how many questions are needed in order to gain reasonable certainty, and how certain clinicians are after asking the questions.

METHODS: Prospective survey of 97 Physi-

atrists in the USA. An on-line recursive survey was developed that permit specialists to anonymously express the value they place on certain clinical questions, the logical order in which they consider the items, and the level of certainty ascertained from the questions. The process presented a scenario and allowed clinicians to ask a question about one of 10 clinical factors. For each selected question, the respondent was informed of the patient answer, and then asked to rate how certain they were that the patient in the scenario had LSS. In order to determine which were the most important questions, analyses were performed focusing on which questions were asked when, and how certain the physician felt of their diagnosis following each question.

RESULTS: The most commonly selected factors were "leg pain while walking" (66%), "must sit down or bend" (66%) and "flex forward while walking" (49%). "Normal foot pulses" (19%), "back pain" (16%) "leg pain" (15%), "relief with rest" (14%), and "sensory deficits" (12%) were of intermediate value. Significant ($P < .05$) change in certainty ceased after 6 questions at 86.2% certainty.

DISCUSSION: Within 6 questions clinicians become 86.2% certain about the diagnosis of clinical LSS. This question set provides one pragmatic criterion for defining LSS. An international Delphi study has been initiated to further investigate the utility of this question set in defining diagnostic criteria for LSS.

076

EXPOSURE OF THE PARAVERTEBRAL MUSCLES AFFECTS CLINICAL OUTCOMES IN PATIENTS WITH MULTI-LEVELS LUMBAR SPINAL STENOSIS

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INTRODUCTION: It is unclear if more patients with lumbar spinal stenosis (LSS) have clinically improvement following preservation of the paravertebral muscle (PVM) than those who exposed it. We used split-spinous process laminotomy without exposing the PVM (modified Marmot operation; MM). The aim of this study was to compare clinical outcomes in patients with LSS (≥3 levels) treated with MM (MM group) with those treated with laminectomy through exposure of the PVM (EX group).

METHODS: Fifty-four patients were allocated into two groups: the MM group or the EX group (each 27 patients). Visual analog scale (VAS) of low back pain (LBP), subscales of Japanese Orthopaedic Association Back Pain Questionnaires (JOABPEQ) and patients' satisfaction were measured at pre and 1 year postoperatively (PO). Operation time, blood loss, C-reactive protein (CRP) and creatine phosphokinase (CPK) at 7 days PO and MRI changes of the PVM at the follow-up were evaluated. Data were analyzed and $P < 0.05$ was considered significant.

RESULTS: There were no differences in pre-operative VAS and JOABPEQ between two groups. Although there was no difference in operation time, blood loss in the MM group was less than that in the EX group (129 vs 205 ml) ($P < 0.05$). Rise in CRP (1.1 vs 2.8 mg/dL) and CPK (68 vs 253 IU/L) showed difference ($P < 0.05$). At the follow-up, all items except psychological disorder of JOABPEQ were improved in both groups and there was no difference in patients' satisfaction. However, VAS of LBP, pain-related disorders, gait disturbance and social life disturbance of the JOABPEQ in the MM group were significantly improved, compared with those in the EX group. Nine patients of the EX group showed positive changes of the PVM.

DISCUSSION: We found that MM was less invasive than laminectomy through exposure of the PVM and that clinical outcomes in the MM group were superior to the EX

group. These results suggest that exposure of the PVM affects clinical outcomes in LSS (≥ 3 levels).

077

INTERSPINOUS SPACERS COMPARED TO DECOMPRESSION OR FUSION FOR LUMBAR STENOSIS: COMPLICATIONS AND REPEAT OPERATIONS IN THE MEDICARE POPULATION

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INTRODUCTION: A randomized trial suggested an advantage of interspinous spacer surgery over non-surgical care, but there are few comparisons with other surgical procedures. Furthermore, there are few population-based data evaluating patterns of use of these devices. We sought to examine whether interspinous distraction procedures are used selectively in patients with more advanced age or comorbidity; and whether they are associated with fewer complications, lower costs, and less revision surgery than laminectomy or fusion surgery.

METHODS: We used Medicare inpatient claims for 2006-2009 to compare age and comorbidity for patients with spinal stenosis having surgery (n=99,084) with (1) an interspinous process spacer alone; (2) laminectomy and a spacer; (3) decompression alone; or (4) lumbar fusion (1-2 level). We also compared groups for cost of surgery and rates of revision surgery, major medical complications, wound complications, mortality, and 30-day readmission rates.

RESULTS: Patients who received spacers were older than those receiving decompression or fusion, but had only modest evi-

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dence of greater comorbidity. Patients receiving a spacer alone had fewer major medical complications than those undergoing decompression or fusion surgery (1.2% versus 1.8% and 3.3% respectively), but higher rates of further inpatient lumbar surgery (16.7% versus 8.5% for decompression and 9.8% for fusion at 2 years). Hospital payments for spacer surgery were greater than for decompression alone, but less than for fusion procedures. These associations persisted after adjusting for age, sex, comorbidity score, and previous hospitalization.

DISCUSSION: Compared to decompression or fusion, interspinous distraction procedures pose a trade-off in outcomes: fewer complications for the index operation, but higher rates of revision surgery. This information should help patients make more informed choices, but further research is needed to define optimal indications for these new dev

078

X-STOP VERSUS DECOMPRESSIVE SURGERY FOR LUMBAR NEUROGENIC CLAUDICATION - A RANDOMIZED CONTROLLED TRIAL WITH TWO-YEARS FOLLOW-UP

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INTRODUCTION: While decompression is the golden standard for lumbar spinal stenosis surgery, interspinous spacers have

been developed for the same purpose but the two modalities have not been compared in a study. We therefore wanted to compare the outcome of indirect decompression by means of the X-Stop implant to conventional decompression in patients with one to two level-symptomatic lumbar spinal stenosis.

METHODS: Prospective randomized controlled trial. Non-inferiority hypothesis. Two-year follow-up. Intention-to-treat as well as As-Treated analyses. Patient sample: After power calculation 100 patients included, 50 in treatment in each group. Randomization performed by envelope. X-Stop operations performed under local anaesthesia. Primary outcome measurement: Zürich Claudication Questionnaire (patient satisfaction, symptom severity and physical function). Secondary outcome measurement: VAS pain leg, back, SF-36, complications and re-operations.

RESULTS: Patients in both surgical groups improved significantly regarding both primary and secondary outcome measures. The results were similar at 6, 12 and 24 months and at no time point any statistical difference between the two types of surgery was seen. Re-operations were significantly more common in the X-Stop group (13) than in the decompression group (3).

Results were identical in ITT and AT analysis.

DISCUSSION: For lumbar spinal stenosis with neurogenic claudication, decompressive surgery as well as X-Stop is rewarding procedures. Similar results were achieved in both groups, however, with a higher number of re-operations in the X-Stop group. Patients having X-Stop removal and decompression experienced results similar to those randomized to and treated with primary decompression.

SP01

OUTCOMES: JUST ASK THE RIGHT QUESTION TO HEAR WHAT YOU WANT TO HEAR!

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INTRODUCTION: It is now accepted that the success of elective spine surgery should be judged in relation to the patient's perception of the outcome. This can be done using Likert scales for rating improvement following treatment, satisfaction with care, or the current status. These constructs are related, but they are not synonymous and may generate differing proportions of "good results".

METHODS: 162 patients who had participated in a trial of lumbar spine fusion versus intensive rehabilitation for chronic LBP on average 13 (SD 1.4; range 9-15) yrs ago completed 4 items:(1) Compared with before treatment, my back problems are..."much better" to "worse";(2) Overall, how much did the treatment help your back problem? "helped a lot" to "made things worse";(3) My back is now..."excellent" to "dreadful";(4) Over the course of treatment for your back problem how satisfied were you with your overall medical care...? "very satisfied" to "very dissatisfied".

RESULTS: There were significant correlations between all the items ($p < 0.0001$). The coefficients were higher for the correlations between the two measures of improvement (items 1&2 above) ($r = 0.80$) and between each of these and current status (3 above) ($r = 0.72-0.83$) than between satisfaction and either improvement or current status ($r = 0.42-0.52$). The "% successes" (=top 2 categories of each scale) were: for improvement, 59% (item 1) and 67% (item 2); for current status, 31%; and for satisfaction, 82%.

DISCUSSION: The proportion of patients

that can be considered a success after surgery depends on how success is defined. Far more patients are satisfied with care than are improved after treatment; fewer still are satisfied with their current status. The difference between these global outcomes must be borne in mind when considering their utility as external criteria for determining the "minimal clinically important difference" of outcome instruments, and when interpreting success rates reported in different studies.

SP02

DYNAMIC SURFACE ELECTROMYOGRAPHY TOPOGRAPHY: A NEW ASSESSMENT TOOL FOR LOW BACK PAIN REHABILITATION

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INTRODUCTION: The dynamic surface electromyography (SEMG) topography can visualize muscle activity during dynamic motion, to be an objective approach to evaluate the progress of low back pain (LBP) rehabilitation. This study was aimed to quantify the pattern features of dynamic SEMG topography from in-vivo lumbar flexion-extension test during LBP rehabilitation, and to propose the potential use of this technique in LBP rehabilitation assessment.

METHODS: EMG signals were recorded in 41 non-specific LBP patients during lumbar flexion-extension. Root-mean-square (RMS) was calculated, while the topographies of RMS distribution were constructed by cubic spline interpolation. The highest 20% RMS value region of the topography was defined as high activity. The relative area (RA), width (RW) and width/height ratio (WHR) of high activity were calculated. All 41 patients received a 12 weeks intensive rehabilitation program, while visual analogy pain-rating scale (VAS) and the Oswestry Disabil-

ity Questionnaire (ODQ) were evaluated before and after rehabilitation. The progress of rehabilitation was classified as good and fair based on the minimal clinically important difference (MCID). Changes in SEMG topography between rehabilitation were compared in good and fair progression groups with one way ANOVA.

RESULTS: Comparing with reported normal SEMG topography, LBP patients had a different dynamic SEMG topography, with an asymmetric, broad, or disorganized distribution. SEMG topography in LBP with good progression showed significant increased RA and RW as well as a significant decreased WHR ($p < 0.05$ by ANOVA).

DISCUSSION: The alternation of SEMG topography in the LBP patients would be an indication of good progression of LBP rehabilitation. SEMG topography provides a quantitative and objective assessment for LBP rehabilitation. It may help identify subjects who will respond to exercise based care, which can benefit the decision making of LBP management strategy.

SP03

CHANGE IN PAIN RATING BETWEEN POST-OPERATIVE AND NON-OPERATIVE PATIENTS SEEKING REHABILITATION

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INTRODUCTION: This study compares change in pain rating in two distinct groups of low back pain patients: 1) those with a history of spine surgery ($n=169$), and 2) those treated solely non-operatively with active exercise ($n=1943$).

METHODS: This was a retrospective study of low back pain (LBP) cases ($n=2112$) assessed at 40 spine care clinics across four provinces between January 2008 and June 2010. The lagtime from surgery to the start of rehabilitation was less than 2 years. All patients had

mechanical LBP as determined by the Saskatchewan Spine Pathway triage methodology.

RESULTS: The mean age of the cohort was 39.9 years ($SD=11.9$, range=18-65) with 62.3% males. There were no baseline statistically significant differences between groups for numerical pain rating, dominant pain location, medication use or constancy. The post surgical group had significantly longer symptom duration, poorer function, fewer at work, more smokers and fewer females. After adjusting for differences between groups, those with a history of spine surgery averaged less pain reduction compared to the non-operative group ($p=0.002$). The surgery group also had significantly more time in treatment, and lower return to work rates ($p < 0.05$).

DISCUSSION: Despite baseline similarities in pain rating, the rehabilitation of those that require treatment after surgery takes longer; these patients do not generally achieve the same reductions in pain as non surgery patients. Those with a history of spine surgery represent a challenging group to treat because they struggle to achieve similar outcomes as non-operative patients.

SP04

CORRELATION BETWEEN LOW BACK PAIN INTENSITY IN LUMBAR SPINAL STENOSIS MEASURED USING THE JAPANESE ORTHOPEDIC ASSOCIATION SCORE AND THE VISUAL ANALOGUE SCALE

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INTRODUCTION: The Japanese Orthopedic Association (JOA) score includes a subjective index of low back pain (3, none; 2, occasional mild pain; 1, continuous pain or occasional severe pain; 0, continuous severe pain). The purpose of this study was to in-

investigate the prevalence of concomitant low back pain (LBP) and lumbar spinal stenosis (LSS), and to examine the correlation between LBP intensity measured using the JOA score and the Visual Analogue Scale (VAS) in LSS patients.

METHODS: A total of 1,021 LSS patients (547 men and 474 women, mean age 68.8 ± 9.7 years) who were surgically treated between 2005 and 2012 were recruited. Pre-operative JOA scores (0–3 points) and VAS values (0–100 mm) were cross-sectionally analyzed. The concomitant LBP was determined as “presents” when the JOA score was 2, 1, or 0. The prevalence of LBP and the distribution of the JOA score and VAS value were analyzed using descriptive statistics. The correlation between the JOA scores and VAS values was analyzed (significance level, 0.05).

RESULTS: The JOA score was 0 in 58 patients, 1 in 520, 2 in 369, and 4 in 74. The prevalence of LBP was 93%. The median value of VAS was 58 (Q1–Q3: 32.5–78). JOA scores did not differ significantly with respect to sex and age. However, age and female gender were significant correlated with a high VAS value. The average VAS values corresponding to the JOA scores of 0, 1, 2, and 3 were 85 (95% confidence interval, 81–89), 65 (63–67), 42 (39–44), and 25 (19–31), respectively. There were significant differences in VAS values within each JOA point interval (0–1, 1–2, and 2–3; $p < 0.0001$). The Spearman’s rank correlation coefficient between VAS and JOA scores was -0.52.

DISCUSSION: This study shows an extremely high prevalence of LBP in LSS patients. In addition, the results suggest that a significant correlation exists between the JOA score and VAS value.

SP05

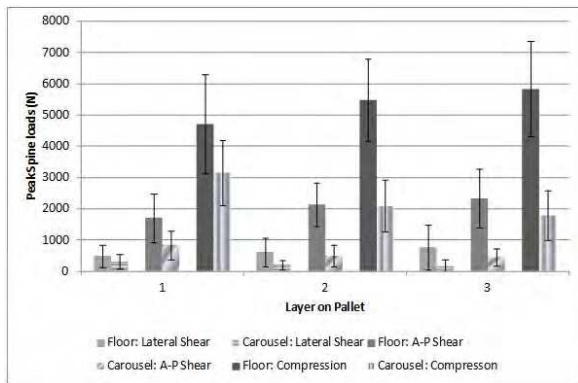
BIOMECHANICAL IMPACT OF A POSITIONING INTERVENTION: CAROUSEL PLATFORM FOR PALLETIZING

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INTRODUCTION: Item selectors in the warehousing sector suffer from an alarming rate of low back injuries. Item selecting requires extensive manual material handling in awkward postures. The objective was to investigate the impact of a positioning device on the spine loads during depalletizing tasks. The intervention adjusts the height of the bags to waist level and rotates pallet to eliminate reaching.

METHODS: Thirteen healthy males between age 18 and 40 lifted bags of cement for the bottom three layers of the pallet while it was positioned on the floor and on a carousel pallet leveler. Bags of cement (weighing: 18 kg) were lifted from the pallet to a flat-bed cart in a standard position. Muscle activity of ten trunk muscles and trunk kinematics as measured by the lumbar motion monitor was input into a well-validated dynamic EMG-assisted model to predict the instantaneous three-dimensional spine loads.

RESULTS: Adjusting the height of the pallet at the origin of the lift during palletizing tasks significantly reduced the three-dimensional spine loads. The reductions in compression was as much as 4000 N (69% reduction) in the lower layers while shear loading was reduced by 1800 N (81%) (Figure).



DISCUSSION: An adjustable carousel platform significantly reduces the complex loading that accompanies one of the most demanding jobs in industry—item selectors in warehousing. The concept is to keep the load at waist level and eliminate reaching by rotating the platform effortlessly. Further, the effectiveness of the carousel platform was most distinct in the most risky positions of the pallet—bottom and farthest away positions. Practically, the results indicated that an intervention solely focused on the origin of the lift can be effective in reducing the biomechanical loading on the spine.

