O92

DIFFERENT LOADING COMBINATIONS ARE ASSOCIATED WITH DIFFERENT INJURY RISK OF THE INTERVERTEBRAL DISC

Nikolaus Berger-Roscher,Gloria Casaroli,Volker Rasche,Fabio Galbusera,Hans-Joachim Wilke
Institute of Orthopedic Research and Biomechanics 89081 Ulm, Germany

INTRODUCTION: The biomechanical mechanism of lumbar intervertebral disc herniation is still not fully understood. It has been shown recently1 that in vivo herniations are either the cause of an anular failure (AF, 35%) or an endplate junction failure (EPJF, 65%). Both cases could be reproduced in an in vitro study2 with complex loading. However, the influence of each loading parameter on the extent of failure is unknown.

AIM: The goal of the study was to investigate how different loading combinations influence the extent of failure.

MATERIALS AND METHODS: Thirty ovine lumbar spinal segments were loaded under five combined loading conditions (0-12° flexion (FE), 0-9° lateral bending (LB), 0-4° axial rotation (AR), 0-800 N axial compression (AC), 1000 loading cycles, 2 Hz. Gr1: all combined, Gr2: w/o AC, Gr3: w/o AR, Gr4: w/o LB, Gr5: w/o FE) in a newly developed dynamic 6-DOF disc loading simulator. During testing macroscopic changes of the posterior part of the disc were recorded by a video camera. After testing the discs were scanned in an ultra-high field MRI (11.7 T) as well as with a µCT.

RESULTS: Herniations did not occur. However, many EPJFs were observed. Gr1: 6x large EPJF; Gr2: 3x large + 3x small EPJF; Gr3: 3x large EPJF; Gr4: 1x large + 1x small EPJF; Gr5: 0x EPJF. Ten out of 13 EPJFs occurred at the caudal part. Highest moments were 54 Nm (FE), 15 Nm (LB), 13 Nm (AR).

CONCLUSION: This study showed that it is possible to create EPJFs in vitro. Herniations will only occur if the cartilaginous endplate is also damaged which probably requires additional AC. The combination of FE, LB, AR, and AC has the highest risk for caudal EPJF. FE without LB and vice versa has the lowest risk for herniations. Both, AC and AR seem to have a strong influence. The mechanism for anular failure seems to be based on other loading conditions that need to be further investigated.

Reference(s):
1.Rajasekaran S, Bajaj N, Tubaki V, et al. ISSLS Prize winner: The anatomy of failure in lumbar disc herniation: an in vivo, multimodal, prospective study of 181 subjects. Spine (Phila Pa 1976) 2013;38:1491-500.
2. Wilke H-J, Berger-Roscher N, Maile S, Rasche V, Kienle A. A New Dynamic 6-DOF Disc-Loading Simulator Allows to Provoke Disc Damage and Herniation. Eur Spine J (under review)

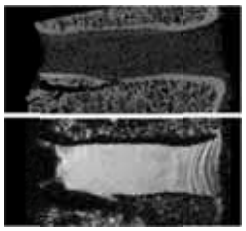


Fig. 1: *Typical caudal endplate junction failure (10x). Sagittal transection of an ovine intervertebral disc (L2-3). µCT (top) and MRI (11.7 T, bottom)*

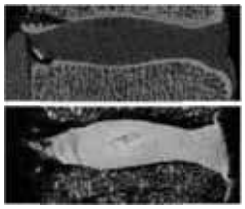


Fig. 2: *Cranial endplate junction failure (3x) with small partial avulsion of the posterior caudal endplate. Sagittal transection of an ovine intervertebral disc (L5-6) µCT (top) and MRI (11.7 T, bottom)*

O93

STRUCTURAL PROPERTIES AND FAILURE MECHANISMS OF THE HUMAN INTERVERTEBRAL DISC-VERTEBRA INTERFACE

Britta Berg-Johansen,Aaron Fields,Jeffrey Lotz
University of California, San Francisco Box 0514 San Francisco, CA 94143-0514, United States

Introduction: Damage at the intervertebral disc-vertebra interface associates with back pain and disc herniation. However, the structural and biomechanical properties of the disc-vertebra interface – and its mechanisms of failure – remain under-explored. Aims: (1) Quantify the avulsion strength of human vertebra-disc-vertebra specimens using biomechanical tests and local strain tracking; (2) associate mechanical properties with interface structural features measured using histology, µCT, and scanning electron microscopy (SEM). Materials and Methods: Seven thoracic motion segments were extracted from one fresh human spine. Vertebra-disc-vertebra specimens (~8x6mm cross-section) were collected from the anterior (n = 5) and posterior (n = 5) regions

of each motion segment. 2mm-thick slices from each specimen were analyzed histologically. Specimens were scanned with µCT, speckle-coated, and loaded to failure in uniaxial tension. Digital image correlation was used to calculate local strains. Failure surfaces were scanned en face using SEM. Results: All specimens failed at the disc-vertebra interface at the inner annulus region, with the cartilage endplate (CEP) being stripped from the underlying bone. Following initial failure, vertebral bone fractures occurred in the outer annulus region, with portions of bone being pulled away with annular fibers. The average stiffness, strength, and failure strain were 0.5 MPa, 2.4 MPa, and 33%, respectively. Strains were highest at the mid-annulus and the lowest within the vertebra. Local strain gradients across the interface increased at each global strain increment (Fig. 1). Histology revealed integration of inner annulus fibers and the CEP, with little integration between the CEP and subchondral bone (Fig. 2 A-C). The outer annulus region did not contain CEP, and fibers anchored directly into the vertebra, shifting the failure location to within the trabecular bone (Fig. 2D). µCT revealed a gradation of bone density from the vertebral endplate to the trabecular bone (Fig. 2E). SEM further indicated a lack of integration between the CEP and bone (Fig. 3); collagen fibers were mainly oriented parallel to the failure interface. The CEP displayed regions of aligned collagen fibers (Fig. 3 B&C), regions of disorganized woven fibers (Fig. 3D), and small regions of fibers oriented perpendicular to the interface (Fig. 3E). The opposing bone surface displayed visible pores (Fig. 3G), large collagen fiber bundles (Fig. 3H), and smaller aligned fibrils (Fig. 3 I&J). Conclusion: Our findings indicate that poor structural connectivity between the CEP and vertebra may explain the apparent weakness of the inner annulus/endplate/vertebra zone. Because the CEP and inner annulus are structurally integrated at this location, tension at the cartilage/bone interface can be generated during spinal movement, leading to cartilage avulsion. Further, failure in this region can trigger reactive bone marrow lesions. Additional structural features, such as collagen fiber thickness/orientation and bone density gradient may be important determinants of interface strength and are currently being quantified. This study's findings inform the development of diagnostics, prevention strategies, and treatments for disc-vertebra interface injuries related to low back pain.

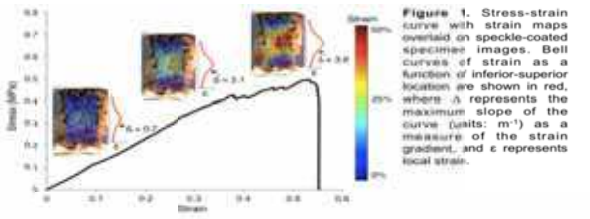


Figure 1. Stress-strain curve with strain maps overlaid on speckle-coated specimen images. Bell curves of strain as a function of inferior-superior location are shown in red, where Δ represents the maximum slope of the curve (units: m^{-1}) as a measure of the strain gradient, and ε represents local strain.

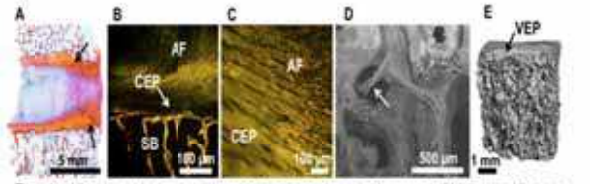


Figure 2. (A) Tri-chrome stain shows cartilage endplate ending at mid-annulus (black arrows). (B&C) Picrosirius Red stain under polarized light shows that annulus fibrosus (AF) fibers join with the cartilage endplate (CEP) but do not anchor into subchondral bone (SB); (D) SEM shows trabecular fracture (arrow) within the vertebra at the outer annulus region; (E) µCT rendering (15 µm resolution) of inferior vertebra shows dense vertebral endplate (VEP) atop porous vertebral body.

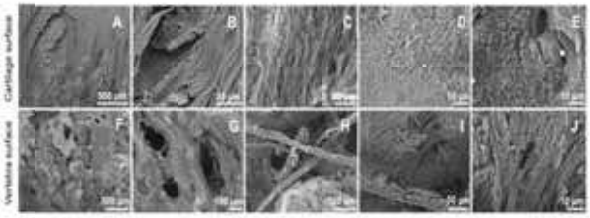


Figure 3. En face failure surfaces imaged at inner annulus region with SEM for (A-E) cartilage endplate surface and (F-J) opposing vertebra surface. Note varying degree of collagen fiber alignment in different regions of tissue surfaces.

O94

DIFFUSION TENSOR IMAGING OF LUMBAR SPINAL NERVES IN PATIENTS WITH LUMBAR DISC HERNIATION

Shin-Yi Chiou,Peter Hellyer,David Sharp,Rex Newbould,Paul Strutton

Imperial College London London W6 8RF, United Kingdom

Introduction: Lumbar disc herniation with radiculopathy is associated with pain and functional impairment. Spinal MRI is currently the primary diagnostic indicator for the clinical decision making process; however, discrepancies between clinical symptoms and MRI features are common. Conventional structural MRI allows only gross assessment of the compression to nerve fibres within the spinal canal or traversing the intervertebral foramina. Diffusion tensor imaging (DTI) with fibre tracking has been used extensively to image white matter tracts in the central nervous system and more recently has been reported to provide information on the degree of damage

or compression to peripheral nerves. Its use in the study of lumbar spinal nerves has been limited. Aims: 1) To use DTI to explore the structure of lumbar spinal nerves and 2) to investigate the relationships between diffusion parameters and functional integrity of the nerves measured using neurophysiology (transcranial magnetic stimulation (TMS) and electrical nerve stimulation (ENS)) in healthy subjects and in patients with lumbar disc herniation. Materials and Methods: Patients with unilateral disc herniation affecting L5 or S1 nerves and healthy age-matched controls were recruited. DTI and neurophysiological measures from relevant muscles (tibialis anterior for L5 and soleus for S1) were performed. Regions of interests of the nerves at the level inferior to the disc were defined on the diffusion-weighted images. Mean fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD) and radial diffusivity (RD) values were calculated. TMS and ENS measures included motor evoked potentials (MEPs), MEP latency, F-wave latency, central and peripheral motor conduction times. Results: Patients had lower mean AD values in the compromised nerve compared to the uncompromised nerve and had longer MEP latencies, F-wave latencies and peripheral nerve conduction times to the muscle on the affected side. This laterality difference in either DTI or neurophysiological measures was not observed in the controls. In addition, patients had lower mean MD, AD, and RD values in the compromised nerve but similar values in the uncompromised nerve compared to the controls. Multiple regression analysis showed significant relationships between neurophysiological measurements and DTI parameters when age, gender and body height were included as covariates; the mean MD and AD values of the S1 nerve were correlated to the normalised soleus MEP amplitudes; these relationships were not observed in patients. Conclusion: The relationship between tract integrity measured using DTI and neurophysiological measurements in healthy subjects indicates that there is an association between structural and functional integrity of lumbar spinal nerves. Further, results from the patients suggest that DTI is potentially useful to identify the damage to the lumbar spinal nerves, which may in turn permit predictions to be made on the likely success of surgical intervention, this is underway in our cohort of patients who are undergoing surgical treatment.

O95

SHORT (2 WEEKS) VS. LONG (6 WEEKS) POST-OPERATIVE RESTRICTIONS FOLLOWING LUMBAR DISCECTOMY: A PROSPECTIVE RANDOMIZED CONTROL STUDY

Christopher M. Bono,Dana A Leonard, Andrew J. Schoenfeld,Thomas D. Cha,Kevin J McGuire, Mitchel B. Harris

Brigham and Women's Hospital 02115 Boston, MA, United States

Introduction: Lumbar discectomy is a well-established treatment for patients with herniated lumbar discs who have failed conservative treatment. Reherniation is reported to occur in a low percentage of patients. Previous data has suggested that lack of postoperative restrictions after index discectomy does not result in an unacceptably high reherniation rate. However, these data were based on noncomparative case series of patients uniformly encouraged to return to full activity as soon as possible. To the authors' knowledge, a prospective, randomized control trial comparing short versus long postoperative restrictions following lumbar discectomy has not been previously published. Aim: To demonstrate whether a short interval of restrictions would result in a higher rate of herniation. Materials and Methods: English-speaking patients who were 18 years of age or older and were undergoing a single-level lumbar discectomy for primary radicular pain at one of two academic hospitals were considered eligible for the study. Patients who had had previous lumbar surgery were excluded. Patients consented to be randomized to one of two groups. In the long restriction group (considered the control as it was the previuos standard of care), patients were instructed not to bend, lift, or twist twisting for 6 weeks after surgery. In the short group, these restrictions were limited to 2 weeks, thought to be ample time for wound healing. Of note, patients were randomized immediately following surgery as to minimize any bias in the manner in which the surgeon performed the procedure. Chi-square

and logistic regression were used to determine if there was a significant difference in the frequency of reherniation between the two groups. Statistical analysis was completed using Stata/SE 13.1. Results: A total of 132 patients were prospectively enrolled. In the end, 109 patients were included and 82 were available for final follow-up. The average age was 43 ± 11 years old. 60 patients were male and 96 were white. 53 patients were randomized to two weeks of postoperative restrictions (the short group) and 56 patients were randomized to six weeks of postoperative restrictions (the long group). Average follow-up was one to two years. At the time of last follow-up, there was no statistically significant difference between the reherniation rates (p=0.45). In the short group, six patients (11%) had reherniations at the index level. In the long group, four patients (7%) had reherniations at the index level. Conclusion: Continuing postoperative restrictions through 6 weeks after lumbar discectomy does not significantly decrease the rate of reherniations. The current data suggests that 2 weeks of restrictions in order to allow the wound heal to adequately heal.

O96

INTRODUCTION OF THE BARRICAID ANNULAR CLOSURE DEVICE - CAUTION WITH NEW TECHNOLOGY

Paul Licina, Emma Johnston
Brisbane Private Hospital BRISBANE QLD, Australia

Introduction: The most common adverse outcome following lumbar discectomy is recurrence. Concern about recurrent herniation often restricts return to activity, and reoperation for recurrence is a significant drawback. For these reasons, annular defect closure is an appealing concept. The Barricaid annular closure device has shown promising results in early studies and was subsequently introduced into our clinical practice. Aim: The aim of this study was to assess the early efficacy of the Barricaid annular closure device with regard to reherniation rates, complications and outcome measures. Materials and Methods: Patients undergoing primary lumbar discectomy surgery performed by the senior author (PL) between April 2014 and April 2015 were prospectively followed. Eligibility criteria included age greater than 18, primary surgery at the index level and absence of osteoporosis, instability, infection, tumour or cauda equina syndrome. Suitability for Barricaid was determined preoperatively if the BMI was less than 40 and the posterior disc height was greater than 5mm on MRI, and confirmed intraoperatively if the annular defect measured at least 5mm high and 6mm wide. Surgical details were collected intraoperatively. Clinical data relating to pain (VAS), disability (ODI) and neurological status was collected preoperatively and at six weeks and one year. Patients were closely monitored for postoperative complications. Results: A total of 143 patients underwent primary lumbar discectomy during the study. Two patients were excluded prior to enrolment. Of the 141 patients included in the study, 46 (32.6%) were identified as potentially suitable for Barricaid preoperatively. At surgery, 31 of these were not suitable for implantation due to defect size or location, or nerve root anatomy. Of the 15 attempted implantations, two were aborted due to buckling of the device, leaving 13 (9.2%) successful implantations. A clinically meaningful reduction in leg pain at six weeks was observed in 12 of 13 (92.3%) of the Barricaid patients and 119 of 128 (93.0%) of the standard discectomy patients (p=1.00). There were three intraoperative complications (two dural tears and one superficial hematoma) in the standard discectomy group and none in the Barricaid group. Three of 13 (23.1%) patients in the Barricaid group developed a postoperative infection, two in the form of an epidural abscess and one a discitis. Of these, two Barricaid devices were subsequently removed and all were treated with antibiotics. At six weeks, there were no reherniations in the Barricaid group and there were three (2.4%) reherniations in the standard discectomy group requiring revision surgery. Conclusion: While there were no early reherniations in the Barricaid group, the proportion of patients suitable for the device in our study was less than anticipated based on earlier trials. Our study also identified a significant infection risk, not identified in the earlier trials. This study highlights the importance of independent data

collection and early analysis of results as well as cautious interpretation of company sponsored trials.

O97

EFFECTIVENESS AND COSTEFFECTIVENESS OF REFERRAL FOR EARLY REHABILITATION AFTER LUMBAR DISCECTOMY

Maurits van Tulder, Teddy Oosterhuis, Raymond Ostelo, Johanna van Dongen, Wilco Peul, Michiel de Boer,Carmen Vleggeert-Lankamp, Mark Arts
VU University 1081 HV Amsterdam, Netherlands

Background: patients who underwent lumbar disc surgery for herniated discs may be referred to early rehabilitation immediately after discharge from the hospital or no referral. The objective of this study was to compare the effectiveness and cost-effectiveness of referral for early rehabilitation versus no referral after lumbar discectomy.
Methods: 169 patients who underwent lumbar discectomy were randomly assigned to the immediate rehabilitation or control group. Immediate rehabilitation consis-ted of 1-2 sessions of exercise therapy during 6-8 weeks, aiming to gradually extend activities of daily living from personal care to housekeeping tasks in the short term, and return to work and prepare for sports and leisure activities in the long term. At 6-8 weeks post-surgery a follow-up consult with the neurosurgeon took place. Whether participants in the intervention group continued rehabilitation or control group participants started rehabilitation after this follow-up consultation was left to the neurosurgeons' discretion. At baseline, 3, 6, 9, 12 and 26 weeks postoperatively, global perceived effect, disability, pain intensity, quality of life and costs were measured. For the cost-effectiveness analysis, missing data were imputed using multiple imputation. The primary analysis was by intention to treat, using a longitudinal multilevel analysis, with linear regression for continuous outcomes and GEE analysis for dichotomous outcomes. The cost-effectiveness analysis was performed from a societal perspective. Incremental cost-effectiveness ratios, cost-effectiveness planes and acceptability curves were produced.
Results: there were no clinically relevant or statistically significant differences between the intervention (n=92) and control group (n=77) for any clinical outcome: global perceived effect OR 1.0;95%CI 0.6, 1.7; functional status (ODI) MD 1.5;95%CI -3.6, 6.6; leg pain (NRS) MD 0,1;95%CI -0.7, 0.8; back pain (NRS) MD 0.3;95%CI -0.3, 0.9; physical function (SF12) MD -3.5;5%CI -11.3, 4.3; mental health (SF12) MD -4.1;95%CI -9.4, 1.3. Mean total costs were €6486 (SD 626) and €6790 (SD 957) for the rehabilitation and control groups, respectively. At 26 weeks no significant cost differences were found.
Conclusion: from the societal perspective, there were no significant differences in cost and clinical effects between rehabilitation starting immediately after hospital discharge and a control group that was not referred to rehabilitation after lumbar disc surgery. These results show that early rehabilitation is not more effective or cost-effective than no referral to rehabilitation in patients who underwent lumbar discectomy.

O98

SIMULATING THE UNIQUE, NONLINEAR DYNAMICS OF THE HUMAN LUMBAR INTERVERTEBRAL DISC DURING VIBRATION

Giacomo Marini,Gerd Huber, Klaus Püschel, Stephen Ferguson
ETH Zurich 8093 Zurich, Switzerland

Introduction: Accurate predictions of the dynamic response of the intervertebral disc to vibration are highly relevant for studies of disc injury, degeneration and ergonomics. Lumped parameter models of the spine have been developed to investigate its response to whole body vibration. However, these models assume the behavior of the intervertebral disc to be linear-elastic. Recently, the authors have reported on the unique nonlinear dynamic behavior of the human lumbar intervertebral disc1. This response was shown to be depen-dent on the applied preload and amplitude of the stimuli, and we hypothesize that this cannot be described by linear-elastic models.

Aim: The aim of this study was therefore to develop a single model that is able to describe the axial, nonlinear quasi-static response and to show that this model can predict the nonlinear, dynamic characteristics of the disc.
Materials and Methods: A 1-D simulation model was implemented in Simulink. The quasi-static, asymmetric tension-compression behavior of the disc1 was described with a polynomial function, fitting both axial states independently while maintaining continuity across the transition. The dissipative properties of the disc were described by an additional term incorporating the strain rate. For validation, our prior base-excitation experiments of human discs were simulated with the model, and for comparison with a model incorporating conventional linear elastic material properties, over a frequency sweep from 1 – 60 Hz and back down.
Results: The model incorporating non-linear elastic properties, with a tension-compression asymmetry, was able to capture the unique dynamic characteristics observed in our prior experimental study, such as softening or hardening behavior of the tissue with increasing frequency, and most importantly, a non-uniform "jump" phenomena in the oscill-ation, whereby the disc enters and exits resonance at different frequencies on the upwards and downwards frequency sweep. Furthermore, hardening or softening behavior, and the characteristic resonance ranges, were predicted well by a model with properties fit only to a priori quasi-static tension-com-pression data. In contrast, a conventional linear elastic model predicted only a single, symmetric resonance point at one characteristic frequency, independent of sweep direction.
Conclusion: Linear elastic material models fail to adequately capture the non-linear dynamic response of the disc to vibration. For dynamic analysis, the use of standard linear-elastic models should therefore be avoided, or restricted to study cases where the amplitude of the stimuli is relatively small. For a biofidelic and accurate simulation of the vibrational response of the disc, the tension-compression asymmetry of the disc should be incorporated.
1. Marini G, Huber G, Püschel K, Ferguson SJ., Nonlinear dynamics of the human lumbar intervertebral disc. J Biomech. 2015 Feb 5;48(3):479-88.

O99

COMPRESSION-TORSION MECHANICAL PROPERTIES OF THE HUMAN INTERVERTE-BRAL DISC JOINT

Grace O'Connell,Semih Bezci
University of California, Berkeley Berkeley, United States

Introduction: The spine experiences large complex loads during daily activity. Together with the intervertebral disc, the facet joints play an important role in absorbing and transferring these loads, especially during axial rotation. The articulating surfaces of the facet joints act to support and protect the intervertebral disc from overloading, which may result in degenerative changes or disc injury. Previous studies suggest that facet joints absorb less than 25% of compressive loads applied to the disc joint in situ. With high compressive loads, the articular surfaces of facet joints might engage and constrain the motion of the disc joint under combined loading modes involving extension or rotation. Early work by Farfan et al. suggest that the facet joints provide 25-45% of the torque strength of the whole intervertebral disc joint; however, the sample size was small (n = 1) and the effect of compression coupled with torsion was not assessed.
Aim: To evaluate compress-ion-torsion mechanics of healthy human lumbar intervertebral discs.
Materials and Methods: Motion segments were prepared from healthy L3-L4 and L4-L5 levels of human spines (n = 9, age: 43 to 80, Pfirrmann grade: I to III). Axial compression was applied at 300, 600, 900 or 1200 N for 2 hours, followed by 10 cycles of rotation (± 2°, 0.05 Hz). Additional care was taken to ensure intact facet joints and intervertebral disc. The facet joints were removed and retested under the same com-pression-torsion conditions. The last cycle of torque-rotation data was analysed and paired samples t-test was used to determine the effect of facet joints on torsional disc mechanics.
Results: There was 23% increase in disc height loss under creep loading after facet joint removal. Meanwhile, torsional mechanical

properties (stiffness, shear modulus, torque range and energy loss) decreased significantly (Figure). During rotation, the axial displacement was observed to follow a sinusoidal response, which was observed in our previous work with bovine discs. The axial displacement range decreased from 0.14 mm with facets to 0.08 mm without the facet joints. Similar relationships were observed for the 300, 900, and 1200 N axial compression groups (data not shown). Conclusion: The present study investigated load distribution between the intervertebral disc and facet joints of healthy human discs under moderate loads. Our results indicated that majority of compressive loads were absorbed by the intervertebral disc. As expected, the facet joints had much more significant contribution (~70%) to the disc torsional mechanics, and acts to protect the disc from damage. Interestingly, the relative contribution by the disc joint remained constant under all axial compression loading conditions, suggesting that torsional loads are not directly transferred to the facet joints at higher compressive loads. This may provide insights into why twisting while lifting heavy objects may lead to lower back pain and disc injury. Future work will evaluate the contribution of the disc to compression-torsion mechanics with injury and degeneration.

O100

A PARADIGM SHIFT OF LIGAMENTUM FLAVUM HYPERTROPHY ANALYSIS : THE HYPERTROPHIC ACTIVITY

Junseok W. Hur,Jang-Bo Lee,Tai-Hyoung Cho, Yong-Gu Chung,Jung-Yul Park

Department of Neurosurgery, Korea University Anam Hospital Seoul 02841, Korea, South

Introduction: Ligamentum flavum hypertrophy (LFH) is a major contributor in lumbar spinal canal stenosis (LSCS) but its pathophysiology is seldom known. The following static one-way algorithm was suggested as a mechanism of LFH; mechanical stress, inflammation, angiogenesis, and fibrosis occurring in consecutive order. Most of the studies explained the mechanism dividing two groups, LSCS and non-LSCS, regarding the thickened LF is fixed in discrete category. However, a number of results show mismatch among the studies so the explanations are often paradoxical.

Aim: We proposed three hypothesis. The LFH is a dynamic and complex mechanism that all the steps are blended so the growth factors/-cytokines which contribute for hypertrophy would have common tendency according to the “hypertrophic activity”. Secondly, this hypertrophic activity would correlate with collagen synthesis (the final production of fibrosis), not the thickness of LF. Third, LF tissue in high hypertrophic activity would contain active form of fibroblast, so called myofibroblast.

Materials and Methods: We studied 48 LF samples of patients who underwent lumbar surgery. The mRNA and protein level of angiopoietin-2, TGF-□, FGF-1, TRPM7, VEGF, Elastin, Collagen-1, 3, 4, 5, and 11 were investigated with real time RT-PCR and representative samples which showed high or low hyperrophic activities were grouped and validated with western blotting. Immunohisto-chemistry study was used to figure out myofibroblast, staining with α-SMA. Clinical and radiologic data, including the thickness of LF, were considered either.

Results: Angiopoietin-2, TGF-□, FGF-1, TRPM7 (an ion channels/kinase which is novel substance in this field) and VEGF showed positive correlation with each other ($p<0.05$). This represents the various steps of hypertrophy mechanism occur simultaneously. All these factors also correlate positively with collagen-1, 3, and 11 which are final product of LFH ($p<0.05$). This explains the above factors are related with the hypertrophy mechanism and collagen 1, 3, and 11 are likely to be the final products. Angiopoietin-2 ($r=0.358$, $p=0.013$) and TGF-□ ($r=0.720$, $p<0.001$) also showed positive correlation with elastin either which propose that although the proportion of elastin/collagen decrease, the absolute sum of elastin could be increased. VEGF was the only factor which showed correlation with thickness of LF ($p=0.14$). Beside the effect of angiogenesis as a link between inflammation and fibrosis, we estimated the angiogenic factor could be induced by hypoxia due to mass growth. Myofibroblast do exist in LF and the active hypertrophic LF cells showed high myofibroblast/fibroblast proportion

Conclusion: The mechanism of LFH has various steps blended with common tendency and the hypertrophic activity could be explained with collagen synthesis. Myofibroblast is derived from fibroblast like LF cell and this might have key function in LFH mechanism.

O101

LATERAL MEASUREMENT OF LUMBAR BONE MINERAL DENSITY CAN POTENTIALLY IMPROVE THE ESTIMATION OF FRACTURE RISK IN EARLY POSTMENOPAUSAL WOMEN AND PATIENTS WITH SEVERE OSTEOPOROSIS. A STUDY OF 2281 CASES.

Tetsuhiro Ishikawa,Masaaki Aramomi
Sanmu Medical Center 289-1326 Chiba, Japan

Introduction: Dual-energy x-ray absorptiometry (DXA) is currently used to quantify vertebral bone mineral density (BMD) which can be informative when estimating the risk of fracture. Anteroposterior measurement of BMD is used clinically; however, posterior elements such as laminae, spinous processes, and abnormal vessel calcifications are included in the BMD measured.

Aim: The aim of the current study was to evaluate a new technique, lateral measurement of BMD in a central portion of the lumbar vertebral body, and to compare lateral with anteroposterior measurements of BMD in lumbar vertebral bodies using DXA.

Patients and Methods: A total of 2281 cases (1606 females and 675 males, ages ranging 22-98 years old) were evaluated retrospectively. Lumbar BMD was measured in L2 to L4 using a QDR series DELPHI-A system (Hologic Co.) from two directions. Differences between lateral and anteroposterior measurement of BMD over several decades were compared. The ratio of the lateral to anteroposterior BMD was calculated and compared with each age group to evaluate the correlation between anteroposterior and lateral measurements. Furthermore, to analyze the vertebra body trabecular BMD to the anteroposterior measurement, the ratio of the lateral BMD to anteroposterior was compared with lateral BMD.

Results: Both lateral and anteroposterior BMDs decreased gradually but significantly with older age ($p<0.01$). The BMD measured anteroposteriorly was significantly higher than that measured laterally in each decade ($p<0.01$). There was a significant decrease in BMD between the fourth and fifth decades in females via lateral scans ($p<0.01$), but not based on the anteroposterior ($p>0.05$) scans. The ratio of the lateral to the anteroposterior BMD was almost unchanged in every age group. However, the lower lateral BMD was associated with a lower ratio of lateral to anteroposterior BMD.

Conclusion: The risk of vertebral fracture should be more closely related to the BMD of the vertebral body than that of the posterior arch. Anteroposterior measurement overestimates BMD compared with lateral. In the current study, the measurement of the central lumbar body by the lateral method can detect bone loss in early postmenopausal women and the difference between anteroposterior and lateral was more significant in patients with a lower BMD. The standard anteroposterior BMD measurement can assess the extent of osteopenia in most patients. However, the lateral method can potentially improve upon the estimation of fracture risk, especially in early postmenopausal women and patients with severe osteoporosis, as laminae and spinous processes can be excluded from the region of interest.

O102

OSTEOPOROSIS-RELATED RADIATING PAIN FOLLOWING OVARIECTOMY IN MICE IS ATTENUATED BY PREGABALIN AND BISPHOSPHONATES.

Miyako Suzuki,Magali Millecamps,Seiji Ohtori, Chisato Mori,Laura S. Stone
Center for Preventive Medical Science, Chiba University 2608670, Chiba, Japan

Introduction: Postmenopausal women with osteoporosis without fractures often present with low back pain of unknown origin. It Pathological changes occurring in the osteoporotic bones have a clear effect on the sensory input to the area and produce a neurogenic inflammatory state. Despite recent advances, characterization of the osteoporosis-related pain and its treatment remain to be elucidated. The purpose of this study was, therefore, to

evaluate pain-related behavioral changes and the effects of pharmacological treatments in a mouse model of ovariectomy-induced osteoporosis.
Materials and Methods: Animals: Mice were randomly assigned to either sham-operated (n=28) or ovariectomy (OVX) (n=22) surgical groups. All surgical procedures were conducted at 6 weeks of age. Separate groups of mice were evaluated for pain-sensitivity at 6 months post-surgery. Evaluation of the bone mineral density (BMD) was performed prior to the behavioral testing and after treatment with each drug. Subsequently, we had 4 treatment groups: Sham+Saline (n=14), Sham+Drug (n=14), OVX+Saline (n=10) and OVX+Drug (n=12). Injection: Following baseline measurements, morphine (10 mg/kg, i.p.), pregabalin (100 mg/kg, i.p.), and bisphosphonate (pamidronate, 0.25 mg/kg, i.p.) was injected. Note that each drug was administered after completely washing out the effect of the previous drug. Pain behavior: Mice were evaluated for signs of axial discomfort (grip force), radiating pain (von Frey, acetone-evoked behavior, cold plate and heat tests), and motor impairment (open field assays).
Results: There was a significant loss in BMD of the OVX group compared to the sham-operated controls; this confirmed that all the mice in the OVX group had osteoporosis. Bisphosphonate use significantly improved BMD in the OVX group compared to the sham-operated group. Consistent with previous reports, the behavioral measures of axial discomfort and radiating pain at baseline were significantly different in the OVX and the sham-operated group. In the OVX group, bisphos-phonate and pregabalin treatments showed significant improvement in the signs of radi-ating pain (von Frey, acetone-evoked behavior, cold plate and heat tests); however, treatment with morphine showed no improvement in pain behavior.
Conclusion: We observed that the osteoporosis model mouse showed pain hypersensitivity. This pain was similar to the characteristic neuropathic type. Furthermore, the pain probably originated from the osteoporotic bone as observed by its significant recovery after treatment with pregabalin and bisphospho-nates.

O103

CHARACTERISTICS AND NATURAL COURSE OF MR FINDINGS IN OSTEOPOROTIC VERTEBRAL FRACTURE – A MULTICENTER PROSPECTIVE COHORT STUDY BETWEEN 2012 AND 2015

Shinji Takahashi,Masatoshi Hoshino,Hiromitsu Toyoda,Kazushi Takayama,Kazumichi Iseki, Tadao Tsujio,Ryuichi Sasaoka,Hiroyuki Yasuda, Fumiaki Kanematsu,Hiroshi Kohno, Hiroaki Nakamura
Osaka city university 545-8585, Osaka city, Japan

Introduction: Generally, osteoporotic vertebral fractures (OVFs) are detected on the basis of the presence of endplate deformities, the lack of parallelism of the endplates, and the general altered appearance compared with neighboring vertebrae. However, MRIs are useful when the apparent deformity of vertebral body is not observed, the fracture can't be confirmed fresh or old, and the detail examination is necessary for nonunion. There have been only few MRI studies that investigated the natural courses of OVF. Aim: To reveal the natural courses of OVF using MRI.
Materials and Methods: Between 2012 and 2015, consecutive patients with symptomatic OVFs were enrolled in this prospective multicenter cohort study. Eleven hospitals participated in the study. At the time of enrollment, the 1-month, 3-month and 6-month follow-up, the patients were examined using MRI. The signal changes on T1-weighted images were classified into 3 patterns: "diffuse low", "confined low" and "no" signal change. The signal changes on T2-weighted images were classified into 4 patterns: "high", "confined low", "diffuse low" and "no" change. The percent height of the anterior wall and the difference of the anterior wall height between supine and weight bearing position were calculated by x-rays.
Results: Among 218 patients, 153 patients (125 females and 28 males) completed the 6-month follow-up (70.2% follow-up rate). The age at the time of enrollment ranged from 65 to 93 years, with a mean age of 75.9 years. At enrollment, 43% and 57% of fractured vertebral body showed diffuse and confined low signal change. At 1-month follow up, the signal change spread

in most of fractured vertebrae and 90% of them showed diffuse low signal change. After 1-month follow-up, the signal change gradually decreased, but disappeared in only 11 % of them. In T2WI, 56 %, 24 % and 5% of fractured vertebrae showed confined low, high and diffuse low signal change at enrollment, respectively. The fre-quency of high and diffuse low signal change showed peak at 1-month follow-up and gradually decreased until 6-months follow-up. In terms of STIR, most of fractured vertebrae showed high signal change until 3-months follow-up, and 87 % of them remained at 6-months follow-up. As an additional analysis, in patients who could be investigated at 12-months follow-up, 68%, 56 % and 64% of fractured vertebrae showed signal change in T1WI, T2WI and STIR, respectively. Diffuse low and high signal change in T2WI were associated with less % height and more mobility of fractured vertebral body.

Conclusion: In most cases, signal change of MR findings in T1WI, T2WI and STIR remained until 6 months. The findings were associated with vertebral compression and mobility.

O104

CHANGES IN THE INCIDENCE OF VERTEBRAL FRACTURES IN A POPULATION-BASED COHORT STUDY OF THE ELDERLY

Junichi Yamada,Koji Akeda,Kazuma Nakase, Akihiro Sudo

Department of Orthopedic Surgery, Mie University Graduate School of Medicine 514-8507 Tsu city, Japan

Introduction: Aging has become a global issue, especially in Japan. Japan's aging rate (the ratio of the population aged 65 and older to the total population) has exceeded 20%, ahead of any other country in the world. Although the treatment of osteoporosis has made remar-kable progress over the last two decades, there have been only a few reports on changes in the incidence of vertebral fractures (VFs) during that time.

Aim: The purpose of this study is to compare the incidence of prevalent and new-onset fractures in 1997 with those of recent years in a population-based cohort study.

Materials and Methods: From 1997-2013, inhabitants of a typical mountain village underwent medical examination every two years. 206 inhabitants (65 males and 141 females; mean age: 72.1 years) who underwent medical examination in both 1997 and 1999 were selected and formed Group A, while 155 inhabitants (49 males and 106 females; mean age: 75.8 years) who underwent medical examination in both 2009 and 2011 (or both 2011 and 2013) were selected and formed Group B. Lateral thoracic and lumbar spine radiographs of each subject were taken at each examination. The type and extent of all VFs identified from T4 to L4 were evaluated using Genant's semi-quantitative method. A logistic regression analysis was performed to identify factors that were associated with the incidence of prevalent and new-onset fractures between Groups A and B. To examine the risk factors that were significantly associated with VFs, these factors were also evaluated using a logistic regression analysis.

Results: 1. Prevalent fractures: 139 (67.4%) inhabitants had prevalent fractures in group A, while 71 (45.8%) inhabitants had prevalent fractures in group B. The incidence of prevalent VFs was significantly lower in group B than group A ($P<0.01$). The treatment history of osteoporosis and BMD were significantly higher in group B than in group A ($P<0.05$). A logistic regression analysis showed that being female and the timing of examination (in 1997) were significantly associated with the incidence of prevalent fracture ($P<0.01$). 2. New-onset fractures: 51 (24.8%) inhabitants had new-onset fractures in group A, while 25 (16.1%) inhabitants had new-onset fractures in group B. The incidence of new-onset VFs was significantly lower ($P<0.05$), and the treatment history of osteoporosis was significantly higher ($P<0.05$) in group B than in group A. A logistic regression analysis showed that the timing of examination (in 1997) was significantly associated with the incidence of new-onset fractures ($P<0.01$).

Conclusion: This study demonstrated, for the first time, that the incidence of VFs had decreased over these twelve years in a typical mountain village in Japan. Furthermore, the results of this study showed that the treatment rate of osteoporosis had increased, and the

BMD of inhabitants had improved. These data suggest that therapeutic drugs for osteoporosis contribute to lowering the incidence of VFs.

O105

THE EFFECT OF TERIPARATIDE ON FRACTURE HEALING OF VERTEBRAL COMPRESSION FRACTURE IN POST-MENOPAUSAL WOMEN

Si Young Park,Seungwoo Suh,Jae Young Hong, Jung Rae Kim

Korea University Dept of Orthopaedic Surgery Seoul, Korea, South

Introduction: Acute vertebral compression fractures may cause severe back pain and usually requires long time to heal. The progression of fracture or nonunion is not rare. Teriparatide is synthetic parathyroid hormone which has been used as anabolic agent and for treatment of osteoporosis. Periodic infusion of teriparatide is known to enhance bone formation and increase bone strength. It can also be used to promote fracture healing in certain conditions. So, we evaluated the effect of periodic teriparatide infusion on fracture healing of acute vertebral compression fractures.

Aim : To evaluate the effect of periodic teriparatide infusion on fracture healing of patients with acute vertebral compression fractures.

Methods: This is a prospective study done by reviewing case report forms. We prospectively enrolled 84 postmenopausal women who had one or two acute painful vertebral compression fractures confirmed by MRI. All patients were treated conservatively. Among them, 32 patients were treated conservatively with teriparatide for at least 6 months (group I), and 52 were treated with antiresorptive agent (group II). The Visual Analogous Scale (VAS) and Oswestry Disability Index (ODI) scores were assessed at each follow up until 1 year after the trauma. We also measured radiographic changes to check the degree of collapse progression.

Results: The progression of fractured vertebral body collapse was shown in both groups, but the degree of progression was significantly lower in group I than in group II. At the last follow-up, mean increments of kyphosis and wedge angle were significantly lower in group I. Clinical outcome measures were closely related to vertebral body collapse.

Conclusion: Periodic infusion of teriparatide has many beneficial effects on acute vertebral compression fractures in postmenopausal women. Patients using teriparatide showed quicker symptomatic improvement and less collapsed vertebral body after 1 year follow up compared to patients using anti-resorptive agent.

O167

NOTOCHORDAL CELL-RICH NUCLEUS PULPOSUS MATRIX AS A POTENTIAL AGENT FOR NUCLEUS PULPOSUS REGENERATION

Stefan de Vries,Marina van Doeselaar,Björn Meij,Marianna Tryfonidou,Keita Ito

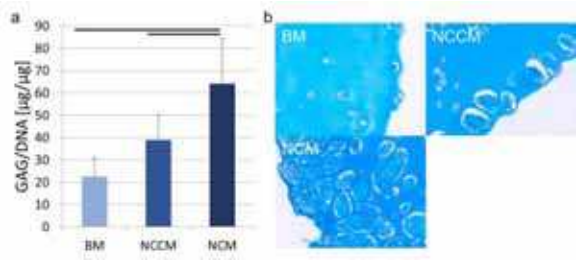
Eindhoven University of Technology 5612 AP Eindhoven, Netherlands

Introduction: Notochordal cell-conditioned medium (NCCM) stimulates matrix production by nucleus pulposus cells (NPCs), showing a promising role for its active factors in intervertebral disc (IVD) regeneration. However, NCCM itself is not practical for treatment of IVD degeneration, and identifying its active factors is not straightforward. Alternatively, NC-rich NP matrix may possess the same regenerative potential.

Aim: To harvest porcine NC-rich NP matrix, and test its potential for NPC stimulation and anti-inflammatory properties.

Materials and Methods: NC-rich NP tissue was harvested from 5 porcine spines. One half per spine was used to produce NCCM (incubate NP tissue in medium for 4 days), the other half was lyophilized and ground to a fine powder (NCM). For testing anabolic effects, bovine NPCs were cultured in alginate beads for 4 weeks in base medium (BM), NCCM and NCM powder added to BM, with the same protein content. For testing anti-inflammatory properties, alginate beads were first cultured in BM for two weeks, after which inflammation was induced by adding 10 ng/ml IL-1β (day 0). At day 2, beads were divided into culturing in BM, NCCM or NCM, and given another dose of IL-1β. At day 4 and 6, RNA was harvested for RT-qPCR of inflammatory genes.

Results: GAG content increased with NCCM (2.5x BM) and even further with NCM (7.1x BM). Similarly, DNA content increased with NCCM (1.4x BM) and NCM (2.5x BM). This resulted in increased GAG/DNA content in NCCM (1.7x BM) but most in NCM (2.8x BM) (fig. 1a). This was verified by Alcian blue staining (fig 1b). Due to technical difficulties, only n=3 was achieved for most of the gene expression groups. Still, patterns were observed that could be statistically significant with more samples (underway). IL-1β at day 6 was lower in NCM (5.7±3.6 x day 0) but not in NCCM (16.4±8.7 x day 0) compared to BM (13.0±5.9 x day 0). For IL-6, no NCM data could be acquired, but its expression in NCCM (245±126 x day 0) was lower than BM (451±152 x day 0). IL-8 expression was lower in NCM (36±13x day 0) and NCCM (24,3±6.4 x day 0) than BM (53±30 x day 0). Conclusion: Even when NCCM and NCM were normalized for total protein (and as it turns out GAG) concentration, NCM's stimulatory effect was far stronger than that of NCCM. This could be attributed to degradation of specific proteins during the 4-day incubation for NCCM production. Alternatively, specific matrix-bound proteins that are not released into NCCM, but are present in NCM and mediate its strong stimulatory effect. In conclusion, NCM shows potential in IVDD treatment, and likely allows a fast translation to in vivo experiments.



O168

MECHANISTIC DETERMINATION OF NOTOCHORDAL CELL-INDUCED ANTI-APOPTOTIC SIGNALING IN HUMAN NUCLEUS PULPOSUS CELLS

Arne Mehrkens,M. Zia Karim,Ajay Matta,Sarah Kim,Michael G. Fehlings,Stefan Schaeren,W Mark Erwin

Spine Surgery, Basel University Hospital 4031 Basel, Switzerland

Introduction: A minimally invasive method through which nucleus pulposus (NP) cell viability and function could be maintained or even enhanced would revolutionize the treatment of degenerative disc disease (DDD). Previously, we demonstrated that notochordal cell conditioned medium (NCCM) (derived from non-chondrodystrophic (NCD) canine IVD NPs) is able to suppress apoptosis of human NP cells in a caspase-dependent fashion in 40% of our donors. Our current work concerns the mechanisms by which notochordal cell-induced anti-apoptotic signaling in human NP cells occurs as well as the characterization of differences in responding vs. non-responding NP-cells to our treatment.

Materials and Methods: We developed NCCM from hypoxic culture of freshly isolated NPs from NCD canines. We obtained human NP cells from 30 patients undergoing spinal surgery. The cells were cultured with ADMEM/F-12 (control media) or NCCM under hypoxic conditions (3.5% O2) and treated with Etoposide (all supplemented with 2% fetal bovine serum). Changes in extracellular matrix and apoptosis-related genes were determined with array-based gene expression methods, Western blots were performed for probing of expression of apoptotic-related proteins. Further studies included Cytokine ELISA and MTT assays.

Results: Cells treated with NCCM demonstrated an upregulation of XIAP and Rab25 as well as a number of important extracellular matrix molecules including collagens and TGFβ1 and downregulation of a number of matrix metalloproteinases. They also showed increased cell viability at 24h. Responder cells secreted low levels of IL-6 and IL-8 into the culture medium whereas non-responder cells secreted elevated levels of both of these cytokines.

Conclusions: In the presence of Etoposide, soluble factors secreted by the NCD IVD NP induce an increased expression of the inhibitor of apoptosis XIAP plus the pro-survival factor Rab25 and increased ECM protein expression as well as TGFβ1. Differences in cytokine expression of responders vs. non-res-ponders suggest a possible biochemical profile for NP cells that may be suitable for biologic therapy. The components of NCCM remain incompletely

identified, however here we identify the mechanisms whereby NCCM suppresses cell death and rescues the expression of ECM genes suggesting that the essential components of factors secreted by notochordal cells could lead to a novel cellular and molecular strategy for the treatment of DDD.

O169

PROTECTIVE ROLE OF PROSTAGLANDIN E1 FOR DISC DEGENERATION BY RECIPROCALLY REGULATING COLLAGENASES AND THEIR ENDOGENOUS INHIBITOR TIMP-3 IN HUMAN INTERVERTEBRAL DISC CELLS

Yasunobu Sawaji,Hidekazu Suzuki,Kenji Endo, Hidetoshi Tanaka,Hirosuke Nishimura,Taiichi Kosaka,Kengo Yamamoto

Tokyo Medical University Shinjuku-ku 160-0023, Tokyo, Japan

INTRODUCTION: Degeneration of intervertebral disc (IVD) preceding peripheral nerve innervation is considered as one of the pathogenesis of discogenic low back pain (LBP). Imbalanced regulation between the catabolic proteinases and their endogenous inhibitor would determine the degeneration of the disc. Because IVD tissue consists of types I and II collagen, collagenases and their inhibitors; tissue inhibitor of metalloproteinases (TIMPs) paly important role in this process. Our previous study demonstrated that PGE1 or its derivative limaprost, which is clinically used for the treatment of LBP in some Asian countries, suppressed the expression of nerve growth factor (NGF) in human IVD cells. However, their action on the disc degeneration has been unknown.

AIM: To investigate the effect of PGE1 and limaprost on the regulation of MMP-1 and -13 and TIMPs-1, -2 and -3 in interleukin (IL)-1-stimulatd human IVD cells.

MATERIALS AND METHODS: Isolated human IVD cells were stimulated with IL-1 in the presence or absence of increasing concentration of PGE1 or limaprost. The expression of MMP-1 and -13 and TIMPs-1, -2 and -3 were measured by real-time PCR. Their production was determined by Western blotting. For the detection of TIMP-3 protein, heparin was added to the culture to trap TIMP-3 in the conditioned medium.

RESULTS: PGE1 and limaprost dose-dependently inhibited IL-1-induced MMPs-1 and -13, and TIMP-1 expression in human IVD cells. TIIMP-2 expression was not significantly affected by PGE1 or limaprost. Interestingly, TIMP-3 expression was increased by treating the cells with PGE1 or limaprost. TIMP-3 protein was only detected in conditioned medium when heparin was supplemented in the culture, and the level was increased by PGE1 or limaprost.

CONCLUSION: Our previous study demonstrated that IL-1 induction of NGF was augmented by a selective COX-2 inhibitor but inhibited by adding PGE2 exogenously, and suggested that PGE2 has a negative feedback role in NGF regulation (1). We also reported that this action of PGE2 can be mimicked by PGE1 and limaprost. In this study, we revealed that PGE1 and limaprost reciprocally regulates MMPs and TIMP-3 in human IVD cells, suggesting that PGE1 may have an additional action in preventing disc from degeneration. Taken together, PGE1 and limaprost can be considered as the choice of treatments for LBP.

REFERENCE(S):

1. Alimasi W., Sawaji Y., Endo K et al. Regulation of nerve growth factor by anti-inflammatory Drugs, a steroid, and a selective cyclooxygenase 2 inhibitor in human intervertebral disc cells stimulated with interleukin-1. Spine 2013; 38(17); 1466-1472.

O170

SELECTIVE INTERFERENCE OF MTOR SIGNALING IS PROTECTIVE AGAINST HUMAN DISC CELLULAR APOPTOSIS, SENESCENCE, AND EXTRACELLULAR MATRIX DEGRADATION WITH AUTOPHAGY INDUCTION

Masaaki Ito,Takashi Yurube,Kenichiro Kakutani, Koichiro Maeno,Toru Takada,Shingo Miyazaki, Yoshiki Terashima,Yuji Kakiuchi, Masahiro Kurosaka, Kotaro Nishida

Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine 650-0017 , Kobe, Japan

Introduction: The mammalian target of rapamycin (mTOR) is a serine/threonine kinase which exists in two complexes of mTOR

complex 1 (mTORC1) containing Raptor and mTOR complex 2 (mTORC2) containing Rictor. mTORC1 plays a central role in cell growth and homeostasis, negatively regulating an important cell stress-response mechanism, autophagy. In addition, an effector of mTORC1, p70/S6K, directly regulates protein synthesis. mTORC1 is regulated by Akt, an essential pro-survival mediator. mTORC2 regulates Akt. Although little evidence exists, these backgrounds suggest likely involvement of mTOR to disc cell matrix homeostasis.

Aim: To elucidate roles of mTOR signaling in human disc cells to provide insight into potential therapeutic targets.

Materials and Methods: Human disc NP cells obtained surgically from patients under-taking lumbar discectomy or interbody fusion were used. To analyze functions of the mTOR pathway, RNA interference for mTOR (targeting mTORC1 and mTORC2), Raptor (targeting mTORC1), Rictor (targeting mTORC2), or Control (coding non-specific sequences) was applied by reverse transfection. (1) Specific interfering effects were confirmed by Western blotting (WB). (2) To assess mTOR signaling affected by RNAi, phosphorylation levels of Akt and p70/S6K were evaluated by WB. (3) To assess autophagy, expression of an autophagy marker, LC3-II, and an autophagy substrate, p62/-SQSTM1, was measured by WB. (4) Cells were treated by IL-1β to simulate inflammatory conditions. Then, apoptosis, senescence, and matrix degradation were determined by TUNEL staining and WB for apoptotic cleaved PARP, cleaved caspase-9, senescent p16/INK4A, catabolic MMP-3, and anti-catabolic TIMP-1. Matrix metabolism was also assessed by real-time PCR for MMP-3 and MMP-13. Results: (1) WB showed significant decreases in specific protein expression by each RNAi (mTOR, 56%; Raptor, 63%; Rictor, 53% reduction: all $P<0.01$). (2) While mTOR and Rictor RNAi decreased both of p70/S6K and Akt phosphorylation, Raptor RNAi decreased p70/S6K but increased Akt phosphorylation. (3) Every RNAi induced increased LC3-II and decreased p62/SQSTM1, consistent with enhanced autophagy. (4) IL-1β-induced increases in %TUNEL-positive cells significantly decreased by Raptor RNAi but further increased by mTOR and Rictor RNAi. Also in WB, IL-1β-induced apoptotic markers decreased by Raptor RNAi. Similarly, IL-1β-induced senescent marker expression decreased by Raptor RNAi compared to Control. Finally, IL-1β-induced MMP-3 release decreased by Raptor RNAi although TIMP-1 expression was unaffected. Quantitative PCR demonstrated significant down-regulation of MMP-3 and MMP-13 expression by Raptor RNAi (both $P<0.05$).

Conclusion: mTORC1 suppression by Raptor RNAi showed protective effects against human NP cell apoptosis, senescence, and matrix degradation. Suppressed mTORC1 and p70/S6K lose the p70/S6K-mediated negative feedback loop, leading to Akt induction. Activated Akt provides pro-survival effects. This gene therapy approach modulating mTORC1/ Raptor provides a possible biological strategy preventing degenerative disc disease, which depends on induction of Akt as well as autophagy.

O171

JAK/STAT INHIBITOR HAS POTENTIAL TO INHIBIT INTERVERTEBRAL DISC DEGENERATION

Satoshi Suzuki,Nobuyuki Fujita,Kota Watanabe, Takashi Tsuji,Ken Ishii,Keisuke Horiuchi,Takeshi Miyamoto, Masaya Nakamura, Morio Matsumoto

Keio University School of Medicine 160-8582 Tokyo, Japan

Introduction: Intervertebral disc degeneration (IVDD) is a major cause of many degenerative spinal conditions such as herniation, lumbar degenerative scoliosis, and lumbar canal stenosis. The etiology is complex and multifactorial, with contributions from aging, mechanical stress, oxidative stress, inflammatory cytokines, and heredity. IL-6 signals through its receptor, IL-6R/IL-6ST (GP130), activating Janus kinases (JAKs), which phosphorylate and activate Signal Transducer and Activator of Transcriptions (STATs), including STAT3. The IL-6/STAT3 pathway activates inflammatory responses during biological processes such as infection and oncogenesis. IL-6 has been also reported to be highly expressed and involved in IVDD. However, the role of IL-6 in IVDD is not well understood.

Aim: The purpose of the present study was to elucidate the contribution of IL-6 pathway to IVDD and the efficacy of the inhibitor of IL-6 pathway for degenerative discs.
Methods: Animal model of IVDD: 8 weeks old Wister rats were anesthetized, and disc puncture was performed with a 23-gauge needle on the 3th–10th coccygeal vertebrae. Human IVD samples: For the experimental use of surgical samples, informed consent was obtained from each patient according to the Keio University Hospital Ethical Guideline. AF cells culture: Rat AF cells were isolated and cultured as reported previously. Statistical analysis: All measurements were performed in triplicates. Data are presented as mean ± standard deviation (SD). Differences between the groups were analyzed by the Student t test (*$p < 0.05$).
Results: A high expression of IL-6 was observed in rat degenerative discs by real-time RT-PCR, immunohistochemistry and Western blotting. Similarly, in human degen-erative discs, immunohistochemistry clearly showed that IL-6 was highly expressed in IVDD. Furthermore, we found the higher expression of SOCS3, the target gene of IL-6/STAT3 pathway, in both rat and human degenerative discs by immuno-histochemistry. In cultured rat AF cells, treat-ment of IL-6 significantly induced the mRNA expression of catabolic factors such as MMP-3, MMP-13, VEGF, and COX-2 in a dose-dependent manner. Western blotting analysis confirmed the phosphorylation of STAT3 in IL-6-treated AF cells. Interestingly, treatment with the JAK-3 inhibitor, CP690550 significantly abrogated the catabolic effect of IL-6, correlated with the reduced phosphorylation of STAT3 in vitro.
Conclusions: The experiments described in this investigation demonstrate that IL-6, which are induced in IVDD, have a catabolic effect on AF cells via STAT3 signaling. These findings lend a strong support to the hypothesis that IL-6/STAT3 pathway is a critical mediator in the pathogenesis of degenerative disc conditions. A second major observation was that CP690550 abrogated the catabolic effect of IL-6 in vitro. CP690550 is in current widespread clinical use for rheumatoid arthritis. Therefore, CP690550 may be a therapeutic option for IVDD in the near future.

O172

EXPRESSION, REGULATION AND RELEVANCE OF HYALURONIDASES IN THE INTERVERTEBRAL DISC

Helen Greutert,Olga Krupkova,Benjamin Gantenbein, Norbert Boos,Stephen J Ferguson, Karin Wuertz-Kozak
ETH Zurich HPP-O12 8093 Zurich, Switzerland

Introduction: Hyaluronic acid (HA) is a glycosaminoglycan with repeated disaccharide units of D-glucuronic acid and N-acetyl-D-gluco-samine connected by β-linkage which can be found in the intervertebral disc (IVD). Upon exposure to either free radicals or hyalu-ronidases (HYALs), HA is degraded, thus causing formation of fragments with various sizes. We have previously shown that HA fragments with 6-12 disaccharides induce an inflammatory and catabolic response in human IVD cells by engaging TLR2, ERK and JNK1. As symptomatic disc degeneration (DD) is characterized by an increased expression of inflammatory medi-ators such as IL-1β and TNF-α, HYALs (and their degradative effect on HA) may thus play a pathological role.
Aim: The aim of this project was to identify which HYALs are expressed in the IVD and to determine whether gene and protein expression or activity are affected by the degree of degeneration. In addition, the aim was to analyze whether expression and activity of expressed HYALs are induced by IL-1β and/or TNF-α treatment.
Materials and Methods: Gene and protein expression of HYAL-1, HYAL-2 and HYAL-3 in human IVD biopsies with different degrees of degeneration were determined by real-time RT-PCR and ELISA, respectively. Total activity (and also HYAL-2 activity, explicitly) are currently being determined with specific HYAL Activity Assays. In a second set of experiments, freshly isolated human IVD cells were stimulated with IL-1β and TNF-α in a dose- and time-dependent manner and changes in the gene and protein expression of HYAL-1, HYAL-2 and HYAL-3 were determined by real-time RT-PCR and ELISA. In addition, changes in HYAL activity upon inflammatory stimulation were analyzed in supernatants and cells.

Results: HYAL-1, HYAL-2 and HYAL-3 mRNA expression was detectable in human IVD biopsies, with HYAL-2 being highest expressed. Biopsies with pronounced DD were characterized by higher HYAL-2 expression, with significant results in the protein level and a trend on the mRNA level. Changes in HYAL activity with degeneration are currently being investigated. Exposure of human IVD cells to IL-1β or TNF-α at different concentrations and for different durations only resulted in minimal chances in HYAL expression and activity.

Conclusion: Expression of HYAL-2 is increased during aggravating DD, with more pronounced results on the protein level. As it has been described that HYAL regulation during health and disease occurs predominantly on the activity level and less on the expression level2, additional experiments on HYAL activity changes during DD are currently in process. Simulating an inflammatory environment as can be found during symptomatic DD did not cause any major changes in the expression or activity of HYALs, although this has been described for chondrocytes3. More complex stimuli (e.g. inflammation plus oxidative stress) as found in vivo during DD may be required to ultimately alter HYAL expression/activity in IVD cells.

Reference(s):

1. Quero L, Klawitter M, Schmaus A, Rothley M, Sleeman J, Tiaden AN, Klasen J, Boos N, Hottiger MO, Wuertz K*, Richards PJ.* Hyaluronic acid fragments enhance the inflammatory and catabolic response in human intervertebral disc cells through modulation of toll-like receptor 2 signalling pathways. Arthritis Res Ther. 2013 Aug 22;15(4):R94

2. Csoka AB, Frost GI, Stern R. The six hyaluronidase-like genes in the human and mouse genomes. Matrix Biol. 2001 Dec;20(8):499-508.