SP06

INCIDENCE OF DISC DEGENERATION OF THE THORACIC SPINE AND ITS EFFECT ON THE SPINAL CANAL AND THE MOTION UNIT IN SYMPTOMATIC PATIENTS

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INTRODUCTION: Even though the prevalence of upper and mid-back pain is lower than that of lower back pain, a number of patients do suffer from thoracic pain with its prevalence of 3% to 23% of the general population. Furthermore, only a few studies have described the disc degeneration in

thoracic spine and the effect of disc degeneration on the motion unit of thoracic spine has not been well understood. The purpose of this study is to investigate the incidence of disc degeneration of thoracic spine in the symptomatic patients and its effect on the spinal canal and the motion unit using kinematic MRI.

METHODS: One hundred, forty-four symptomatic patients underwent weight-bearing kMRI with dynamic motion of the thoracic spine. In total, 1584 disc levels from T1/2 to T11/12 were analyzed in this study. The disc degeneration was evaluated based on the Pfirrmann's classification system. The degree of disc bulge and the spinal canal diameter were measured using T2-weighted images at the neutral position, and the angular and translational motion were calculated using the flexion and extension images.

RESULTS: Moderate or severe disc degeneration at 1 or more intervertebral levels was found in 80% of subjects. Severe degeneration was more commonly found at the mid-thoracic level than at the upper- or lower-thoracic. The mean disc degeneration grade of each patient was significantly correlated with the patient's age ($R=0.61$, $p<0.001$). As the disc degeneration became more severe, the degree of disc bulge significantly increased and the spinal canal diameter significantly decreased. However, there were no significant differences in segmental motion with different grades of disc degeneration.

DISCUSSION: The disc degeneration of thoracic spine is frequently found in symptomatic patients, and its degree was associated with the age. Severe disc degeneration contributes to disc buldge and canal compromise, but their effect on the motion is small in thoracic spine.

SP07

INTERVERTEBRAL DISC DECOMPRESSION FOLLOWING ENDPLATE DAMAGE:

SPECIAL POSTERS

IMPLICATIONS FOR DISC DEGENERATION DEPEND ON SPINAL LEVEL AND AGE

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INTRODUCTION: Disc degeneration can be initiated by damage to a vertebral body endplate, which decompresses the adjacent nucleus and concentrates stress within the annulus. The magnitude of these changes, and hence their potential to initiate disc degeneration, varies considerably between specimens. This study investigated how spinal level and age influence disc decompression arising from endplate fracture.

METHODS: 174 cadaveric motion segments from T7-8 to L5-S1, aged 19-96 yrs, were subjected to controlled compressive overload to damage a vertebral endplate. 'Stress profilometry' was performed before and after damage to quantify changes in intradiscal pressure (IDP), and compressive stresses in the annulus. 86 of the undamaged vertebral bodies were sectioned in the mid-sagittal plane, and the thickness of the central bony endplate was measured from microradiographs. Multiple regression analysis was used to compare the relative influences of spinal level, age, disc degeneration and gender on results obtained.

RESULTS: Endplate fracture occurred at an average force of 3.4 kN, and reduced vertebral body height by an average 1.88 mm. Pressure loss in the adjacent nucleus varied linearly from 93% at T8-9 to 38% at L4-5 ($R_{sq} = 22\%$, $P < 0.001$), and increased with age ($R_{sq} = 19\%$, $P < 0.001$) especially in males. Stress concentrations in the posterior annulus increased following endplate fracture, with the effect being greatest at

upper spinal levels ($R_{sq} = 7\%$, $P < 0.001$). Endplate thickness increased by approximately 50% between T11 and L5 ($R_{sq} = 21\%$, $P < 0.001$).

DISCUSSION: Endplate fracture creates abnormal stress distributions in the adjacent intervertebral disc, increasing the risk of internal disruption and degeneration. Effects are greatly reduced in the lower lumbar spine, and in young specimens, primarily because of differences in nucleus volume, and materials properties, respectively. Disc degeneration between L4 and S1 may often be unrelated to endplate fracture.

SP08

A NEW NUMERICAL METHOD BASED ON CONTRAST-ENHANCED MRI TO INVESTIGATE THE TRANSPORT PROPERTIES OF HEALTHY AND DEGENERATED VERTEBRAL ENDPLATES

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INTRODUCTION: Disc nutrition is believed to be based on diffusion of nutrients through the vertebral endplates. Serial contrast-enhanced MRI was widely employed for the investigation of the in vivo transport of small molecules, but the interpretation of those data is only qualitative. In this work, a novel quantitative method based on contrast-enhanced MRI to predict the transport behavior of the contrast agent in the vertebral endplates by means of finite element optimization is presented.

METHODS: Patient specific one-dimensional finite element models aimed to replicate the diffusion of the contrast agent (Gd-HP-DO3A) from the vertebral bodies to the nucleus pulposus through the vertebral

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endplates were developed. The diffusion coefficients of the vertebral structures were optimized in order to minimize the error between the Gd-HP-DO3A concentration predicted with the model and the actual concentration determined by MRI acquisitions during the first six hours after injection of the contrast agent. Simulations were run to calculate the diffusive properties of 68 discs from a population of 32 patients suffering from low back pain.

RESULTS: The transport properties of Gd-HP-DO3A showed a high variability within the population. In general, the predicted diffusion coefficients were higher than the bulk diffusion coefficients of oxygen in water, thus showing that other chemico-physical processes in addition to pure diffusion may be involved in disc nutrition. Comparisons between different age groups and disc degeneration degrees did not reveal any relevant differences.

DISCUSSION: The novel computational method is able to predict the transport properties of the endplates in a patient-specific manner. Results are in agreement with recent literature showing that endplate permeability is not generally decreased in presence of disc degeneration, and showed that the common assumption of disc nutrition being based on pure diffusive processes may need to be revised.

SP09

A CHARACTERIZATION OF SUB-ENDPLATE DAMAGE DURING INTERVERTEBRAL DISC HERNIATION

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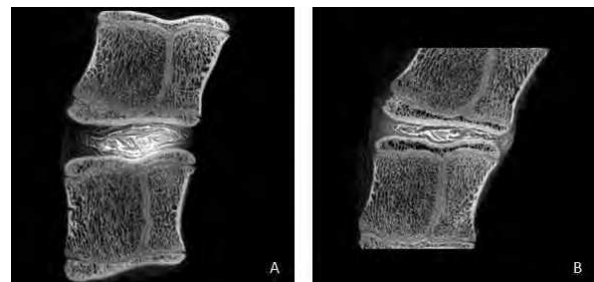
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INTRODUCTION: Documentation of the damage that occurs during intervertebral disc herniation has largely emphasized the annulus and posterior migration of nucleus

pulposus. There has been documentation of endplate damage occurring during gradual and acute disc herniation and the endplate has been identified as the weak point of the intervertebral disc. Identifying sources of damage and failure in areas other than the annulus could serve to direct clinical findings towards a single primary mechanism of injury.

METHODS: Six porcine cervical spines were dissected into motion segments consisting of the C5 and C6 vertebral bodies and intervening disc. Two additional specimens were used as controls. Specimens were imaged using micro CT before and after mechanical testing and a radio-opaque dye was injected into the disc in order to track and verify the presence of herniation. Mechanical testing consisted of 10000 cycles of repeated flexion and extension under 1500N of axial compression. Presence of herniation was confirmed radiologically and damage to the trabecular bone underneath the endplate was determined and assessed by a radiologist.

RESULTS: Evidence of herniation was found in all six specimens. Comparison of experimental specimens before and after mechanical testing confirmed the presence of damage to the trabecular bone directly beneath the endplate (Figure 1).



DISCUSSION: During the process of gradual intervertebral disc herniation, the trabecular bone directly beneath the endplate experiences damage and weakening. These findings could offer an explanation with respect to the formation of Schmorl's nodes or Modic changes that are sometimes evi-

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dent on radiological images. Damage to the trabecular bone in this manner further strengthens confirmation of a herniation mechanism in a patient. Clinicians should be aware of these potential alternate sources of damage that are present during herniation and recognize them as part of the same mechanism.

SP10

SEGMENTAL LUMBAR FACET JOINT MOTION

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INTRODUCTION: The facet joints play a major role in lumbar segmental motion that is susceptible to morphological changes, eventually leading to segmental instability. Recent advancements in medical imaging enabled the development of innovative methods to study in-vivo three-dimensional kinematics and morphology of the facet joint. The aim of this study was to describe facet motion in-vivo using image-based methods.

MATERIALS: This IRB-approved study obtained lumbar spine CT scans of 91 subjects aged 22-59 at 0° and 50° of torso rotation to the right. The resulting CT data of 5,284 individual facet joint surfaces was analyzed with custom numerical routines to describe both the vertebral and facet joint segmental motion using a series of coordinate transformations. This enabled the description of all six degrees of freedom for each facet pair using a facet-based coordinate system set on the centroid of the superior facet of the inferior vertebra for each motion segment. Level effects and significant differences were analyzed with ANOVA and Fisher post hoc tests. Significance was set at $p=0.05$.

RESULTS: Segmental rotations in axial and

lateral direction were coupled. In general, upper lumbar motion segments (L1L2, L2L3) showed greater axial rotation compared with the lower levels (L3L4, L4L5), while lower lumbar segments exhibited larger lateral bending. In axial rotation, differences in levels were significant between L1L2, L2L3, and L3L4 ($p=0.001$). There were also significant differences between segmental rotational ROM at L1L2 and all remaining levels at lateral bending ($p<0.0001$).

DISCUSSION: This study demonstrates coupled motion for the facets during axial torsion. Eigenvector analysis allowed identification of each vertebra's principal orientation. This reference datum determined a local coordinate system for the individual facet joint surfaces. This work contributes to the field with high-accuracy in vivo baseline data.

SP11

KYPHOPLASTY CORRECTS SEVERE VERTEBRAL WEDGE DEFORMITIES BETTER THAN VERTEBROPLASTY

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INTRODUCTION: Vertebroplasty and kyphoplasty can provide analgesia and facilitate early mobilisation for patients with osteoporotic vertebral fractures. This study compared the ability of each procedure to restore vertebral height, shape and mechanical function following severe vertebral wedge fractures.

METHODS: Thoracolumbar "motion segments" from cadavers aged 70-97 yrs were overloaded in compression and flexion in order to create severe anterior wedge fractures. One specimen from each spine underwent vertebroplasty, the other (paired) specimen received kyphoplasty. Cement

augmentation was followed by sustained compression to allow cement consolidation. Initially, and after each intervention, the following parameters were measured: vertebral height and shape (from radiographs), compressive stiffness, and stress distributions within the intervertebral discs. The latter indicated the intra-discal pressure (IDP) and neural arch load-bearing (FN).

RESULTS: Vertebral wedge fracture reduced mean anterior vertebral height by an average 34%, and increased its wedge angle from 5.0° to 11.4°. It also reduced IDP by 96.2%, increased FN by 57.5%, and caused compressive stiffness to fall by 44.3%. Vertebral height was restored by both procedures, but effects were greater for kyphoplasty than vertebroplasty, both immediately after augmentation (97% vs 59%, $p < 0.001$) and following subsequent creep loading (79% vs 47%, $p < 0.001$). Kyphoplasty reduced wedging more than vertebroplasty, both after augmentation (7.2° vs 4.2°) and after consolidation (6.6° vs 4.0°, both $p < 0.02$). The procedures were equally effective at providing partial restoration of mechanical function (IDP, FN and compressive stiffness).

DISCUSSION: Vertebroplasty and kyphoplasty had similar effects on restoring mechanical function following severe wedge fractures. However, kyphoplasty produced greater improvements in vertebral height and shape, and may be better able to prevent or reduce deformity in life.

SP12

ROLE OF FACET ORIENTATION AND SOFT TISSUE INTEGRITY IN UNSTABLE DEGENERATIVE SPONDYLOLISTHESIS: A LABORATORY MODEL

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INTRODUCTION: Degenerative changes that lead to segmental instability in degenerative spondylolisthesis (DS) affect all structures in the spinal motion segment. These changes include: disc degeneration, facet arthropathy, increased facet sagittal alignment, ligamentous degeneration and muscular dysfunction. We investigated the anatomical causation of anterior shear instability by experimentally altering soft tissues of cadaveric lumbosacral spines in the setting of variable facet angulations. We hypothesized that anterior shear instability will increase with increasing sagittal orientation of the facets in the presence of disc degeneration and facet osteoarthritis.

METHODS: Eight healthy cadaveric spine specimens (L1-sacrum) (30-57 yo) were selected using radiographs, CT, MRI and baseline ROM testing. Specimens were evaluated using shear force applied to the intact segment, and after sequential surgical changes: simulated disc degeneration, facet degeneration and complete bilateral facet resection. In total 40 segments were tested, 8 each from (L1-2, L2-3, L3-4, L4-5 and L5-S1).

RESULTS: A reproducible pattern of DS was created with statistical significance ($p < 0.05$) at all lumbar levels (L1-L5) with each step of simulated spinal degeneration. The spondylolisthesis pattern created was not significantly different between lumbar levels ($p > 0.05$). The sagittal facet angulation of lumbar facets did not correlate ($R^2 = 0.065$) to the magnitude of anterior slip.

DISCUSSION: DS was consistently produced at all lumbar interspinous levels regardless of the facet angulation. While more cranial lumbar segments have increasing sagittally oriented facet joints, there was no correlation between lumbar segment and magnitude of anterior slip. This observation sug-

gests that increased sagittal facet angulation is not an anatomical predisposition for DS, but rather a result of remodeling due to degenerative wear on the facet.

SP13

ASSESSMENT OF THE NEUROCENTRAL SYNCHONDROSIS IN PEDIATRIC SPINES AND THE "DEVELOPMENTAL" ETIOLOGY OF SCHMORL'S NODES

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INTRODUCTION: Schmorl's nodes of the thoraco-lumbar region have been associated with the presence and severity of disc degeneration in adults. The etiology of Schmorl's nodes remains precarious; however a unique multilevel phenotype of "kissing" nodes seems to suggest a developmental origin. The neurocentral synchondrosis (NCS) are cartilaginous growth plates near the neural arch ossification centres in a growing vertebrae that may play a direct role in the development of endplate abnormalities, such as Schmorl's nodes. This study assessed the NCS in pediatric spines to raise discussion of a developmental component of Schmorl's nodes.

METHODS: A retrospective imaging study of pediatric patients at a single institute assessed over a 5 year period (age range: 0 to 10 years) was performed. Patients with spinal disorders (e.g. scoliosis) were excluded. 102 patients (57 males, 45 females) and a total of 113 sets of MRI images were reviewed. The thoraco-lumbar regions (T12-S1) were evaluated. Sagittal T1- and T2-weighted images were assessed for the presence or absence of the NCS, defined as a hypointense vertical line located between

the vertebral body anteriorly and the posterior arch. The presence of Schmorl's nodes was also noted.

RESULTS: NCS was noted in 46% of the MRIs. No statistically significant difference in the disappearance of the NCS between different age groups ($p=0.063$) or gender ($p=0.706$) was found. The NCS was noted to be completely fused at the midpoint of the vertebrae. Indentation of the vertebral endplates resembling Schmorl's node at many of the rostral and caudal ends of the unfused NCS were observed (Figure 1).



Figure 1: (Left) Sagittal T1-weighted MRI of an 8 year old male with incompletely fused NCS (see arrow). (Right) Sagittal T2-weighted MRI in an adult with multiple "kissing" Schmorl's nodes phenotypes in a similar alignment pattern to the NCS.

CONCLUSIONS: The significance of further characterizing the nature of NCS closure may lie in potential associations with failure of complete closure with endplate abnormalities, such as Schmorl's nodes. Our MRI study provides a foundation that a developmental etiology of Schmorl's nodes exists.

SP14

HOW FAR INTO A DEGENERATED ANNULUS CAN BLOOD VESSELS AND NERVES PENETRATE?

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INTRODUCTION: Discogenic pain is associated with ingrowth of blood vessels and

nerves, but uncertainty over the extent of ingrowth is hindering development of appropriate treatments. We hypothesise that adult human annulus fibrosus is such a dense crosslinked tissue that ingrowth via the annulus is confined to a) peripheral regions, and b) annulus fissures extending to the disc periphery.