3. Flannery CR, Little CB, Hughes CE, Caterson B. Expression and activity of articular cartilage hyaluronidases. Biochem Biophys Res Commun. 1998 Oct 29;251(3):824-9.

O173

NATURAL HISTORY OF LUMBAR DISC DEGENERATION AND OTHER SPINAL PHENOTYPES ON MRI: A PROSPECTIVE, COMPARATIVE FIVE-YEAR LONGITUDINAL STUDY

Dino Samartzis,Jaro Karppinen,Jason Cheung, Cora Bow,Keith Luk,Kenneth Cheung

The University of Hong Kong 102 Pokfulam Road Pokfulam, Hong Kong

Introduction: Lumbar disc degeneration and other spinal phenotypes (e.g. disc displacement, high intensity zones (HIZs), endplate abnormalities, Modic changes, spondylolisthesis) occur in every population and have been associated with low back pain (LBP). Although numerous cross-sectional MRI studies have been addressed noting the prevalence of such phenotypes, longitudinal studies addressing the natural history of these findings in a population-based cohort are lacking.

Aim: To address the natural history of lumbar disc degeneration and other spinal phenotypes on MRI in a population-based cohort.

Methods: Based on the Hong Kong Disc Degenera-tion Population-Based Cohort Study, a prospective, comparative five-year longitudinal MRI study of Southern Chinese was conducted. No subject had surgery of the lumbar spine. Subjects underwent 3T MRI of L1-S1. Baseline and five-year minimum follow-up MRI assessment was performed. Disc degeneration was based on the Schneiderman classification scheme. The presence or not of disc displacement (i.e. bulge/protrusion/-extrusion), HIZ, endplate abnormalities (e.g. Schmorl's nodes), Modic changes and spondylolisthesis were also noted. Age and gender were considered. Pain and disability profiles at baseline and follow-up were assessed.

Results: There were 1,351 subjects (62.5% males) included in this study with a mean age at baseline of 43.6 years (range: 21 to 63 years; SD: ±8.2). At baseline, 78.3% of all subjects had some degree of disc degeneration (28.5% disc space narrowing), 50.3% had disc displacement, 20.5% had HIZs, 6.8% had Modic changes, 12.6% had endplate abnormalities, and 1.6% had spondylolisthesis. At five-year follow-up, 89.6% of all subjects had some degree of disc degeneration (34.2% disc space narrowing), 63.7% had disc displacement, 23.1% had HIZs, 15.2% had Modic changes, 12.9% had endplate abnormalities, and 3.0% had spondylolisthesis. With the exception of endplate abnormalities, the development of spinal phenotypes increased in incidence and exhibited age-, gender-,

and spinal-level-specific effects. Baseline LBP (past year) prevalence, pain intensity (VAS score – severest pain) and Oswestry Disability Index Scores were 73.1%, 49.2, and 10.1, respectively, Similarly, five-year follow-up values were 74.9%, 49.7, 10.7, respectively.
Conclusions: Based on the largest population-based prospective MRI study, we noted that the incidence of lumbar disc degeneration and other spinal phenotypes increased within a five-year period. However, the incidence rate of spinal phenotypes varied, based on the type of phenotype, spinal level, age and gender. Although the incidence of spinal phenotypes increased upon follow-up, pain profiles remained similar to baseline.

O174

MEASURING LUMBAR DISC DEGENERATION AND PATHOLOGY

Michele Battié,Tapio Videman,Laura Gibbons, Kevin Gill
University of Alberta T6G 1W2 Edmonton, Canada

Introduction: The ability to adequately measure a phenomenon is critical to understanding it. Since 1957, a variety of subjective visual grading methods have been used to assess disc degeneration on imaging, but have been limited by gross ordinal scales and imprecision, as well as suboptimal reliability. Cerebrospinal fluid has been used as a reference for quantitative signal measures of disc desiccation, but practical measurement issues limit its use as a way to standardize objective measurements of disc signal. Further development of conceptually sound, objective, precise measurements is needed to advance knowledge of disc degeneration and pathogenesis.
Aim: To investigate the validity of a new system to quantitatively measure lumbar disc degeneration or pathology.
Materials and Methods: The new measure was based on variations in fluid concentration and associated T2 MRI signal heterogeneity between the nucleus and inner and outer annulus regions indicative of disc desiccation and loss of annulus integrity. The result was a signal-ratio based, quantitative measurement system for disc degeneration, referred to as SpIn, for use with routinely acquired sagittal or axial MR images. The construct validity of the new measure was tested with lumbar MRI from 108 men, 35-63 years of age, who were initially scanned with a 1.5 T Siemens Magnetom, and approximately 15 years later with a Siemens Avanto, forming two scanner-age groups. Image analysis software was used to measure the required areas and signal of the designated ROIs for the SpIn measurements, using either mid sagittal or mid disc axial MR images, and morphological measurements of the lumbar vertebrae and discs, such as height, were also obtained. In addition, discs were qualitatively assessed using the 5-point Pfirrmann grade. Regression modeling was used to compare associations of SpIn values and Pfirrmann grading with age and other degenerative and morphological changes over follow-up.
Results: Associations with age were clearly weaker for Pfirrmann grade than for SpIn values. The variance in age explained by axial SpIn values ranged from 12.4% - 23.4% (AR2), depending on the SpIn measure, spinal level and scanner-age group, as compared to 5.9 - 12.9% for Pfirrmann grade, with sagittal SpIn measures generally intermediate. Baseline SpIn values and Pfirrmann grade were both associated with structural degenerative changes in lumbar discs and vertebrae, but almost all associations were stronger with SpIn. Also, in the upper lumbar region, changes in SpIn values over the 15-year follow-up were associated with many structural changes, while no such associations between changes in Pfirrmann grade and structural changes were seen. Few changes in either SpIn or Pfirrmann grade were associated with morphological changes in the lower lumbar region.
Conclusion: SpIn provides an objective, continuous digital measure of disc degeneration, with stronger construct and predictive validity than Pfirrmann grade when used in middle-aged and older adults, which could benefit related research using T2 MR images.

O175

DIABETES MELLITUS IS A SIGNIFICANT RISK FACTOR FOR LUMBAR DISC DEGENERATION IN A LONGITUDINAL POPULATION- BASED COHORT: THE WAKAYAMA SPINE STUDY

Masatoshi Teraguchi,Hiroshi Hashizume, Noriko Yoshimura,Shigeyuki Muraki,Hiroshi Yamada, Hiroyuki Oka,Akihito Minamide,Keiji Nagata, Yuyu Ishimoto,Ryohei Kagotani, Munehito Yoshida

Wakayama Medical University 641-8510, Japan

Objective: Nowadays, the difference in pathology of intervertebral disc degeneration (DD) in the upper and lower lumbar region has been noticed and very few studies have addressed this. However, these issues still remains elusive because they have several limitations. The present study examined the incidence of DD and their risk factors in the upper and lower lumbar region on magnetic resonance imaging (MRI) in a longitudinal population-based cohort.

Methods: Subjects in the baseline Wakayama Spine study who had participated in 2008 were followed up with lumbar spine MRI after 4 years in seacoast region. A total of 617 paired MRIs (78.7 % of the original sample; mean age 61.5±12.1y) were classified using the Pfirrmann system. A subject was defined as having the incidence of DD in the entire lumbar region, upper lumbar region (L1/2 to L3/4), and lower lumbar region (L4/5 and L5/S1) if all intervertebral discs had grade 3 or less at baseline and at least one intervertebral disc progressed grade 4 or higher at follow-up, respectively. To determine risk factors for the incidence of DD in the entire lumbar, upper lumbar, and lower lumbar region, respectively, multiple logistic regression analysis was used with hypertension, dyslipidemia, diabetes mellitus, occupation of driving, lifting of weight, endplate change, and low back pain as explanatory variables after adjustment for age, sex, and body mass index.

Results: The incidence of DD in the entire lumbar region, upper lumbar region, and lower lumbar region per year was 7.9, 7.1, 7.3 % in men and 11.2, 9.5, 11.1 % in women, respectively. Age was a significant risk factor for DD in the lumbar region (odds ratio (OR) 1.12, per year, 95% confidence interval (CI) 1.05-1.22). The incidence of DD in the upper lumbar region was significantly associated with diabetes mellitus (OR 9.35, 95%CI 1.34-193.0) and endplate change (OR 2.09, 95%CI 1.02-4.32) at baseline. On the other hand, there is no significant association with the incidence of DD in the lower lumbar region.

Conclusion: This longitudinal study firstly clarified the incidence of DD in the lumbar region and their risk factors in a large population-based cohort. We demonstrated that diabetes mellitus was an important risk factor of DD in the upper lumbar region. This study provides the foundation for elucidating the etiologies and mechanisms of DD.

O176

INCIDENCE AND PAIN CHARACTERISTICS OF DISC DEGENERATION ACCOMPANIED WITH EARLY-STAGE LUMBAR SPONDYLOLYSIS IN ADOLESCENT PATIENTS.

Yasuchika Aoki,Shiro Sugiura, Atsuya Watanabe, Takayuki Nakajima,Makoto Takazawa, Seiji Ohtori,Kazuhisa Takahashi,Satoru Nishikawa

Eastern Chiba Medical Center Chiba, Japan

Introduction: Lumbar spondylolysis is an acquired defect of the pars interarticularis, and may increase the loading and accelerate degeneration on the adjacent disc. However, there is no report describing the incidence and pain characteristics of disc degeneration accompanied with early-stage spondylolysis.

Aim: To examine the incidence of disc degeneration in adolescent patients with early-stage spondylolysis, and to study the pain characteristics of such patients.

Materials and Methods: One-hundred eighteen adolescent patients with early-stage spondylolysis were included (within a month after the onset). Patients were diagnosed as early-stage spondylolysis when lumbar spine pedicle showed bone marrow edema on magnetic resonance imaging, although fracture line was faint or not observed on computed tomography. All of lumbar discs from L1-L2 to L5-S1 were evaluated using Pfirrmann grading system, and correlation with the level of spondylolysis was studied. The patient's low back pain (LBP) were evaluated by a traditional VAS scoring system, the Oswestry Disability Index (ODI), and detailed VAS scoring system in which LBP is

evaluated in three different postural situations (in motion, standing, and sitting). Characteristics of LBP in patients with disc degeneration were evaluated and compared with patients without disc degeneration.
Results: Of 590 discs in 118 patients (mean age: 14.3 years-old; 95 boys/23 girls), 23 discs (20 patients) showed disc degeneration (≥ grade 3). Adjacent discs below the spondylolysis showed non-significant tendency toward higher incidence of disc degeneration (6.8%) as compared with other discs (3.2%, p =0.074). Patients were divided into degeneration group (the sum of Pfirrmann grading score of 5 discs was 7 or more), and non-degeneration group. Of the 118 patients, 35 patients met the criteria for the degeneration group. Evaluation of traditional VAS and ODI score showed no significant difference between the degeneration group and non-degeneration group. The results of detailed VAS were (5.5, 2.3, 3.0) in the degeneration group and (4.8, 2.5, 2.4) in the non-degeneration group. Degeneration group showed significantly higher VAS score for LBP in motion and sitting ($p<0.05$). Eight patients had disc degeneration (≥ grade 3), and the patients' detailed VAS score (4.3, 2.4, 3.4) showed more severe LBP in sitting than other patients (5.0, 2.5, 2.5).
Conclusion: This study revealed that disc degeneration occurs before or at the same timing as spondylolysis in some cases, suggesting that disc disruption leads to increased load to pars interarticularis, and is possibly related to the occurrence of stress fracture. Patients with early-stage spondylolysis have severe LBP in motion, but less LBP in standing and sitting, however, in case disc degeneration accompanied with spondylolysis, patients showed relatively severe LBP in sitting.

O177

HETEROCHRONIC PARABIOSIS: IS IT POSSIBLE TO INTERRUPT THE PROCESS OF AGE-ASSOCIATED INTERVERTEBRAL DISC DEGENERATION?

Debora Colangelo,Enrico Pola,Patil Ramesh Prashanti, Luigi Aurelio Nasto,Laura Niedernhofer, Paul Robbins,Nam Vo

Division of spinal surgery, Department of Orthopedic Surgery and traumatology, Università Cattolica del Sacro Cuore, "A. Gemelli" University Hospitall 00168 Rome, Italy

Introduction Aging is the main risk factor for intervertebral disc degeneration (IDD), and over the last few years our research efforts have been aimed at studying how the aging process contributes to IDD. We have previously shown that the DNA repair deficient mice model (Ercc1-/Δ) is a reproducible and effective model to study aging-induced disc degeneration. Moreover our previous studies showed that injection of stem cells into Ercc1-/Δ mice (progeroid mouse) lead to healthspan. Could circulating stem cells and their secreted factors positively impact disc health? In this study we focus on heterochronic parabiosis, a novel experimental technique whereby two organisms of different age are joined together surgically to develop a single, shared circulation.
Aim: To test whether heterochronic parabiosis between young wild type mice (WT) and prematurely aging mice (Ercc1-/Δ) can delay or reverse disc degeneration in the aging mice.
Materials and Methods: 3 different parabiotic pairs were generated: WT+WT 40-days old (isochronic parabiosis), Ercc1-/Δ+Ercc1-/Δ 64-days old (isochronic parabiosis), and WT+Ercc1-/Δ (heterochronic parabiosis). Systemic injection of Evans blue dye and fluorescent nanobeads was used to demonstrate development of shared circulation in all pairs after surgery. Mice were sacrificed 4 weeks after surgery. Disc proteoglycan (PG) content was assessed by safranin-O staining and quantitative DMMB assay. Disc aggrecan content was assessed by immunoflourescence and senescent cells in the disc identified by loss of laminin b1 expression. Activation of stress-response pro-survival transcription factors in senescent cells and resident stem cells was also analyzed. µCT was also performed to assess vertebral bone quality.
Results: Compared to the unpaired controls, Ercc1-/Δ mice heterochronically paired with young WT mice had significantly improved disc PG content (0.378 vs 0.727, $p<0.0023$). Immunofluorescence also showed higher aggrecan levels in Ercc1-/Δ mice after heterochronic pairing. Moreover, lower levels of the senescence marker lamin B1 were observed in discs of Ercc1-/Δ after heterochronic pairing. Histo-

logical analysis (EE & Saf-O) revealed an improvement in the disc structure for the Ercc1-/Δ after heterochronic pairing when compared to the unpaired mice. Reactivation of resident stem cells in aging mice was also observed after exposure to serum of younger mice (evaluated by stem cells GFP expression moving from younger mouse to the progeroid one).
Conclusion: Our results show that it is possible to delay disc degeneration in aging mice by shared circulation with young mice (heterochronic parabiosis). Our results suggest the existence of one or more blood-borne systemic factors controlling disc metabolism and aging.

O178

VERTEBRAL TRABECULAE ADJACENT TO THE DISC ARE HIGHER QUALITY IN THE CRANIAL THAN CAUDAL SIDE IN THE UPPER LUMBAR SPINE, AND ARE UNRELATED TO AGE OR DISC DEGENERATION

Ge Yang,Crites-Battié Michele,Videman Tapio, Boyd Steven,Yue Wang
Department of Orthopedic Surgery, 1st Hospital of Zhejiang University Hangzhou, ZJ, 571, China, People's Republic of

INTRODUCTION: In spine development, a sclerotome is gradually separated by the growing disc and forms half of each vertebral body that is cranial and caudal to the disc. In adults, endplate and vertebral body fractures are more common caudal to the disc. Our previous studies revealed that the cranial endplate of a disc is thicker and has greater BMD than the corresponding caudal endplate. In this study, we examined the symmetry of vertebral trabeculae on either side of a lumbar disc to provide further insight into fracture risk.
OBJECTIVE: To determine differences in vertebral trabecular structures cranial and caudal to a lumbar intervertebral disc, and their associations with age and disc degeneration.
MATERIALS AND METHODS: Ninety-two spinal functional units from 46 cadaveric lumbar spines (males, mean age 50 years, L1-L5) were included from a spine archive. Plain radiography and BaSO4 discography were performed to assess disc narrowing and disc degeneration. µCT (82µm) images were obtained and processed to include only vertebral trabeculae. Using image processing, the vertebral trabecular compartment was divided into cranial and caudal halves, and then into central and peripheral regions, and further into anterior and posterior portions. Microarchitecture measurements for each vertebral region were obtained using structural analyses. Paired test and regression analysis were used to determine differences in structural measurements between cranial and caudal trabeculae and their associations with age and disc degeneration, with the lumbar spine categorized into upper (L1/2-L3/4 discs) and lower (L4/5) regions.
RESULTS: There were 46 upper and 46 lower lumbar functional units. Fifteen (16.3%) discs had no degeneration, 29 (31.5%) slight, 20 (21.8%) moderate, and 28 (30.4%) severe. There were 56 discs with no space narrowing, 26 with slight-moderate, and 6 with severe narrowing. In the upper lumbar region, the trabeculae cranial to a disc on average had 5.3% greater bone mineral density and trabecular bone volume, 3.6% greater trabecular number, 9.7% greater connectivity density , and 3.7% less trabecular separation than the corresponding caudal trabeculae ($P<0.05$ for all). Similar trends were observed in peripheral, anterior and posterior regions. Yet, no structural difference was observed in the trabeculae adjacent to L4/5 discs. Structural asymmetries of vertebral trabeculae were not associated with age, disc degeneration, or disc narrowing.
CONCLUSIONS: Trabeculae in the vertebra cranial to a disc are higher quality than caudally in the upper lumbar spine, but not at L4/5. This structural asymmetry was unrelated to age or disc degeneration, suggesting it may be a result of adaptations to stress distribution within a vertebra. Findings may explain why vertebral fractures are more common at the caudal side of a disc.

O179

FAMILY HISTORY OF LOW BACK PAIN IS A SIGNIFICANT PREDICTOR OF PAIN AND DISABILITY BETWEEN EXTREME STAGES OF LUMBAR DISC DEGENERATION

Dino Samartzis,Cora Bow,Jaro Karppinen,Keith Luk,Bernard Cheung,Kenneth Cheung
The University of Hong Kong 102 Pokfulam Road Pokfulam, Hong Kong

Introduction: Low back pain (LBP) is the world's most disabling condition. Moderate/severe degrees of lumbar disc degeneration on MRI have been associated with LBP. However, the association of LBP with disc degeneration remains controversial as there are asymptomatic individuals with very degenerative spines and, conversely, there are individuals with non-degenerated discs with LBP.
Aim: The following large-scale population-based study addressed the role of various determinants comparing individuals with non-degenerated vs. moderate/severe lumbar disc degeneration on MRI and the occurrence of LBP.
Methods: This was a cross-sectional study of the Hong Kong Disc Degeneration Population-Based Cohort, composed of 1,800 Southern Chinese volunteers who had undergone T2-weighted MRI of the lumbar spine and cardiovascular/occupational/lifestyle assess-ment. Degree of disc degeneration was based on the Schneiderman classification. Based on an overall summated grading scheme (i.e. DDD score) from L1-S1, two groups were determined: Group 1 (n=229) was composed of individuals with non-degenerated discs (DDD score=0) and Group 2 (n=335) entailed individuals with moderate/severe disc degeneration (DDD score ≥5). Additional MRI spinal phenotypes were also assessed (e.g. Modic changes, disc displacement). Serum biomarkers and LBP profiles and family history were also obtained. Oswestry Disability Index (ODI) questionnaire was administered, with a total score ≥20/100 representing an abnormal profile.
Results: In Group 1, 30.6% of individuals had LBP. The mean age was 49.6 and 68% were females. Multivariate regression modelling noted that a family history of LBP (OR: 3.80), younger age (OR: 0.92), and elevated hs-CRP (OR: 1.26) were related to the presentation of LBP. Similarly, family history of LBP (OR: 10.62), younger age (OR: 0.83), and elevated hs-CRP (OR: 1.97) were significantly associated with abnormal ODI values for Group 1. Regarding Group 2, 61.5% of individuals had LBP. The mean age was 54.6 and 56% were females. In a multivariate regression model, males (OR: 14.84), younger age (OR: 0.80), and elevated ESR (OR: 1.11) were significantly associated with LBP. In a similar multivariate analysis, females (OR: 3.68) and family history of LBP (OR: 5.28) were significantly related to abnormal ODI values in Group 2.
Conclusions: Based on one of the largest population-based studies addressing risk factors of disc degeneration and LBP, this study has illustrated for the first time that a "family history of LBP" is one of the most significant risk factors, followed by systemic biomarkers and sexual dimorphism, that may account for the variation between imaging findings of spine degeneration on MRI and pain/disability profiles. This study raises awareness that family upbringing/values or a genetic predisposition to pain may exist in the context of MRI findings.

O180

THE ASSOCIATION BETWEEN THE CROSS-SECTIONAL AREA OF THE DURAL SAC AND LOW BACK PAIN IN A LARGE POPULATION: THE WAKAYAMA SPINE STUDY

Hiroki Iwahashi,Noriko Yoshimura,Hiroshi Hashizume, Hiroshi Yamada,Hiroyuki Oka, Munehito Yoshida

Department of Orthopaedic Surgery, Wakayama Medical University 641-8510 Wakayama City, Japan

Introduction: Low back pain (LBP) in patients with lumbar spinal stenosis (LSS) is multi-factorial. Patients with LSS often have facet arthrosis and degenerative discs. These pathologies may explain LBP in these patients. Recent studies have shown that LBP significantly improves following spinal decompression alone. The association between the cross-sectional area (CSA) of the dural sac and LBP has been attracting more attention. However, no research thus far has focused on the association between the prevalence of LBP and the CSA of the dural sac in the general population. Aim: The purpose of this study was to evaluate relations between the degree of encroachment, measured as the CSA of the dural sac, and LBP in a large population.
Patients and Methods: We conducted a cross-sectional study using a population-based cohort. Data were obtained from the second survey of the Wakayama Spine Study that was performed from 2012 to 2013 in the western

part of Japan. We analyzed data from 802 participants (247 men, 555 women; mean age, 63.5±13.1 years). CSA was measured on axial T2-weighted images. The minimum CSA (mCSA) was defined as the CSA of the dural sac at the most constricted level in the examined spine. Participants were divided into three groups according to quartiles of m CSA. Multivariate logistic regression analysis was used to estimate the association between the mCSA and the prevalence of LBP. In the regression analysis, we used the presence or absence of LBP as the objective variable and mCSA and the presence or absence of disc degeneration and buttock and leg pain as explanatory variables, in addition to basic characteristics, such as age, sex, and body mass index (BMI).

Results: The mean mCSA was 117.3 mm2 (men: 114.4 mm2; women: 118.6 mm2). The prevalence of LBP increased as mCSA decreased. A logistic regression analysis adjusted for age, sex, BMI, and other confounding factors, including disc degeneration, showed that the narrow mCSA (mCSA less than the first quartile measured) was significantly associated with LBP (odds ratio, 1.78; 95% confidence interval, 1.13–2.80, vs the wide mCSA group: mCSA greater than the third quartile measured).

Conclusion: This is the first report to show an association between the CSA of the dural sac and LBP in a large population. The necessity of fusion surgery for LBP has been discussed in LSS patients. This report might support the hypothesis that some LSS patients with LBP could be treated with spinal decompression surgery without fusion.

O181

LOW BACK PAIN AND FUNCTIONAL LIMITATIONS IN ADULT POPULATION OF THE UNITED STATES

Haiou Yang,Scott Haldeman,Margareta Nordin
University of California, Irvine 100 Theory, Suite 100 92617, United States

Introduction. Low back pain (LBP) is a high prevalence musculoskeletal condition with profound impact on individuals, business and society. LBP has been reported as a leading cause of disability in many countries. Understanding functional limitations associated LBP could provide information to estimate the related costs for LBP and to develop strategies to reduce the burden of LBP.

Aim. The goal of this study is to explore the functional limitations related to LBP in the US adult population, including self-care functional limitations, upper extremity functional limitations, and lower extremity functional limitations.

Materials and Method. The data for this study came from the 2009 to 2012 National Health Interview Survey (NHIS) which is a general health survey conducted in the US. LBP in NHIS was defined as non-specific low back pain within the past three months. This study combined files from the NHIS core data sets and a supplementary survey on functioning and disability for 2011, 2012 and 2013. For the purpose of this study in exploring functional limitations and LBP, the population was defined as 18 to 85 and over years of age, with no joint pain and no neck pain. The total number of study population size was 27,389. In order to account for the complex sampling design of the NHIS, the Taylor linearized variance estimation method in STATA 12 was used. Risks of functional limitations were estimated using the logistic regression method. Five sets of logistic regression analyses were conducted to explore the associations between functional limitations and LBP, controlling demographic characteristics and socioeconomic status: a) self-care, b) upper extremity functional limitations in picking up small objects, c) upper extremity functional limitations in raising heavy objects, d) lower extremity functional limitations in walking and climbing steps, and d) needing assistance in walking, using equipment or receiving help for getting around.

Results. Compared with those who had no LBP, those with LBP had a minor increase in risk for self-care functional limitation (OR 1.41, CI 1.07, 1.86). For upper extremity functional limitations, those with LBP had a small increase in risk for having difficulty in picking up small objects with hands and fingers (OR 1.63, CI 1.30, 2.05), and those with LBP had a small increase in risk for difficulty in raising heavy objects (OR 1.65, CI 1.29, 2.10). For lower extremity functional limitations, those with LBP had a large increase in risk for difficulty in walking and climbing steps (OR 2.46, CI 1.94, 3.12) and an increased

risk for needing assistance in walking - using equipment or receiving help for getting around (OR 1.58, CI 1.25, 1.99). This study also indicated that a positive association between age and functional limitations and a negative association between socioeconomic status (education and earning) and functional limitations.

Conclusion. This study identified functional limitations associated with LBP in the US adult population which excluded those persons who also had neck or extremity pain. This study may have both policy and clinical implications to reduce the burden of LBP.

O182

THE INTERRELATION OF MODIC CHANGES, OTHER IMAGING FINDINGS AND BACK PAIN IN MEN

Michele Battié,Yue Wang,Laura Gibbons,Tapio Videman,Kevin Gill

University of Alberta T6G 1W2 Edmonton, Canada

Introduction: Although intensively studied, the associations between low back pain (LBP) and vertebral signal variations on MRI, known as Modic changes (MCs), remain controversial. Furthermore, evidence from studies of general population samples is insufficient to clarify MCs' relation to LBP.

Aim: To examine the associations of various MC phenotypes, including type and extent, and other MRI findings with LBP frequency and disability in a general population sample of men.

Subjects and Methods: 589 men from the population-based Finnish Twin Cohort were included in the study. Back pain history was acquired through a structured interview including LBP frequency and associated disability (days experiencing difficulty performing daily activities due to LBP) during the prior 12 months. Lumbar T1- and T2-weighted MRIs were obtained using a 1.5T imager. The presence and type of MCs were evaluated at each lumbar endplate from L1 to S1. Measurements of the largest anteroposterior and transverse diameters of MCs, as well as the number of endplates affected, represented the extent of MCs. In addition, disc narrowing, bulging, herniation, and Schmorl's nodes were assessed qualitatively. Two quantitative signal-based measures of disc degeneration (CSF-adjusted disc signal and a signal-ratio based measure) also were acquired. Ordinal logistic regression analyses were used to examine the associations studied.

Results: LBP at least once in the prior 12 months was reported by 393 (66.7%) men. One day or more of LBP related disability was reported by 161 (27.3%) men, and >30 days by 42 (7.1%). Crude associations of nearly all MC phenotypes with LBP frequency and disability were highly statistically significant, but of small effect, and remained so after controlling for age and body mass index (BMI). When considering all MC and other imaging variables, as well as age and BMI, only the number of endplates with MCs (OR=1.2, 95%CI=1.10-1.32) and the presence of Type 1 MCs (OR=1.64, 95%CI=1.13-2.38) entered the multivariable model explaining LBP frequency over the prior 12 months. The final multivariable model explaining disability days included age, BMI, maximum disc bulging score and maximum bulging at an endplate with Type 1 MCs, maximum Schmorl's node, and disc degeneration as measured with the signal-ratio based disc degeneration measure.

Conclusion: Of the factors investigated, MCs, particularly their extent and the presence of Type 1, were most associated with LBP frequency over the prior year. However, a broader range of imaging findings, along with age and BMI, were independently associated with LBP disability days, with Type 1 MCs contributing when present in conjunction with disc bulging. The effects of MCs extent or severity and their concomitance with disc degeneration and other MR findings on LBP warrants further investigation.

O183

DOES RA PATIENT HAVE LUMBAR LESION OR LOW BACK PAIN MORE FREQUENTLY THAN HEALTHY POPULATION? –CROSS SECTIONAL ANALYSIS IN COHORT STUDY WITH AGE AND SEX MATCHED HEALTHY VOLUNTEER

Akinobu Suzuki,Koji Tamai,Javid Akhgar, Hidetomi Terai,Masatoshi Hoshino,Hiromitsu

Toyoda, Kazunori Hayashi,Shoichiro Ohyama, Hiroaki Nakamura
Dept. of orthopaedic surgery, Osaka city university graduate school of medicine 5458585 Osaka, Japan

INTRODUCTION: Rheumatoid arthritis (RA) often involves not only cervical spine but also lumbar spine. However, there have been few studies comparing the epidemiology of lumbar lesion or low back pain in RA patients with that in healthy population. The purpose of this study was to investigate the prevalence of lumbar lesion and low back pain in RA patients and healthy volunteer.
PATIENTS AND METHODS: This cross-sectional study included 185 patients with RA (RA group) and sex-age matched 185 healthy volunteer without RA (Control group). Lumbar spondylolisthesis and prevalent vertebral fracture were evaluated on plain lateral X-ray. Thoraco-lumbar scoliosis was evaluated on the image of dual-energy X-ray absorptiometry. Low back pain within 4weeks was assessed with visual analogue scale (VAS) and Rolland Morris Disability Questionnaire (RDQ). The status of anxiety and depression were evaluated using Hospital Anxiety and Depression Scale (HADS)
RESULTS: The prevalence of spondylolisthesis and prevalent vertebral fracture was significantly higher in RA group than control group (spondylolisthesis: 46.5% vs. 26.6%, $p<0.01$, vertebral fracture: 45.9% vs. 33.9%, $p=0.01$). The prevalence of thoraco-lumbar scoliosis was tend to be higher in RA group (29.7%) than control (22.9%) ($p=0.08$). The average VAS score was 25.3±28.7mm in RA group and 21.1±25.5mm in control group, and there was not significant difference between the two group. However, the score of RDQ was significantly worse in RA group ($p<0.05$). The anxiety score in HADS was similar between the two, but depression score tended to be higher in RA group than control ($p=0.06$).
DISCUSSION AND CONCLUSION: This is the first study which investigated the difference in the prevalence of lumbar lesion and low back pain between RA patients and healthy population. The present results demonstrated that RA patients are more likely to have radiological lumbar lesion. The prevalence of low back pain in RA patients is similar to that in healthy population, but the activity of daily living can be more affected by low back pain in RA patients.