METHODS: Disc tissue was examined from 61 patients (aged 37-75 yrs) undergoing surgery for herniation, discogenic back pain, spondylolisthesis, or scoliosis. Frozen sections, 5 μm thick, were stained with H & E to identify cells, matrix features, and tissue types. Thick (30 μm) frozen sections were examined by immunofluorescence, using a laser scanning confocal microscope to detect cells positive for CD31 (endothelial cell marker), PGP 9.5 (general nerve marker), and Substance P (nociceptive nerve marker). Image analysis software was used to quantify the number and total cross-sectional area of labelled structures, and their distance from the nearest free surface (either disc periphery or annulus fissure).

RESULTS: Maximum penetration of blood vessels and nerves from the peripheral annulus was 4,800 μm and 2,200 μm respectively. Blood vessels and nerves were associated with fissured (especially herniated) annulus fibrosus, and their maximum distance from the nearest free surface (of a disc or of a fissure) was 888 μm and 236 μm respectively. Substance P (but not PGP 9.5) was co-localised with blood vessels, and both the number and area of Substance P-positive structures were correlated with grade of disc degeneration.

DISCUSSION: Thick sections and fluorescent markers can show reliably where labelled structures are absent, so the results support our hypothesis. Deep penetration of blood vessels and nerves into the human annulus fibrosus is likely to occur only when annulus fissures are present.

SP15

COX-2 INHIBITOR INHIBIT AXONAL GROWTH OF RAT SENSORY NEURONS COCULTURED WITH INJURED INTERVERTEBRAL DISC IN VITRO

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INTRODUCTION: Ingrowth of sensory nerve fibers into the annulus fibrosus is considered a crucial factor in the pathology of discogenic low back pain(LBP). The ingrowth is induced by proinflammatory cytokines produced in the degenerated intervertebral disc (IVD). Nerve growth factor(NGF) promotes axonal growth of sensory neurons in vitro; however, there is no evidence of the effects of analgesic agents on axonal growth. COX-2 inhibitor, celecoxib(CEL), is commonly used clinical analgesic for its selectivity for COX-2. The present study aimed to investigate the effects of degenerated IVD material and CEL on axonal growth in vitro in rats.

MATERIALS AND METHODS: Degenerated IVD material was produced by puncturing the L4-5 IVD of male Sprague–Dawley rats and harvested 24 h after the treatment. Intact IVDs were harvested from nontreated animals. Isolated dorsal root ganglia (DRG) from rat neonates were plated on a glass-bottomed dish. The IVDs were cultured with the plated DRG neurons for 19 h. Experimental groups were as follows: (1)Ctrl: DRG neurons cultured w/o IVD, (2)Ctrl_Nml: coculture of intact IVD and DRG neurons, (3)Ctrl_Deg: coculture of injured IVD and DRG neurons, (4)CEL+Deg: coculture of injured IVD and DRG neurons in medium w/ 0.1% CEL, and (5)positive Ctrl: DRG neurons cultured in NGF-containing medium. These groups were immunostained with anti- β -

tubulin antibody after the incubation. The axonal growth among the groups were statistically evaluated.

RESULTS: Without CEL, the average lengths of axonal growth were in the following order: Ctrl (208.6±14.9(µm, average±SEM)) <Ctrl_Nml(363.4±24.7)<Ctrl_Deg(377.7±16.4)<positive Ctrl(400.8±24.9). Each neighboring data set was significant (P < 0.05). CEL+Deg group showed significantly decreased axonal growth (332.8±12.2) .

CONCLUSION: Injured IVD can induce axonal growth, which can be inhibited by CEL administration. NSAIDs can positively influence discogenic LBP pathology by inhibiting activities of sensory neurons.

SP16

THE ROLE OF DIABETES TYPE I IN INTERVERTEBRAL DISC DEGENERATION

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INTRODUCTION: Diabetes Mellitus (DM) affects 25.8 million people of all ages (8.3% of the U.S population). Previous studies suggest a link between DM and several connective pathologies including those of cartilage and bone. Currently it is not clear if DM is an important etiologic factor in intervertebral disc degeneration (IDD). The goal of this study was to determine disc degenerative changes in a murine model of human type I diabetes to establish the causal relationship between DM and IDD.

METHODS: Intervertebral discs (IVDs) were obtained from both spine and tail of Wt mice and the B6 Akita mouse model of type I DM. B6 Akita mice are hyperglycemic due to the Ins2Akita insulin mutation, typically

used for analysis of human islet and beta stem and progenitor cell function. Total disc proteoglycan (PG) content [1,9-dimethyl-methylene blue (DMMB) assay and safranin O/fast green histology], hematoxylin and eosin histology for cellularity and structural morphology, mason trichrome for collagen content were assessed. Newly PG synthesis (35S-sulfate) was also analyzed.

RESULTS: The IVDs of the diabetic mice showed decreased disc total GAG content (DMMB assay) compared to the matched Wt controls. Consistently, safranin-O staining also revealed a reduction of PGs in the IVDs of diabetic mice compared to controls. However, newly PG synthesis was slightly increased in diabetic IVDs, which may indicate a compensatory response to deficiency of glucose uptake in these diabetic animals.

DISCUSSION: IVDs of diabetic mice demonstrated overall PG matrix loss similar to disc degenerative changes in humans, providing novel evidence that DM negatively impacts IVD health. These preliminary results show that diabetic mice may represent a useful model to explore the mechanism of disc degeneration as it is related to glucose metabolism.

SP17

LOSS OF NOTOCHORDAL CELLS TRIGGERS EXTRACELLULAR MATRIX DEGRADATION IN A RAT TAIL TEMPORARY STATIC COMPRESSION-INDUCED DISC DEGENERATION MODEL

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INTRODUCTION: Intervertebral disc degeneration (IDD) is characterized by matrix degradation. Our objective was to elucidate the pathogenesis of matrix degradation in IDD using a rat tail temporary static compres-

sion model.

METHODS: Eighty-four Sprague-Dawley rat tails were attached with an Ilizarov-type device with springs, loaded statically at 1.3 MPa, and divided into 3 groups: loaded for the first 1 day (the D1 group), loaded for the first 7 days (the D7 group), and unloaded for 56 days (the sham group). Observation for up to 56 days was performed by X-ray, MRI, histology, immunofluorescence (notochordal cell [NC]-phenotypic cytokeratin-8 and galectin-3), real-time RT-PCR (MMP3, ADAMTS5, aggrecan1, and collagen type 2- α 1), and immunohistochemistry (MMP3, ADAMTS5, and MMP- and aggrecanase-cleaved aggrecan neoepitopes).

RESULTS: In X-ray, progressive disc height loss was observed in the D7 group while the D1 group kept disc height. In MRI and histology, the D7 group showed higher degenerative scores than the D1 group. In immunofluorescence, disc cells decreased with compression. The percentage of cytokeratin-8- and galectin-3-co-positive cells, indicating notochordal origin, further decreased in the D7 group (20%) compared to the D1 (44%) and sham (68%) groups. In PCR, MMP3 was up-regulated in the D7 group from day 7 ($P<0.05$) but not in the D1 group. ADAMTS5 was constant in the D7 group but up-regulated in the D1 group at day 56 ($P<0.05$). Aggrecan1 and collagen type 2 α -1 were down-regulated in both groups ($P<0.05$). Immunopositivity for MMP3 increased in non-NCs of the D7 group ($P<0.05$). That for ADAMTS-5 increased in non-NCs of the D1 and D7 groups ($P<0.05$). MMP- and aggrecanase-cleaved aggrecan neoepitopes increased around non-NCs of the D1 and D7 groups ($P<0.05$).

DISCUSSION: Decreased NCs and increased non-NCs immunopositive for MMP3, ADAMTS5, and both-cleaved aggrecan neoepitopes following compression suggest that the loss of NCs triggers matrix degradation in IDD.

SP18

TISSUE-ENGINEERED ALLOGRAFT INTER-VERTEBRAL DISC TRANSPLANTATION FOR THE TREATMENT OF DEGENERATIVE DISC DISEASE: EXPERIMENTAL STUDY IN A BEAGLE MODEL

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OBJECTIVES: To investigate whether the intervention of NP cells or hTERT gene transfected NP cells can prevent the degeneration process after allograft total disc transplantation.

METHODS: Canine nucleus pulposus cells were isolated and transduced with rAAV2-hTERT. The cells were injected into the cryopreserved discs to construct a "tissue-engineered" allograft disc (group A). NP cells and DMEM/F12 were used for controls (group B and C). 18 beagle dogs received the 3 groups of allograft IVD composites implantation respectively. Radiographic examination was performed post implantation. At 12 weeks, all dogs were sacrificed and the lumbar spines were harvested for the biomechanical and histological analysis, ectogenic NP cell tracing and hTERT mRNA analysis.

RESULTS: Bony fusion between intervertebral disc allograft and adjacent host intervertebral body were observed in all animals. The disc height and T2 signal intensity preservation in group A and B was better than group C. In group A, the MRI grayscale of the transplanted disc was significant higher than that of the controls at 12 weeks. Biomechanical test showed a poor stability preservation in group C compare to group A and B. PKH-26 positive cells were identified within the allograft discs in group A at 12 weeks. Histological analysis showed

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the NP cell morphology, cell number and distribution of the allograft discs was better preserved in group A and B compared to group C at 12 weeks follow up.

CONCLUSION: The present study demonstrated that NP cells or hTERT loaded NP cells intervention could effectively resist the degeneration of the allogenic transplanted intervertebral discs in a beagle model. The hTERT loaded NP cells had a better anti-degeneration effect on the transplanted disc than NP cells. This modified disc regeneration technique through NP cell injection or manipulation may have the potential to ensure the long term function preservation of allograft disc transplantation.

SP19

LOCAL PLACEMENT OF CLONIDINE PELLET REDUCED NEUROPATHIC PAIN IN A RAT FACET JOINT ARTHRITIS MODEL

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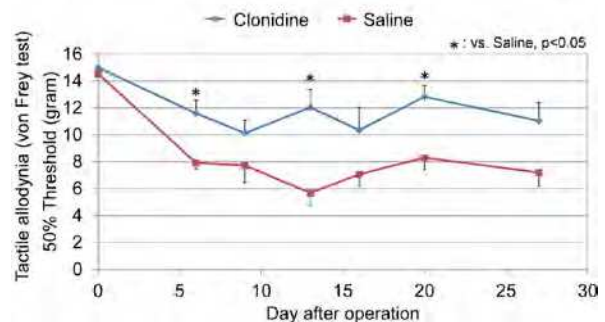
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INTRODUCTION: Facet joint inflammation is implicated as a major cause of neuropathic back pain. Clonidine, a clinically effective antihypertensive drug, is an alpha-2 adrenergic receptor agonist whose primary mechanism of action is inhibition of central sympathetic outflow. The purpose of this study was to determine if local placement of a slow releasing clonidine pellet reduces neuropathic pain in a rat thrombin-induced acute facet joint arthritis model.

METHODS: Sixteen SD rats (weighing 250-300g, female) received an intra-articular injection of bovine thrombin (20U/2µL) into the right facet joint with the local placement of a pellet containing clonidine

(~2.4ug/day, n=8) or saline (n=8) in the multifidus muscle adjacent to the injected facet joints and were evaluated for 28 days with a weekly assessment of tactile allodynia (von Frey test) and gait abnormality (TreadScan, CleverSys, Inc.). The degree of facet cartilage degeneration was histologically analyzed by Safranin O staining.

RESULTS: Histology revealed that cartilage degeneration was induced by intra-articular injections of thrombin in both the clonidine and saline groups. The clonidine group, compared to the saline group, showed a statistically higher tactile threshold throughout the study (two-way ANOVA; $p < 0.05$) and at 6, 13 and 20 days (unpaired t-test; $p < 0.05$). The stance time of the clonidine group tended to be higher than that of the saline group (unpaired t-test; $p = 0.12$) at 2 weeks.



DISCUSSION: Throughout the study, the local placement of a clonidine pellet significantly attenuated tactile allodynia induced by intra-articular injections of thrombin. The reduction of neuropathic pain in this rat model of acute facet joint arthritis indicates that the slow releasing clonidine pellet is effective with a single placement in inducing analgesic effect and behavioral improvement. Further studies to confirm the mechanism of pain reduction is warranted to support future clinical applications.

SP20

MECHANISTIC ASSESSMENT OF ALLODYNIA AND GAIT DISTURBANCE IN A NICOTINE-INDUCED INTERVERTEBRAL DISC DEGENERATIVE RAT MODEL; AN APPROACH USING VARIOUS PHARMACOLOGICAL AGENTS

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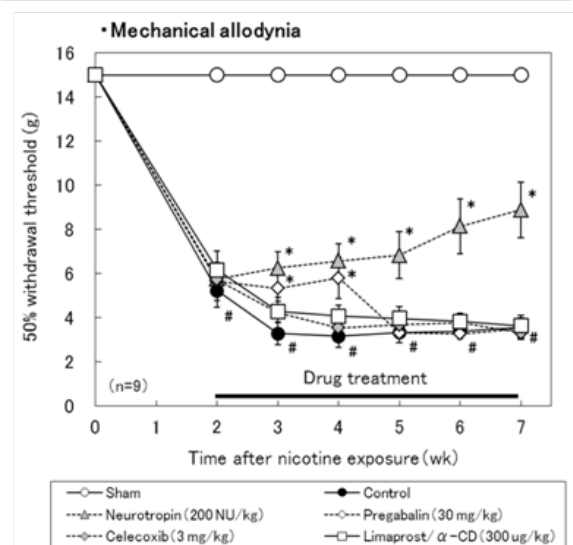
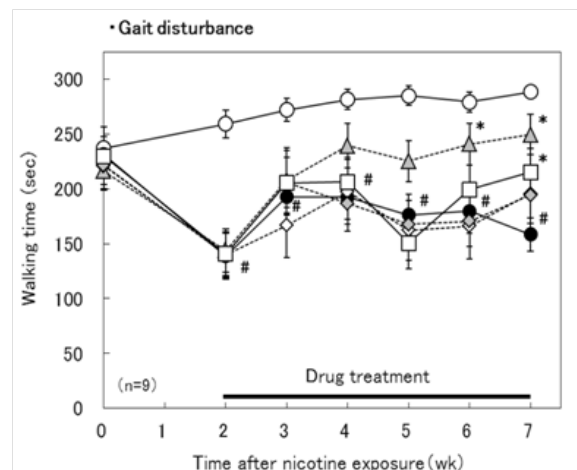
INTRODUCTION: Intervertebral disc (IVD) degeneration, thought to cause low back pain, may be mediated by decreased blood flow to the IVD. Nicotine use, which decreases blood-flow, has been utilized to induce IVD degeneration in animals. These animals have reduced blood vessel numbers in the endplate and catabolic changes in the IVD, as well as mechanical allodynia and locomotor disturbances. Using a nicotine-induced rat IVD degeneration model, the purposes of this study were to reveal the mechanism of symptom expression by using drugs with different mechanism of actions, and to assess the effects of Neurotropin® (NTP) on these symptoms.

METHODS: SD rats (9wks) were implanted subcutaneously with Alzet osmotic minipumps (0.25µL/hr) filled with a nicotine solution (400mg/mL). Two weeks post-implantation, the rats were divided into 5 groups (n=9) and orally administered 1) vehicle; 2) NTP (200NU/kg); 3) pregabalin (30mg/kg); 4) celecoxib (3mg/kg); or 5) limaprost α-cyclodextrin clathrate (300µg/kg) daily for 5 weeks. Mechanical allodynia (von Frey) and locomotor disturbances (RotaRod) were measured weekly (if applicable, 24hrs after drug administration) throughout the study.

RESULTS: Pregabalin temporally alleviated only mechanical allodynia. Limaprost ameliorated only locomotor disturbances. Celecoxib had no effect. NTP abrogated

both mechanical allodynia and locomotor disturbances (p<0.05); the effect was cumulative over time with repeated administration.

CONCLUSIONS: Our results suggest that mechanical allodynia is related to abnormal nervous function (pregabalin), decreased blood flow is involved in locomotor disturbances (limaprost), and the COX2 pathway is not involved in development of either symptom (celecoxib). Repeated administration of NTP demonstrated effectiveness on both parameters, suggesting the multiple mode of action of this drug. This characteristic may be advantageous for the treatment of back pain, which has multiple mechanisms of symptom expression.



*P<0.05 or #P<0.05, significantly different from control or sham, respectively.

SP21**ACTIVATION OF ASTROCYTES AND MICROGLIA IN THE C3–T4 DORSAL HORN BY LOWER TRUNK AVULSION IN A RAT MODEL OF NEUROPATHIC PAIN**

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PURPOSE: Brachial plexus pain is not thought to be generated by avulsed roots, but rather by nonavulsed roots, because avulsed roots could not possibly transmit action potentials to central nerves. The aim of this study was to evaluate pain-related behavior and the extent of glial activation in a model of brachial plexus avulsion.

METHODS: We used 24 male Wistar rats. In rats in a brachial plexus avulsion (BPA) group, the C8–T1 roots were avulsed from the spinal cord at the level of the lower trunk (n = 10). Rats in a sham-surgery group underwent a similar surgery, although without the root avulsion (n = 7). Rats in a naïve group underwent no surgery (n = 7). Mechanical hyperalgesia of the forelimb plantar surfaces corresponding to C6 and C7 dermatomes was evaluated using a von Frey filament test every third day for 3 weeks (n = 15). Activation of astrocytes and microglia was examined immunohistochemically using anti-GFAP and anti-Iba-1 antibodies 3 days after surgery (n = 9).

RESULTS: Rats in the brachial plexus avulsion group displayed significant mechanical hyperalgesia in the dermatome innervated by uninjured nerves both ipsilaterally and contralaterally, continuing through day 21 compared with rats in the sham-surgery and naïve control groups. Iba1-immunoreactive microglia and GFAP-immunoreactive astrocytes were significantly activated on the ipsilateral side of the BPA group from levels C3–T3 compared with the sham-surgery and naïve group rats.

DISCUSSION: Activation of glia at uninjured levels of the dorsal horn may facilitate pain transmission following brachial plexus avulsion injury. Consequently, spared spinal glial cells may represent therapeutic targets for treatment of pain related to brachial plexus avulsion injury.

SP22**THERAPEUTIC EFFICACY OF PREGABALIN IN PATIENTS WITH LEG SYMPTOMS DUE TO LUMBAR SPINAL STENOSIS SECOND REPORT: ONE-YEAR FOLLOW-UP**

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INTRODUCTION: We presented our findings that combination therapy with nonsteroidal anti-inflammatory drugs (NSAIDs) and pregabalin (PGB) is more effective for relief of leg symptoms due to lumbar spinal stenosis (LSS) compared with NSAIDs monotherapy in the chronic phase over 3 months after symptoms were evoked, and prevented aggravation of subjective symptoms in patients with radicular- and mixed-type neurogenic intermittent claudication (NIC), at the International Society for the Study of the Lumbar Spine (ISSLS) 2012 conference. The purpose of this study was to analyze the therapeutic efficacy of PGB and determine if spine surgery could be avoided in patients with leg symptoms due to LSS for up to 1 year after start of medical treatment.

METHODS: Study subjects were classified into two groups according to the treatment they received: the PGB group (n= 49, 27 males, 22 females), treated with combination NSAIDs and PGB therapy, and the control group (n= 47, 22 males, 25 females)

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treated with NSAIDs monotherapy. We compared the operation rate for spine surgery at 1 year after start of medical treatment between the two groups. Statistical analyses were performed by Mann-Whitney's U test.

RESULTS: Six of 49 patients (12.2%) in the PGB group and 22 of 47 patients (46.8%) in the control group required spine surgery between 3 months to 1 year after start of medical treatment. The spine surgery rate at 1 year after start of medical treatment was significantly lower in the PGB group than in the control group ($p=0.0035$).

DISCUSSION: NSAIDs and PGB combination therapy may enable avoidance of spine surgery for up to 1 year after start of medical treatment in patients with leg symptoms due to LSS, compared to NSAIDs monotherapy.

SP23

GENDER DIFFERENCE OF SYMPTOM SEVERITY IN LUMBAR SPINAL STENOSIS: ROLE OF PAIN SENSITIVITY

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INTRODUCTION: Given that gender differences in pain perception, there would be difference in pain responses between men and women with lumbar spinal stenosis (LSS). Furthermore, it may lead to a difference in the degree of impairment in both physical function and quality of life between men and women. Therefore, the purpose of this study was to elucidate the difference of symptom severity of LSS between men and

women in relation to pain sensitivity.

METHODS: In 160 patients who had symptomatic LSS, 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. Using the MR images, the degree of canal stenosis and disc degeneration was graded based on the method by Schizas and the Pfirrmann classification, respectively. Symptom severities, pain sensitivity, and radiologic findings were compared between men and women. In subgroup analysis, the correlation between pain sensitivity and symptom severities were analyzed.

RESULTS: After adjustment for age and the grade of disc degeneration, the pain sensitivity represented by total PSQ and PSQ-minor was significantly higher in women than in men. Moreover, higher VAS for back pain/leg pain and ODI were demonstrated in women than in men after adjustment for BMI, age, and the grades of canal stenosis and disc degeneration. Additional adjustment for pain sensitivity including total PSQ and PSQ-minor led to no differences in VAS for back pain/leg pain between genders. Women also demonstrated a lower quality of life regarding PF, RP, BP, GH, and PCS than men. A subgroup analysis showed that pain sensitivity has an influence on symptom severity and disability caused by LSS in both women and men.



DISCUSSION: Women showed increased low back pain and leg pain due to LSS com-

pared to men. The current study demonstrates it is mediated by pain sensitivity.

SP24

ATTEMPTING TO UNDERSTAND THE TEMPORAL RELATIONSHIP BETWEEN LUMBAR MUSCLE INFLAMMATION AND PERCEIVED LOW BACK PAIN

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INTRODUCTION: A low back pain diagnosis may be severely impacted by the limited understanding of the temporal relationship between injury, muscle inflammation, and perceived pain. While traditional research has concentrated on subjective assessments, recent imaging technology, specifically magnetic resonance spectroscopy, can identify responses in brain chemicals that result from pain stimuli. The objective was two-fold: 1) establish the strength of the relationship between the pain-induced brain metabolites and subjective pain ratings, and 2) determine the temporal correlation between muscle injury and pain.

METHODS: Ten individuals completed a battery of MRS scans of the brain, subjective pain ratings (0-10 scale) and MRI T2 scans of the erector spinae at baseline, immediately following a fatiguing lifting task, and 24 hours post-lifting task.

RESULTS: T2 values significantly decreased below baseline levels immediately following lifting task (~3%), and then rose (~5%) at 24-hrs. MRS data from the frontal cortex revealed that N-acetylaspartate (NAA) levels dropped immediately after lifting task and then increased at the 24-hrs follow-up time for females. Males had an opposite trend. All subjects reported no pain at baseline and a significantly higher level (4.6) immediately following lifting, which then decreased to 4.0 24-hrs post-lifting task.

DISCUSSION: The results provided an unclear picture of a temporal relationship. The initial drop in T2 values was unexpected, but followed a lack of increase in creatine and lactate, but not the elevated subjective ratings. 24 hrs post-lifting task T2 values increased above baseline, but were not accompanied by any brain metabolite changes. Subjective pain levels remained elevated which correlated with the MRI findings. Future work should focus on the latency period with more observations so a better understanding of the temporal link between biological response in the muscle, brain, and perceived pain can be established

SP25

PREDICTORS OF DYNAMIC INSTABILITY IN DEGENERATIVE SPONDYLOLISTHESIS

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INTRODUCTION: The factors that influence dynamic instability in patients with degenerative spondylolisthesis (DS) are not fully understood. The goal of this study is to determine the effects of disc height, disc degeneration, and spondylosis on dynamic instability in DS in order to better identify patients that are likely to develop slip progression.

METHODS: A retrospective review was performed on data from 125 patients with a known L4-L5 DS diagnosis. Radiographs of the lumbar spine in neutral, flexion, and extension views were used to determine degree of slip, disc height, translational motion, angular motion, spondylotic changes, and lumbar lordosis. Dynamic instability was defined as either 3mm of translation of one vertebral body on another and/or greater than 10 degrees of angular motion between adjacent endplates when comparing flexion/extension radiographs. ANOVA was

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used to find significant associations between dynamic instability and radiographic and demographic factors.

RESULTS: Thirty-nine patients (31%) in the cohort were found to meet criteria for dynamic instability. A significant correlation was found between increased disc height and increased angular motion ($p=0.0041$). The presence of increased spondylotic changes (osteophytes, subcartilaginous sclerosis, and facet hypertrophy) was significantly correlated with decreased translational motion ($p=0.047$). Furthermore, there was a significant correlation between advanced disc degeneration on MRI (as defined by the Pfirrmann grading system) with decreased angular motion ($p=0.025$).

DISCUSSION: In this study, increased disc height correlated with dynamic instability. This finding may represent a greater potential for slip progression over time in these patients. In contrast, disc height loss, disc degeneration on MRI, and spondylotic changes were inversely correlated with dynamic instability and may represent re-stabilization mechanisms in patients with DS.

SP26

HIP-SPINE SYNDROME (COMPLEX, MISDIAGNOSED): INCLUDING OVERDIAGNOSED SPINE DISESES AND UNDERDIAGNOSED HIP OSTEOARTHRITIS

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INTRODUCTION: Spine disorder and osteoarthritis of the hip (HOA) may sometimes coexist in the elderly. Therefore, MacNab advocate the concept of complex and misdiagnosed Hip-spine syndrome (HSS) to call attention to a symptom complex that results from concurrent hip and spine pathology. HSS is a well-known entity, however,

few papers have investigated the occurrence of misdiagnosed HSS and complex HSS. The object of study is to determine the incidence of overlooked HOA.

METHODS: The medical records of 1163 patients (138 men and 1025 women) (30-90 years) due to HOA treated with total hip arthroplasty were reviewed. Avascular necrosis, hip fracture, infection, and Perthes disease were excluded.

RESULTS: 1110/1163 patients (95%) has been previously diagnosed to have HOA. 53 patients (5%) were initially misdiagnosed, 52(98%) patients with spine-related conditions (SRC) and 1(2%) patients with knee osteoarthritis had been diagnosed and treated. The diagnoses of SRC were sciatica in 19 (37%), chronic LBP in 10 (19%), lumbar disk hernia in 10 (19%), spinal stenosis in 12 (23%) and lumbar spondylolisthesis in 1 (2%). A total of 6/53 (11%) were operated on, including 3 patients who underwent an operation for lumbar disk hernia without a satisfactory (misdiagnosed), and 3 patients who underwent an operation for spinal stenosis and the effect was insufficient (complex). All 6 of these patients, however, demonstrated a complete recovery from their symptoms after undergoing total hip arthroplasty.

DISCUSSION: The misdiagnosis rate among Japanese for HOA was 5%. Of these 5%, 95% of the final diagnoses were SRC. Particularly regarding HSS in HOA, patients presenting with these symptoms may lead to a misdiagnosis and erroneous treatment because of a failure to recognize the presence of concurrent of HOA and SRC, an atypical history, unexpected clinical findings, and the lack of radiological changes.

SP27

A FRACTURE OF THE TRANSVERSE PROCESS OF L5 IS A SENTINEL MARKER OF THE SEVERITY OF A PELVIC FRACTURE

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INTRODUCTION: A fracture of the transverse process of L5 (L5TP) may be associated with pelvic fracture instability and other organ injuries. However, there is little evidence to support this view. The objective of this study was to determine the significance of L5TP fracture in relation to the severity of pelvic fractures.

METHODS: A total of 56 patients (30 male and 26 females; mean age 53 years) who sustained a pelvic fracture were included. Every patient had a CT scan of the head, chest, abdomen and pelvis on admission. The patient demographics, circumstances of pelvic fracture, associated injuries and the need for blood transfusion and surgical intervention were recorded. The pelvic fractures were divided into the stable and the unstable types according to the Burgess and Young classification. The data were analyzed using the chi-squared test. The odds ratios for L5TP fracture as a predictor of the severity of pelvic fractures were calculated. A p-value < 0.05 was considered to be statistically significant.

RESULTS: There were 15 L5TP fracture (25%) and 41 non-L5TP fracture (75%). Of these patients, there were 8(53%) and 9(22%) with unstable fracture ($P<0.05$), 12(80%) and 20(49%) with sacral fracture ($P<0.05$), 4(27%) and 9(22%) with abdominal organ injury ($P=0.646$), 13(87%) and 25(61%) needed for blood transfusion ($P<0.05$), and 7(47%) and 6(15%) needed for surgical intervention ($P<0.05$), respectively. The odds ratios for the unstable type, sacral fractures, and the need for surgical intervention in the patients with L5TP fractures compared with non-L5TP fracture were 3.78 (95% confidence interval [CI], 1.05-13.58), 4.2 (95%CI, 1.03-16.98) and 5.4 (95%CI, 1.43-20.43), respectively.

DISCUSSION: The data suggest that a L5TP

fracture can be regarded as a sentinel marker of the severity of pelvic fractures in relation to the pelvic fracture instability, likelihood of a sacral fracture, need for blood transfusion and need for surgical intervention.

SP28

DISC INFILTRATION WITH PLASMACYTOID DENDRITIC CELLS, BUT NOT MACROPHAGES IS ASSOCIATED WITH SEVERE MUSCLE WEAKNESS AND ABSENCE OF STRAIGHT LEG RAISING I

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INTRODUCTION: Neurological deficits and sciatic pain have been reported as frequent symptoms of sequestration type of herniation of the lumbar disc. An immune response directed towards herniated nucleus pulposus has been suggested to represent one pathogenic mechanism for inducing these symptoms. Macrophages and plasmacytoid dendritic cells (PDCs) are thought to be involved in initiation of an immune response. Stronger disc infiltration with macrophages has been reported to be associated with severe muscle weakness and presence of straight leg raising (SLR). The aim of the present finding was to replicate these findings.

METHODS: Total 18 patients with sequestered disc herniations underwent neurologic examinations before microdiscectomy. A scale ranging from 0 (no muscle contraction) to 5 (normal strength) was used to evaluate severity of muscle strength. Single cells were separated from digested discs, counted, stained with specific surface markers of macrophages (CD11c, CD14), PDCs (CD123, CD4) and memory CD4+T cells (CD4, CD45RO) and

analyzed by flow cytometry.

RESULTS: Discs of patients with severe loss of muscle strength (grade 2 and 3) and patients with mild muscle weakness (grade 4 and 5) were infiltrated by macrophages ($p < 0.67$) and memory CD4+T cells ($p < 0.63$) in similar proportions. Disc infiltrates of patients having severe neurologic deficits were found to contain PDCs in a higher proportion. Patients with severe muscle weakness did exhibit a negative SLR more frequently than patients with mild deficits ($p < 0.03$).

DISCUSSION: The findings of the present study indicate that severe muscle weakness and absence of SLR is accompanied by a stronger disc infiltration with PDCs and not macrophages. These findings imply that PDCs may be involved in the pathophysiology of neurologic deficits. Since memory CD4+T cells did infiltrate discs it is reasonable to assume that PDCs may stimulate naïve CD4+T cells to acquire a TH2 effector function.

SP29

IMPROVED DIAGNOSTIC ACCURACY OF LUMBAR FORAMINAL STENOSIS BY USE OF THREE DIMENSIONAL MR IMAGING : COMPARISON WITH CONVENTIONAL MR IMAGING

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INTRODUCTION: Failure to diagnose lumbar foraminal stenosis (LFS) is the main reason for failed back surgery syndrome, and difficulty in identifying LFS with conventional imaging modalities is a well-recognized issue. Therefore, new imaging techniques to detect LFS are required. The aims of this study were to assess the reliability of 3-dimensional MRI

(3D-MRI) and conventional MRI (c-MRI) in the detection of LFS and to compare the diagnostic accuracy of the 2 imaging modalities

METHODS: A total of 60 sets of 3D-MR and c-MR images from 20 normal volunteers and 40 LFS patients were qualitatively rated according to defined criteria by 2 independent, blinded readers. Diagnostic criteria on 3D-MRI were as follows: (1) transverse path of the nerve, (2) obscurity of the spinal ganglion, (3) spinal nerve constriction, and (4) nerve swelling. On c-MRI, obliteration of the perineural fat surrounding the nerve root in the intervertebral foramen was considered a positive finding for LFS. Kappa statistics were used to characterize intra- and inter-reader reliability for qualitative rating data. Multireader, multicase analysis was used to compare LFS detection between the 2 imaging modalities.