O184

THE INFLUENCE OF LUMBAR DEGENERATION ON THE TREATMENT OUTCOME OF INDIVIDUALS WITH LOW BACK PAIN FOLLOWING SPINAL MANIPULATION.

Arnold Wong,Eric Parent,Sukhvinder Dhillon, Narasimha Prasad,Dino Samartzis, Greg Kawchuk
Hong Kong Polytechnic University Hong Kong, Hong Kong

DESIGN: Non-randomized clinical trial Objective. To identify differences at baseline in the degenerative status of low back pain subjects who respond, or do not respond, to spinal manipulative therapy. Summary of Background Information. Patients with low back pain (LBP) who report benefitting from SMT demonstrate differential post-SMT changes in spinal stiffness and lumbar multifidus contraction as compared to treatment non-responders. Unfortunately, the causes of this differential response remain unclear.
METHODS: Thirty-two LBP participants received SMT on the first two of three sessions conducted over a 1-week period. Lumbar magnetic resonance imaging was obtained from all participants before SMT on session 1. A radiologist, who was blinded to patient clinical information, graded six lumbar degenerative factors (Modic changes, disc degeneration, facet degeneration, spondylolisthesis, interspinous ligament lesion, and fat infiltration in multifidus) on T1- and T2-weighted images using various validated categorical grading scales. Another rater, who was blinded to patient data, measured the apparent diffusion coefficient of lumbar intervertebral discs, which is a proxy for disc degeneration. A lower apparent diffusion coefficient value represents poorer disc diffusion (a sign of disc degeneration). Participants with LBP were dichotomized as responders and non-responders using a cutoff of >30% reduction in baseline modified Oswestry disability index scores on session 3. This cutoff represents a recommended minimally clinically important change in LBP-related disability. Chi-square tests and a multivariate linear model

were used to analyze between-group differences in degenerative factors and apparent diffusion coefficients, respectively.
RESULTS: Compared to the responders, non-responders demonstrated a higher prevalence of severely degenerated facet joints ($\chi^2 = 3.86$; Cramer's V = 0.142, p = 0.05). Similarly, SMT non-responders displayed significantly lower apparent diffusion coefficients at the L4-5 and L5-S1 discs as compared to the responders (mean difference = 0.10 x 10-3 mm2/s, p < 0.05). No significant difference in other degenerative factors was noted between the two subgroups at baseline.
CONCLUSION: This study is the first to suggest the existence of physical differences at baseline between SMT responders and non-responders. Specifically, spinal degeneration appears to affect the post-SMT treatment outcomes in patients with LBP. Importantly, the apparent diffusion coefficient might be more sensitive than traditional qualitative assessment of disc degeneration to detect early sign of intervertebral disc diffusion. Our results suggest that controversial findings of previous research regarding the effectiveness of SMT may be attributed to varying ratios of SMT responders and non-responders in study samples.

O185

LATERAL INTERBODY FUSION AS A TOOL IN ADULT SPINAL DEFORMITY SURGERY: CORRECTION AND COMPLICATIONS WITH HYBRID VERSUS POSTERIOR-ONLY APPROACH

Russell Strom,Junseok Bae,Jun Mizutani,Frank Valone III,Christopher Ames,Vedat Deviren
University of California, San Francisco San Francisco, CA 94143, United States

Introduction: When combined with percutaneous screw fixation, lateral lumbar interbody fusion (LLIF) provides modest coronal > sagittal correction of adult spinal deformities. In our practice a hybrid strategy is employed: LLIF is followed by an open posterior approach, with facet osteotomies and rod-cantilevel technique used to enhance sagittal correction.
Aim: To compare radiographic correction, complications, and outcomes of adult deformity surgery using a LLIF+posterior versus posterior-only approach Methods: A two-surgeon team's cases were reviewed for all adult thoracolumbar deformity operations from 2009 to 2014. Patients with previous fusion, severe sagittal imbalance (SVA > 200 mm or PI-LL > 40°), and those undergoing ALIF were excluded. LLIF+posterior and posterior-only patients were compared with regard to baseline clinical and radiographic variables, immediate and delayed complications, and ultimate impact on spinal alignment and quality of life.
Results: 32 LLIF+posterior and 60 posterior-only patients were identified. Other than higher preoperative VAS back pain in the LLIF+posterior group (mean 7.2 versus 4.8, p=0.024), there were no significant differences in baseline clinical variables, radiographic parameters, or posterior interspaces fused (mean 10 versus 11, p = 0.193). 3.8 LLIFs were performed in the LLIF+posterior group on average. LLIF+posterior patients had significantly lower total blood loss (mean 1129 versus 1833 mL, p=0.016). The incidence of new postoperative leg pain, numbness, or weakness was similar (28% versus 22%, p=0.609). All leg symptoms resolved within 6 months, except for persistent weakness and numbness in one posterior-only patient. LLIF+posterior patients had significantly lower rates of durotomy (0% versus 23%, p=0.002). LLIF+posterior patients required significantly less ICU care (mean 0.7 versus 2.8 days, p<0.001) and were less likely to require inpatient rehabilitation (63% versus 87%, p=0.015). Follow-up was similar between the groups (mean 28 versus 25 months, p=0.462). LLIF+posterior patients had dramatically lower pseudarthrosis rates (6% versus 27%, p=0.026). LLIF+posterior patients had a significantly greater improvement in VAS back pain (mean decrease 4.0 versus 1.9, p=0.046) and ODI (mean decrease 21 versus 12, p=0.035). LLIF+posterior provided superior lumbar Cobb angle correction (mean 22° versus 14°, p=0.010). LLIF+posterior provided a mean 22° lumbar lordosis gain, intermediate between posterior-only without PSO (11°, p<0.001) and posterior-only with PSO (29°, p=0.045).
Conclusion: Coupled with an open posterior approach, multilevel LLIF appears to be a safe and effective tool in treating adult spinal deformity of moderate severity. Except for severe rigid deformities requiring three-column osteotomy, LLIF+posterior provided superior restor-

ation of lumbar sagittal and coronal alignment compared to a posterior-only approach. The hybrid approach was associated with faster recovery, lower pseudarthrosis, and greater relief of back pain and disability.

O186

EFFECTIVENESS OF DECOMPRESSION WITH FUSION COMPARED WITH DECOMPRESSION ALONE FOR LUMBAR SPINAL CANAL STENOSIS IN PATIENTS AGED 80 YEARS OR OLDER: A MULTI-INSTITUTIONAL RETROSPECTIVE STUDY

Atsushi Kimura,Katsushi Takeshita
Jichi Medical University Shimotsuke Tochigi 329-0498, Japan

Introduction: Lumbar spinal canal stenosis (LSCS) is a major cause of morbidity among elderly people. Spinal fusion is often recommended to treat LSCS associated with instability or deformity. However, little information is available regarding clinical outcomes of decompression with fusion in patients aged ≥ 80 years.
Aim: This study aimed to investigate the effectiveness of decompression with fusion compared with decompression alone to treat patients aged ≥ 80 years with LSCS.
Materials and Methods: The study population comprised 156 patients who underwent decompression with fusion (fusion group: n =51) or decom-pression alone (decompression group: n = 105) for LSCS at 35 participating spine centers. Inclusion criteria included age ≥ 80 years at the time of surgery and a minimum follow-up of 1-year. We retrospectively analyzed data on patient demographics, operation time, blood loss, postoperative complications, low back pain, and leg pain. Pain intensity was assessed using the 11-point numerical rating scale (NRS) preoperatively and at final follow-up. All patients completed a self-administered questionnaire to assess the degree of patient satisfaction with outcome (5-point NRS: 1, “Very dissatisfied”; 2, “Dissatisfied”; 3, “Neutral”; 4, “Satisfied”; and 5, “Very satisfied”) and improvement (4-point NRS: 1, “Worsened”; 2, “Unchanged”; 3, “Improved”; and 4. “Markedly improved”) on five quality of life domains: bodily pain, daily activity, walking ability, work or household tasks, and general health status. Results: Patients in the fusion group had significantly lower age (81.7 ± 2.0 vs. 82.9 ± 2.3 years, P = 0.002) and significantly higher baseline low back pain intensity (6.6 ± 2.0 vs. 5.6 ± 2.6, P = 0.023) than those in the decompression group. Patients in the fusion group showed significantly longer operation time (232.7 ± 106.5 vs. 131.3 ± 62.0 min, P < 0.001) and significantly higher blood loss (599.2 ± 82.5 vs. 133.6 ± 135.1 ml, P < 0.001) than those in decompression group. The overall incidence of perioperative complications was higher in the fusion group than in the decompression group, but the difference was not significant (31% vs. 20%, P = 0.125). The most common complications in the fusion and decompression groups were delirium (five cases) and dural tear (four cases), respectively. Patients in the fusion group reported significantly lower leg pain intensity and significantly greater improvements in daily activity and walking ability than those in the decompression group. Patient satisfaction was also significantly higher in the fusion group than in decompression group.
Conclusion: In patients aged ≥ 80 years with LSCS, decompression with fusion yielded significantly better patient-reported outcomes than decompression alone. However, because decompression with fusion was associated with significantly increased operation time and blood loss, indication for fusion surgery should be determined with caution in elderly patients.

O187

EFFECT OF BIOACTIVE PEDICLE SCREWS WITH HYDROXYAPATITE-FORMING POTENTIAL IN THE CANINE LUMBAR SPINE

Koji Akeda,Seiji Yamaguchi, Tomiharu Matsushita, Tadashi Kokubo,Koichiro Murata, Norihiko Takegami,Junichi Yamada,Akihiro Sudo
Mie University Graduate School of Medicine 2-174 Tsu, Japan

Introduction: Spinal instrumentation with a pedicle screw (PS) system is usually in place over long periods of time, or semi-permanently. Titanium (Ti)-6Al-4V alloy, widely used in spinal instrumentation with a PS system, does not form a chemical bond with bone; therefore significant clinical problems, including the loosening and back-out of PSs, exist. Over the

last decade, a novel technology to produce bio-active Ti by chemical and heat treatments, which induces the spontaneous formation of a layer of hydroxyapatite (HA) on the surface of Ti materials in vitro and vivo, has been reported. Aim: The purpose of this study was to examine the effect of bioactivation of Ti-6Al-4V PSs on the ability of HA to form in vitro and its bone-bonding ability in vivo in the canine lumbar spine.

Materials and Methods: PSs (diameter: 2.5 mm; length: 14 mm) were prepared from Ti-6V-4Al alloy and bio-activated by NaOH-CaCl2-heat-water treatments. The HA-forming ability of bioactive PSs, examined by incubation in simulated body fluid (SBF), was evaluated by field emission scanning electron microscopy (FE-SEM) and energy dispersive X-ray analysis (EDX).

Animal study: six 11-month-old female beagle dogs were used: bioactive and control (without bioactivation) PSs were placed from L1 to L6. One and three months after surgery, lumbar spines were removed, followed by biomechanical (torsional screw extraction and pull-out strength) and histological (Villanueva's goldner method) analyses.

Results: In vitro: The surface analysis of bioactive PS by FE-SEM showed that substantial HA deposits covered the entire surface. EDX analysis showed that, in addition to Ca and P, the HA deposits contained small amounts of Mg, Na and C, which were taken from Mg2+, CO32-, and Na+ ions in SBF, and thus should represent bone-like apatite. In vivo: The averaged extraction torque was significantly higher in bioactive PSs compared to that of the control PSs (1M: +3.1%, P=0.06; 3M: +61.1%, P<0.05, all vs. control PSs). There were no significant differences in pull-out strength between control and bioactive PSs, both at one and three months after surgery. Histologically, in the control group, a fibrous tissue layer was interstitially spread between the bone tissue and screw surface. On the other hand, bone tissue, including bone matrix and bone marrow, was closely attached to the surface of bioactive PSs. The ratio of contact area between bone tissue and screw surface was higher in bioactive PSs compared to controls (1M: +12.9%; 3M: +57.8%).

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

O188

CHARACTERIZATION OF THE GAIT PATTERN AND THE DISABILITY IN ADULT SPINAL DEFORMITY PATIENTS. – FACTORS AFFECTING THE GAIT ABNORMALITY -

Mitsuru Yagi,Shinjiro Kaneko,Yoshiyuki Yato, Masafumi Machida,Takashi Asazuma

National Hospital Organization Murayama Medical Center Tokyo 2080011 Tokyo, Japan

Introduction: Questions regarding to the gait pattern in patients with Adult spinal deformity (ASD) have not yet been fully documented. Aim: To assess the dynamic balance during walking of adult spinal deformity patients and related it to the patient demographic and radiographic factors.

Materials and Methods: 39 consecutive adult female patients with ASD but without neurological deficit were included. Charts and Xrays were reviewed. The gait pattern of the patients were compared with age, gender, and BMI matched 33 healthy volunteers. All patients received gait analysis with optical markers in the all joints, the ear canal and spinal processes on a 10.8m custom-built force platform. To evaluate the lean composition of lower leg, whole body DXA score was obtained from all patients. Means were compared with Mann-Whitney U and chi-square test. P value of <0.05 with confidence Interval 95% was considered significant.

Results: The mean age was 67.1 years (51-74 years) and BMI was 22.5±2.5kg/m2 The Cobb angle was 46.8±18.2 deg., CVA 1.5±3.7cm, C7PL 9.1±6.4 cm, Gravity Line (drawn from the ear canal) 10.1±7.5cm, thoracic kyphosis 17.1±15.9 deg., lumbar lordosis -7.3±21.5 deg. PI-LL 38.2±22.1 deg., and the lean volume of lower leg was 5.5±0.6 kg. The gait velocity (54±10m/min vs 70.7±12.9m/min, p<0.001), stride (97.8±13.4cm vs 115.3±15.1cm p<0.001), and cadence (113.8±13.7s/min vs123.1±8.1s/

min, p=0.01) were significantly worse in ASD while no difference was observed in stance-swing ratio (stance 63.1% vs swing 36.8%). The timing of the individual gait phases was normal but asymmetric. Asymmetric ground reaction force in medial-lateral direction and anterior/-posterior direction were seen in ASD patients. The ROMs of hips, knees, and pelvis were significantly decreased in ASD whereas no difference was noted in the ROMs of lumbar spine and ankles. Normal butterfly pattern ground reaction force vector was observed in healthy volunteers whereas significant deterioration was observed in ASD patients. The correlation coefficient tests showed the significant correlation with gait velocity and GL, SVA, PI-LL, stride and lean of lower extremity, GL, PI-LL, and the ROM of hip and Cobb angle (Table).

Conclusion: Gait velocity, stride, and cadence were all deteriorated when compared with HV due to the spinopelvic mal-alignment, limited ROMs and angle of LE joints. Surgical correction of both spinopelvic alignment and coronal alignment may important to achieve appropriate gait ability in patients with ASD.

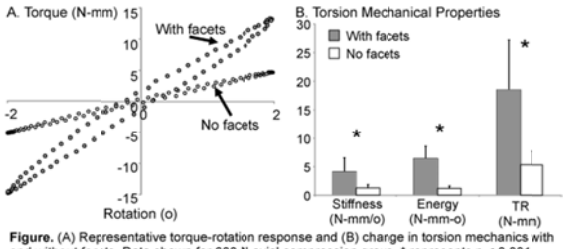


Figure. (A) Representative torque-rotation response and (B) charge in torsion mechanics with and without facets. Data shown for 600 N axial compression group. * represents p < 0.001

O189

LUMBAR DISC DEGENERATION AND MODIC CHANGE 35 YEARS AFTER SURGERY FOR ADOLESCENT IDIOPATHIC SCOLIOSIS: LONG-TERM MRI FOLLOW-UP

Tsutomu Akazawa,Toshiaki Kotani,Tsuyoshi Sakuma,Shohei Minami,Masashi Takaso,Gen Inoue,Masayuki Miyagi,Yasuchika Aoki, Sumihisa Orita,Kazuhisa Takahashi,Seiji Ohtori

Dept. of Orthopedic Surgery, Seirei Sakura Citizen Hospital Sakura 285-8765, Japan

Aim: The aim of this study was to survey adolescent idiopathic scoliosis (AIS) patients who had been surgically treated with spinal fusion. In a long-term follow-up, we looked for signs of intervertebral disc degeneration and Modic changes in non-fused segments using MRI.

Materials and Methods: The subjects were 252 patients diagnosed with AIS that had been surgically treated between 1968 through 1988. Mean age at the time of surgery was 14.8 years, and the preoperetive Cobb angle was 68.3º, while the postoperative Cobb angle 2 years after surgery was 39.4º. Questionnaires were mailed and those patients who gave their informed consent underwent lumbar MRI and whole spine X-ray. MRIs of the lumbar spine were taken to assess intervertebral disc degeneration (DD) based on Pfirrmann disc scores, and Modic changes were assessed from signal intensity changes in vertebral end plate. Pfirrmann grades 4 or 5 were considered DD(+), while those with other scores were considered DD(-). Those with Modic changes were Modic(+) and those without were Modic(-). Questionnaires included SRS-22, Roland-Morris Disability Questionnaire, and Oswestry Disability Index.

Results: Out of the 252 patients, 48 questionnaires were collected, and 25 patients underwent imaging examinations. Mean age of the 25 patients at the time of observation was 49.4 years (range: 40-60), and the mean duration of follow-up was 35.0 years (range: 27-44). Lower instrumented vertebra were as follows: L1, 4 patients; L2, 9 patients; L3, 6 patients; L4, 5 patients; L5, 1 patient. Mean Pfirrmann disc scores were L1-2, 3.3; L2-3, 3.2; L3-4, 3.2; L4-5, 3.5; L5-S1, 3.3. Modic changes in 85 non-fused segments were type 1, 5; type 2, 9; and type 3, none. Compared to the DD(-) group, the DD(+) group had a smaller lumbar lordosis angle (37.5 vs 53.9º, p=0.008), a larger pelvic tilt (25.0º vs 10.4º, p=0.001), larger sagittal vertical axis (SVA) (47.1 mm vs 4.7 mm, p=0.013), and there were no significant differences in questionnaire scores. There were no significant differences in the X-ray parameters or questionnaire scores between the Modic (+) and Modic (-) groups.

Conclusions: After an average of 35 years of follow-up in AIS patients after spinal fusion, there were signs of intervertebral disc degeneration and Modic changes in non-fused segments, but there were no findings associated with low back pain or health-related quality of life. In patients with signs of intervertebral disc degeneration, the lumbar lordosis decreased,

the pelvic tilt increased, and the SVA shifted towards the front with sagittal imbalance.

O190

SPINAL ALIGNMENT OF PARKINSON'S DISEASE PATIENTS WITH CHRONIC LOW BACK PAIN: COMPARISON WITH ADULT SPINAL DEFORMITY

Kei Watanabe,Toru Hirano,Masayuki Ohashi, Hirokazu Shoji,Naoto Endo,Masatoyo Nishizawa,Takayoshi Shimohata

Department of Orthopaedic Surgery, Niigata University Medical and Dental Hospital 951-8510, Niigata City, Jarvis Island

Introduction: Spinal malalignment including loss of lumbar lordosis, increased sagittal vertical axis (SVA) and pelvic retroversion is considered to be exacerbating factors of low back pain (LBP) and quality of life (QOL) in the general population with adult spinal deformity (ASD). There have been few reports investigating the relationships between radiographic spinal alignment and LBP or QOL in patients with Parkinson's disease (PD),

Aim: To investigate the characteristics of spinal alignment in PD, and the relationships to chronic LBP and QOL.

Materials and Methods: Forty-seven PD patients complaining of chronic LBP were included (group PD). Age-matched 55 patients with adult spinal deformity were selected as a control group (group ASD). PD condition using the Hoehn and Yahr (H-Y) stage, radiographic spinal alignment, lumbar range of motion (ROM), and QOL assessments associated with LBP were evaluated. The QOL assessments included visual analog scale (VAS) of LBP, and the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) with five subscales (LBP, lumbar function, walking ability, social function and mental health). A negative value indicated lordosis.

Results: Spinal alignment (group PD/group ASD) demonstrated C7 coronal deviation (36.3/26.5mm), scoliotic Cobb angle (24.2/28.7°); sagittal vertical axis (SVA; 24.9/98.1mm); pelvic incidence (49.9/52.3°), in which no significant differences were found. On the other hand, there were significant differences in thoracic kyphosis (27.9/15.0°), lumbar lordosis (-21.9/-8.2°), and pelvic tilt (25.3/33.7°) (all comparisons, $p<0.05$). QOL assessments using the JOABPEQ demonstrated low back pain (46.0 point); lumbar function (41.4 point); walking ability (32.1 point); social function (34.0 point); mental health (35.9 point); LBP VAS (5.9/10 point). With regard to correlations between radiographic parameters and clinical conditions, SVA was significantly related to H-Y stage, LBP VAS, and the scores of JOABPEQ including low back pain, and walking ability (all comparisons, $p<0.05$). Lumbar lordosis was related to LBP VAS, and the scores of JOABPEQ including low back pain and walking ability (all comparisons, $p<0.05$). Lumbar ROM was related to H-Y stage, LBP VAS, and the scores of JOABPEQ including walking ability, and social function (all comparisons, $p<0.05$).

Conclusion: Spinal sagittal malalignment and decreased lumbar ROM in PD correlate with severity of LBP and QOL impairment, which are similar conditions to ASD. On the other hand, the present study suggests that existence of characteristic spinal conditions in PD, which include progression of sagittal malalignment without compensatory mechanism such as loss of thoracic kyphosis, and pelvic retroversion. Specific treatment strategy should be established under consideration of the characteristics of spinal alignment in PD.

O191

NOVEL VIRTUAL MODELING OF ALIGNMENT FOLLOWING ASD SURGERY: ESTABLISHING RELATIONSHIPS BETWEEN COMPENSATORY CHANGES AND OVERCORRECTION DUE TO PROXIMAL JUNCTIONAL KYPHOSIS

Renaud Lafage,Shay Bess,Steven Glassan, Christopher Ames,Doug Burton,Bassel Diebo, Robert Hart,HanJo Kim,Eric Klineberg,Bret Line, Justin Scheer,Themistocles Protopsaltis, Frank Schwab, Virginie Lafage,International Spine Study Group

Hospital for Special Surgery New York, NY 10021, United States

INTRODUCTION: It is difficult to analyze patients' postoperative sagittal alignments once they develop PJK since they often dramatically compensate for the deformity. Until now, there was no effective way to model post-op align-

ment that was free of PJK's compensatory influence. This study proposes a novel virtual modeling technique that eliminates PJK's impact on global alignment. Examining these models will lead to a better understanding of alignment factors associated with PJK.

Aims: The purpose of this study is to develop a novel virtual model of the spine following ASD surgery that can help improve our understanding of post-operative alignment by removing the influence of PJK.

MATERIALS AND METHODS: A multicenter retrospective ASD database was used to model virtual post-op alignments (VIRTUAL) for patients with pelvic fusion. Patients were divided into groups with/without PJK (PJK vs. NOPJK). VIRTUAL combined the 2-year post-op alignment of the instrumented segments (pelvis to UIV-1) with the pre-op alignment of the unfused segments (C2 to UIV); pelvic retroversion was corrected based on a published predictive formula. VIRTUAL was validated by comparisons to actual 2-year post-op alignment (REAL) in NOPJK patients.

RESULTS: 458 patients (78F; mean 57.9y) were analyzed. Initial validation of VIRTUAL versus REAL demonstrated coefficients of correlation above 0.880 for all measures except SVA (r=0.604). At 2 years, 215 (47%) patients had PJK (PJK angle=21°). PJK patients were older than non-PJK (59.7 vs. 62.6y, p=0.007). On REAL, PJK had smaller PI-LL mismatch and larger TK than NOPJK (resp. PI-LL: 3.1 vs. 8.2°, TK: -44.6 vs. -37.3°, all p<0.001), but similar SVA, TPA and PT. However, analysis of VIRTUAL demonstrated that PJK not only had less PI-LL (3.1 vs. 7.7°), but also less PT (20 vs. 23°), less SVA (10 vs. 24mm) and less TPA (15 vs. 18°) than NOPJK (p<0.05).

CONCLUSIONS: This novel modeling technique demonstrated high correlations with actual post-op alignment in patients without PJK. Comparing REAL to VIRTUAL models indicates that PJK may be a component of the compensatory mechanism, rather than simply an alignment failure.

O192

SAGITTAL IMBALANCE IN DEGENERATIVE SCOLIOSIS CAN BE CORRECTED BY ADDRESSING ONLY THE SYMPTOMATIC LEVELS

Steven Presciutti,Philip Louie,Sarah Johnson, Michael Hellman,Howard An

Emory University 2nd flr, Surgery Office 30033, United States

Introduction: The optimal method of addressing the loss of lumbar lordosis (LL) often present in degenerative scoliosis (DS) is controversial. The goal is to achieve an adequate decompression as well as correct the sagittal and coronal deformities, as this has been shown to correspond to a better quality of life. An important distinction is whether or not the loss of LL often seen is truly structural or whether it is more positional in nature given that spinal stenosis is almost always present in these patients.

Aim: To determine (1) if the loss of LL often associated with DS is structural or rather largely due to positional factors secondary to spinal stenosis, and (2) if the entire DS curve or rather a lesser local fusion of only the neurologically symptomatic levels need to be addressed in order to achieve appropriate sagittal correction.

Patients/Methods: Pre- and post-operative radiographs and preoperative MRIs were analyzed for LL, pelvic incidence (PI), and pelvic tilt (PT). Patients were included if they had DS, a loss of LL preoperatively (PI-LL > 9o), and underwent a decompression and instrumented fusion of only their symptomatic levels. Patients were excluded if they had an osteotomy or placement of an interbody graft or if they had a previous fusion.

Results: Sixty-eight consecutive patients with an average follow-up of 22 months were reviewed. In addition to decompression, instrumented fusion was most commonly performed from L4-S1 (N = 27) followed by L3-S1 (N = 22). The average PI found pre-op and post-op was 52o and 53o, respectively. The average PT found pre-op and post-op was 25o and 27o, respectively. Mean preoperative LL was 32o (2-60o). Preoperative MRIs and lumbar extension radiographs revealed an average LL of 42o (10-66o) and 48° (20-74°), respectively. LL postoperatively was corrected to a mean of 44o (14-68o,

p<0.001), resulting in an average PI-LL of 9o. Out of 24 patients who achieved PI-LL within 9o on their extension radiographs, 15 were within 9o on their postoperative films (63%). This is in contrast to only 15% of patients who were not able to achieve that mismatch on extension radiographs (p=0.001, OR=9.58). Similarly, 54% of patients were able to achieve a PI-LL < 9o postoperatively if they achieved it on their preoperative MRI. In contrast, only 22% of patients achieved that goal postoperatively if their mismatch was greater than 9o on their MRI (p=0.003, OR=4.25).
Conclusion: Despite an average PI-LL > 20o preoperatively, LL was corrected to within 9o of the PI in this cohort of symptomatic DS patients with decompression and instrumented fusion of their symptomatic levels only, without exposing them to the complications associated with longer instrumented fusions and/or osteotomies. Importantly, the loss of LL is positional rather than structural and the amount of LL correction achievable can be predicted from preoperative MRI and extension radiographs.

O193

HOW TO RESTORE AN OPTIMAL PELVIC POSITION IN ELDERLY PATIENTS WITH ADULT SPINAL DEFORMITY

Yu Yamato,Tomohiko Hasegawa,Sho Kobayashi, Daisuke Togawa,Tatsuya Yasuda, Yukihiro Matsuyama, Takahiro Iida,Akira Matsumura, Naobumi Hosogane,Morio Matsumoto
Department of Orthopedic Surgery, Hamamatsu University School of Medicine 431-3192 Hamamatsu, Japan

Introduction: Sagittal spino-pelvic alignment including pelvic position is important for maintaining high standard quality of life in adult spinal deformity (ASD) patients. In order to achieve successful corrective fusion in ASD patients with sagittal imbalance, it is essential to not only correct the sagittal spinal alignment, but also obtain a suitable pelvic inclination. Aim: The objective of this study is to identify the target lumbar lordosis (LL) angle for restoring the optimal pelvic tilt (PT) in ASD patients. Materials and Methods: To establish the target LL angle, we investigated optimal PT of elderly people and the relationship between post-operative LL and PT in patients who underwent ASD surgery. Two groups were included in this study. The first group included 184 elderly volunteers (age, 51-70 years; mean, 64 years) with an Oswestry Disability Index score less than 20%. The relationship between PT or LL and PI in normal individuals was investigated using single regression analysis. The other group included 116 ASD patients (age, 37-84 years; mean, 66 years) who underwent thoracolumbar corrective fusion in 4 spine centers. The postoperative PT value was calculated from collected parameters using multiple regression analysis. Based on these studies, an ideal LL angle was determined.
Results: In the first study, the linear regression equation for optimal PT and LL according to PI was found to be “optimal PT = 0.47 × PI - 7.5” and “optimal LL = 0.57 × PI +16.2”, respectively. In the second study, the postoperative PT was determined according to PI and corrected LL by multiple regression analysis, using the equation “postoperative PT = 0.7 × PI - 0.5 × corrected LL + 8.1”. The ideal LL angle was determined based on these 2 equations (mathematically equalize each of PTs), as follows: “ideal LL = 0.45 × PI + 31.8”. This equation reveals that the ideal LL is approximately 10 degrees larger than the optimal LL determined from volunteers.
Conclusion: The target LL angle for restoring optimal pelvic inclination can be determined to be 0.45 × PI + 31.8. We can use this equation as a reference in surgical planning in corrective fusion of ASD.