RESULTS: Intra-reader reliability of 3D-MRI showed excellent agreement, with kappa = 0.88, and that of c-MRI showed good agreement, with kappa = 0.63. Inter-reader agreement of 3D-MRI was good, with kappa = 0.76, while that of c-MRI demonstrated moderate agreement, with kappa = 0.41. The average area under the ROC curve (AUC) values for the detection of LFS using 3D-MRI and c-MRI were 0.96 and 0.91, respectively. The detection of LFS with 3D-MRI was significantly better than that using c-MRI ($P = 0.0326$).

CONCLUSIONS: 3D-MRI demonstrated good reliability and detectability of LFS. Furthermore, readers' performance in the diagnosis of LFS can be improved with the use of 3D-MRI. Therefore, 3D-MRI is recommended when using imaging for the diagnosis of LFS.

SP30

IN VIVO MRI MEASUREMENT OF SPINAL CORD DISPLACEMENT IN THE THORACOLUMBAR REGION: PART 1 - STRAIGHT LEG RAISE TEST.

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INTRODUCTION: The investigated in vivo spinal cord displacement in the thoracolumbar vertebral canal during the performance of the passive SLR in asymptomatic subjects as to obtain quantitative data that will describe the mechanical behavior of the neural tissues of this clinically important region.

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.

The position of the medullar cone relative to a reference point on the upper plateau of the adjacent vertebral body during the unilateral passive right and left SLR was quantified and compared with the position of the conus in the neutral (anatomic) position. Each movement was performed twice in order to calculate intraclass correlation coefficients (ICC). Four practitioners performed the SLR maneuvers in a random sequence in order to avoid possible series effects.

RESULTS: Compared to the position in the

neutral (anatomic) position, the medullar cone displaced caudally in the spinal canal by $2.6 \pm 1.1\text{mm}(\mu \pm \text{SD})$ during the right SLR ($p=0.000$) and $2.5 \pm 1.2\text{mm}$ during the left SLR ($p=0.000$). The ICCs were as follows: reference position = 0.994, right SLR = 0.997, left SLR= 0.996. Number of required subjects to get statistically significant results ($p<0.05$) is 4 both for right and left SLR.

CONCLUSIONS: These in vivo data show that the spinal cord in the thoracolumbar region slides distally in response to the clinically applied SLR test. Due to the neural continuum, it is likely that this distal movement occurs via sliding of, and transmission of forces through, the lumbosacral neural roots and dura. We speculate that there may be a proportional relationship between the behavior of the conus and the mobility of the lumbar nerve roots.

SP31

SHOULD THE PRESENCE OF BACK PAIN BE CONSIDERED WHEN MAKING SURGICAL DECISIONS FOR LUMBAR SPINAL FUSION?

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INTRODUCTION: When deciding on surgical treatment of lumbar degenerative disease cases with indications for spinal fusion, surgeons may take the degree of back pain into consideration. We reported that back pain significantly improves after lumbar decompression surgery. If decompression surgery shows equivalent treatment effects in improvement of back pain with fusion surgery,

back pain need not be a consideration in decision making. In this study, improvement of back pain following decompression surgery and fusion surgery was evaluated.

METHODS: Patients with lumbar degenerative disease treated by decompression surgery (decompression: n=24) or fusion surgery (fusion: n=28) were evaluated pre- and post-operatively using the Oswestry Disability Index (ODI) and a visual analogue scale (VAS: 0-100 mm) for back pain. Detailed VAS evaluations for back pain in three situations (in motion, standing, sitting) were also performed for patients with VAS>40.

RESULTS: The mean evaluation scores (pre-operative, post-operative) were: ODI, decompression (38, 24), fusion (43, 23); VAS for back pain, decompression (47, 32), fusion (55, 23). The mean detailed VAS scores for back pain were: decompression, in motion (66, 34), standing (74, 37), sitting (70, 34); fusion, in motion (75, 24), standing (77, 28), sitting (62, 31). Improvements of VAS for back pain and ODI were significantly better in the fusion group ($p<0.05$). Fusion surgery showed a non-significant tendency towards better improvement in pain in motion (22 vs. 50; $p=0.095$), and no significant differences in pain in standing and sitting.

DISCUSSION: Compared with decompression surgery, better improvement of back pain may be expected after fusion surgery. Particularly, if patients show severe back pain in motion, fusion surgery may be indicated even for cases with a relative indication

SP32

INDICATION OF FUSION USING THE INTRAOPERATIVE SEGMENTAL MOTION MEASUREMENT SYSTEM FOR LUMBAR CANAL STENOSIS ~ A PROSPECTIVE STUDY ~

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INTRODUCTION: There is still controversy on the indication of fusion for the patients

with lumbar spinal stenosis (LSS). The purpose of this study was to investigate if a biomechanical definition of segmental instability and an indication of fusion using a novel intraoperative measurement system (IOMS) are effective.

METHODS: In 111 patients with LSS in whom instability was measured for L4-5 lesion using IOMS, 36 patients were enrolled in this study. Instability was determined as a segment with neutral zone (NZ) > 2 mm/N using IOMS (JBJS 2011). Surgical procedures were determined during surgery with IOMS: if NZ \leq 2 mm/N, decompression with laminoplasty (Group D) and if the NZ > 2 mm/N, fusion (TLIF) was indicated (Group F) respectively. 27 patients in Group L (M/F=16/11, 68 years) and 9 in Group T (M/F=3/6, 59.9 years) with L4-5 lesion followed more than 3 years. The symptom was compared between the groups by using SF-36 (physical function) and visual analog scale (VAS) of low back and leg pains. X-ray parameters (disc height, ROM, spondylolisthesis, lumbar lordosis [LL], Sacral slope [SS]) were also compared at the final follow-up (F/U).

RESULTS AND DISCUSSION: Clinical symptoms of both groups were significantly improved (PreOP SF-36: D=41.4, F=50.8, VAS/low back & leg: D=61.9&67.7, F=77.5&69, at final F/U SF-36: D=75.5, F=84, VAS/low back & leg: D=19.2&14.5, F=47&22.5) ($p<0.05$). All the segments in Group F were fused. In Group D, there was no significant change in disc height, ROM, grade of spondylolisthesis, LL, and SS at the final F/U. There was no complication in both groups. Thus, the surgical treatment determined by IOMS which realized a biomechanical definition of instability in clinical setting, was effective. This suggests that a biomechanical evidence for surgical indication instead of anecdotal one contributes to better result.

SP33

ACCELERATION OF LUMBAR POSTEROLATERAL FUSION USING A COLLAGEN-BINDING DOMAIN FUSED WITH bFGF AND ALLOGRAFTING IN A RAT MODEL.

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INTRODUCTION: Recombinant growth factors including bone morphogenetic protein are currently approved for human use, but some adverse effects including ectopic bone formation and inflammatory reactions have been reported. To enhance stable bone formation using growth factors, we fused basic fibroblast growth factor (bFGF) to a collagen binding domain (bFGF-CBD) in order to extend its activity. This was combined with allograft in posterolateral fusion surgery in rats.

METHODS: Twenty-two Wistar rats underwent bilateral posterolateral arthrodesis with 150g of frozen allograft on each side at L4-5. The animals were divided into three groups: (1) no treatment (sham group, n=2); (2) phosphate buffered saline-impregnated (PBS group, n=10); and (3) bFGF-CBD-impregnated allograft (bFGF group, n=10). Anteroposterior radiographs were taken every week and rats were sacrificed at twelve weeks for evaluation of spinal fusion using manual palpation, radiographs, and micro-computed tomography (CT). The volume of new bone was quantified and compared in the three groups.

RESULTS: The fusion rates, as determined by manual palpation, were 0% in the sham group, 12.5% in the PBS group, and 79.2% in

the bFGF group. Optical density of fusion masses in the bFGF group was significantly higher than in the sham and PBS groups (4.6 ± 1.6 vs 0.01 ± 0.00 mm²) ($p < 0.05$). Total bone volume was significantly higher in the bFGF group than in the other groups ($p < 0.05$). Histologically, the fusion site of the FGF group showed a larger volume of reactive bone and levels of vascularity compared with the other groups. A complete bony bridge between the transverse processes was not observed in the sham and PBS groups. Vascular density was significantly greater in the peri-apophyseal region compared to the center region.

CONCLUSIONS: bFGF-CBD combined with allograft may fulfill a current need for an osteoinductive factor. bFGF induced active osteogenesis both radiologically and histologically in a rat posterolat

SP34

RADIOLOGICAL ASSESSMENT OF LUMBAR SPINAL FUSION: RADIO-STEREOMETRIC ASSESSMENT VERSUS COMPUTED TOMOGRAPHY IN A LARGE ANIMAL MODEL.

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INTRODUCTION: Computed Tomography (CT) is used to assess fusion integrity following surgery, but has a high radiation penalty. Radiostereometric analysis (RSA) is an alternative method with lower radiation exposure. This study compares RSA and CT to assess fusion using histology as the gold standard in an animal model.

METHODS: Three non-adjacent anterior lumbar interbody fusions were carried out in the lumbar spine using a PEEK cage and autologous bone graft in 9 sheep (total 27 levels). Tantalum markers were inserted at 5-7 positions in each vertebral body. The sheep were divided into 3 groups; Group 1 (n=9

levels) underwent RSA post-operatively, 3 and 6 months after surgery. Group 2 (n=9 levels) had in addition, a further RSA assessment at 9 months and Group 3 (n=9) had in addition, a further RSA assessment at 12 months. All animals were sacrificed following the last scheduled RSA. The lumbar spine was removed and fine-cut CT was carried out at each level and followed by histological assessment. RSA films were examined using UmRSA software v 6.0 (RSA Biomedical, Umea, Sweden,) to determine fused levels. Fine-cut CT scans were used to assess fused levels by three independent radiologists. Histology sections were reviewed by two trained observers.

RESULTS: Using histology as the gold standard for assessing fusion status, RSA demonstrated superior results (sensitivity 100%, specificity 66.7%, PPV 27.3%, NPV 100.0%) compared to CT (sensitivity 66.7%, specificity 60.0%, PPV 16.7%, NPV 93.8%). However inter-observer reliability of CT scan assessment was poor ($k = 0.07$, p -value = 0.353).

DISCUSSION: Using histology as the gold standard for assessing fusion in this animal model, RSA demonstrated higher sensitivity and specificity when compared to CT. Furthermore RSA offers a lower radiation exposure compared to fine cut CT. Future studies are required to see if RSA remains superior to CT Scan for the assessment of spinal fusion in the clinical setting.

SP35

THE EFFECT OF PLATELET-RICH PLASMA (PRP) ON POSTEROLATERAL FUSION (PLF) IN A RAT MODEL

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INTRODUCTION: The purpose of this study was to examine PRP for its effect on the amount of bone formation after PLF, and to

follow the immunohistochemical changes in calcitonin gene-related peptide (CGRP) in dorsal root ganglion (DRG) neurons innervating the discs.

METHODS: FluoroGold (FG) was applied to the surface of L4/5 discs in 60 rats. 10 rats constituted a non-punctured disc sham group, while another 10 rats constituted a group that underwent only puncture of the L4/5 discs. 40 rats were in experimental groups in which L4/5 discs were punctured; PLF was performed with the use of PRP or without PRP. PRP was made from 10 donor rats and analyzed for growth factor concentrations. After surgical treatment, micro CT examinations evaluated the amount of bone formation and the L4/5 lumbar spines were harvested to evaluate bone union in the experimental groups, followed by resection of DRG neurons in all groups. The DRGs were processed for CGRP, pain-associated inflammatory neuropeptide. The percentages of FG-labeled and CGRP-immunoreactive (IR) neurons were calculated. The harvested spines were sliced and stained with hematoxylin and eosin.

RESULTS: The platelet count in PRP was about 4.2-times higher than that in blood, and the concentration of growth factors in PRP was more than ten-times higher than that in blood ($P < 0.05$). Bone volumes of L4/5 intertransverse processes in the PLF + PRP group were significantly greater than those in the normal PLF group ($P < 0.05$). However, a significant difference in joined bones was found only at four weeks. The proportion of CGRP-IR neurons was significantly greater in the punctured group than in other groups. No significant differences were found between the normal PLF group and the PLF + PRP group.

DISCUSSION: PRP appears to promote bone formation and has a tendency to shorten the time required for bone union. But, the use of PRP did not influence the inflammatory pain originating from the degenerative interver-

tebral disc.

SP36

SURGICAL MANAGEMENT OF DEGENERATIVE LUMBAR SPONDYLOLISTHESIS: A COMPARATIVE STUDY OF 5-YEAR OUTCOMES FOLLOWING DECOMPRESSION WITH FUSION AND MICROENDOSCOPIC DECOMPRESSION

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INTRODUCTION: This study was undertaken to compare the outcomes following decompression with fusion (FU) and microendoscopic decompression (MED) for patients with degenerative lumbar spondylolisthesis (DS).

METHODS: Forty-one consecutive patients with DS were treated surgically. The first 16 patients (FU group) underwent FU, the second 25 patients (MED group) underwent MED, and the outcomes following the two surgical methods were compared 5 years after surgery. Patients in the MED group were classified into two groups based on all preoperative radiological measurements: a group with measurements of larger (group L) and a group with measurements of smaller (group S). All degrees of improvement (DOIs: postoperative score - preoperative score of the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire) were statistically compared between the FU and MED groups, and between groups L and S.

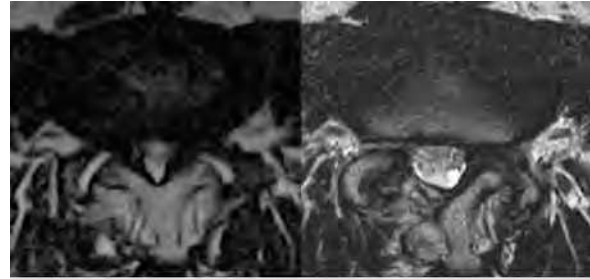


Fig. T2-weighted MR axial images obtained in a 68-year-old man with L4 degenerative spondylolisthesis in the MED group. Preoperative image (left) showed severe stenosis at L4/5. Postoperative image at 5 years after MED (right) showed sufficient decompression and preservation of the posterior structures of the spine.

RESULTS: DOI in social life function was significantly greater in the MED group than in the FU group. DOIs in the other 4 functional scores (FSs) were greater in the MED group than in the FU group. DOI in low back pain was significantly greater in group S than in group L in respect to the percentage of slipping (POS) in neutral position. DOIs of 3 FSs were significantly greater in group S than in group L in terms of the POS at maximal extension. DOIs of 3 FSs were significantly greater in group L than in group S regarding the intervertebral angle at flexion. Although statistically not significant, DOIs in all 5 FSs were greater in the FU group than in the MED group regarding the preoperative POSs in neutral position among the cases with over 20% slipping and in maximum extension among those with over 15% slipping.

DISCUSSION: MED is a useful, minimally invasive surgery and can lead to a better clinical outcome than FU for DS (Fig.), but from the results of this study and our 2-year outcome ('11, ISSLS), FU is advocated in case DS shows more than 20% slipping.

SP37

RISK FACTORS FOR SEVERITY OF SYMPTOMS IN PATIENTS WITH LUMBAR SPINAL STENOSIS

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INTRODUCTION: There is insufficient evidence about a correlation between clinical symptom/function with canal stenosis in patients with lumbar spinal stenosis (LSS). The purpose of this study was to verify the correlative factors including canal stenosis with a disease-specific outcome in LSS.

METHODS: We recruited patients with LSS with no previous treatment for the last 3 months. Patients completed questions about their backgrounds and patient-reported outcome (: Zurich Claudication Questionnaire (ZCQ), and Hospital Anxiety and Depression Scale (HADS). The ZCQ is a LSS-specific patient-reported outcome which consists of three domains: the Symptom Severity (SS) scale, the Physical Functional (PF) scale, and the Satisfaction. The severity of canal stenosis was graded by the T2-weighted axial imaging at the most stenotic level; Grade 0: no central canal stenosis, Grade 1: (cross-sectional area) $<1/4$ of its normal size, Grade 2: $1/4 <$ (cross-sectional area) $<1/2$, Grade 3: $1/2 <$ (cross-sectional area) $<3/4$, Grade 4: $3/4 <$ (cross-sectional area). A General linear regression models were applied to find parameters which had have association with the SS/PF scales. A significance level was used to 0.05.