O299

COMPLICATIONS AND REPEAT OPERATION ASSOCIATED WITH GREATER SURGICAL INVASIVENESS IN LUMBAR SPONDYLOLIS-THESIS: FINDINGS OF THE HIGH VALUE HEALTHCARE COLLABORATIVE.

Brook Martin,Kevin McGuire,Barbara Gladders, Jon Lurie,Farrokh Farrokhi,James Weinstein
Geisel School of Medicine at Dartmouth College Orthopaedics/ HB 7541 03756, United States

Introduction: Surgical treatment for lumbar spondylolisthesis is often considered for those who have failed non-operative care, especially with persistent or recurrent symptoms, progressive displacement, or worsening functional

decline. Criteria for selecting surgical candidates are variable, and decisions about what type of operation to perform is discretionary.
Aim: Using uniform data from the High Value Health Care Collaborative (HVHC), a network of diverse health care systems throughout the United States, we examined variation in the use of different types of procedures, and the association of repeat spine operation (1-year), wound problem (90-day), and all-cause rehospitalization (90-day) with surgical invasiveness.
Materials and Methods: We included patients (n = 884) undergoing decompression or fusion for lumbar spondylolisthesis, excluding those with scoliosis, cancer, HIV, spinal cord injury, spinal fracture, cervical or thoracic problems, corpectomy, and device removal/revision procedures. A validated Surgical Invasiveness Index was calculated based on Current Procedural Terminology codes. Logistic regression models with site-specific robust standard errors were used to identify the association between the Surgical Invasiveness Index and safety outcomes, while controlling for patient age, sex and select Elixhauser (v3.7) comorbidities.
Results: The adjusted mean adverse event rates were 2.1% for repeat surgery within 1-year, 1.3% for 90-day wound problems, and 4.2% for 90-day readmission. The Surgical Invasiveness Index was significantly associated with wound problems (OR 1.10, $p<0.05$) and all-cause rehospitalization (OR 1.07, $p<0.01$), even after controlling for patient characteristics and comorbidity. Each one-point increase in the Surgical invasiveness Index was associated with a 10% increase in the likelihood of having a wound problem. The Surgical Invasiveness Index was not significantly associated with 1-year repeat spine operation. Patient age and sex were not significantly associated with any of the adverse safety indicators, but select comorbidities were important. Valvular disease was associated with repeat surgery and rheumatoid arthritis was associated with wound problems and all-cause readmission.
Conclusion: Greater use of complex spine operations in treating spondylolisthesis might reflect surgeons' intention to reduce repeat operations based on instability, even in cases of mild spondylolisthesis. However, we found that greater surgical invasiveness is associated with increased risk for wound problems and readmissions, even after controlling for patient characteristics and comorbidity. Therefore, the decision to perform more complex procedures should be carefully balanced against the risk for harm, and patients should be fully informed about the greater risk associated with more complex procedures.

O300

INCIDENTAL DURA LESIONS AND THE EFFECT ON OUTCOME AFTER DECOMPRESSION FOR LUMBAR SPINAL STENOSIS: RESULTS OF A PROSPECTIVE MULTI-CENTER STUDY

Christoph Siepe,Markus Quante,Nils Engler, Sandra Pirchner,Franziska Heider,Ralph Kothe
Schön Clinic Munich Harlaching; Spine Center D-81547 Munich, Germany

Introduction: Incidental durotomy is one of the most common complications in lumbar spine surgery. The reported incidence of dura lesions in patients with lumbar spinal stenosis ranges between 4% - 17%, with previous surgeries / increased patient age with being associated with a higher incidence. To date there are conflicting reports whether or not a dura lesion is a predictor of inferior outcome after lumbar decompression. The purpose of this prospective spine registry study was to analyse the effect of dura lesions on the clinical outcome in this particular cohort of patients.
Material and Methods: 980 patients (mean age 70 years) with lumbar spinal stenosis and exclusive decompression surgery were included in this prospective study. All procedure were performed in 2012 in three large spine centers in Germany. Outcome measures (ODI, EQ5D, VAS back pain / leg pain) were recorded preoperatively, at discharge, 3 and 12 month after surgery. The effect of incidental durotomy on the outcome was statistically analyzed using SAS 9.3. Absolute and relative changes in both groups (Dura+ and Dura-) were calculated and compared using the independent sample t-test.
Results: In 67 patients (6.8%) an incidental intraoperative dura lesion occurred (Dura+). Both groups (Dura+ and Dura-) showed no differences regarding risk factors and co-morbidities (previous surgery, age, BMI, Charlson-Index, ASA). The FU for the outcome measures was 71% after 3 months and 76%

after one year. Patients without dura lesions (Dura-) demonstrated a significantly better improvement for the VAS back pain after 12 months (Δ21.4 versus Δ7.2 points; p0.05).
Discussion: In the presented study we analyzed the effect of an incidental durotomy on the clinical outcome after lumbar decompression on the basis of a homogenous patient cohort over a defined period of time. In contrast to the current perception that a dura lesion does not affect the outcome after lumbar surgery, the present data revealed a significantly better improvement of the VAS back pain in the patient group without durotomy (Dura-). A follow-up rate of 76% after one year is highly satisfactory result for a spine registry, so that the present findings can be interpreted as valid data.
Literature:
1. Desai A, Ball PA, Bekelis K et al. Surgery for lumbar degenerative spondylolisthesis in Spine Patient Outcomes Research Trial. Does incidental Durotomy affect Outcome? Spine 2012;37:406-13
2. Strömqvist F, Jönsson B, Strömqvist B et al. Dural lesions in decompression for lumbar spinal stenosis: incidence, risk factors and effect on outcome. Eur Spine J 2012;21:825-8

O301

THE IMPACT AND VALUE OF UNI- AND MULTIMODAL INTRAOPERATIVE MONITORING (MIOM) ON NEUROLOGICAL COMPLICATIONS DURING SPINE SURGERY: A PROSPECTIVE STUDY OF 2'728 PATIENTS

Martin Sutter,Andreas Eggspühler,Dezsö Jeszenszky, Frank Kleinstueck,Tamàs Fekete, Daniel Haschtmann,François Porchet,Jiri Dvorak
Schulthess Clinic CH-8008 Zurich, Switzerland

Aim: The objectives of this study were to determine the value of unimodal and multimodal intraoperative monitoring (MIOM) in providing immediate neural function feedback during spine surgery and its impact on the detection of neurological complications.
Materials and Methods: As part of an on-going 12-year prospective study, MIOM data derived from sensory spinal and cortical evoked potentials (SEPs) combined with electromyography (EMG), motor evoked potentials (MEPs) recorded from the spinal cord and muscles were evaluated and compared with any postoperative new clinical signs of the central or peripheral nerve system. Patients were categorized based on their true positive or negative postoperative neurological status.
Results: In 2,728 spine operations we had 909 (33.3%) monitoring alerts, 130 (4.7%) of them existing at the end of surgery with reduced signal amplitudes >50%, increased latencies >10%, or sustained neurogenic discharge in EMGs. Based on MIOM data 2,590 were true negative cases, 8 were false negatives, 107 were true positives, and 23 were false positives. The sensitivity and specificity of MIOM was 93.0% and 99.1%, respectively. The positive predictive value was 82.3% and negative predictive value 99.7%. The frequency of neurological complications was 4.2% (n = 115), although only 0.37% (n = 10) were permanent. Analysis of the individual modalities yielded sensitivities for EMG 15%, SEPs with peripheral nerve stimulation and spinal epidural or subarachnoidal recording 81%, SEPs with cortical recording 40%, “SEPs” spinal stimulation and spinal recording 15%; MEPs with transcranial electrical stimulation and spinal recording (“D-wave Monitoring”) 49%, MEPs with multiple muscle recordings 81%. The combination of muscular MEPs and cortical SEPs showed sensitivity of 89% , the additional combination with D-wave monitoring 93%. The specificities of all modalities raged 99.1 to 100%.
Conclusion: MIOM is an effective method for assessing spinal cord and nerve root function during complex spine surgeries, and leads to a reduction in both neurological complications and false negative findings compared to unimodal monitoring. MIOM should be considered as the standard of care in all complex spine surgeries.

O302

VALIDATION OF THE MIRZA INVASIVENESS INDEX IN PATIENTS UNDERGOING SURGERY FOR LUMBAR SPINAL DISORDERS REGISTERED IN EUROSPINE’S SPINE TANGO REGISTRY

Anne Mannion,Frank S Kleinstueck,Dezsoe Jeszenszky, Francois Porchet,Tim Pigott,Ralph Greiner-Perth,Ulrich Berlemann,Emin Aghayev
Schulthess Klinik 8008 Zürich, Switzerland

Introduction: The magnitude of an operation influences the blood loss, duration of surgery, risk of complications, time for recovery and possibly outcome. Mirza et al1 developed and validated an index of surgical invasiveness to document the magnitude of surgery and allow potential confounding to be minimised when comparing complication rates among surgical techniques, hospitals, or surgeons.

Aim: We sought to validate this index using data from Eurospine's Spine Tango registry.

Methods: This was a cross-sectional analysis of data from Spine Tango (from 2012 to 2015). The invasiveness score was calculated from information documented on the Tango surgery form as the sum, across all vertebral levels, of 6 possible interventions on each operated vertebra: anterior decompression, anterior fusion, anterior instrumentation, posterior decompression, posterior fusion, and posterior instrumentation1. The correlation between the index scores and blood loss, duration of surgery, and surgical and general complications was evaluated in 18'583 spine surgeries, adjusting for potential confounders (age, sex, morbidity, body mass index, diagnosis, vertebral level and number of previous surgeries). Blood loss and duration of surgery were documented on the Tango form using ordinal categories: none, 2000ml (blood loss); and 10hrs (duration of surgery).

Results The average invasiveness index was 3.1 (range 1-27). An increase of one-point in the invasiveness index was associated with an increase in 0.112 blood loss categories (95%CI, 0.103-0.120; p<0.001); with an average category-increment of 500 ml, this equates to approx 60ml. A one-point increase in the invasiveness index was associated with an increase of 0.306 (95%CI 0.292-0.319; p<0.001) duration of surgery categories; with an average category increment of 60 min, this equates to approx 18 min (cf, approx 13 min in the original study). The R2 values for the models were lower (18-26%) than in the original study (53-54%1). The invasiveness index was significantly associated with both surgical complications (OR1.16, 95%CI 1.12-1.20) and general medical complications (OR1.15, 95%CI 1.09-1.22) i.e. a one-point increase in invasiveness increased the odds of a complication by 15-16%.

Conclusion The invasiveness index showed good construct validity in the Spine Tango data. Our lower R2 values may be due to the lower spread of invasiveness scores (1-27 vs 0-48 in the original study1), the use of (untransformed) categorical values for blood loss/surgical duration and the more heterogeneous data typical of a registry. The index was easy to determine from the given fields on the Tango form. It should prove useful in surgical decision-making and in adjusting for surgical case-mix in studies comparing complication rates and outcomes for different surgeons, hospitals, and surgical procedures within the Registry.

1Mirza SK et al (2008) Spine 33(24):2651–2661

O303

RISK FACTOR ANALYSIS OF SURGICAL SITE INFECTIONS AFTER POSTERIOR INSTRUMENTATION FUSION SURGERY FOR SPINAL TRAUMA: PROSPECTIVE MULTICENTER STUDY

Satoshi Ogihara,Takashi Yamazaki,Toru Maruyama, Hirotaka Chikuda,Hirohiko Inanami, Kota Miyoshi,Yasushi Oshima,Seiichi Azuma, Takashi Yamada,Motoaki Murakami,Naohiro Kawamura, Kiyohumi Yamakawa,Jiro Morii, Kazuo Saita

Sagamihara National Hospital 252− 0392, Kanagawa, Japan

Introduction: Surgical site infection (SSI) is a serious complication after spinal surgery, and it is associated with high morbidity rates, high healthcare costs, and poor patient outcomes. Accurate identification of risk factors is essential for developing strategies to prevent devastating infections. High quality studies based on a prospective design and a large sample size are required to identify precise independent risk factors for SSI following spinal surgery.

Aim: The purpose of this study was to identify risk factors for SSI in patients undergoing posterior instrumentation fusion surgery for spinal trauma using a prospective multicenter research method.

Materials and Methods: From July 2010 to December 2013, we performed a prospective multicenter study in patients who had developed SSI after undergoing posterior instrumentation fusion surgery for spinal trauma at 12 participating hospitals. Detailed preopera-

tive and operative patient characteristics were prospectively recorded using a standardized data collection form. The recorded preoperative patient characteristics included age at time of surgery, sex, body mass index (BMI), smoking, diabetes mellitus, the patient's American Society of Anesthesiologists (ASA) score and steroid use. The recorded operative patient characteristics included operating time, estimated blood loss, anatomic location of spinal surgery (cervical, thoracic, lumbar), emergency surgery, iliac crest bone grafting, dural tear and use of intraoperative fluoroscopy. Identification of SSI was based on the Centers for Disease Control and Prevention definition. Data were analyzed using multivariate regression analysis with $P < 0.05$ set as the significance level.

Results: A total of 349 consecutive patients (208 male and 141 female patients; mean age, 58.2 [15-97] years) were enrolled, of whom 10 (2.9%) developed postoperative wound infections (1 superficial and 9 deep SSI). Staphylococcus was the predominant pathogen in SSIs (50.0%). Multivariate regression analysis indicated 2 independent factors: ASA score ≥3 (P=0.025; odds ratio [OR]=4.4, 95% confidence interval [CI] 1.2-16.1) was a statistically significant independent preoperative risk factor, while dural tear (P=0.008; OR=7.5, 95% CI 1.7-33.0) was a statistically significant independent operative risk factor for developing SSI. Conclusion: ASA score ≥3 was an independent preoperative risk factor, and dural tear was an independent operative risk factors for SSI in the present study. Identification of these risk factors can be used to develop protocols aimed at decreasing the risk of SSI following instrumentation fusion surgery for spinal trauma in the future.

O304

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

Yuichiro Goda,Kosaku Higashino,Yoichiro Takata, Toshinori Sakai,Koichi Sairyo

Kochi National Hospital 7808077 Kochi, Japan

INTRODUCTION: Screw malposition, such as lateral wall breach or end-plate breach, is one of the main pitfalls of inserting pedicle screws1,2. Intraoperatively a malpositioned screw is often removed and then re-directed and inserted along the correct axis.

AIM: To evaluate pullout strength of: 1) a re-directed pedicle screw following lateral wall breach; 2) a re-directed pedicle screw following end-plate breach; and 3) a pedicle without re-direction after end-plate breach without re-direction.

MATERIALS AND METHODS: From 14 fresh spines 43 vertebrae (T9-L5) were harvested (13 male, 1 female, mean age 85.0 years). In each vertebra on one pedicle the screw was inserted correctly down the axis of the pedicle, while on the other pedicle the screw was inserted to breach the lateral wall (14 vertebrae) or the end-plate (29 vertebrae). Left and right pedicles were alternated on each successive vertebra. The pedicle screws that breached the lateral wall were then removed and re-directed along the correct axis of the pedicle. The 17 pedicle screws that breached the end-plate were removed and re-directed along the correct axis of the pedicle. The 12 other pedicle screws that had breached the end-plate were not removed. In each vertebra, each left and right pedicle received a screw (6.5 mm diameter) inserted to the same depth. Each screw was then pulled out and the force was measured (Shimadzu AG Universal Testing Machine, Japan). Mann-Whitney U test was used to compare the results.

RESULTS: 1) The mean pullout strength for the re-directed screws following lateral wall breach was 20.9% less as compared to the correctly aligned screws ($P < 0.05$). The average pullout force was 576.3 N for the re-directed and 665.7 N for the correctly aligned screws; 2) The mean pullout strength for the re-directed screws following end-plate breach was 18.7% less as compared to the correctly aligned screws. The average pullout force was 572.2 N for the re-directed and 825 N for the correctly aligned screws; 3) The mean pullout strength for the pedicle screws end-plate breach was 6.6% less as compared to the correctly aligned screws. The average pullout force was 647.7 N for the end-plate breach screws and 745.1 N for the correctly aligned screws.

CONCLUSION: The pullout strength of re-directed pedicle screws after either a lateral

pedicle breach or end-plate breach is significantly less than the pullout strength of correctly aligned screw. A pedicle screw that is not redirected after end-plate breach is weaker than a pedicle screw correctly aligned, however the difference is not significant.

References:

1. Boachie-Adjei O, Girardi FP, Bansal M, Rawlins BA. Safety and efficacy of pedicle screw placement for adult spinal deformity with a pedicle-probing conventional anatomic technique. J Spinal Disord. 2000, Dec;13(6):496-500.

2. Lehman RA Jr, Lenke LG, Keeler KA, Kim YJ, Cheh G. Computed tomography evaluation of pedicle screws placed in the pediatric deformed spine over an 8-year period. Spine (Phila Pa 1976). 2007, Nov 15;32(24):2679-84.

O305

DO LUMBAR DECOMPRESSION AND FUSION PATIENTS RECALL THEIR PREOPERATIVE STATUS? RECALL BIAS IN PATIENT-REPORTED OUTCOMES

Ilyas Aleem,Jonathan Duncan,Amin Ahmed, Jason Eck,John Rhee,Bradford Currier,Ahmad Nassr

Mayo Clinic 55905 Rochester, United States

Introduction: Although patient-reported outcomes (PROs) have become increasingly important in the evaluation of spine surgery patients, interpretability may be limited by a patient's ability to recall pre-intervention impairment. The accuracy of patient recall of preoperative back pain, leg pain, and function after spine surgery remains unknown.

Aim: To characterize the accuracy of patient recall of preoperative symptoms in a cohort of lumbar spine surgery patients.

Materials and Methods: We analyzed consecutive patients undergoing lumbar decompression or decompression and fusion for lumbar radiculopathy by a single surgeon over a four-year period. Using standardized questionnaires, we recorded back and leg numeric pain scores (NPS) and Oswestry Disability Indices (ODI) preoperatively and asked patients to recall their preoperative status at a minimum of one-year following surgery. We then statistically compared actual and recalled preoperative scores. Multivariable linear regression was used to identify factors that had an impact on recollection. Pearson correlation coefficients quantified relations between recalled and actual scores.

Results: Sixty-two patients with a mean age of 66.1 years (55% female) were included. Compared to their preoperative scores, patients showed significant improvement in back pain (mean difference (MD) = -3.2, 95% CI -4.0 to -2.4, $p < 0.01$), leg pain (MD -3.3, 95% CI -4.3 to -2.2, $p < 0.01$), and disability (MD -25.0%, 95% CI -28.7 to -19.6, $p < 0.01$) postoperatively. Patient recollection of preoperative status was significantly more severe than their actual preoperative status for back pain (MD +2.3, 95% CI 1.5 to 3.2, $p < 0.05$), leg pain (MD +1.8, 95% CI 0.9 to 2.7, $p < 0.05$) and disability (MD +9.6%, 95% CI 5.6 to 14.0, $p < 0.05$). This was maintained across age, gender, time between date of surgery and recalled outcomes, and duration of symptoms prior to surgery. The magnitude of recall bias was moderate to severe and exceeded the minimal clinically important difference (MCID) in more than 67% of patients for back and leg pain and more than 40% of patients for disability. No significant correlation between actual and recalled scores with regards to back ($r=0.18$) or leg pain ($r=0.24$) and only moderate correlation with disability ($r=0.44$) was seen. Conclusion: Patient recollection of preoperative status one year after lumbar spine surgery was significantly more severe than their actual preoperative status for back pain, leg pain, and disability, thus overestimating the effect of surgery. These findings indicate that relying on patient recollection does not provide an accurate measure of preoperative status following lumbar spine surgery, limiting the interpretation and applicability of PROs.

O306

CONCORDANCE BETWEEN PATIENTS' AND SURGEONS' EXPECTATIONS OF LUMBAR SPINE SURGERY

Federico Girardi,Carol Mancuso,Roland Duculan, Frank Cammisa,Andrew Sama, Alexander Hughes,Darren Lebl

Hospital for Special Surgery New York, United States

Background Context: Patients undergo lumbar surgery because they expect improvement in physical and psychological symptoms. Patients and surgeons need to share an understanding of what are possible, probable and realistic expectations so they can work toward the same goals.
Purpose: The objective of this study was to compare concordance (agreement) within the patient-surgeon pair regarding expectations of lumbar surgery.
Study Design/Setting: Cross-sectional, tertiary spine center
Patient Sample: 184 patients scheduled for lumbar surgery and their surgeons
Outcome Measures: Hospital for Special Surgery Lumbar Spine Surgery Expectations Survey
Methods: Patients scheduled for lumbar surgery were recruited from the practices of 5 spine surgeons and interviewed in person several days before surgery with several patient-centered questionnaires including the modified Oswestry Disability Index (ODI) (score range 0-100, higher is worse), the Geriatric Depression Scale (score range 0-30, ≥11 is a positive screen for depression) and the valid Lumbar Spine Surgery Expectations Survey. The 20-item Expectation Survey addresses symptoms, physical function, and psychological well-being, and asks how much improvement is expected with response options of "complete" (=4 points), "a lot" (=3 points), "a moderate amount" (=2 points), "a little" (=1 point), or "no improvement/this expectation does not apply to me" (=0 points). An overall score is calculated as the sum of all responses (range 0-100, higher is greater expectations); a clinically important difference is 20 points. Before surgery, surgeons completed an identical survey asking them to rate how much improvement they expected for each item for each of their patients. The surgeon's survey is scored similarly to generate an overall score (range 0-100). Concordance between scores for each patient-surgeon pair was measured with the intraclass correlation coefficient (ICC) for continuous data [range -1 (perfect disagreement), 0 (agreement no better than chance); +1 (perfect agreement)].
Results: Patients completed the Expectations Survey a mean of 10 days before surgery; mean age 54 years, 51% men, mean ODI score 54±13, 33% had a positive screen for depression, 16% had a diagnosis of acute herniated nucleus pulposus, and 84% had a degenerative condition. The 5 surgeons were age 37-59 years, in practice for 4-27 years, and all had completed a spine fellowship. The number of patients per surgeon ranged from 22-57. The mean Expectation Survey score was 73±19 for patients and 57±16 for surgeons. 87% of patients had higher scores (i.e. greater expectations) and 11% of patients had lower scores (i.e. lesser expectations) than their surgeons, and for 43% the difference exceeded a clinically important difference. The concordance in scores (ICC) between patient-surgeon pairs for the entire sample was .37. There were differences in ICC based on: demographic characteristics [men (.47) versus women (.27)]; diagnosis [acute herniated nucleus pulposus (.55) versus degenerative condition (.32)]; psychological status [negative screen for depression (.43) versus positive screen for depression (.22)]; and disability [better ODI score (.46) versus worse ODI score (.23)].
Conclusions: There was wide variation in expectation scores between patients and their surgeons and for more than one third of patients this exceeded a clinically important difference. Lower concordance was not exclusively related to any particular feature but was associated with demographic, diagnostic, and clinical characteristics.

O307

INFLUENCE OF PREVIOUS SURGERY ON PATIENT-RATED OUTCOME AFTER SURGERY FOR DEGENERATIVE DISORDERS OF THE LUMBAR SPINE

Pascal Zehnder,Emin Aghayev,Tamas F Fekete, Daniel Haschtmann,Tim Pigott,Anne Mannion
Schulthess Klinik 8008 Zürich, Switzerland

Introduction: Few studies have used multivariate models that account for possible confounders when quantifying the effect of previous spine surgery on patient-oriented outcome after spine surgery.

Aim: This study sought to quantify the effect of the number of any prior spine surgeries on 12-month postoperative outcomes in patients undergoing surgery for different degenerative disorders of the lumbar spine.

Material and methods: The study included 4940 patients with lumbar degenerative disease documented in the Spine Tango Registry of Eurospine, the Spine Society of Europe, from 2004 to 2015. Preoperatively and 12 months postoperatively, patients completed the multidimensional Core Outcome Measures Index (COMI; 0-10 scale). Patients' medical history and surgical details were recorded using Spine Tango Surgery forms. Multiple linear regression models were built to investigate the relationship between the number of any previous surgeries and the 12-month postoperative COMI score, controlling for the baseline COMI score and other potential confounders (age, sex, smoking, BMI, comorbidity, duration of previous conservative treatment, number of affected vertebral levels).

Results: There was a significant (p<0.001) reduction in COMI score preoperatively to 12 months' postoperatively for each of the "number of previous surgeries" groups (see Figure 1). However, the extent of the reduction diminished as the number of any previous surgeries increased. In other words, the improvement after surgery was less good for those with a greater number of previous spine surgeries.

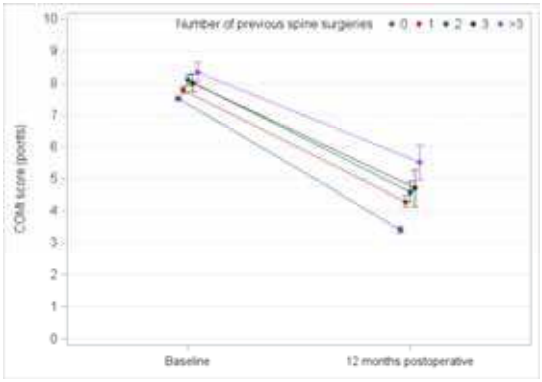


Figure 1. Influence of number of previous surgeries on the reduction in COMI scores from baseline to 12 months postoperative (unadjusted mean values ± 95% CI; the lower the COMI score the better the outcome).

In the multivariable model (adjusting for baseline values and possible confounders), the 12-month COMI score showed a 0.37-point worse value (95% confidence intervals [95%CI] 0.29 – 0.45; p<0.001) for each additional prior spine surgery. For the subgroup of patients with lumbar disc herniation, the corresponding effect was 0.52 points (95%CI 0.27 – 0.77; p<0.001) and for lumbar degenerative spondylolisthesis, 0.40 points (95%CI 0.17 – 0.64; p=0.001).

Conclusion: We were able to demonstrate a clear "dose-response" effect for previous surgery: the greater the number of any prior spine surgeries, the systematically worse the outcome at 12 months' follow-up. The results of this study can be used when considering or consenting a patient for further surgery, to better inform the patient of the likely outcome and to set realistic expectations

O308

PREOPERATIVE PSYCHOLOGICAL FACTORS AFFECT SURGICAL SATISFACTION IN ELDERLY PATIENTS WITH LUMBAR SPINAL STENOSIS

Mamoru Kawakami,Yuyu Ishimoto,Keiji Nagata, Tomoko Kitagawa,Masakazu Minetama, Masahumi Nakagawa,Daisuke Fukui

Spine Care Center, Wakayama Medical University Kihoku Hospital 649-7113, Ito Gun, Japan

Introduction: Depression is associated with poor surgical outcomes in patients with lumbar spinal stenosis (LSS). Attention has focused on identifying depressive symptoms before surgery, although it is unknown whether other psychological factors such as pain catastrophizing affect the surgical outcomes.

Aim: The objective of this observational prospective study was to investigate the effects of psychological factors on short-term outcomes after surgery in elderly patients with LSS.

Patients and Methods: Surgery was performed on 90 elderly patients with clinically and radiologically defined LSS: mean age at surgery, 73 years; 46 men and 44 women. Patients completed questionnaires before surgery and 1 year postoperatively. At the baseline and follow-up, patients were asked about demographic background and duration of symptoms before surgery. They used a self-administered visual analogue scale (VAS) to assess their expectations of surgery and the intensity of low back pain, leg pain, and leg numbness. The Roland Morris Disability

Questionnaire (RDQ), five subdomains of the Japanese Orthopaedic Association Back Pain Questionnaire (JOABPEQ), MOS 36-Item Short-Form Health Survey (SF-36), and satisfaction for surgery (VAS) were completed. At baseline, psychological factors were assessed using the Self-Rating Questionnaire for Depression (SRQ-D), Hospital Anxiety and Depression scale (HADS), Pain Catastrophizing Scale (PCS), which includes rumination, magnification, and helplessness, Pain Anxiety Symptoms Scale-20, and Brief Scale for Psychiatric Problems in Orthopaedic Patients (BS-POP). At follow-up, patient satisfaction was evaluated using 2 items: (1) satisfaction with surgery and (2) whether the patient would undertake the same surgery again. These were scored using a VAS (range 0–100 mm), with higher scores indicating greater satisfaction. The preoperative factors independently associated with surgical satisfaction were analyzed statistically.

Results: Patients improved at 1 year in the VAS for low back pain (baseline, 67 mm; 1 year, 37 mm); leg pain (baseline, 73 mm; 1 year, 36 mm); and leg numbness (baseline, 64 mm; 1 year, 39 mm) ($p<0.05$). RDQ, each domain of the JOABPEQ, and SF-36 scores improved at the follow up ($p<0.05$). The scores were 73 and 55 mm for patient satisfaction items 1 and 2, respectively. Satisfaction item 1 correlated negatively with the VAS for low back pain, leg pain, numbness, JOABPEQ social life disturbance score, SF-36 physical function score, and HADS anxiety score ($p<0.05$). Satisfaction 2 correlated negatively with age at surgery, VAS of leg pain, PCS magnification score, and BS-POP score ($p<0.05$). Multiple regression analysis showed significant associations between satisfaction 1 and SF-36 physical function and HADS anxiety scores, and between satisfaction 2 and PCS magnification score ($p<0.05$).

Conclusion: Physical function, anxiety, and pain catastrophizing were identified as preoperative factors that affected patient satisfaction with surgery. Preoperative assessment of psychological factors and interventions for anxiety and pain catastrophizing may help improve patient satisfaction after surgery for LSS.

O309

WHAT HEALTH-RELATED OUTCOME MEASURE BEST PREDICTS FUTURE HEALTHCARE COSTS AFTER SPINE SURGERY FOR DEGENERATIVE SPINAL DISORDERS?