RESULTS: A total of 249 patients participat-

ed in the study. Over half of patients (55.9%) had stenosis of Grade 3 or 4 ($1/2 <$ cross-sectional area). The PF scale had a significant correlation with the severity of canal stenosis (Grade 4 versus Grade 0-2: $p=0.0008$) and the HADS total score (over 20 versus below 11: $p<0.0001$). The SS scale had a significant correlation with the HADS total score (over 20 versus below 11: $p<0.0001$).

DISCUSSION: This study showed that the severity of canal stenosis by the unloaded MRI has the association with the physical function by adopting a disease-specific outcome.

SP38

SCOLIOSIS IS A RISK FACTOR FOR GASTROESOPHAGEAL REFLUX DISEASE IN ADULT SPINAL DEFORMITY

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INTRODUCTION: Patients with DLKS (degenerative lumbar kyphoscoliosis) are at risk of developing various visceral organ disorders due to their trunk deformity. The aim of this study was to evaluate the influence of the trunk deformity on gastroesophageal reflux disease (GERD).

METHODS: One-hundred-fifty-nine patients over 40 years of age (mean 70.3 years, 39 males and 120 females) who had whole spine X-ray and answered to the Quest (Q; Questionnaire for the diagnosis of reflux disease) were included in this study. Quest is an 18-point scale and has been developed

for the screening of GERD patients. Patients with Q score 6 points or more were defined as GERD positive. Radiological parameters including Cobb angle, sagittal alignment and trunk balances were measured and evaluated the relation to the Q score with Pearson's correlation coefficient analysis. Multivariate logistic regression analysis was performed to evaluate the risk factors for GERD.

RESULTS: There were 50 GERD positive patients among 159 patients. In order to discriminate the direction of lumbar curve, we defined right convex curve as negative and left convex curve as positive value. There were 40 patients with right convex lumbar curve (mean -34.2°) and 68 patients with left convex lumbar curve (mean $+34.9^\circ$). Q score was significantly correlated with lumbar Cobb angle ($R=0.28$) and thoracic Cobb angle ($R=-0.19$). There were no significant correlations with sagittal parameters. In multivariate regression analysis, lumbar Cobb angle was significantly associated with the presence of GERD (Odds ratio 1.03, 95% CI 1.10-1.04). Moreover, lumbar Cobb angle larger than 30° was strongly associated with the presence of GERD (Odds ratio 10.06, 95% CI 2.03-49.86).

DISCUSSION: This study showed that left lumbar curve larger than 30° was a significant risk factor for the presence of GERD. We should consider that lumbar deformity may affect the visceral organ when evaluating DLS patients.

SP39

DECOMPRESSIVE SURGERY REDUCED RISK OF FALLING MORE SIGNIFICANTLY IN PATIENTS WITH LUMBAR SPINAL STENOSIS COMPARED WITH CONSERVATIVE TREATMENT

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INTRODUCTION: To demonstrate the effect of decompressive surgery on the risk of falling in patients with lumbar spinal stenosis(LSS) compared with conservative treatment, as there has been no report to demonstrate the effect of decompressive surgery on the risk of falling in patients with LSS.

METHODS: From June 2011 to September 2011, 33 patients who underwent decompressive surgery for LSS and 30 patients who received conservative treatments for LSS were enrolled prospectively. Walking distance, Oswestry disability index (ODI), and EuroQol 5 dimension (EQ-5D) visual analogue scale were measured depending on treatment modality. Four functional mobility tests were used to evaluate the risk of falling, including the Alternate-Step Test (AST), Six-Meter-Walk Test (SMT), Sit-to-Stand test (STS), and Timed Up and Go test (TUGT).

RESULTS: The mean age was 65.3 (51~84) years in surgery group and 68.3 (58~82) in conservative treatment group. The preoperative mean single walk distance was 113.1 (range, 0~400) m in surgery group and 140.3 (range 30~400) m in conservative treatment group. The mean ODI was 25.8 (9~39 preoperatively in surgery group) and 21.4 (9~37 before treatment in conservative group) ($P < 0.05$). The mean EQ-5D VAS was 34.9 (0~70) preoperatively and 45.7 (30~70) at starting point of conservative treatment($P < 0.05$). The preoperative mean values of the four functional tests were not different significantly in both group. Among the four tests, the AST and STS values were reduced significantly in both surgery and conservative treatment group at follow-up 3 months and 1 year, but more significantly decreased in surgery group after decompressive surgery ($P < 0.05$).

DISCUSSION: Surgical treatment in elderly patients with LSS will be helpful not only in reducing pain but in decreasing risk of falling compared with conservative treatment.

SP40

DEPRESSIVE BURDEN IS ASSOCIATED WITH A POORER 5- YEAR SURGICAL OUTCOME IN LUMBAR SPINAL STENOSIS

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OBJECTIVE: Our studies examined factors related to the rehabilitation period after surgery, and demonstrated that depressive symptoms in the preoperative and early recovery phase were strong predictors of the outcome of surgery on 1- and 2-year follow-ups.

To investigate the effects of depressive symptoms on the 5-year outcome of surgery among lumbar spinal stenosis (LSS) patients.

METHOD: Altogether, 102 patients underwent decompressive surgery and completed a set of questionnaires preoperatively and 3 and 6 months, and 1, 2 and 5 years after the surgery. Depressive symptoms were assessed with the Beck Depression Inventory (BDI). The depressive burden was estimated by summing all individual BDI scores. The outcome of surgery was evaluated with the Oswestry Disability Index (ODI) for estimating functional ability, the Visual Analogue Scale (VAS) for estimating pain and the self-reported walking capacity.

RESULTS: On 5-year follow-up, a high depressive burden associated with a poorer outcome of surgery when assessed with the ODI. In linear regression analysis, a high depressive burden associated with a higher ODI score (B 0.14, $p < 0.05$, adjusted $R^2 = 64.4\%$).

CONCLUSION: Even slightly elevated long-term depressive symptoms in LSS-patients associated with an increased risk of a poor outcome following decompressive surgery. To conclude, our results strongly suggest that even subclinical depressive symptoms

in LSS patients should not be ignored at any phase of the rehabilitation period.

Significant Outcomes: Long-term depressive symptoms in LSS-patients are associated with an increased risk of a poor outcome following decompressive surgery.

Limitations: This study was based on a small sample. There might be other, unrecorded factors that confound our results.

SP41

SUBOPTIMAL VITAMIN D INCREASES RISK FOR INFECTION AFTER SPINE SURGERY

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INTRODUCTION: Vitamin D deficiency has increased in the general population over the past decade. The traditional actions of vitamin D in promoting bone health and mineralization provide reason for deficiency screening prior to spinal fusion, especially with the prevalence of bone diseases such as osteoporosis. Interestingly, we found it equally important to test vitamin D levels prior to fusion based on its nonskeletal function as a key factor in immunomodulation.

METHODS: 50 male Sprague Dawley rats were randomized into four experimental vitamin-D diet adjusted groups: controls (CD, 5 IU/g), deficient (DD, 0 IU/g), insufficient (ID, 2.25 IU/g), and hypervitamin D (HD, 40 IU/g). Diets were modified for 1 month prior to fusion surgery and maintained until sacrifice. Posterolateral lumbar fusion was performed using a tailbone autograft implanted into the L4-L5 intertransverse process space. No antibiotics were administered. Adverse events were systematically documented throughout the study. Plasma was collected at surgery and sacrifice and 25(OH)D levels were determined via radioimmunoassay.

RESULTS: Rats fed vitamin D deficient chow (DD, 0 IU/g, 9.3 ± 1.6 25 ng/mL (OH)D levels) had a 15.4 % mortality rate during the first week after surgery. All of the rats fed ID, CD,

and HD chow survived through the end of the study. Deep surgical infections were significantly greater in DD fed rats 18% and ID fed rats 16.7% (15.6±5.0 ng/mL 25(OH)D) than in CD 0% (19.6±5.6 ng/mL 25(OH)D) or HD fed rats 0% (88.4±9.9 ng/mL 25(OH)D), $p < 0.03$.

DISCUSSION: Numerous studies link vitamin D insufficiency with various immune disorders, however little to no data exists on effect of suboptimal vitamin D on surgical patients despite their vulnerable post-operative status. The result of this preliminary study suggests preoperative screening and supplementation of vitamin D may be a cost effective way to reduce infection and decrease mortality after spinal fusion.

SP42

PROPIONIBACTERIUM ACNES CAUSES DELAYED SURGICAL SEITE INFECTION ONLY IN THE PRESENCE OF IMPLANT.

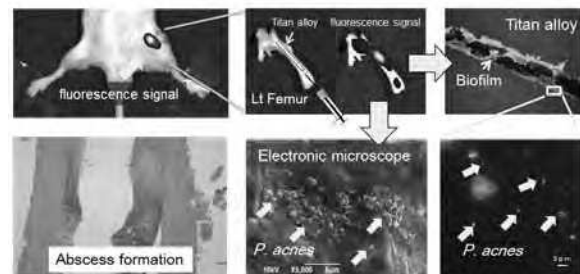
Shiono Y.1, Ishii K.1, Nagai S.2,3, Kuramoto T.1, Yoshioka K.1, Ishihama H.1, Funao H.1, Kakinuma H.5, Sasaki A.4, Aizawa M.5, Okada Y.4, Koyasu S.2, Toyama Y.1, Matsumoto M.1

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INTRODUCTION: It is recently reported that Propionibacterium Acnes (*P. acnes*) causes implant-associated infection (IAI) in spinal surgery. We also showed that *P. acnes* was frequently detected in the intraoperative specimens from the scoliosis surgery even though no infectious symptoms were ob-

served (Spine 2011). Thus, little is known about the kinetics of *P. acnes* in vivo. Here we examined whether *P. acnes* causes the surgical site infection.

METHODS: In the model of osteomyelitis simulating the pyogenic spondylitis, *P. acnes* ($1E+8$ CFU) was inoculated into the femur of the adult mouse with (implant group) or without (control group) 0.5 x 8mm titan alloy bar. Fluorescent bacterial detection probe was injected intravenously, then *P. acnes* was tracked using IVIS® Lumina optical imaging system for 6months. The biofilm formation on the implanted bars and histological tissues were observed under a microscope.



RESULTS: During first 7days, bacterial signal from *P. acnes* was clearly identified in the femur in both groups. Afterward, the signal completely disappeared in the control group. Surprisingly, in the implant group, the bacterial signal was maintained over 6months. Microscopic findings showed that *P. acnes* survived in the biofilm around the implant, and active inflammation and abscess formation were shown over 3months in the implant group, but not in the control group. Moreover, the presence of *P. acnes* was confirmed in the specimen from the femur of 6month-mice by PCR.

DISCUSSION: We have successfully proved that *P. acnes* cause delayed IAI over 6months in the osteomyelitis model. Interestingly, *P. acnes* could not survive for a long term without implant. To our knowledge, this is the first demonstration of delayed surgical site infection caused by *P. acnes*.

SP43

IMPLEMENTATION AND IMPACT OF PRE-OPERATIVE PEER CASE REVIEW IN A SPINE PRACTICE

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INTRODUCTION: A vital part of quality surgical care is selecting the most appropriate procedure for each patient, which can be very challenging in those with complex problems. The purpose of this study was to describe a practice-based peer-review process in a private practice and analyze its impact on surgeries performed.

METHODS: Pre-operative case review was initiated in 2009 to review proposed complex surgeries (excluding emergencies, deformity, and tumor): fusion of >2 levels, significant anesthesia or vascular risk, body mass index of >40, multiple prior surgeries at the same level, and advanced age. Indications and rationale for the proposed surgery were discussed, which resulted in: approval as proposed, modifying surgical plan based on options and risks, further diagnostics and possibly re-reviewing the case, or not performing surgery. Surgery logs were reviewed to monitor compliance with submitting cases to review and if a reviewed patient underwent surgery, to compare the procedure performed to committee's recommendation.

RESULTS: The committee reviewed 261 proposed cases. Of these, 189 (72.4%) were approved. The committee disagreed with the proposed surgery in 72 (27.6%) cases. In these, the committee suggested: no surgery in 2 (2.8%), change surgical plan 47 (65.3%; reduce number of levels, alter procedure, etc.), and further diagnostics 23 (31.9%). In 72 cases where the committee disagreed with proposed surgery, the plan was changed in 72.2% (2 cases too recent to

classify). In all cases where less extensive surgery was performed as the committee recommended, no subsequent surgery was needed.

DISCUSSION: The peer-review program impacted 23% of reviewed cases and remains active. By using well-defined criteria, cases can be identified for review with the goal of increased safety and quality by taking advantage of multiple surgeons' experience to derive a treatment plan after non-operative care fails. This program can serve as a model for other clinics.

SP44

OUTCOMES FOLLOWING TRANSFORAMINAL ENDOSCOPIC SURGERY - TWO YEAR RCT RESULTS

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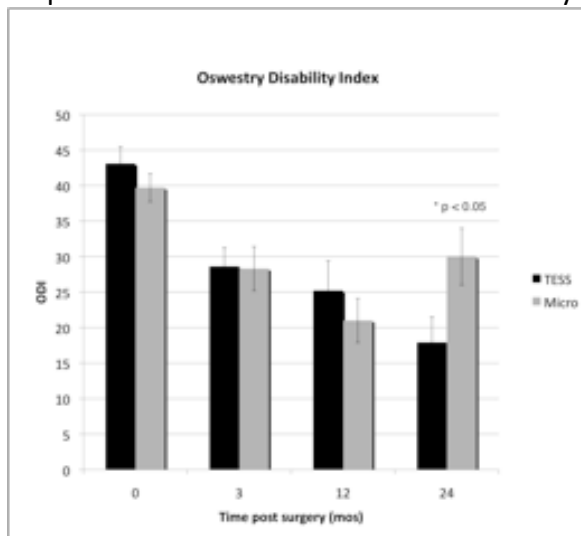
INTRODUCTION: Transforaminal endoscopic discectomy (TESS) is less-invasive than microdiscectomy (Micro) but long-term outcomes should be equivalent to support routine use of the technique. The aim of this study was to compare outcomes and cost data 3 months, 1 and 2 years after surgery.

METHODS: Patients aged 25-55 and <100kg weight with a single-level primary lumbar disc prolapse were randomly allocated by computer to TESS or Micro. Anaesthesia was by Sedation plus LA, or GA respectively. Assessments were made of leg and back pain (VAS), Oswestry Disability index (ODI), and SF-36 as primary outcomes measures. Costs were collated.

RESULTS: 54 TESS and 55 Micro patients are reported with similar age, sex, smoking status, affected disc levels (56 vs. 65% L5/S1) and site (33 vs. 29% central prolapse) respectively. Three months following surgery leg pain scores (affected leg) had decreased by 50 and 44% in the two groups (N.S.). Patient satisfaction ratings were equal. ODI

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had decreased 15 points in both groups by 1yr but by 2 years benefits from microdiscectomy had leveled off, compared to a continuing improvement after TESS (ODI TESS 18 ± 13 vs. Micro 30 ± 18 (n=49, means \pm SD, p<0.05). SF-36PF, and SF-36MH scores were similar at 1 and 2 years, with approximately a 40% improvement in PF over baseline. Mean overnight stay was lower in the TESS group (0.2 ± 0.45 TESS -v- 1.1 ± 0.45 Micro, p<0.05). Physio requirements of 2.8 ± 6.5 and 3.4 ± 4.5 visits respectively and other post-operative costs were similar. Four TESS patients required revision surgery within one year, all from the early part of the series. One TESS and one Micro required revision between 12 and 24 months. Three patients chose repeat endoscopic



DISCUSSION: Equivalent results are achieved following the two procedures. Functional improvements are maintained to two years.

SP45

CLINICAL AND RADIOGRAPHIC LONG-TERM RESULTS OF PEEK-NON-FUSION SPINE IMPLANTS

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INTRODUCTION: Independent validation of clinical and radiographic long-term outcomes of interspinous implants are needed. The aim of this study was to investigate outcomes in patients undergoing Wallis™ implantation.