David O'Riordan,Mirjam von Büren, Anne Mannion

Schulthess Klinik 8008 Zürich, Switzerland

Introduction: It is commonly accepted that, for elective spine surgery, the patient is the best judge of outcome. Many different outcome measures are used for measuring success, some based on the change in validated instrument scores measured over time, others based on a retrospective rating of the overall improvement/deterioration, and yet others based on the current status. Sometimes, the results based on one type of outcome are not reflected by those based on another. The decision regarding which “measure of success” is most appropriate to use is often made arbitrarily, without any justification for its external validity.

Aim: This study evaluated which outcome measure best indicated whether surgery was successful, by relating the 3-month postoperative outcomes to future healthcare costs in the same hospital in the subsequent 2 years.

Methods: Data from all patients (N=636) undergoing surgery for herniated disc, spinal stenosis, spondylolisthesis, or degenerative segment disease in the year 2008 were extracted from our in-house Spine Outcomes registry. Patients had completed a Core Outcome Measures Index (COMI) preoperatively and 3 months postoperatively (92% follow-up rate), from which the achievement of a Minimum Clinically Important Change (MCIC) of 2.2 points could be determined. At 3 months’ postoperatively, patients also rated: global outcome (how much did the operation help?); satisfaction with care; and how they would feel if they had to spend the rest of their life with their current symptoms (symptom-specific well-being; SSWB). Costs of inpatient and outpatient treatment in the hospital were extracted from the hospital clinic information system and log transformed (log x+1). Multiple stepwise linear regression analysis controlling for age, gender and health-insurance status was used to select the outcome variable most strongly related

with subsequent costs at 1 and 2 years after the 3-month follow-up. Results: Univariate correlations between the 3-month outcome measures and the 1-year costs were all significant ($p<0.0001$) with coefficients as follows: 0.331 for COMI, 0.301 for SSWB, -0.273 for achievement of COMI MCIC, 0.262 for global outcome, -0.241 for change in COMI from baseline values, 0.147 for satisfaction with care. Similar rankings were seen for the instruments in relation to the 2-year costs. In regression analysis, the 3-month COMI score was the most significant predictor of future costs over 1 and 2 years; once this had been entered into the model, none of the other outcome measures at 3mo explained any additional variance in costs. Conclusions: The severity of the back problem as measured by the multidimensional COMI score 3 months' postoperatively was the best predictor of subsequent costs over a 1-year and 2-year period, with a worse status on the COMI being associated with significantly higher costs. Satisfaction with care was the least predictive. This information is useful to know when attempting to justify the choice of outcome instrument in trials, especially when considering the economic impact of treatment for back problems.

O310

ASSESSING THE UTILITY OF A CLINICAL PREDICTION SCORE REGARDING 30-DAY MORBIDITY AND MORTALITY FOLLOWING METASTATIC SPINAL SURGERY: THE NEW ENGLAND SPINAL METASTASIS SCORE (NESMS)

Andrew J. Schoenfeld,Dana A Leonard, Christopher M. Bono,Mitchel B. Harris
Brigham and Women's Hospital 02115 Boston, MA, United States

Introduction: The New England Spinal Metastasis Score (NESMS) was recently proposed to help predict one-year survival following surgery for spinal metastases. Its ability to predict short-term outcomes, including 30-day morbidity, mortality and hospital length of stay has not been evaluated.

Aim: Assess the NESMS' capacity to predict 30-day morbidity and mortality, as well as hospital length of stay, following surgery for spinal metastases.

Materials and Methods: This was a validation study performed using all patients who had undergone spinal surgery with a history of metastatic spinal disease within the National Surgical Quality Improvement Program (NSQIP; 2007-2013). Outcome measures inclu-ded mortality, complications, failure to rescue, length of stay. Demographic, oncologic, laboratory and surgical data were obtained from the NSQIP. All patients were assigned a NESMS score (0-3). The effect of the NESMS score on the outcomes of interest was assessed using multivariable logistic regression and negative binomial regression that controlled for confounders. Final model discrimination and calibration were assessed using the c-statistic and Hosmer-Lemeshow test, respectively. Internal validation was performed using a bootstrapping procedure.

Results: NSQIP data on 776 patients were included in this analysis. The 30-day mortality rate was 11%% (n=87) and 51% of patients (n=395) sustained one or more complications. The final adjusted model demonstrated that the NESMS was a statistically significant predictor of 30-day mortality ($p<0.001$), major systemic complications ($p<0.001$), and failure to rescue ($p=0.03$) following metastatic spinal surgery. Patients with a NESMS score of 3 had an 89% reduction in mortality (95% CI 0.04, 0.31), a 74% reduction in major systemic complications (95% CI 0.11, 0.62) and an 88% reduction in failure to rescue (95% CI 0.03, 0.47) as compared to those with a score of 0. The final model explained 71% of the variation in 30-day mortality. Findings were unchanged in the bootstrap analysis performed among 77,600 patient replicates.

Conclusion: This study demonstrates the clinical utility of the NESMS score for predicting short-term major morbidity and mortality following metastatic spinal surgery. The success of this score in an independent cohort of patients collected from centers across the U.S. indicates its potential for translation to clinical practice.

O311

PROINFLAMMATORY CYTOKINE UPREGULATES THE EXPRESSION OF GLIAL CELL LINE-DERIVED NEUROTROPHIC FACTOR BY HUMAN INTERVERTEBRAL DISC CELLS

Junichi Yamada,Koji Akeda,Koichi Masuda, Keianne Yamada,Kevin Cheng,Norihiko Takegami, Kazuma Nakase, Akihiro Sudo
Department of Orthopedic Surgery, Mie University Graduate School of Medicine 514-8507 Tsu city, Japan

INTRODUCTION: Intervertebral disc (IVD) degeneration is one of the important factors responsible for low back pain. The neurotrophin family, including nerve growth factor (NGF) and brain-derived neurotrophic factor (BDNF), has been shown to be present in the IVD and is considered to play a role in inflammatory responses and pain transmission. The glial cell line-derived neurotrophic factor (GDNF) ligands (GFLs) family, the other neurotrophic factor family, is crucial for the nervous system and pain transmission.

AIM: The expression of the GFLs family, including GDNF, in the IVD remains unknown. The purpose of this study was to (1) to examine the expression of GDNF and its receptors GFRα1, GFRα2, and RET in human IVD cells, and (2) to evaluate the effect of a proinflammatory cytokine on the expression of GDNF and its receptors by human IVD cells.

MATERIALS AND METHODS:Human nucleus pulposus (NP) and annulus fibrosus (AF) cells, separately isolated from IVD tissues (Pfirrmann's classification grades 2-3) obtained from spine surgeries, were cultured in monolayer. Immunohistochemical analysis and western blotting were performed to examine the protein level of GDNF and its receptors. To examine the effect of proinflammatory cytokines on the expression of GDNF and its receptors, IVD cells, including both AF and NP cells (5 donors, Pfirrmann's classification: MRI grades 3-4), were cultured in the presence of interleukin-1β (IL-1β; 0.1, 1.0 and 10 ng/ml) for 48 hours. mRNA expression of GDNF and its receptors was quantified by real-time PCR analysis.

RESULTS: Confocal images revealed that immunoreactivity to GDNF was mainly distributed in the cytoplasm of both AF and NP cells, whereas the expression of GFRα1, GFRα2 and RET was found both in the cytoplasm and cell membranes. In protein extracts from both AF and NP cells, a single band against GDNF and its receptors was identified by western blot analysis. mRNA expression of GDNF in IL-1β-treated groups (1.0 and 10 ng/ml) was significantly higher compared to that of the control group ($p<0.01$). GFRα1 expression was significantly stimulated by IL-1β (1.0 ng/ml, $P<0.01$; 10 ng/ml, $P<0.05$). GFRα2 expression was also significantly upregulated by IL-1β stimulation (1.0 and 10 ng/ml, $P<0.01$). The expression of RET showed no trend for significant stimulation by IL-1β.

CONCLUSION:Our results demonstrate, for the first time, that human AF and NP cells constitutively express GDNF and its receptors at both mRNA and protein levels. The expression of GDNF and its receptors, except for RET, were upregulated by IL-1β stimulation. GDNF has been reported to have the potential to generate pain (especially mechanical hyperalgesia) in peripheral tissues. The results of this study suggest the possibility that the enhanced expression of GDNF within degenerated discs may be associated with the generation of discogenic pain.

O312

CHANGES OF PAIN-RELATED BEHAVIOR AND μ-OPIOID RECEPTOR EXPRESSION IN A RAT LUMBER DISC HERNIATION MODEL.

Yoichi Kaneuchi,Miho Sekiguchi,Yoshihiro Kobayashi, Takuya Kameda,Shinichi Konno
Fukushima medical university school of medicine. Department of Orthopaedic Surgery 960-1295 Fukushima city, Japan

INTRODUCTION: Opioid drugs, including morphine, are widely used to relief intractable pain. The efficacy of the drugs, however, are sometimes inadequate in several pathological conditions of pain. Among the rodent, in the acute inflammatory pain model, the expression of mu opioid receptor (MOR) increase in both spinal cord (SC) and dorsal root ganglion (DRG), and the analgesic potency of MOR agonists increase. In the neuropathic pain model, on the other hand, both MOR expression and the analgesic

potency of MOR agonists decrease. Although the expression of mu opioid receptor is suggested to be varied according to the pathophysiological conditions and time course, the mechanism is not well-known.
AIM: The aim of the present study was to evaluate the association between pain-related behavior and the change of the mu opioid receptor expression in DRG using an application of nucleus pulposus rat model.
MATERIALS AND METHODS: Adult female Sprague-Dawley rats (n= 69) were used and divided into three groups; NP, sham and naive. NP harvested from the tail was applied onto the left L5 DRG of rats in the NP group. In the sham group, the same procedure was performed without NP application on the DRG. Von Frey test was carried out before surgery and postoperative days 2, 7, 14, 21 and 28 to examine the mechanical withdrawal threshold. On the same time points as von Frey test, expression of mu opioid receptor in the left L5 DRG was tested by immunoblotting. Naive rats were used as control. Statistical analysis was performed by two-way analysis of variance (ANOVA), followed by post-hoc wilcoxon and Dennett's methods. P values less than 0.05 were considered significant.
RESULTS: In the NP group, withdrawal threshold decreased from day 2 and was significantly lower than that of in the sham group for 28 days after surgery ($p<0.05$). In the NP group, expression of MOR protein decreased from day 2, and was significantly lower than that of in the sham group at days 7 and 14 ($p<0.05$). There were, however, no significant difference of MOR expression between the NP and sham groups at days 21 and 28. In the NP group, during the period of the lower threshold compared with the sham group (days 2, 7, 14), MOR expression also decreased. These results indicated that the decrease of MOR protein might be related to the attenuation of analgesic potency of MOR agonists.
CONCLUSION: This study suggested that the expression of mu opioid receptor in DRG was associated with pain-related behavior. This result may useful in order to reveal the pathophysiology of neuropathic pain, and select the appropriate drugs and the time of administration.

O313

EFFECTIVENESS AND COST-EFFECTIVENESS OF RADIOFREQUENCY DENERVATION FOR CHRONIC LOW BACK PAIN ORIGINATING FROM THE FACET JOINTS

Maurits van Tulder,Esther Maas,Johan Juch, Raymond Ostelo,George Groeneweg, Jan Willem Kallewaard,Bart Koes,Arianne Verhagen, Hanneke van Dongen,Frank Huijgen
VU University 1081 HV Amsterdam, Netherlands

Background Radiofrequency (RF) denervation is widely used for treating low back pain originating from the facet joints. The aim of the study was to evaluate whether RF denervation added to a standardized exercise programme is effective and cost-effective for patients with chronic low back pain originating from the facet joints.
Methods We performed an economic evaluation from a societal perspective alongside a multicentre randomised controlled trial. Eligible participants did not respond to conservative primary care and had chronic low back pain originating from the facet joints (based on ≥50% pain reduction after a positive diagnostic block). Participants were randomly assigned to the intervention or control group, in which the control group received a standardized exercise programme of three months (8-12 hours) and psychological support if needed. The intervention group additionally received RF denervation. Primary outcomes were pain intensity (0-10 numeric rating scale), global perceived recovery (1-7 Likert scale; 1-2 was defined as success), and functional status (0-100 Oswestry Disability Index) three months after the intervention. Participants completed questionnaires at baseline, 3 and 6 weeks, 3, 6, 9 and 12 months after start of the treatment. Costs were collected using self-completed questionnaires. Participants and care providers were not blinded. Longitudinal mixed-model analyses for the effects and seemingly unrelated regression analyses were performed by intention to treat for the cost-effectiveness.
Results Between March 4th, 2013 and June 3rd, 2014, 251 participants were randomised to the

intervention- (n=125) and control group (n=126). Mean between-group differences adjusted for baseline characteristics were not statistically significant for pain intensity (at three months: -0.18; 95% CI -0.76 to 0.40), functional status (at three months: -2.45; 95% CI -5.93 to 1.03), and secondary outcomes at all measurements during the 12-month follow-up. For global perceived recovery, small effects favouring the intervention group were found at three weeks (OR 7.04; 95% CI 2.46 to 20.12) and six weeks (OR 3.28; 95% CI 1.43 to 7.52) after start of the treatment. After 12 months, there were no significant between-group differences in societal costs (€1184.51; 95%CI -78.10 to 2472.40) and no reasonable probability of cost-effectiveness was reached. Conclusions No clinically relevant between-group differences, regarding pain and functional status were found at any follow-up measurement. Only small statistically significant short-term (three weeks and six weeks) effects on global perceived recovery were found in favour of the intervention group. RF denervation is not cost-effective based on QALYs when added to a standardized exercise programme.

O383

CONSENSUS ON THE CLINICAL DIAGNOSIS OF LUMBAR SPINAL STENOSIS: RESULTS OF AN INTERNATIONAL DELPHI STUDY

(ISSLS Prize Winner)

Christy Tomkins-Lane, Markus Melloh, Jon Lurie, Matt Smuck, Michele Battie, Brian Freeman, Dino Samartzis, Richard Hu, Thomas Barz, Kent Stuber, Michael Schneider, Andrew Haig, Constantin Schizas, Jason Cheung, Anne Mannion, Lukas Staub, Christine Comer, Luciana Macedo, Sang-ho Ahn, Kazuhisa Takahashi, Danielle Sandella,

Mount Royal University, Canada

Study Design: International Delphi study. **Background**: Lumbar spinal stenosis (LSS) is a poorly defined clinical syndrome, which may account for suboptimal treatment outcomes and increased health-care costs. Criteria for clearly defining LSS are needed and should be informed by the experience of expert clinicians. **Objective**: Obtain a consensus among international experts on which factors obtained from history are most important in the clinical diagnosis of LSS.

Methods: Phase 1 (Delphi Items): The 20 members of the International Taskforce on the Diagnosis and Management of LSS confirmed 14 history items considered important in diagnosis of LSS. An innovative on-line survey was developed that permits specialists to express the logical order in which they consider the items, and the level of certainty ascertained from the questions. Phase 2 (Delphi Study) Round 1: Survey was distributed to members of the International Society for the Study of the Lumbar Spine. Round 2: An in-person meeting of 9 members of Taskforce was conducted, and consensus was reached on a final list of 10 items. Round 3: Final survey was distributed internationally. Phase 3: Final consensus meeting of the Taskforce.

Results: 279 clinicians from 29 different countries, with a mean of 19 (±SD: 12) years in practice participated in Round 3. The six top items, confirmed by the Taskforce were “leg or buttock pain while walking”, “flex forward to relieve symptoms”, “feel relief when using a shopping cart or bicycle”, “motor or sensory disturbance while walking”, “normal and symmetric foot pulses”, “lower extremity weakness” and “low back pain”. Significant change in certainty ceased after 6 questions at 80% ($p<.05$).

Conclusions: This is the first study to reach an international consensus on the clinical diagnosis of LSS, and suggests that within six questions clinicians are 80% certain of diagnosis. We propose a consensus-based set of “7 history items” that can act as a pragmatic criterion for defining LSS in both clinical and research settings, which in the long-term may lead to more cost-effective treatment, improved health-care utilization and enhanced patient outcomes.

O384 VIBRATION REALLY DOES DISRUPT THE DISC - A MECHANICAL AND MICROANATOMICAL INVESTIGATION

(ISSLS Prize Winner)

Kelly Wade,Meredith Schollum, Peter Robertson, Ashvin Thambyah,Neil Broom

The University of Auckland Auckland 1142, New Zealand

INTRODUCTION: Whole body vibration, to which a large percentage of workers are exposed throughout life, has been implicated in a range of musculoskeletal disorders, of which low back pain appears the most dominant. Epidemiological evidence suggests that it is the disc that is mostly damaged in cumulative whole body vibration and thus primarily implicated in low back pain. Other investigators describing the effects of low frequency cyclic loading alone and cyclic loading followed by vibration as an exacerbating factor have hypothesized alternate failure modes to that induced by acute loading, but offer only limited structural analysis. The paucity of published studies describing structural disruption of the disc prior to any obvious vertebral body damage may be largely attributed to the technical difficulty of capturing subtle micro-level changes in the disc's complex architecture.

AIM: In this new study we have applied vibration loading and specialised imaging techniques to investigate the hypothesis that when the motion segment is subjected to vibration at sub-critical peak loads, micro-level structural damage will occur in the disc tissue prior to any major failure of the motion segment.

MATERIALS AND METHODS: 29 healthy mature ovine lumbar motion segments flexed 7° and subjected to vibration loading (1300 ± 500N) in a sinusoidal waveform at 5Hz to simulate moderately severe physiologic exposure. Discs were tested either in the range of 20,000 – 48,000 cycles (medium dose) or 70,000 - 120,000 cycles (high dose). Damaged discs were analysed microstructurally.

RESULTS: There was no large drop in displacement over the duration of both vibration doses indicating an absence of catastrophic failure in all tests. No motion segment exposed to vibration loading showed any external evidence of sudden failure during testing. However, the tested discs suffered internal damage that included delamination and disruption to the inner and mid annular layers as well as tracking of nucleus material, and involved both the posterior and anterior regions. Less frequent tearing between the inner disc and endplate was also observed. Annular distortions also progressed into a more severe form of damage which included intra-lamellar tearing and buckling and visible strain distortion around the bridging elements within the annular wall. A scoring system was devised to enable quantification of this damage, which revealed that the tested sample groups exhibited significantly higher levels of damage than the control; and that distortions of the nucleus, inner annulus, and inner-mid annulus were highest for the high-dose group.

CONCLUSION: Vibration loading causes delamination and disruption of the inner and mid annular layers and limited tracking of nucleus material. These subtle levels of disruption could play a significant role in initiating the degenerative cascade via micro-level disruption leading to cell death and altered nutrient pathways.

O385

PARAVERTEBRAL MUSCLE DEGENERATION IS THE MOST SIGNIFICANT FACTOR ASSOCIATED WITH SAGITTAL IMBALANCE: THE WAKAYAMA SPINE STUDY

Hiroshi Hashizume,Noriko Yoshimura,Hiroshi Yamada, Hiroyuki Oka,Masatoshi Teraguchi, Hiroki Iwahashi,Yoshiki Asai,Takahide Sasaki, Shigeyuki Muraki,Ko Matsudaira,Shunji Tsutsui, Akihito Minamide,Yukihiro Nakagawa, Hiroshi Iwasaki,Munehito Yoshida

Wakayama Medical University 641-8510 Wakayama, Japan

Introduction: A forward shift of the sagittal vertical axis (SVA) is reported to be a radiographic predictor of low back pain (LBP) as well as the inability to perform activities in daily living in the elderly. Disc degeneration, vertebral deformity due to osteoporotic fracture, and spinal stenosis have been reported as possible causes of sagittal imbalance. However, these degenerative changes often coexist and may be corroborant in causing sagittal imbalance.

Aim: The purpose of this study was to elucidate the association between degenerative changes observed on magnetic resonance imaging (MRI) and the occurrence of sagittal imbalance in a general population.

Methods: We selected a Japanese population-based cohort for this cross-sectional study. Of the 952 subjects who participated in the second survey of the Wakayama Spine Study, a total of 794 participants (male, 239; female, 555; mean

age, 63.6 ± 13.1 years) underwent whole-spine sagittal radiography (performed with the patient in a standing position) and whole-spine MRI. The C7 sagittal vertical axis (SVA) and pelvic tilt (PT) were measured (in mm) from the radiograph. Disc degeneration (Pfirrmann classification: grade 1-5) and morphometric fracture in the T1-L5 vertebral bodies (semiquantitative method: grade 0-3) were evaluated on sagittal MRI. Percentage fatty degeneration in the paravertebral muscle (PVM) at L1 upper endplate level and cross-sectional area of the dural tube at L1/2-L5/S1 levels were measured on axial MRI using DICOM software. Information on the presence of LBP within 1 month before scan and visual analog scale score for current LBP were obtained via participant interviews. Statistics: Sagittal imbalance was defined as C7 SVA ≥ 50 mm. Logistic regression analysis was performed to determine the association between spinal imbalance and LBP. In addition, multivariate logistic regression analysis was performed to determine the association between C7 SVA and radiographic parameters. Age, sex, and body mass index were used as adjusting variables in both the models. The significance level was set at $p < 0.05$.

Results: Spinal imbalance was significantly associated with the presence of LBP, especially LBP of intensity more than 25 mm. Significant associated factors with spinal imbalance were the percent area of fatty degeneration of the PVM (≥10.6%; odds ratio [OR], 4.8; 95% confidence interval [CI], 2.6-9.0]), sum of the grades of morphometric vertebral fracture (≥4; OR, 1.8; 95% CI, 1.1-3.2), and pelvic tilt (≥20°; OR, 2.0; 95% CI, 1.2-3.5). The area under the curve in this model was 0.85; sensitivity and specificity were 0.73 and 0.83, respectively.

Conclusion: Degeneration of the PVM, morphometric fractures, and PT were factors significantly associated with sagittal imbalance. Hence, physicians must consider these factors when treating patients with spinal imbalance.

O386

IMPACT OF FATIGUE ON MAINTENANCE OF UPRIGHT POSTURE: DYNAMIC ASSESSMENT OF SAGITTAL SPINAL DEFORMITY PARAMETER AFTER 10 MINUTES OF WALKING

Junseok Bae,Alexander A. Theologis,Jee-Soo Jang, Sang-Ho Lee,Vedat Deviren

Wooridul Spine Hospital Gangnam-gu Seoul, Korea, South

Introduction: Spinal sagittal imbalance is associated with poor health-related quality of life scores. Disability is driven by energy expenditure for compensatory mechanisms to maintain adequate sagittal balance. While routine activities of daily living may exacerbate functional disability, there is limited understanding of how sagittal parameters and compensatory mechanisms are affected by activity.

Aim: To present how sagittal parameters and compensatory mechanisms are affected by activity.

Materials and Methods: Consecutive adults (age >18 years) with sagittal-plane spinal deformity at a single institution in Wooridul Spine hospital, South Korea were retrospectively reviewed. All patients were initially evaluated with full-length standing spinal radiographs and then asked to walk in clinic for 10 minutes. Subsequently, all were re-evaluated with a second full-length standing spinal radiograph. Spinal deformity sagittal parameters were measured on each radiograph and were compared before and after the timed walk for two groups: Compensated Sagittal Deformity (CSD: SVA≤4cm and PT>200) and Decompensated Sagittal Deformity (DSD: SVA>4cm and PT>200). Student T-tests were used to assess changes between radiographic parameters and Pearson's correlation coeffici-ents were used to assess correlations between changes in the sagittal parameters and the change in SVA after walking.

Results: One hundred fifty seven patients (143 females, 14 males; average age 68 ± 6 years) met inclusion criteria. Initial average SVA was 1.7cm for CSD and 11.5cm for DSD (p300 and TK was <110 for both groups (p =0.412 and p=0.691). DSD patients had greater initial PI-LL mismatch than CSD patients (p=0.026). After walking 10 minutes, significant deteriorations in average SVA were observed for CSD and DSD (p<0.01). For both groups, this was accompanied by a decrease in PT and LL (p<0.01), and increase of PI-LL (p<0.01). TK increased after walking for DSD only (p<0.01). For CSD, the

change in SVA was determined by decreased PT and loss of LL, while SVA change for DSD was correlated to worsening of all sagittal parameters.
Conclusion: After 10 minutes of walking, compensatory mechanisms to maintain sagittal balance are less pronounced than before walking in patients with ASD, which results in significant sagittal decompensation, irrespective of the initial SVA. As we postulate that loss of compensatory mechanisms is due to fatigue on pelvic and spinal extensor muscles, sagittal parameters should ideally be re-evaluated with radiographs obtained after patients walk 10 minutes to unmask a hidden compensated sagittal deformity.

O387

THE DIFFERENCE OF TOTAL SPINAL SAGITTAL ALIGNMENT BETWEEN UP RIGHT AND STEPPED POSITION

Kenji Endo, Hidekazu Suzuki,Hirosuke Nishimura, Makiko Yorifuji,Kazuma Murata,Hidetoshi Tanaka,Kengo Yamamoto
Tokyo Medical University Shinjuku-ku, Tokyo 160-0023, Japan

INTRODUCTION: Although the cone of economy is a well-known concept, the understanding of the up-right standing posture alone may not be sufficient when considering the walking in elderly persons. The concept of cone of economy is also important in walking phase. The purpose of this study was to evaluate the stable walking by comparing total spinal sagittal alignment between up-right standing and gait posture.
MATERIALS AND METHODS: We investigated the total sagittal spino-pelvic alignment by up-right standing and stepped position (the terminal point of the double support phase) in 30 elderly persons (ave.75.0 y.o.). The following parameters were measured on lateral radiographs: gait angle (GA; the angle of the each line of both femur shafts), C2-7SVA, SVA, TK, LL, PT and PI. The length of radiography is not limited by using additional filum.
RESULTS: The change in mean values of parameters from up-right standing to stepped position were C2-7SVA+17.5cm, SVA+20.8cm, TK+10.6°, LL-5.2°, SS+7°, PT-3°. The change of SVA to stepped position had negative correlation to the SVA at upright standing ($r=-0.48$, $P<0.01$). In stepped position, the C2-7 SVA and SVA tended to be increased with pelvic anterior rotation and thoracic anterior tilt. Stepped position had similar correlation among the parameters of total spinal sagittal alignment in upright standing. GA had negatively correlated with age and SVA, and positively correlated with the change in SVA. ICC was 0.88 to 0.92.
CONCLUSION: Between up-right standing and stepped position, the spino-pelvic alignment was different, but, the correlation among the parameters were similar. The changes of alignment at stepped positon from standing were not all the same. Usually positive spinal imbalance in standing posture was stabilized by decreasing step length and compensated by pelvis and lower leg joints. When the C7 plumb line is beyond the steps length in stepped posture, the walking would be unstable. The spino-pelvic sagittal alignment in stepped position is helpful for evaluating the spinal stability in walking.

O388

SPINO-PELVIC MISMATCH IS THE MOST SIGNIFICANT INDICATOR ON LOW BACK SYMPTOM MEASURED BY ODI SCORE

Kazuhiro Hasegawa,Okamoto Masashi, Shimoda Haruka,Ono Masatoshi,Hatsushikano Shun
Niigata Spine Surgery Center Konan-ku 950-0165 Niigata, Japan

Introduction: HRQOL declines with increasing sagittal vertical axis (SVA).1 A relationship between ODI score and sagittal spinal alignment is, however, not fully investigated.
Aim: The purpose of this study is to clarify a relationship between sagittal spinopelvic alignment determined by a new slot-scanning X-ray Imager (EOS) and ODI score.
Materials and Methods: 67 subjects (mean age: 57.9 years (15~84y), M/F=23/44) including 38 degenerative lumbar diseases, 21 adult spine deformities, and 8 adolescent scolioses were investigated. Following ODI questionnaire, x-ray parameters (T1/T12 kyphosis, LL, SS, PT, PI, and SVA) were measured using EOS. Relationships among ODI and X-ray parameters including PI-LL were analysed using liner regression analysis.

The subjects were divided into 3 groups of PI=<45deg (A), 45deg<PI=<60deg (B), and 60deg<PI (C)2 and a relationship between PI-LL and ODI score was also analysed.

Results: There was significant correlation among ODI score and LL, PT, SVA, and PI-LL. On the other hand, kyphosis and PI did not correlate with ODI score. Among the parameters, PI-LL showed the most significant positive correlation with ODI score (R2=2043, p=0.0002). There was variation of the correlation among the group of PI grade. The higher the PI was, the higher the correlation coefficient between ODI score and PI-LL was (Fig.1).

Conclusion: Among the sagittal parameters, PI-LL, a representative of spino-pelvic mismatch,3 showed the most significant positive correlation with ODI score, suggesting that the spino-pelvic mismatch is the most sensitive indicator of low back-related symptom. Furthermore, the tendency was most remarkable in the patient with high PI. Therefore it is important to observe PI and spino-pelvic relationship in not only deformity cases but also in subjects with degenerative lumbar disease.

Reference(s):

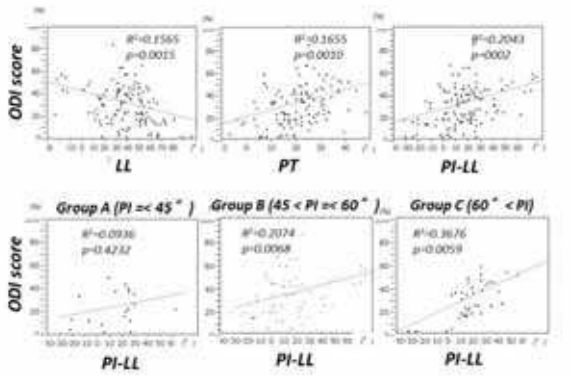


Fig.1 ODI score v.s. sagittal alignment

1. Glassman SD, Bridwell K, Dimar J, et al. The impact of positive sagittal balance in adult spinal deformity. Spine 2005;30:2024-9.