METHODS: Retrospective cohort study of patients who underwent surgery for sole implantation of Wallis™ implant or in combination with discectomy, sequestrectomy, decompression and/or spondylodesis. Exclusion criteria were implant-associated revision surgery and missing clinical or radiographic data. Clinical measures were back and leg pain on the Visual Analogue Scale (VAS) and functional limitation defined by the Oswestry Disability Index (ODI); resorption at the implant-bone interface was examined using x-rays.

RESULTS: Twenty-one patients (13 male, 8 female, mean age 60 yrs [min 35, max 78]) with Wallis™ implantation at level L4/5 (11), L1/2 (4), L2/3 (4) and L3/4 (2) were assessed. After mean follow-up of 3.7 yrs (min 2, max 5.3), patients showed improved functional limitation (pre-op ODI 41, post-op 31, Wilcoxon signed rank test p=0.04) and leg pain (pre-op VAS 6.5, post-op 4.8, p=0.03), while back pain did not change (pre-op VAS 6.6, post-op 5.8, p=0.32). In 18 patients (85%) x-rays showed resorption at the implant-bone interface, and 2 of these also had fractures of the spinous processes. Six of the 21 patients were scheduled for surgical revision at the time of the last follow-up.

DISCUSSION: In the long-term follow-up,

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interspinous implants demonstrate considerable rates of implant-associated complications despite the improvement in functional limitation and leg pain. The time-limited effectiveness of the Wallis™ implant has to be taken into consideration when making treatment decisions and consulting with the patient.

SP46

OUTCOMES OF ANTERIOR, POSTERIOR, AND CIRCUMFERENTIAL LUMBAR FUSIONS

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INTRODUCTION: Lumbar fusions are commonly performed through anterior or posterior approaches, or both for degenerative pathologies. Epidemiology, complications and costs differences based upon surgical approach are not well known. A population-based database was analyzed in order to characterize these differences on a national level.

METHODS: Data from the Nationwide Inpatient Sample database was obtained from 2002-2009. Patients undergoing lumbar fusion for degenerative etiologies were identified and separated into three cohorts: anterior lumbar fusion (ALF), posterior lumbar fusion (PLF), and anterior & posterior spinal fusion (APLF). Patient demographics, co-morbidities, hospitalization days, costs, complications, and mortality were compared. Students T-test and χ^2 -test were used to assess significant differences. A p-value of <0.0005 was used to denote significance.

RESULTS: A total of 222,312 lumbar fusions were identified in the database from 2002-2009. PLF was the most commonly performed procedure comprising 82.6% of cases ($p<0.0005$)(Table 1). Patients in the PLF

group were older with more co-morbidities than the ALF and APLF groups ($p<0.0005$). ALFs had significantly increased costs and complication rates compared to the PLF group. Specific complications that were higher in ALFs were DVTs and infections, while neurologic complications were more common in PLFs. APLFs incurred the greatest costs and hospitalizations, and had the highest complication rates of all three groups. There was no significant difference in mortality amongst the three groups.

DISCUSSION: Our study concludes that patients undergoing circumferential lumbar fusions are at increased risk for complications and need to be monitored closely in the perioperative period. Furthermore, when choosing between surgical approach-

	Anterior Fusion	Posterior Fusion	Anterior-Posterior Fusion	ALF vs. PLF p-value	ALF vs. APLF p-value	PLF vs. APLF p-value
Count (unweighted)	20,089	183,716	18,507			
Age (mean)	47.9	57.1	50.5	<0.0005	<0.0005	<0.0005
% Male	44.9	43.6	45.6	<0.0005	0.17	<0.0005
% Female	55.1	56.4	54.4	<0.0005	0.17	<0.0005
CCI	1.71	2.68	1.99	<0.0005	<0.0005	<0.0005
Race (% Caucasian)	83.3	84.4	82.3	<0.0005	0.002	<0.0005
Insurance						
Medicare	17.2	36.6	20.7			
Medicaid	6.1	4.1	4.5	<0.0005	<0.0005	<0.0005
Private/HMO	58.2	46.6	56.0			
Other	18.5	12.8	18.9			
Teaching Hospital (%)	52.4	51.6	48.7	0.04	<0.0005	<0.0005
LOS (Days)	4.1	4.2	5.3	0.36	<0.0005	<0.0005
Costs	\$27,442	\$25,556	\$39,330	<0.0005	<0.0005	<0.0005
Mortality (per 1000 cases)	1.8	1.2	2.0	0.009	0.72	0.002
Overall Complications (per 1000 cases)	49.4	44.0	67.8	<0.0005	<0.0005	<0.0005
PE	2.5	2.4	4.4	0.82	0.001	<0.0005
DVT	6.7	3.3	7.4	<0.0005	0.39	<0.0005
Infection	13.1	6.2	16.4	<0.0005	0.007	<0.0005
Cardiac	8.6	8.9	13.5	0.62	<0.0005	<0.0005
Hematoma	14.7	13.2	19.1	0.07	0.001	<0.0005
CSF Leak	0.5	1.5	1.0	0.001	0.13	0.07
Shock	0.9	0.7	1.5	0.32	0.08	<0.0005
Neuro Comp	2.4	7.8	4.6	<0.0005	<0.0005	<0.0005

*All complications listed as incidence per 1000 cases.

es (ALF vs. PLF), the surgeon must consider specific complications that are more common to each approach while educating the patients on potential risks.

SP47**CURVE PROGRESSION AFTER DECOMPRESSION SURGERY IN PATIENTS WITH MILD DEGENERATIVE LUMBAR SCOLIOSIS**

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INTRODUCTION: The curve progression after decompression surgery in DLS (degenerative lumbar scoliosis) has not been studied. We evaluated the outcomes of decompression surgery in DLS patients to estimate its relevancy to DLS.

METHODS: Among 852 lumbar canal stenosis patients, 50 patients with lumbar curve $>5^\circ$ preoperatively and $>10^\circ$ at the final follow-up were included in the study (18 males, 32 females; mean age 70.2 ± 5.8 years, mean follow-up 2.8 ± 1.4 years). Patients with intolerable back pain due to trunk imbalance ($>5\text{cm}$), lumbar curve $>40^\circ$ or foraminal stenosis were excluded. Radiological parameters such as Cobb angle and degree of osteophyte were evaluated. Clinical outcomes were evaluated with Japan Orthopaedic Association Back Pain Evaluation Questionnaire and SRS-22.

RESULTS: Preoperative lumbar curve was $16.9 \pm 7.3^\circ$ (5 to 40°) and progressed $3.4 \pm 3.9^\circ$ (-2.0 to 22.0°). We divided patients into two groups according to the degree of curve progression: 11 patients with curve progression of $>5^\circ$ (P), and 39 patients with $\leq 5^\circ$ (NP). The preoperative lumbar curve was $P16.1^\circ$ vs. $NP17.2^\circ$, and progressed to $P24.6^\circ$ vs. $NP19.1^\circ$. The degree of curve progression was $P8.5^\circ$ vs. $NP2.0^\circ$. There were no significant differences in surgical method, level of decompression or location of the apex relative to decompression level. Multivariate logistic regression analysis for elucidating risk factors for progression

showed marginal significance ($p=0.062$) for vertebral osteophyte on the concave side. The rate of revision surgery was similar in two groups (1 in P and 4 in NP), and none had multilevel correction and fusion due to curve progression. Clinical outcomes at final follow-up were not significantly different between two groups.

DISCUSSION: These results indicate spinal correction and fusion is not always necessary if the patient's symptom derives from spinal canal stenosis. Also, osteophyte at the concave side may be a candidate predictive factor of curve progression.

SP48**PROSPECTIVE, RANDOMIZED, MULTICENTER STUDY COMPARING THE CLINICAL OUTCOMES OF TWO MINIMALLY INVASIVE INTERSPINOUS DEVICES FOR THE TREATMENT OF LUMBAR SPINAL STENOSIS**

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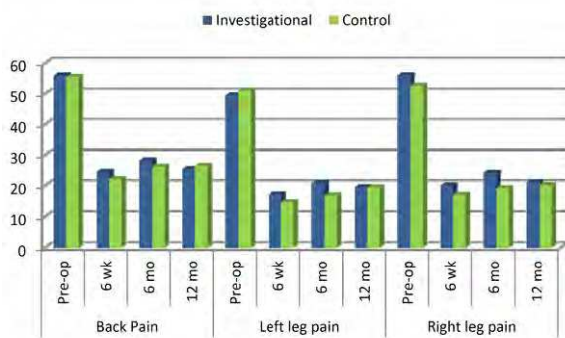
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INTRODUCTION: Lumbar spinal stenosis is a significant problem, often occurring in the elderly. In such patients, minimally invasive surgery may be particularly appealing. The purpose of this study was to compare outcomes of two lumbar minimally invasive interspinous implants.

METHODS: A total of 416 patients were enrolled and received an interspinous implant. Currently, 12-month follow-up is available for 293 patients, 153 randomized to Superior device (Investigational) and 140 to X-STOP (Control). Primary selection criteria were spinal stenosis at 1 or 2 levels between L1 and L4, minimum age 45 yrs, pain relief with flexion, failed at least 6 months of non-op care, and no spondylolisthesis greater than Grade I. Outcome measures included visual analogue scales (VAS) assessing pain, Oswestry Disability Index

(ODI), Zurich Claudication Questionnaire (ZCQ), complications, and re-operations.

RESULTS: Demographic factors were similar in the 2 groups. Mean blood loss (14.0 vs. 37.3 cc) and incision length (23.9 vs. 51.8 mm) were significantly less in the Investigational group and operative time was longer (56.5 vs. 47.1 min) compared with Controls ($p < 0.05$). VAS scores for left and right leg pain and back pain improved significantly in both groups by 6 weeks and remained significantly improved during 12 mo follow-up (all $p < 0.05$; see figure).



At no time on any of the measures was there a significant difference between groups. ODI and ZCQ scores followed a similar pattern of significant improvement with no significant difference between groups. At 12-mo follow-up, there was no significant difference in the re-operation rates (5.9% Investigational vs. 4.3% Control).

DISCUSSION: This study supports that interspinous devices provide significant improvement in neurogenic claudication symptoms in appropriately selected patients, with no significant difference in outcome between treatment groups. Outcome data were stable and significant improvement maintained on multiple measures.

SP49

FORAMINAL STENOSIS CAUSED BY OSTEOPOROTIC VERTEBRAL COMPRESSION FRACTURE OF THE LUMBAR SPINE

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INTRODUCTION: The lumbar nerve root can be compressed in the intervertebral foramen due to a herniated disc or bony structures, such as a hypertrophied facet, spur from the vertebral endplate. Changes in endplate shape, degree of disc bulging and foraminal height caused by osteoporotic vertebral compression fracture (OVCF) may lead to foraminal stenosis. The purpose of this study is to clarify the incidence and proportion of foraminal stenosis caused by OVCF of the lumbar spine.

METHODS: Between 2006 and 2010, 197 consecutive patients with OVCF aged over 65 years old underwent MRI at the first presentation. There were 60 males and 137 females and their mean age was 78 years. Collapsed areas of the vertebra were determined using sagittal T1 weighted images. Patients were classified into four types according to the collapsed area of the vertebra; upper type, central type, lower type and whole type. A paucity of peripheral fat surrounding the nerve root and a foramen of diminished size on parasagittal T1 weighted images were defined as foraminal stenosis. The foramina of both sides were observed.

RESULTS AND DISCUSSION: The incidences of foraminal stenosis were 5.2% in L1-2 caused by L1 and/or L2 OVCF, 13.6% in L2/3 caused by L2 and/or L3 OVCF, 22.4% in L3-4 caused by L3 and/or L4 OVCF, 38.2% in L4-5 caused by L4 and/or L5 OVCF and 60.7% in L5-S caused by L5 OVCF. The incidence of foraminal stenosis was observed in 13.6% of upper type at the superior adjacent foramen and that was observed in 37.5% of

lower type at the inferior adjacent foramen. This study demonstrated that foraminal stenosis caused by OVCF frequently observed at the lower lumbar spine. Collapse of the lower part of the vertebra caused foraminal stenosis in 60% of the cases. Collapse of the lower part of vertebra may lead to loss of foraminal height and alter the relationship between superior and inferior processes of the facet joints.

SP50

EFFECT OF PREVALENT VERTEBRAL FRACTURES ON THE OCCURRENCE PATTERN OF NEW VERTEBRAL FRACTURES - A POPULATION-BASED COHORT STUDY-

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INTRODUCTION: Vertebral fractures, which have the possibility of causing spinal deformity and/or chronic back pain, are associated with increased mortality. Vertebral fractures significantly increase the lifetime risk of future fracture; however the effect of prevalent vertebral fractures on the occurrence pattern of new vertebral fractures has not been evaluated. The purpose of this study was to determine if the presence of prevalent fracture at baseline can affect the type and location of new vertebral fractures in a population-based retrospective cohort study.

METHODS: Over a 10-year period (1997-2009), inhabitants of a typical mountain village in Mie, Japan, undergoing medical examinations and followed for more than 4 years were the subjects of this study (111 men, 235 women: mean age: 70.2 years [57-83]). Lateral thoracic and lumbar spine radiographs of each subject were taken; the presence and type of fractures at baseline and follow-up examination were evaluated using a semi-quantitative technique. Radiographic data were analyzed by dividing all

the subjects into two groups: the prevalent fracture (PF) absent (36%) and PF present (64%) groups.

RESULTS: During an average follow-up period of 8.0 years, new vertebral fractures occurred in 52% of the subjects. Among those, PF absent and PF present groups were 29.4% and 70.6%, respectively. There were no significant changes in fracture types between PF absent and PF present groups. In the PF absent group, new vertebral fractures were distributed bimodally with peaks at T7 and T12. In the PF present group, new fractures tended to locate at thoracolumbar levels. The level of prevalent fractures had no significant association with the occurrence rate of new fractures.

DISCUSSION: The results of this study showed that the existence of prevalent vertebral fractures can affect the occurrence rate and location of new vertebral fractures.

SP51

TERIPARATIDE ACCELERATES LUMBAR POSTEROLATERAL FUSION IN WOMEN WITH POSTMENOPAUSAL OSTEOPOROSIS: PROSPECTIVE STUDY.

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INTRODUCTION: Intermittent parathyroid hormone (PTH) treatment increases bone mass and reduces the risk for osteoporotic vertebral fractures. Recombinant human PTH (1-34) has already been approved as a treatment for severe osteoporosis. Preclinical data support the efficacy of PTH for lumbar spinal fusion. However, clinical results of PTH for spinal fusion have not yet been reported.

METHODS: Fifty-seven women with osteoporosis diagnosed with degenerative

spondylolisthesis were divided into 2 treatment groups, a teriparatide group (n = 29; daily subcutaneous injection of 20 µg of teriparatide) and a bisphosphonate group (n = 28; weekly oral administration of 17.5 mg of risedronate). All patients underwent decompression and 1- or 2-level instrumented posterolateral fusion with a local bone graft. Fusion rate, duration of bone union, and pain scores were evaluated 1 year after surgery.

RESULTS: Pain scores improved after surgery; however, no significant difference was noted between the groups after surgery. The rate of bone union was 82% in the teriparatide group and 68% in the bisphosphonate group. Average duration of bone union was 8 months in the teriparatide group and 10 months in the bisphosphonate group. The rate of bone union and average of duration of bone union in the teriparatide group patients were significantly superior to those in the bisphosphonate group.

DISCUSSION: Daily subcutaneous injection of teriparatide for bone union using local bone grafting after instrumented lumbar posterolateral fusion in women with postmenopausal osteoporosis was more effective than oral administration of bisphosphonate.

SP52

ACUTE VERTEBRAL FRACTURE AT THE FUSED SEGMENT AFTER LUMBAR FUSION SURGERY IN ELDERLY PATIENTS WITH OSTEOPOROSIS

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INTRODUCTION: Adjacent and nonadjacent remote level vertebral fractures (VF) are reported to occur in the long-term follow-up after lumbar spinal fusion surgery. We have encountered cases with acute VF at the fused segment after lumbar fusion. The purpose of this study was to assess the prevalence of VF at the fused segment in lumbar fusion with rigid instrumentation and to analyze the factors regarding such complications.