2. Le Huec JC, Charosky S, Barrey C, Rigal J, Aunoble S. Sagittal imbalance cascade for simple degenerative spine and consequences: algorithm of decision for appropriate treatment. Eur Spine J 2011 ;20 (Suppl 5):S699-S73.

3. Shwab F, Blondel B, Bess Set al. Radiographical spinopelvic parameters and disability in the setting of adult spinal deformity. Spine 2013;38:E803-E812.

O389

EFFECTS OF PRE-EXISTING ADJACENT-LEVEL PATHOLOGIES AND SPINOPELVIC ALIGNMENT ON THE PREVALENCE OF ADJACENT SEGMENT DISEASE AFTER SINGLE-LEVEL LUMBAR FUSION

Yukitoshi Shimamura,Masahiro Kanayama, Fumihiro Oha,Kei Kuroki,Yuichiro Hisada, Kahoru Tashiro,Yuki Suzuki,Tomoyuki Hashimoto, Kazuo Kaneko

Spine Center, Hakodate central general hospital 0408585 + Hakodate, Japan

Objective: Spinal fusion increases mechanical stress at the adjacent segment, and might accelerate degenerative changes. Although several risk factors have been reported, it remains unclear whether or not pre-existing foraminal stenosis and/or segmental instability at adjacent levels might affect the occurrence of adjacent segment disease (ASD). Also, relationship between ASD and spinopelvic parameters has not been adequately studied. The aim of this study is to investigate the effects of pre-existing adjacent segment pathologies and spinopelvic alignment on the prevalence of ASD after single-level lumbar fusion.

Materials and Methods: A total of 198 patients who had undergone a single-level lumbar interbody fusion (PLIF/TLIF) from 2009 to 2013 were included in this study. They were 71 males and 127 females. The mean follow-up period was 3.4 years. Degenerative lumbar scoliosis (Cobb angle > 30°), tumors and traumas were excluded. Fusion level was L3-L4 in 33 patients, L4-L5 in 128 patients, and L5-S1 in 38 patients. Preoperative adjacent-level parameters included anterior or posterior vertebral slip (>3mm) in flexion/extension radiography, facet angle (FA) on CT, foraminal stenosis on MRI, and addition of adjacent-level laminoplasty. Spinopelvic alignment was measured immediately after surgery using a standing whole spine film; the parameters included lumbar lordosis (LL), sacral slope (SS), pelvic tilt (PT), pelvic incidence (PI), anterior deviation of sagittal vertical axis (SVA), and the value of PI-LL. ASD was defined in this study as neurological deterioration related to adjacent segment pathologies which

required additional surgeries. Parameters were compared between the ASD group and non ASD group using a Chi-square test or a paired t-test.
Results: Twenty-one patients (10.6%) underwent additional surgeries for ASD. The rates of pre-existing adjacent-level pathologies were not statistically different between the ASD group and non-ASD group: 19% vs 15% in vertebral slip, and 10% vs 15% in asymptomatic foraminal stenosis, respectively. As well, no statistical differences were observed in facet tropism (33˚ vs 37˚ in FA) and addition of adjacent-level laminoplasty (48% vs 34%). Spinopelvic parameters were not statistically different between the two groups: 46˚ vs 44˚ in LL, 34˚ vs 31˚ in SS, 21˚ vs 20˚ in PT, 55˚ vs 52˚ in PI, 37mm vs 27mm in SVA, and 9˚ vs 8˚ in PI-LL value.
Discussion: The current study demonstrated that pre-existing adjacent-level pathologies and spinopelvic parameters were not associated with increase in ASD occurrence. In case of single-level lumbar fusion, segmental correction for global spinal realignment is not a priority, and asymptomatic adjacent segments are not required to be fused even with vertebral slip and/or foraminal stenosis.

O390

DOES SARCOPENIA IMPACT ON SAGITTAL MALALIGNMENT OR NOT?

Shoichiro Ohyama,Masatoshi Hoshino, Hiromitsu Toyoda,Shinji Takahashi,Hidetomi Terai, Akinobu Suzuki,Kazunori Hayashi,Koji Tamai, Hiroaki Nakamura
Dept. of Orthopedic surgery, Osaka City University Graduate School of Medicine Asahimachi, Abeno-ku, 545-8585 Osaka-city, Japan

INTRODUCTION: Sarcopenia described as an age-related decline in skeletal muscle mass as well as muscle function (defined by muscle strength or physical performance) has been accepted as a new geriatric syndrome. Sarcopenia is also considered to be part of the cause of sagittal malalignment. However the relationship of sarcopenia with spinopelvic parameters or the impact of sarcopenia on sagittal malalignment are not well known.
AIM: The purpose of this study is to clarify the relationship between sarcopenia and spinopelvic parameters.
MATERIALS AND METHODS: 40 outpatients over sixty-five years (mean age; 79y.o. M/F=24/16) who had underwent decompression surgery for lumbar spinal stenosis were enrolled. We measured their height-adjusted skeletal muscle mass using bioimpedance analysis machine (MC-980A, TANITA), handgrip strength and gait speed. We diagnosed patients as sarcopenia by using diagnostic algorithm of Asian Working Group for Sarcopenia (AWGS). Patients with sarcopenia were assigned to the S group (n=7). Others were assigned to the N group (n=33). From lateral view of whole spine radiograph, we measured following spinopelvic parameters; (1) lumbar lordosis (LL), (2) pelvic tilt (PT), (3) sacral slope (SS), (4) pelvic incidence (PI), (5) C7 sagittal vertical axis (C7SVA), and (6) PI minus LL (PI-LL). We compared these parameters between two groups.
RESULTS: Spinopelvic parameters of each group(S group, N group) were following; (1) LL: 42±15°, 40±15°(p=0.82), (2) PT: 25±8°, 23±12°(p=0.66), (3) SS: 29±7°, 28±8°(p=0.84), (4) PI: 54±10°, 51±14°(p=0.61), (5) C7SVA: 68±45mm, 44±27mm (p=0.26), (6) PI-LL: 12±15°, 11±14°(p=0.87). There were no significant difference between two groups. When limited to patients with PI-LL mismatch (PI-LL>10°), C7SVA of S group was more deteriorated than that of N group (S group: 122mm, N group: 66mm (p<0.01)).
CONCLUSION: There was no significant difference about spinopelvic parameters whether patients were sarcopenia or not. However, under condition of PI-LL mismatch, sarcopenia might impact on spinopelvic malalignment. Our study suggest that patients with sarcopenia are not able to compensate their sagittal malalignment because of decline in skeletal muscle mass and strength

O391

INTERVERTEBRAL DISC REPAIR WITH AUTOLOGOUS NUCLEUS PULPOSUS CELL TRANSPLANTATION: A TWO-YEAR CLINICAL STUDY

Dike Ruan,Chaofeng Wang,Qing He,Chao Zhang, Lisheng Hou

Department of ortheapadic 100048 + Beijing, China, People's Republic of

Introduction: Degeneration of the lumbar intervertebral discs is irreversible, with no treatment currently available. Disc herniation treated by discectomy results in a significant loss of nucleus material and disc height. Biological restoration through the use of autologous disc cell transplantation offers a potential to achieve functional integration of disc metabolism and mechanics. Building upon experimental studies that demonstrated the importance of the nucleus pulposus (NP) in preserving disc structure, we demonstrated that reinsertion of NP cells slowed further disc degeneration and significantly up-regulated the viability of NP cells in basic and pre-clinical studies. Here, we show a 2-year result of a prospective clinical study, aimed to assess the safety and efficacy of activated NP cell transplantation.

Aim: We analyzed the safety and the regenerative restoration ability of autologous NP cells in there section of nucleus pulposus of lumbar intervertebral discs. If intervertebral discs can be regenerated and repaired, then disc re-herniation and damage to adjacent intervertebral discs can be avoided.

Materials and Methods: Subjects were 30 patients aged from 20 to 55 years. All patients had been diagnosed lumbar disc herniation and been given the discectomy. Nucleus pulposus cells were cultured in GMP condition. Fifteen patients had been given the transplantation of NP cell to target intervertebral disc by a minimally invasive procedure 4 weeks postoperatively. Other fifteen patients hadn't been given the transplantation of NP cell as a control group. The safety NP cell transplantation were assessed by symptom and blood assay. Long-term pain relief and functional scores was assessed by the VAS scores, JOR scores , ODI Index and Sf-36 Index. The repair and regeneration of herniated disc was assessed by X-ray and Magnetic resonance imaging during 2 years follow-up postoperatively.

Results: No complication and abnorm-ality were observed after autologous NP cell transplantation. During 2 years after transplantation, all functional scores at two groups, including VAS scores, JOR scores , ODI Index and SF-36 Index, had the significant improvements to pre-operation. The data of VAS score in the two groups was 1.8 and 1.6 at 1 month post-operation compared with 6.5 and 6.3 at pre-operation. The data of JOR score in the two groups was 26.2±1.2 and 25.8±1.4 at 1 month post-operation compared with 16.5±1.6 and 16.0±2.1at pre-operation. The data of ODI Index in the two groups was 11.8±0.7 and 12.6±0.6 at 1 month post-operation compared with 32.6±4.2 and 31.8±2.1at pre-operation. The data of SF-36 Index in the two groups was 71.8±11.7 and 68.6±8.6 at 1 month postoperative compared with 33.6±8.2 and 32.7±7.1 preoperative. Furthermore, all functional scores hadn't the significant difference between two groups in different observing points postoperatively. During 2 years follow-up, X-ray results showed that the height of intervertebral disc at two groups hadn't the significant difference. At 2 years after transplantation, on T2-weighted magnetic resonance imaging, the index of intervertebral discs signal intensity was 73.3±13.6 in NP cell-treated group compared with 33.6±9.7 in control group. ($p<0.05$). The MRI result indicate that the NP cell-treated disc had the higher water contents than the control disc.

Conclusion: Our clinical study confirmed the safety of autologous NP cell transplantation, and the findings suggest the efficacy of this treatment to slow down the further degeneration of human intervertebral discs.

O392

DISC REGENERATION USING MSC TRANSPLANTED VIA THE ENDPLATE ROUTE

Gianluca Vadala,Fabrizio Russo,Maria Musumeci, Francesca De Strobel,Marco Bernardini, Luca Denaro,Domenico D'Avella, Rosaria Giordano, Vincenzo Denaro

Università Campus Bio-Medico di Roma Rome, Italy

INTRODUCTION: Stem cell based intervertebral disc (IVD) regeneration is quickly moving towards clinical applications. However, many aspects need to be investigated to routinely translate this therapy to clinical applications, in particular, the most efficient way to deliver cell to the IVD. Cells are commonly delivered to the

IVD through the annulus fibrosus (AF) injection. However, recent studies have shown serious drawbacks of this approach suggesting that intradiscal injection through the AF route itself is not completely innocuous and may disable the treatments to therapeutic agents delivered [1-3]. As an alternative we have described and tested a new surgical approach to the IVD via the endplate-pedicles (transpedicular approach) [4].

AIM: The Purpose of the study was to test MSCs/hydrogel transplantation for IVD regeneration in a grade IV preclinical model of IDD on large size animals via the transpeducular approach with cell dose escalation.

MATERIALS AND METHODS: Adult sheep (n=18) underwent bone marrow aspiration for autologous MSC isolation and expansion. MSC were suspended in autologous PRP and conjugated with Hyaluronic Acid and Batroxobin at the time of transplant (MSCs/hydrogel). Nucleotomy was performed via the transpedicular approach in four lumbar IVDs and that were injected with 1) hydrogel, 2) Low doses of MSC/hydrogel, 3) High doses of MSC/hydrogel, 4) no injection (CTRL). The endplate tunnel was sealed using a polyurethane scaffold. X-ray and MRI were performed at baseline and 1,3,6,12 months. Disc macro- and micro-morphology were analyzed at each time point.

RESULTS: The MRI index showed a significant decrease in the untreated group, the disc injected with hydrogel and those injected with low MSC dose compared to healthy discs in all time points. The discs treated with high dose of MSC showed maintenance of the MRI index compared to the healthy disc. Morphologically, the grade of degeneration was in agreement with the grade observed at the MRI.

CONCLUSION: An effective dose of autologous MSC (1x107 cell/ml) delivered via the alternative transpedicular approach regenerates the NP in a preclinical model of grade IV IDD maintaining the AF intact. This preclinical study has high translational value as large animal model with the long fallow up were used, MSCs were expanded in GMP facility simulating the clinical scenario, and the hydrogel were composed of clinically available drags and materials.

REFERENCE(S):

1. Carragee EJ, et al. 2009 ISSLS Prize Winner: Does discography cause accelerated progression of degeneration changes in the lumbar disc: a ten-year matched cohort study. Spine (Phila Pa 1976) 2009: 34:2338-2345;

2. Korecki CL, et al. Needle puncture injury affects intervertebral disc mechanics and biology in an organ culture model. Spine (Phila Pa 1976) 2008: 33:235-241;

3. Vadala G, et al. Mesenchymal stem cells injec-tion in degenerated intervertebral disc: cell leakage may induce osteophyte formation. J Tissue Eng Regen Med 2012: 6:348-55;

4. Vadala G, et al. The transpedicular approach as an alternative route for intervertebral disc regeneration. Spine (Phila Pa 1976) 2013: 38:E319-24;

O393

FUNCTIONAL SELF-ASSEMBLED PEPTIDE NANOFIBERS FOR BMSCS ENCAPSULATION IN NUCELUS PULPOSUS REGENERATION

Yaohong Wu,Dike Ruan,Zhiwei Jia,Chaofeng Wang,Hui Tao

Department of Orthopaedics, Navy General Hospital, Beijing, China 100048, Beijing, China, People's Republic of

Introduction: Recent studies have demonstrated that transplantation of mesenchymal stem cell (MSCs) can regenerate degeneration and the regenerative effect can be enhanced by using hydrogel carrier. Bioactive hydrogel provide greater potential for cell encapsulation, but most of the bioactive hydrogel formed by loading with entire growth factor. In this study, a new functional self-assembled peptide nanofiber for BMSCs encapsulation in nucleus pulposus regeneration was investigated.

Aim: To determine whether RADA16-I functionalized with BMP-7 bioactive peptide(RFBBP) could be used as an potential carrier for BMSCs encapsulation in regeneration of nucleus pulposus.

Materials and Methods: The RFBBP was manufactured by combining bioactive peptide of BMP-7 onto the C-terminal of RADA16-I. Physicochemical characterization of self-assembled peptide nanofibers were detected by macroscopy, HE staining and Atomic force microscope(AFM). Then, viability, proliferation, chondrogenic differentiation of BMSCs on different self-assembled peptide nanofibers

was investigated. Finally, chemotactic migration of BMSCs and the viability of BMSCs encapsulated in hydrogel after implantation into ex-vivo disc were evaluated.
Results: Results of physicochemical characterization revealed that self-assembled peptide nanofibers could assemble into hydrogel rapidly and formed weaved nanofibers structure; Live/Dead staining showed both RFBBP or RADA16-I displayed good cell viability (> 90%); MTT assay showed BMSCs with higher growth rate on RFBBP scaffold compared to RADA16-I($p < 0.05$); After culturing on RFBBP and RADA16-I for 21 days, BMSCs on RFBBP showed higher expression of Aggrecan both in mRNA and protein levels($p < 0.05$); Transwell assay showed superior chemotactic migration ability of BMSCs towards RFBBP after 48 hours($p < 0.05$); Encapsulation with RFBBP, viability of BMSCs can maintain at level of 70% for 14 days.
Conclusion: RFBBP could enhance proliferation, chondrogenic differentiation, and chemotactic migration of BMSCs, moreover, maintain viability of BMSCs after implantation into ex-vivo disc. Therefore, RFBBP can be selected as an potential carrier for BMSCs encapsulation in regeneration of nucleus pulposus.

O394

AXIAL LOADING DURING MRI COMBINED WITH T2 MAPPING PROVIDE NEW INSIGHTS INTO DISC DEGENERATION AND BIO-MECHANICS IN LBP PATIENTS

Hanna Hebelka, Kerstin Lagerstrand, Helena Brisby, Martin Nilsson
Institution of Clinical Sciences, Department of Radiology 426 71 Västra Frölunda, Sweden

INTRODUCTION: T2 mapping is a quantitative method to assess the T2 relaxation time and thus the intervertebral disc´s (IVD´s) biochemical composition. The impact of instantaneous spinal loading on T2 relaxation times, with regard to degenerative signs and biomechanics, has not been previously investigated in patients. Axial loading during MRI (alMRI) combined with T2 mapping might provide a tool to detect early biochemical/biomechanical alterations in degenerated IVD´s.
AIM: To investigate if alMRI combined with T2 mapping reflects IVD degeneration and bio-mechanical disc properties in low back pain (LBP) patients.
Materials and Methods Eleven patients (54 lumbar discs) with chronic LBP were examined with sagittal T2 mapping both with conventional MRI and alMRI (using the Dynawell® loading device). Pfirrmann grade and IVD angel for each disc and the lumbar lordosis angle were recorded. Each disc was divided into five regions of interests (ROI) on the three most central sagittal images. The mean T2 relaxation time in each ROI was determined generating five volumetric ROI´s in each disc; anterior annulus fibrosus (AF) (ROI 1), the interface anterior AF- nucleus pulposus (NP) (ROI 2), NP (ROI 3), the interface NP-posterior AF (ROI 4) and the posterior AF (ROI 5). T2 relaxation times changes induced with alMRI were for each ROI compared with Pfirrmann-grades, lumbar lordosis angles and IVD angles.
RESULTS: Pfirrmann grading in the 54 IVD were: grade I - 3 discs, grade II- 27, grade III- 16, grade IV- 8 and grade V – no discs. For reasons of statistical power Pfirrmann grades were digitomized into two groups; I-II and III-IV respectively. Absolute values of alMRI T2 relaxation time were in all ROI's higher in the Pfirrmann I-II group compared with group III-IV ($p<0.001$). Changes in T2-relaxation times with alMRI were higher in the I-II group in ROI 1 ($p<0.001$), ROI's 2-3 ($p<0.05$) respectively lower in ROI 5 ($p<0.05$), compared with group III-IV. alMRI induced an increase of lumbar lordosis of mean 11° (SD 5º), which correlated with increased disc angle at L5-S1 ($p<0.05$). Disc angle changes were induced correlating to concomitant T2 relaxation time changes in ROI 1-3 ($p<0.05$, $k=0.3$) and for ROI 5 (<0.01, k= -0,4).
CONCLUSIONS: Significant changes in IVD T2 relaxation times, induced with alMRI, correlated with degeneration severity and changes in disc angles, reflecting dynamic influences on the disc´s biochemical composition. alMRI combined with T2 mapping offer a method to assess disc degeneration features both quantitatively and dynamically, which can increase the understanding of LBP in relation to IVD changes. This method may have the potential to become a new diagnostic tool in the selection process of LBP patients for

surgical procedures, however it first need to be evaluated in lager patient materials.

O395

THE INFLUENCE OF SUB-DIAGNOSIS ON RADIOGRAPHIC AND CLINICAL OUTCOMES AFTER LUMBAR FUSION FOR DEGENERATIVE DISC DISORDERS: A 15-YEAR META-ANALYSIS

Amandeep Bhalla,Andrew Schoenfeld,Jaiben George,Christopher Bono

Brigham & Women's Hospital, Dept of Orthopaedic Surgery, Harvard Medical School Boston, 02115, United States

Introduction: There is a large body of literature describing lumbar fusion surgery and associated clinical and radiographic outcomes for degenerative disc diseases, considered together as a broad category. However, there is scant discussion in the literature of how outcomes for lumbar fusion are influenced by preoperative diagnosis.

Aim: By performing a 15-year meta-analysis, the authors sought to better understand the relationship between preoperative diagnosis and outcomes for lumbar fusion surgery.

Patients and Methods: With adherence to the PRISMA guidelines for meta-analysis, electronic searches were performed through PubMed, Scopus, and Web of Science to gather all studies involving lumbar fusion for degenerative disc disorders from January, 2000 to August, 2014. A detailed analysis of papers yielded by the query was performed. Disorders occurring at various points along the degenerative cascade were included, namely, degenerative spondylolisthesis (DDDsp), adult degenerative scoliosis (DDDsc), painful, dynamically unstable, degenerative disc disease (DDDu) (excluding spondylolisthesis), and degenerative disc disease not specified as stable or unstable (DDDn). Exclusion criteria included revision surgeries and the diagnosis of isthmic spondylolisthesis or spinal stenosis alone. Abstracted information included diagnosis, fusion technique, study design, number of levels fused, length of follow up, complication rate, and validated outcome measures.

Results: 100 articles met inclusion criteria and yielded data for 8,706 patients. The most common diagnosis was DDDn (44%), followed by DDDsp (43%), DDDsc (11%), and DDDu (2%). The mean clinical improvement in VAS scores was significantly different among the diagnoses ($p<0.001$) with DDDsp demonstrating the highest improvement (60%) and DDDns having the lowest (45%). Complication rates also differed significantly based on the diagnosis ($p<0.001$), with highest rate seen in the DDDsc group (18%), followed by DDDsp (14%), DDDn (12%), and DDDu (7%). There was not a significant difference in the fusion rates by preoperative diagnosis.

Conclusion: The preoperative diagnosis of degenerative spondylolisthesis showed a statistically significant greater clinical benefit from lumbar fusion compared to other diagnoses. The senior author (CB) performed a similar analysis of the literature over a 20-year period (1979-2000), and published findings indicative of a relationship between preoperative diagnosis and outcomes(Bono & Lee, 2005). The prior study, as well as this one, shows DDDsc to have the highest complication rate. Over the past 15 years, when compared to the prior 20 years, there is greater success in achieving bony fusion, regardless of preoperative diagnosis. This information may be helpful in discussing anticipated outcomes of lumbar fusion surgery for patients with lumbar degenerative disc disorders.

O396

CAN PROPIONIBACTERIUM ACNE REALLY CAUSE MODIC CHANGES? EVIDENCE FROM A RABBIT MODEL

Fengdong Zhao,Zhi Shan,Shengyun Li,Xuyang Zhang,Tianming Yu

Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University Hangzhou, Zhejiang, China 310000, China, People's Republic of

Introduction: MCs have been widely observed, and closely associated with low back pain, but their origins remain unclear. There are no previous animal models of MCs.

Aim: To evaluate the feasibility of inducing of Modic Changes (MCs) by means of injection of Propionibacterium acne (P.acne) into the disc-

subchondral bone junction area of the lumbar spine in rabbits.
Materials and Methods: Twenty New Zealand white rabbits were used for P.acne injection or control (10 rabbits each). The rabbits for 'P.acne' were injected percutaneously with 1 mL P.acne (1.6 x 107 CFU/mL) into the disc-subchondral bone junction area superior to the L4-5 and L5-6 discs. About the rabbits for control, disc-subchondral bone junction superior to the L4-5 and L5-6 discs were injected with nothing ('Sham') and 1mL normal saline ('Vehicle'), respectively. The subchondral bone superior to discs of L3-4 were used as blank. The development of MCs was investigated by magnetic resonance imaging (MRI) before operation and at 2 weeks, 1, 2, 3 and 6 months postoperatively. After sacrifice, histological analysis, blood test, real-time polymerase chain reaction and micro-CT were performed.
Results: From the post-operate 3-months, the P.acne group showed increased signal intensity in T1WI, which is significant at the 6th month. Also, higher signal intensity can be found after 3 months in T2WI. Positive culture results at 6 months were obtained from 9/20 endplate regions injected with P.acne. RT-PCR showed that expression of TNF-α, IL-1β and IFN-γ were significantly up-regulated following injection of P.acne, but no obvious changes were seen on histology, blood or Micro-CT.
Conclusion: P.acne can survive within the endplate region, and might initiate mild inflammatory response leading to signal intensity change in MR, likely simulated Modic changes.

O397

PSYCHOMETRIC ALTERATIONS AND BRAIN IMAGES IN CHRONIC LOW BACK PAIN

Shoji Yabuki,Sei Fukui,Shin-ichi Kikuchi,Shin-ichi Konno
Department of Orthopedic Surgery 060-1295 + fukushima City, Japan

Introduction: Chronic low back pain (CLBP) is one of the most important pain disorders with increasing social and economic implications. CLBP is thought to be a multidimentional process associated with comorbidities such as depression and pain catastrophizing. Advancement of in vivo brain imaging technologies has revealed increasing insights into the etiology and pathogenesis of chronic pain; however, the exact mechanisms of chronification of LBP remain still unclear.
Aim: The purpose of the current study was to analyze the psychometric alterations and the characteristics of brain images in CLBP.
Methods: Nine cases with CLBP (M/F=6/3) and 18 cases without pain (M/F=12/6) were included in this study. All of 27 cases answered questionnaires: Pain Disability Assessment Scale (PDAS), Hospital Anxiety and Depression Scale (HADS), Pain catastrophizing scale (PCS) and EuroQol-5D (EQ-5D). Also, magnetic resonance spectroscopy (MRS) and voxel-based morphometry (VBM) were performed on these cases. All MRI, MRS and VBM were performed on 3T clinical imaging instrument. On MRS, the value of N-acetyl aspartate (NAA) was measured relative to concentration for creatine/phosphocreatine complex (Cr) and choline (Cho), which is commonly used as an internal standard. The NAA/Cr and NAA/Cho in anterior cingulate cortex (ACC), prefrontal cortex (PFC) and thalamus (Th) were compared between 2 groups. On VBM, regional gray matter volume was analyzed in both groups.
Results: Scores of PDAS, HADS and PCS were statistically significantly higher in the CLBP group compared with the control group. On the other hand, EQ-5D was significantly lower in the CLBP group compared with the control group. On MRS, NAA/Cho in PFC was significantly lower in the CLBP group compared with the control group. On VBM, regional atrophy of gray matter (z-score < -2) was observed at right orbitofrontal cortex, left superior frontal gyrus, or left pallidum only in the CLBP group.
Conclusion: It was confirmed that the cases of CLBP showed disability, anxiety, depression, and lower QOL. Pain catastrophizing is thought to be an important factor in the development of chronic pain. Pain catastrophizing might be related to CLBP from the results of the current study. Since pain is realized in brain, functional brain imaging is important to clarify the pathogenesis of CLBP. The current study showed that functional change occurred in the PFC which is an affective-cognitive-evaluative area. Also, brain morphometric changes were seen in CLBP. These changes might be related to the

chronification of LBP. However, the current study was a cross-sectional study. A further longitudinal study is needed to better clarify the pathomechanisms of CLBP.

O398

OBSERVATION OF BONE VOLUME CHANGE IN OSTEOPOROTIC VERTEBRAL BODY AFTER VERTEBRAL FRACTURE BY CT COLOR MAPPING TECHNIQUE

Takahiko Hamasaki,Daisuke Sadaoka
National Hospital Organization Kure Medical Center, Chugoku Cancer Center Kure 7370023, Hiroshima, Japan

INTRODUCTION: Observing how much and where vertebral bodies change during the healing process in terms of bone volume after osteoporotic fracture can be difficult when done with conventional black and white CT images. Therefore, we established a new CT color mapping technique to show and visualize the healing process after an osteoporotic vertebral fracture.

MATERIAL AND METHODS: We analyzed 11 cases (all women, avg. 77 years old) with osteoporotic vertebral fracture. A CT scan was done at time of injury and 4 and 12 weeks after the injury. We did not use any phantoms for this technique. Initial CT images at the time of injury were transferred to a work-station. Cancellous and cortical CT values were calculated from three axial images of the vertebral body (cephalad 1/3, center, and caudal 1/3). For cancellous CT values, we checked five points (center of vertebral body and its front and back, right and left) on each axial image, resulting in 15 points for the region of interest (ROI), which we averaged. Cortical CT values were checked at three points (inner wall of canal, center lamina, right and left of pedicles) on each axial image, resulting in 9 points for ROI, which we averaged. Next, we set the lowest window width (WW) at the cancellous CT values, and the highest WW at the cortical CT values. Color mapping was then done according to the window width to establish a color map baseline and synchronize sequential images.