MATERIALS AND METHODS: This retrospective analysis included 59 consecutive patients (17 males and 42 females, average age 74 years old) with posterior lumbar fusion for degenerative spinal diseases. Fusion segments were 3-vertebral levels in 44 cases, 4-levels in 9, 5-levels in 4 and 6-levels in 2 cases. Eight cases were fused in thoracolumbar spine and the rest were in lumbar spine. Mean follow-up period was 2.1 years. The incidence and VF level at the fused segment were assessed and other factors such as (age, lumbar disease, fused level, history of vertebral compression fractures at other levels) were analyzed.

RESULTS: Six patients (10%) (females, mean age 81) had a newly developed VF at the fused segment within 2 weeks after fusion surgery. The VF occurred at the upper most vertebra with pedicle screw fixation in all 6 patients. Three patients (7%) had VF in 3-vertebral level fusion, 1 patient (9%) in 4-level and 2 patients (50%) in 5-level fusion. Three patients (60%) had VF below L1 fusion, 1 patient (11%) below L2, and 2 patients (7%) below L3. No patient had VF below L4 fusion or in thoraco-lumbar fusion. All patients with VF had a past history of a vertebral compression fracture at another level.

DISCUSSION: Postmenopausal female patients who underwent lumbar spinal instrumentation surgery were at risk to develop VF at the fused segment. Most upper vertebra had a risk of VF. Special attention

should be paid to subsequent VF at the fused segment of the lumbar spine in female patients with a history of vertebral compression fractures.

SP53

INCIDENCE RATE AND PRIMARY DIAGNOSTIC ACCURACY OF OCCULT VERTEBRAL FRACTURE IN AGED WOMEN COMPLAINING OF ACUTE LOW BACK PAIN

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INTRODUCTION: Elderly female patients complaining of acute low back pain (LBP) sometimes have occult vertebral fractures (VF) that are not undetected on primary radiographic examination. The present study aimed to investigate the incidence rate and the diagnostic accuracy of occult VF in such patients by using primary magnetic resonance (MR) imaging, which is reported to have high accuracy in detecting early-stage VF without any morphological change.

MATERIALS AND METHODS: The subjects were women (age > 70 yo) who presented at our clinic with acute low back pain with accurate onset. Subjects underwent lumbar radiography, MR imaging, and bone mineral density (BMD) measurement at their first visit to detect any evidence of VF and its associate properties. The accuracy of MR imaging for detection of VF was approximated to 100%.

RESULTS: Fifty-one acute LBP women were examined (ave. 77.6 yo). Primary MR imaging indicated 39 cases (76.5%) of VF, of which 15 were diagnosed as VF in other incorrect vertebrae on radiography. Excluding these 15 cases, the diagnostic accuracy

of radiography for the remaining 24 cases was as follows: sensitivity, 45.8%; specificity, 75.0%; and likelihood ratio, 1.832. The overall accuracy in all the subjects was 51.3%, 13.6%, and 0.684, respectively. On the basis of the BMD measurement, 24 of the 51 patients (47.1%) were diagnosed with osteoporosis, and 21 of these 24 patients (87.5%) had VF. Primary radiography could correctly detect only 5 of these (20.8%).

CONCLUSION: Of the 51 acute LBP female patients, 76.5% had VFs detectable on MR imaging and 61.5% had fractures undetectable on radiography—regarded as occult fracture. Primary diagnostic accuracy of radiography had a 1.832 likelihood ratio excluding the cases with misidentification of fracture levels, while the overall ratio decreased in all of the LBP cases. Furthermore, VF was diagnosed in only 20.8% of the osteoporotic LBP patients on radiography.

SP54

AGING-ASSOCIATED CHANGES IN PARASPINAL MUSCLES AND PSOAS MUSCLES

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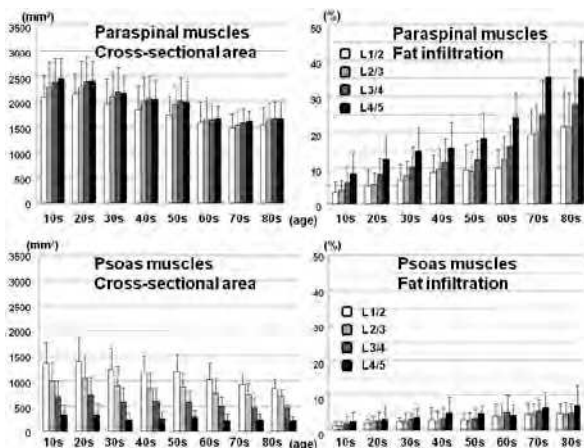
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INTRODUCTION: Age-related sarcopenia is becoming a common problem in aging societies. However, it is still unknown whether all muscles atrophy at the same rate with aging. Both the paraspinal muscles and psoas muscles play important roles in stabilizing the spine. Disruption in the balance of these muscles can lead to spinal deformities such as kyphosis or sagittal imbalance. The aim of this study was to determine if there was a difference in the aging-associated changes in the paraspinal muscles and the psoas

muscles.

METHODS: Previous studies have reported that muscle degeneration may be indicated by decreased muscle cross-sectional area (CSA) and increased amounts of intramuscular fatty tissue deposits. A total of 160 patients, stratified into groups based on age and sex (10 men and women in each decade between the ages of 10 to 80 years), who had maintained lumbar lordosis over 20 degrees were included in this study. Axial T2-weighted MR images and a digital image analysis technique were used to measure CSA and fat infiltration of the paraspinal muscles and psoas muscles at the intervertebral disc levels from L1 to L5. **RESULTS:** The CSA of the paraspinal muscles and psoas muscles showed a similar decreasing trend with age at all levels.

Subjects over 70 years old showed a significant decrease in CSA when compared to subjects that were younger than 30 years ($p < 0.01$). The findings obtained using MRI demonstrated that fat infiltration of the paraspinal muscles was higher than that of the psoas at all spinal levels ($p < 0.001$). Both muscle groups showed increasing fat infiltration with aging, but the rate of change was markedly different and dependent upon the spinal level examined (16-25% vs. 3%). Total fat deposition was higher within the paraspinal muscles than the psoas at all levels.



CONCLUSION: This study demonstrates that

paraspinal muscles are more prone to degeneration than the psoas muscles and that these changes can affect the spinal column.

SP55

FALL AND LUMBAR SPINAL STENOSIS IN THE COMMUNITYS

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INTRODUCTION: Lumbar spinal stenosis (LSS) is very common in the elderly and has negative influence on physical function such as gait and balance. However, there is little survey regarding the relationship between a fall and LSS in the community. The purpose of this study was to assess the influence of LSS on a fall in the community.

PARTICIPANTS AND METHODS: 1712 people agreed to participate and were interviewed about LSS, subjective knee pain and posture, and fall within a year. The presence of LSS was assessed by a specially designed questionnaire (Sensitivity 0.84, Specificity 0.78, by Konno S, BMC Musculoskel Disord 2007). 339 of 1712 participants also received stabilometry in order to assess the balance function.

RESULTS: 1) By a multiple logistic regression analysis, male (Odds ratio 1.446), LSS Odds ratio 1.627), and knee pain (Odds ratio 1.737) statistically influenced on a fall within a year. Aging did not affect a fall (Odds ratio 0.986).

2) In the stabilometry, participants with LSS statistically impaired envelop area. On the other hand, knee pain and abnormal posture did not affect any parameter of stabilometry.

CONCLUSION: From the current study, LSS might be one of risk factors for a fall in the community through disequilibrium (disturbance of balance function) which showed in the stabilometry.

SP56

VISUALLY ASSESSED SEVERITY OF LUMBAR SPINAL CANAL STENOSIS IS PARADOXICALLY ASSOCIATED WITH LEG PAIN AND OBJECTIVE WALKING ABILITY

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INTRODUCTION: Lumbar spinal stenosis (LSS) is commonly used to describe patients with symptoms related to anatomical reduction of the size of lumbar spinal canal. On the other hand, some subjects can have a narrowed canal without any symptoms rising questions what actually is the role of central canal stenosis in symptomatic patients. Purpose of this study was to compare the visually and quantitatively evaluated radiological lumbar spinal canal stenosis (LSS) with clinical findings.

METHODS: Eighty patients (mean age 63 ± 11 years, male 44 %) with symptoms indicative of significant LSS were included. Standard lumbar magnetic resonance imaging (MRI) was performed and one experienced neuroradiologist classified patients into three groups: 0 = normal, 1 = moderate stenosis, 2 = severe stenosis. In addition, the same observer measured the minimal dural sac area from the inferior aspect of L1 to

the inferior aspect of S1. The association between radiological and clinical findings were tested with Oswestry Disability index questionnaire (ODI), overall Visual Analogue Pain scale (VAS), specific low back pain (LBP; NRS-11), specific leg pain (LP NRS-11), Beck Depression index (BDI) and walking distance in treadmill exercise test.

RESULTS: In the visual classification of the central spinal canal, the leg pain was significantly higher and walking distance was lower in patients with moderate central stenosis group than in patients with severe central stenosis (7.33 ± 2.29 vs 5.80 ± 2.72; P = 0.008 and 421 m ± 431 vs 646 m ± 436; P = 0.021, respectively). No correlation between visually or quantitatively assessed stenosis and other clinical findings was found.

DISCUSSION: There is no straightforward association between stenosis of dural sac and patients' symptoms or functional capacity indicating that dural sac stenosis is not the single key in the pathophysiology of LSS.

SP57

PREVALENCE OF VITAMIN D DEFICIENCY IN PATIENTS WITH LUMBAR SPINAL STENOSIS AND ITS RELATIONSHIP WITH PAIN

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INTRODUCTION: Patients with lumbar spinal stenosis (LSS) are at a great risk of a fall and fracture, which vitamin D (VitD) has protective effect on. However, VitD deficiency is expected to be highly prevalent in LSS patient, and the degree of pain is thought to have a profound effect on VitD status by limiting their activity and sunlight exposure. A single-center cross-sectional

study was performed for 350 LSS patients to identify the risk of VitD deficiency according to the degree of pain.

METHODS: Pain was categorized into 4 groups based on location and severity: 1) mild to moderate back or leg pain; 2) severe back pain; 3) severe leg pain; and 4) severe back and leg pain. Multivariable logistic regression analysis (LRA) was used to adjust all risk estimates for covariates. Finally odd ratio for osteoporosis according to pain category was calculated.

RESULTS: Mean serum 25-OHD level was 15.9 ± 7.1 ng/ml (range, 2.5 ~ 36.6). 260 patients out of 350 (74.3%) were VitD. Univariate LRA showed significantly higher prevalence of VitD deficiency in the following patients with: 1) medical comorbidity; 2) urban residence; 3) lower sunlight exposure; and 4) severe pain category. The analysis to find out the relationship between pain and other covariates showed significant association between severe pain category and lower sunlight exposure ($p=0.010$). However, multivariate LRA showed that severe pain category was associated with increased odd ratio for VitD deficiency even after adjustment for covariates ($p<0.001$). Moreover, severe pain category was also associated with increased risk for osteoporosis ($p=0.017$).

DISCUSSION: VitD deficiency was highly prevalent in LSS patients, and severe pain was associated with higher prevalence of VitD deficiency and osteoporosis which could be potential risk factors of a fall and fracture. As evidenced by the present study, assessment of bone mineral density and VitD administration can be recommend in LSS patients with severe pain.

SP58

CONSERVATIVE AND SURGICAL TREATMENT IMPROVES PAIN AND ANKLE-BRACHIAL INDEX IN PATIENTS WITH LUMBAR SPINAL STENOSIS

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INTRODUCTION: The pathological mechanism of lumbar spinal stenosis is reduced blood flow in nerve roots and degeneration of nerve roots. Exercise and prostaglandin E1 is used for patients with peripheral arterial disease to increase capillary flow around the main artery and improve symptoms; however, the ankle-brachial index (ABI), an estimation of blood flow in the main artery in the leg, does not change after treatment. Lumbar spinal nerve roots contain somatosensory, somatomotor, and unmyelinated autonomic nerves, and improved blood flow by medication with prostaglandin E1 and decompression surgery in these spinal nerve roots may improve the function of nerve fibers innervating muscle, capillary, and main vessels in the lower leg, resulting in an increased ABI. The purpose of the study was to examine whether these treatments can improve ABI.

MATERIALS AND METHODS: The subjects were 107 patients who received conservative treatment such as exercise and medication ($n=56$) or surgical treatment ($n=51$).

Low back pain and leg pain scores, walking distance, and ABI were measured before treatment and after 3 months of conservative treatment alone or surgical treatment followed by conservative treatment.

RESULTS: Low back pain, leg pain, and walking distance significantly improved after both treatments ($P<0.05$). The ABI significantly increased in each group ($P<0.05$).

DISCUSSION: This is the first investigation of changes in ABI after treatment in patients with lumbar spinal stenosis. Improvement of the spinal nerve roots by medication and decompression surgery may improve the supply of blood flow to the lower leg in patients with lumbar spinal stenosis.

SP59

SURGICAL DECOMPRESSION OF LUMBAR SPINAL STENOSIS NORMALIZES IMPAIRMENT IN OBJECTIVE MEASURES OF PHYSICAL ACTIVITY: A CASE-CONTROL STUDY

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Introduction: Impaired ambulation is a hallmark of spinal stenosis, yet objective assessment of activity tolerance outside the laboratory has evaded spine researchers. Accelerometers have advanced the knowledge of physical activity's impact on various diseases and recently gained the attention of spine researchers. The aim of this study was to compare baseline measures of physical activity in lumbar stenosis patients to controls, and to measures obtained 6-months post decompression surgery.

METHODS: In this prospective case-control study, patients ($N=16$) and controls ($N=10$) wore an accelerometer for 7 consecutive days (Actigraph GT3x+), performed a self-paced walking test (SPWT), and completed a battery of validated self-reported measures (Swiss Spinal Stenosis Questionnaire, Neurogenic Claudication Outcome Score, Oswestry Disability Index, and SF-36). Patients repeated all tests 6-months post decompression. Differences between group means were evaluated using independent samples t-tests.

RESULTS: At baseline, patients differed significantly ($p<0.05$) from controls in all self-reported measures, SPWT (time, distance, and speed), and multiple accelerometry thresholds in the sedentary and light ranges. At 6-mo post-op, significant differences persisted in the self-reported measures (except the SF-36 physical function and bodily pain subscales) while differences between patients and controls were no longer significant for SPWT (distance and speed) and accelerometry thresholds.

DISCUSSION: Objective and self-reported measures provide different insights into the impact of lumbar spinal stenosis. Accelerometry measures in lumbar stenosis patients demonstrate differences primarily in the light activity range, relative to controls, with more robust normalization than self-report following decompression.

SP60

THE EFFECT OF DECOMPRESSION SURGERY ON LOW BACK PAIN WITH LUMBAR SPINAL STENOSIS: ANALYSIS FROM THE SYMPTOM CAUSED BY GAIT-LOADING TEST

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INTRODUCTION: We can predict the effect of the decompression surgery on leg symp-

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toms and intermittent claudication of lumbar spinal stenosis (LSS) before an operation. On the other hand, the effect of the decompression surgery on low back pain with LSS is not clarified enough. The present study aimed to clarify the feature of low back pain improved after the only decompression surgery from the symptom caused by gait-loading test before an operation.

METHODS: The study design is a cohort study. Objects were 102 patients of LSS that complain of low back pain with radicular type intermittent claudication. All cases were underwent decompression surgery alone and observed for a postoperative period of ≥ 1 year. The gait -loading test was done before an operation, and it classified into the following two groups. That is, they are a group by which low back pain is caused with leg symptom (wLBP group), and a group by which low back pain is not caused by gait-loading test (w/oLBP group). Moreover, postoperative low back pain (VAS) was judged by “improvement”, “disappearance”, and “unchanging/ aggravation” as compared with the low back pain just before the operation.

RESULTS AND DISCUSSION: There were 42 cases in the wLBP group, and 60 cases in the w/oLBP group. In the w/oLBP group, “improvement” was 16.7%, “disappearance” was 21.7%, and “unchanging/ aggravation” was 61.6%. On the other hand, in the wLBP group, “improvement” was 40.5%, “disappearance” was 40.5%, and “unchanging/ aggravation” was 19.0%. wLBP group is significantly higher in the ratio that low back pain improves by only decompression surgery in comparison with w/oLBP group.

CONCLUSION: In the case of a lumbar spinal stenosis with radicular intermittent claudication, when low back pain is caused with leg symptom by gait-loading test before an operation, the ratio that low back pain improves by decompression surgery is high.