RESULTS AND CONCLUSIONS: Figure 1 shows CT color mapping images (A: at the time of injury; B: 4 weeks after injury; C: 12 weeks after injury), and conventional CT images (D: at the time of injury; E: 4 weeks after injury; F: 12 weeks after injury). CT color mapping images provide an obvious and clear description compared to conventional CT images. Other devices or phantoms are unnecessary for this technique. This technique has the potential to show and visualize the healing process of osteoporotic vertebral fractures. Figure 1 CT color mapping images (A: at the time of injury; B: 4 weeks after injury; C: 12 weeks after injury), and conventional CT images (D: at the time of injury; E: 4 weeks after injury; F: 12 weeks after injury)

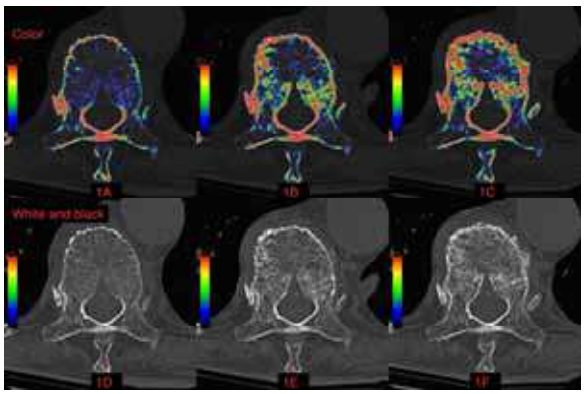


Figure 1 CT color mapping images (A: at the time of injury; B: 4 weeks after injury; C: 12 weeks after injury), and conventional CT images (D: at the time of injury; E: 4 weeks after injury; F: 12 weeks after injury)

O399

THE DIAGNOSIS OF DOUBLE-CRUSH LESION IN THE L5 LUMBAR NERVE USING DIFFUSION TENSOR IMAGING

Hirohito kanamoto,Yawara Eguchi,Seiji Ohtori, Munetaka Suzuki,Yasuhiro Oikawa,Hajime Yamanaka, Hiroshi Tamai,Tatsuya Kobayashi, Sumihisa Orita,Kazuyo Yamauchi,Miyako Suzuki, Yasuchika Aoki,Atsuya Watanabe, Kazuhisa Takahashi
Chiba University 260-8670,Chiba, Japan

INTRODUCTION: Double-crush lesions are a condition in which the lumbar nerve is compressed both medially and laterally in the spinal canal, where diagnosis can be very difficult. Diffusion Tensor Imaging (DTI) was used to determine DTI parameter fractional anisotropy (FA) values and apparent diffusion

coefficient (ADC) in both intraspinal column lesions alone and double-crush lesions.
METHODS: 10 cases with L5 radiculopathy due to L4/5 stenosis (Intraspinal stenosis group (Group I); mean age: 74.7 years), and 5 cases with persistent symptoms due to L5 foraminal stenosis despite L4/5 decompression surgery (Double crush Group (Group D); mean age: 77.6 years) were targeted. Five healthy cases (mean age: 54 years) were studied as controls. DTI was performed prospectively by 1.5T MRI before surgery. Intraspinal zone (Iz), nerve root (N), and extraforaminal zone (Ez) were established as the ROI, and the L5 nerve FA and ADC values were determined on the affected side. Student's t-test was used for group comparisons, and a $p<0.05$ was considered statistically significant.
RESULTS: FA values (Iz, N, Ez) were 0.415, 0.448, and 0.517, increasing as sites became more distal. Group I values were 0.335, 0.393, and 0.484, and Group D values were 0.296, 0.367, and 0.360. Compared to the healthy volunteers, Group D had significantly lower Iz ($p<0.05$) and Ez ($p<0.001$) values, while Group I had significantly lower Iz ($p<0.05$) values. In Group D, Ez FA values were significantly lower ($p<0.001$) than in Group I. ADC values (Iz, N, Ez) in the healthy control group were 1.270 mm2/s, 1.151 mm2/s, and 0.937 mm2/s with values decreasing as sites grew distal. In Group I, the ADC values were 1.406 mm2/s, 1.184 mm2/s, and 1.001 mm2/s, while in Group D they were 1.551 mm2/s, 1.412 mm2/s, and 1.329 mm2/s. Iz ($p<0.05$) and Ez ($p<0.05$) values were significantly higher in Group D compared to the healthy volunteers. N ($P<0.01$) and Ez ($p<0.001$) ADC values were significantly higher in Group D than in Group I.
DISCUSSION: Depending on where the nerve was compressed, changes in DTI parameters revealed nerve damage in the intraspinal canal in the Intraspinal Group, and over a widespread area in the Double-crush Group spanning the medial to lateral spinal canal. Our research suggests that in cases where double-crush is suspected before surgery, failed back surgery syndrome may be prevented by evaluating DTI images.

O400

THE CHANGE OF DURAL SAC CROSS-SECTIONAL AREA (DCSA) WITH SYMPTO-MATIC LUMBAR SPINAL STENOSIS: 10-YEAR COMMUNITY FOLLOW-UP

Igari T, Otani K, Sekiguchi M, Seki S, Tominaga R, Kobayashi Y, Kameda T, Kaneuchi Y, Sato R, Konno S
Department of Orthopaedic Surgery, Fukushima Medical University School of Medicine Fukushima City, Japan

INTRODUCTION: We previously reported the change of symptomatic lumbar spinal stenosis (LSS) in community-dwelling people for 10 years, using a diagnostic support tool for LSS (LSS-DST) (Konno S, BMC Musculoskelet Disord. 2007). It is well known that dural tube compression do not always correlate with LSS symptoms. However, little has been reported the relationship between the natural history of LSS and the dural tube compression in the community. The purpose of this study was to assess the change of the dural sac cross-sectional area (DCSA) of lumbar spine with symptomatic LSS in the 10 year follow-up (F/U).
METHODS: One hundred thirty three people (43 males, 90 females; age range, 48-90 years in 2015), replied to the LSS-DST in both 2004 and 2014. They examined MRI of lumbar spine in both 2004 and 2015. The DCSA at each lumbar intervertebral disc level (L1/2 -L5/S1) on axial T2 weighted image was measured by using the conventional method (Hamanishi C, JSD 1994). The t-test was used to investigate the differences in DCSA of two groups. The Tukey-Kramer multiple comparison test were performed to compare the differences in DCSA of four groups. Statistical significant was established at $p < 0.05$.
RESULTS: A total of 20 (15.0%) of 133 people were diagnosed with LSS in 2014 (F/U (+)). Meanwhile, subjects with LSS in 2004 (initial (+)) included 33 people (24.8%), and 10 of 33 subjects (30.3%) were LSS-positive in both 2004 and 2014 (A group), while 23 of 33 subjects (69.7%) switched from LSS-positive in 2004 to LSS-negative in 2014 (B group). There were 100 LSS-negative subjects in 2004 (initial (-)), and 10 of 100 subjects (10.0%) switched from LSS-negative in 2004 to LSS-positive in 2014 (C

group), while 90 of 100 subjects (90.0%) were LSS-negative in both 2004 and 2014 (D group). There were not significant differences of DCSA between the A and the B groups in 2004 and 2015, respectively. In contrast, there were significant differences of L3/4 level DCSA between the C and the D groups in both 2004 and 2015. The DCSA of L4/5 level was the smallest in each group, and there were not significant differences of L4/5 level DCSA among four groups. There were not significant differences of the DCSA changes from 2004 to 2015 in each lumbar disc level among four groups.

CONCLUSIONS: Overall, in 69.7% of the LSS initial (+) group, symptoms improved over 10 years, while 10.0% of the LSS initial (-) group switched to LSS F/U (+). The stenosis of L3/4 level DCSA may affect the onset of LSS symptoms 10 years later. The amount of change in DCSA each disc level do not change among four groups for 10 years.

O401

PROGNOSIS AND PROGNOSTIC FACTORS AFTER SUCCESSFULLY TREATED BY NON-SURGICAL PROCEDURES IN PATIENTS WITH LUMBAR SPINAL CANAL STENOSIS

Masanori Tsubosaka[1], Shuichi Kaneyama[1], Tomonori Yano[2], Masatoshi Sumi[1], Koichi Kasahara[1], Aritetsu Kanemura [1], Masato Takabatake[1], Akihiro Koh[1], Hiroaki Hirata[1], Yuki Takeoka[1]

Kobe Rosai Hospital 651-0053, Kobe, Japan

Introduction: Conservative treatment is generally considered as a first choice of treatment procedure in lumbar spinal canal stenosis (LSS) for most of the cases without severe symptoms1, 2, while we experience the patients who show their symptoms worsen even after successful conservative treatment. This long-term follow-up study (more than 5 years) investigated the prognosis of LSS after successful conservative treatment and indicated their prognostic factors to predict the risk of aggravation.

Materials and Methods: Sixty LSS patients (26 males, and 34 females; mean age at admission was 64.8 y.o.) underwent conservative treatment between 2007 and 2010 and were followed up over 5 years with an average of 7.4 years (5.4 - 9.4 years). They were classified clinically as follows: radicular type, 39 cases; cauda equina type, 12 cases; and mixed type, 9 cases. We defined “deterioration” in this study as the patients presenting with intermittent claudication at shorter distances than at discharge and/or when the paralysis appeared or progressed. The risk factors of the deterioration was analyzed by logistic regression analysis with following items: clinical classification, intermittent claudication at the initial visit (100m or less), muscle weakness in lower limb, vertebral body slip (3mm or more), scoliosis (Cobb angle 10°or greater), level of block on myelography, and the presence or absence of redundant nerve roots of the cauda equine. The long-term outcome of conservative treatment of LSS was analyzed by Kaplan-Meier analysis and log-rank testing was performed to assess the impact of risk factors by logistic regression analysis of prognosis.

Results: No deterioration was observed in 34 patients (56.7%) during follow-up, whereas 26 patients (43.3%) showed deterioration and 19 of them received subsequent surgical intervention. From the logistic regression analysis, intermittent claudication of 100 m or less at the initial visit ($p=0.015$; odds ratio, 6.04) and muscle weakness in lower limb ($p=0.030$; odds ratio, 5.08) were identified as the risk factors of deteriorations of symptoms. Kaplan-Meier analysis presented that 57.2% of the patients maintained their improved condition at the time of hospital discharge for at least 7 years. The patients with intermittent claudication of 100m or less at the initial visit had poor prognosis compared to the patients with mild intermittent claudication (>100m) in 7 years (deterioration rates; 66.7% and 32.6%, respectively: $p<0.01$). The patients with muscle weakness in lower limb at the initial visit also had poor prognosis compared to the patients without muscle weakness in 7 years (deterioration rates; 64.6% and 31.6%, respectively: $p<0.01$).

Discussion: A good long-term clinical outcome of conservative treatment for LSS was demonstrated in this study as 57.2% of the patients showed improvement in their pretreatment condition for more than 7 years. However, the patients with intermittent claudication of 100m

or less at the initial visit or muscle weakness in lower limb should be carefully followed up because those are the significant deterioration candidates despite the success in conservative treatment.

O402

DETERMINANTS OF PATIENT SATISFACTION AFTER SURGERY FOR CENTRAL SPINAL STENOSIS WITHOUT CONCOMITANT SPONDYLOLISTHESIS

Freyr Gauti Sigmundsson,Bo Jönsson,Björn Strömqvist

Department of Orthopedics Malmö S-202 05 Malmö, Sweden

Introduction: Satisfaction with treatment is a popular and important outcome measure but information about the determinants of patient satisfaction after surgery for central spinal stenosis (CSS) are lacking.

Aim: The aim of the study was to analyze determinants of patient satisfaction one year after surgery for CSS without degenerative spondylolisthesis (DS).

Materials and Methods: This prospective register study from the Swedish Spine Register included 5,100 patients operated for central spinal stenosis without DS. 88% received decompression only and 12% had decompression and fusion. The patient reported outcome measures (PROMs) were the EuroQol-5D, the Short-Form 36, the visual analogue scale for leg and back pain, the Oswestry disability index and the self-estimated walking distance. Logistic regression reporting odds ratios (OR) for being satisfied was used.

Results: There were significant baseline differences between satisfied and dissatisfied patients in all patient reported outcome measures except leg pain. Factors decreasing the likelihood for satisfaction included previous spine surgery OR: 0.4 (95%CI: 0.3-0.5), smoking OR: 0.6 (95%CI: 0.4-0.8), unemployment OR: 0.6 (95%CI: 0.4-0.9), back pain exceeding one year OR: 0.6 (95%CI: 0.4-0.9), back pain predominance OR: 0.7 (95%CI: 0.5-0.8). Fusion surgery did not predict satisfaction OR: 1.3 (95%CI: 0.9-1.9). Preoperative self-estimated walking distance >1000m predicted satisfaction, OR: 2.4 (95%: 1.6-3.6). Satisfied patients generally reported improvements in the PROMs while dissatisfied deteriorated but the spread in the data showed that reporting dissatisfaction despite improvement was common as was reporting satisfaction without significant improvement in the PROMs.

Conclusion: Numerous factors have predictive value for satisfaction after surgery for CSS without DS. Satisfaction is a complicated outcome measure, variably reflecting significant improvements in the PROMs. The results from this study can constitute background data in the shared decision making process when discussing surgery with patients suffering from CSS.

SP01

EFFECTIVENESS AND COST-EFFECTIVENESS OF RADIOFREQUENCY DENERVATION FOR CHRONIC LOW BACK PAIN ORIGINATING FROM THE SACROILIAC JOINTS

Maurits van Tulder, Johan Juch,Esther Maas, George Groeneweg,Raymond Ostelo, Bart Koes, Arianne Verhagen,Jan Willem Kallewaard, Hanneke van Dongen,Frank Huygen

VU University 1081 HV Amsterdam, Netherlands

INTRODUCTION: Radiofrequency (RF) denervation has been used for treating chronic low back pain originating from the sacroiliac joints (SIJ) for decades. To date, the efficacy of RF denervation has not been demonstrated unequivocally. The aim of this study is to establish whether RF denervation has an additional value when added to a standardized exercise programme in terms of effectiveness and cost-effectiveness compared to a standardized exercise programme alone for patients who are referred to a pain clinic.

METHODS: We performed a multicentre, randomised controlled trial with economic evaluation from a societal perspective in 16 pain clinics in the Netherlands; evaluating patients with chronic low back pain originating from the SIJ based on a positive diagnostic block (≥50% pain reduction), irresponsive to conservative treatment. All participants received a standardized exercise programme of three months (8-12 hours) and psychological support if needed. The intervention group additionally received RF denervation (Cooled RF , Palisade, or Simplicity III). Primary outcomes were pain intensity (0-10 numeric rating scale), global perceived recovery (1-7 Likert scale; 1-2 was defined as success), and functional status (0-100 Oswestry Disability Index) three months after the intervention. Participants completed questionnaires at baseline, 3 and 6 weeks, 3, 6, 9 and 12 months after start of the treatment. Costs were collected using self-completed cost questionnaires. Participants and care providers were not blinded. Longitudinal mixed-model analyses for the effects and seemingly unrelated regression analyses were performed by intention to treat for the cost-effectiveness.

RESULTS: 228 participants participated in this study; 116 were randomised to the intervention group and 112 to the control group. We found a significant mean between-group difference adjusted for baseline characteristics at 3 months for pain (-0.71; 95%CI -1.35 to -0.06), global perceived recovery (OR 2.45; 95%CI 1.17 to 5.13) and functional status (-4.15; 95%CI -7.52 to -0.78) favouring the intervention group. At 6, 9 and 12 months follow-up there were no significant differences between the groups. After 12 months, the intervention group was more costly €1933.69 (95%CI 279.64 to 3633.03) and not cost-effective compared to the control group.

CONCLUSION This study shows that RF denervation in the treatment of SIJ pain shows small short-term effects, but has no added value to a standardized exercise programme in the long term and is not cost-effective.

SP02

DOES BREAST SIZE PREDICT BACK PAIN?

Paul Sanderson,Debbie Lees,Andrew Bowey, Ignacio Serrano-Pedraza

Newcastle NHS Trust Dipton Mill Road Hexham, United Kingdom

Introduction: Back pain is commonly assumed to be related to large breast size. A common indication for breast reduction surgery is back pain. Most studies suggest a relationship between breast size and back pain. However all these studies are highly biased and only look at females with back pain. Few if any of these studies look at females without back pain.

Aim: To assess breast size and prevalence of thoracic and low back pain and any association.

Materials and Methods: 1650 questionnaires were sent out to women . 1233 were returned of which 88 were incomplete. 1145 were analysed. Pain diagrams were completed. Pain assessed on a VAS scale and analgesic requirements in the previous 3 months for back pain. Time off work due to back pain was also recorded and whether professional help had been sought for back pain. Bra size was self-reported. Breast volume was calculated from cup size. 73% had undergone professional breast measurement. Age, height, weight and

type of job were also recorded. Data was analysed by SPSS software.
Results: 672 (58.7%) reported back pain during this period. There was no relationship between back pain and age, BMI or height. There was a strong association between breast volume and thoracic back pain, but no relationship between low back pain and breast volume. Using logistic regression the goodness of fit for thoracic back pain was G2 = 6.54. The goodness of fit p-value was p=0.477. There is thus a very good estimation of the percentage of thoracic pain as a function of breast volume. In the case of low back pain the goodness of fit was G2=28.8. The goodness of fit p-value was p<0.001. Thus breast volume gives a very poor estimation of the percentage of low back pain.
Conclusion: There is a clear association between breast size and thoracic back pain, but no association with low back pain. Moreover in thoracic pain there is a clear relationship between the volume of the breast and the amount of pain. This is the first study to have show that thoracic back pain is related to breast size but not to low back pain

SP03

SIMULATION OF MULTIFACTORIAL CAUSES OF LOW BACK PAIN

Jacek Cholewicki,Pramod Pathak,N. Peter Reeves, John Popovich Jr.
Michigan State University East Lansing 48824, United States

Introduction: Low back pain (LBP) is a multifactorial problem. Many bio-psycho-social factors associated with LBP have been identified. However, the exact causes underlying LBP are often unknown, which makes selecting the appropriate treatment challenging. Therefore, much of the current research efforts are directed toward identifying causal factors responsible for LBP or subgrouping patients with similar characteristics (collection of factors) to improve the match between these specific factors and the appropriate treatment. Subsequently, randomized clinical trials (RCT) are conducted to evaluate whether such treatment strategies lead to improved outcomes1. Unfortunately, to date, “no classification system is supported by sufficient evidence to recommend implementation into clinical practice”1. Therefore, the purpose of this study was to assess the likelihood of achieving such goals with current research strategies.
Aim: Two hypotheses are tested using a multifactorial model of LBP: (i) When dealing with a large number of factors, it is not possible to identify subgroups effectively based on individual factors and (ii) Providing a number of treatments arbitrarily targeting any two or more factors is more effective than identifying and treating a single factor that maximally contributes to LBP.
Materials and Methods: The model consisted of a large population (n=106) with LBP. Factors contributing to LBP for each individual were uniformly distributed random variates between 0 and 1. For each individual, each factor xi was normalized by dividing it by the sum of k factors to create a fraction contribution to the total pain effect of 1: (x1+x2+…+xk)=1. Empirical and theoretical investigations were performed to calculate: (i) Percentage of individuals that could be sub-grouped by identifying a single factor xi exceeding a certain threshold θ and (ii) The average reduction in pain when a treatment eliminates the largest contributing factor vs. a number of the arbitrary factors.
Results: With an increasing number of factors, the probability of classifying an individual to a subgroup based on xi>θ tends to zero (Fig. 1). Even with a low threshold of θ=0.2, less than 1% of the LBP population can be sub-grouped when the number of factors exceeds 11. Applying arbitrary treatments addressing any two or more factors is more effective than diagnosing and treating a single factor that maximally contributes to LBP (Fig. 2).
Conclusion: Given the multi-factorial nature of LBP, it is unlikely that effective factor-identification methods or subgrouping schema can be discovered using the RCT strategies. These simulations also suggest a multi-disciplinary approach to LBP treatment may be more effective than a non-multidisciplinary treatment.

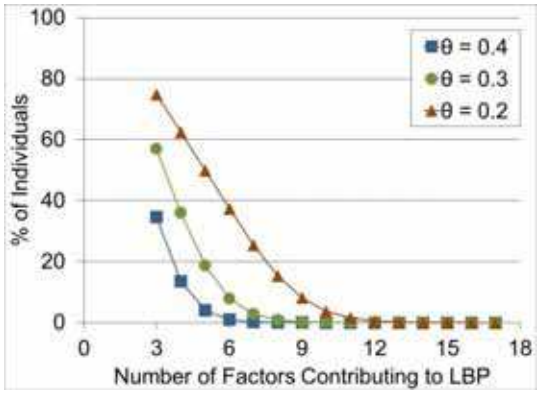


Figure 1

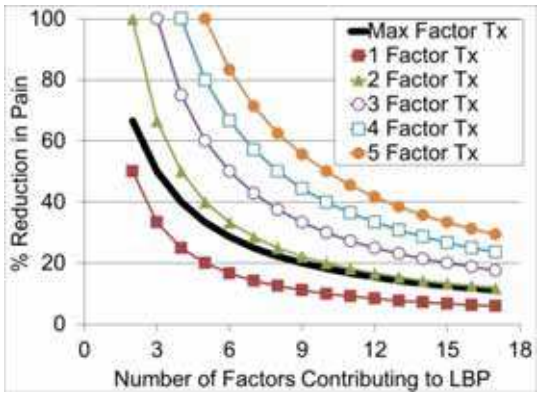


Figure 2

Reference(s): Kamper SJ, Maher CG, Hancock MJ, Koes BW, Croft PR, Hay E. Treatment-based subgroups of low back pain: a guide to appraisal of research studies and a summary of current evidence. *Best Pract Res Clin Rheumatol*, 2010, 24(2):181-191.

SP04

NOVEL CLASSIFICATION AND RISK FACTORS OF HIGH INTENSITY ZONES OF THE LUMBAR SPINE: THE WAKAYAMA SPINE STUDY

Masatoshi Teraguchi,Dino Samartzis,Hiroshi Hashizume, Hiroshi Yamada,Shigeyuki Muraki, Hiroyuki Oka,Jason Cheung, Noriko Yoshimura,Kenneth Cheung,Munehito Yoshida
Wakayama Medical University 641-8510, Japan

Introduction: For over 20 years, T2-weighted (T2W) MRI has been utilized to identify high intensity zones (HIZ) of lumbar discs. Inconsistencies exist in previous reports regarding the significance of HIZ as a biomarker for pain. This could be due to the speculative role of alternative imaging, such as T1-weighted (T1W) MRI, and the morphological/topographical variants of HIZ that would assist in elaborating on this entity and standardizing its phenotype. Furthermore, risk factors and association with other spinal phenotypes of HIZ remain unclear.
Aim: To address the multimodal imaging assessment, morphological/topographical variants, risk factors and association with other spinal phenotypes of HIZ.
Methods: A cross-sectional study of 814 (69.8% females) Japanese volunteers (mean age: 63.6yrs) was performed. Mean body mass index (BMI) was 23.0 kg/m2. Sagittal T2W and T1W MRIs of L1-S1 (4,070 discs) were assessed in all subjects. Prevalence and spatial distribution of HIZ were noted. HIZ characteristics were classified based on disc level, shape type (round, fissure, vertical, rim, and giant), location within the disc (anterior, posterior, both), and signal type on T1W (iso, high and low intensity) compared to the typical high intensity on T2W. Additional MRI spinal phenotypes were also assessed (e.g. disc degeneration (DD), disc bulge/protrusion, Modic changes, endplate abnormalities).
Results: HIZ was noted in 38.0% of subjects. Of HIZ subjects, the prevalence of posterior, anterior, and both disc locations containing HIZ were 47.3%, 42.4%, and 10.4%, respectively. Posterior HIZ were most common, occurring at L4/5 (32.5%) and L5/S1 (47.0%), whereas anterior HIZ were common at L3/4 (41.8%). Multiple level HIZs were as prevalent in posterior discs as anterior discs (36.0%). T1W iso-intensity type of HIZ were most prevalent (71.8%), followed by T1W high-intensity (21.4%) and T1W low-intensity (6.8%). At all discs, round types were most prevalent (anterior: 3.6%, posterior: 3.7%) followed by vertical type (posterior: 1.6%). At all affected levels, there was clear association between HIZ and DD, disc bulge/protrusion and Modic changes ($p<0.05$). Posterior round and T1W high-intensity type of HIZ were significantly associated with disc bulge/protrusion and Modic changes ($p<0.05$), in particular with Modic type 2. Endplate abnormalities, age, sex and BMI did not significantly differ between subjects with and without HIZ ($p>0.05$).
Conclusions: This is the first large-scale study reporting a novel classification scheme of HIZ and the potential utility of both T2W and T1W MRIs in its assessment. Although HIZ were frequently found to be posteriorly located within the disc, they did occur anteriorly as well and were associated with specific Modic

changes. With a more detailed description of the HIZ phenotype, this scheme can be standardized for future clinical and research initiatives.

SP05

PREVALENCE AND GENETIC ASSOCIATIONS OF MODIC ENDPLATE CHANGES IN THE LUMBAR SPINE

Rishi Kanna,S Rajasekaran,N Senthil,Ranjani Reddy, KMC Cheung,Danny Chan
Ganga hospital, Coimbatore Chinnammal Street Extension Coimbatore, India

Introduction: Though infective and biochemical causes have been proposed, the etio-pathogenesis of Modic changes remains unclear. Recent studies indicate a strong genetic predisposition for disc degeneration, and several single nucleotide polymorphisms (SNP) have been implicated in its causation. However the genetic associations of MC have not been described.
Aim: The present study purports to evaluate the prevalence of MC and the role of genetic polymorphisms in 40 candidate genes (including 71 SNPs) in a large Indian cohort.
Methods: The study was a cross sectional study of 809 patients and the inclusion criteria were age (18-70 years), no evidence of other spinal diseases, previous surgery & trauma. MRI including T1 and T2 sagittal sections of the lumbar spine was studied for the presence, location and type of Modic changes. Patients were divided into cases and controls depending on the presence of MC. Genotyping of SNPs were performed using the Sequenome® platform and genetic association analysis of 71 SNPs belonging to 40 genes was studied.
Results: The mean age of the patients was 36.7 ± 10.8 years (M-455, F-354). Based on the presence of MC at any one of the five lumbar discs, the total population was divided into 702 controls and 107 cases. 64 patients had single level MC (7.9%), 32 had double level MC (3.9%), five each had three and four level MC (0.6%) and one patient had multi-level MC. MC were identified in 251 endplates among the 1070 endplates and was more commonly situated in the lower endplates (149, 59.4%) than in the upper endplates (102, 40.6%). L4-5 endplates were the most commonly affected level (n=77, 30.7%) followed by L5-S1 (n=66, 26.3%). Type 2 MC was the most commonly observed pattern (n=206, 82%), followed by Type 1 (n=27, 10.8%) and Type 3 (n=18, 7.2%). Mirroring endplate MC was observed in 75 discs (29.8%). Mixed patterns were observed in 9 discs including two (I and II pattern) and seven (II and III pattern). Among the 40 candidate genes studied, the rs2228570 SNP of Vitamin D receptor (VDR) gene (p=0.02) and rs17099008 SNP of Matrix Metallo proteinase (MMP 20) (p= 0.03) were significantly associated with MC. The rs2066826 SNP of cyclo-oxygenase (COX2) gene (p=0.01) and rs11247361 of Insulin Growth Factor Receptor (IGF1R) (p=0.03) were significantly associated with Type 2 MC (n=84).
Conclusion: The significance and etiology of MC are not clear but have been increasingly implicated in low back pain. Understanding their etiopathogenetic mechanisms would tremendously help us to plan preventive and therapeutic strategies. The present study identifies genetic polymorphisms of VDR, MMP 20, COX 2 and IGF1R to be significantly associated with MC in a large population. These associations have not been reported previously.

SP06

PSYCHOLOGICAL STRESS RESULTS IN MECHANICAL ALLODYNIA, BUT NOT IN LOW BACK PAIN IN THE RAT

Daisuke Fukui,Mamoru Kawakami,Mitsuru Naiki, Tomonori Matsumoto
Wakayama Medical University Kihoku Hospital Wakayama city, Japan

Introduction: Numerous clinical reports note the associations between psychological stress and low back pain. However, the physiological mechanism is unknown and there are no reports utilizing animal models to elucidate whether such stress causes low back pain.
Aim: The purposes of this study were to evaluate what kinds of behavioral changes resulted from psychological stress in the rat, and to compare the results with the reported behavioral changes seen in models of sciatic nerve injury models and low back pain.
Materials and Methods: Twenty rats were divided into two groups of 10. They received either

specific alternation of rhythm in temperature (SART) stress or no SART stress (control group). Rats in the SART group were exposed to stress according to a published procedure. Briefly, rats housed at room tempe-rature (24 ± 2 °C) were transferred to a cold (–3 °C) environment at 11:00. After 1 h, the rats were returned to room temperature for an additional 1 h. This procedure of alternating cold–warm environments was repeated between 11:00 and 17:00, and then the animals were kept at –3 °C for another 17 h from 17:00 until 10:00 the following morning. This repeated exposure to SART stress was applied for 4–5 days per week for 7 weeks. The control group was simply housed at 24 ± 2 °C. Seven weeks after the SART stress exposure, the von Frey test was performed to assess quantitative allodynia in each group. The 50% paw with-drawal threshold was calculated by the up-and-down method of Dixon. In addition, behavioral changes were evaluated utilizing the CatWalk method. Results: Significant body weight loss was seen in the SART group 7 weeks after starting the SART stress ($p<0.01$). In this group, the mean reductions in the 50% paw withdrawal threshold were significantly lower than at baseline. Threshold withdrawal values for the hind paw in the SART group were significantly lower than those in the control group ($p<0.01$). The SART stress resulted in significant decreases in the CatWalk step cycle ($p<0.01$), standing time ($p<0.01$), duty cycle ($p<0.05$), and maximum contact ($p<0.01$) compared with those in the control group.

Conclusion: The reduction in paw withdrawal threshold in the SART group indicated that this stress resulted in allodynia. In addition, the abnormal CatWalk gait patterns observed in this group were similar to those seen in models of sciatic nerve injury reported previously, but not to those reported in models of low back pain. These results suggest that psychological stress as induced by SART does not initiate or induce low back pain in the normal lumbar spine.

SP07

DEFINING THE ROLE OF LOWER LIMBS IN COMPENSATING FOR SAGITTAL MALALIGNMENT

Renaud Lafage,Barthelemy Liabaud,Bassel Diebo, Jonathan Oren,Isaac Gammal,Shaleen Vira, Elizabeth Tanzi,Themistocles Protopsaltis, Thomas Errico,Frank Schwab,Virginie Lafage

Hospital for Special Surgery New York, NY 10021, United States

Introduction: While lower limbs compensatory mechanisms are an established response to progressive sagittal malalignment, their specific role and impact on surgical planning has not been evaluated. This study evaluates ability of knee flexion (KF) and pelvic shift (P.shift) to counteract high SVA and defines the relationship between lower limb compensatory apparatus and PT.

Aim: The purpose of this study is to quantitatively evaluate the lower limbs' role in maintaining the center of gravity over the polygon of sustentation and to investigate the impact of the lower limbs on pelvic retroversion.

Materials and Methods: Single center retrospective review of full body xrays was performed in patients (pts) >20 yrs. Parameters were measured with dedicated software. Population was stratified by 50mm intervals of SVA and one-way ANOVA was performed to compare P.shift. (P.Shift=antero-posterior translation of the pelvis versus the feet) across SVA groups. Antero-posterior offset of each vertebra versus vertical line erected from distal tibial metaphysis (TM) was investigated. Linear regression was performed to predict PT using KF and P.Shift while controlling for pelvic incidence minus lumbar lordosis mismatch (PI-LL) and SVA.

Results: 2124 pt visits were included (PI 55.1±14.1°, PT:21.0±11°, PI-LL:6.3±17.3°, SVA:29±51mm). With progressively increased SVA, P.shift decreased from 30 to -100mm (all $p<0.005$). Analysis of vertebrae offsets from the distal tibial metaphysis revealed that T9 was aligned with TM line across all SVA groups. Prediction of PT based on PI-LL and SVA yielded $R2=0.76$ ($p<0.001$); addition of KA and P.shift as independent parameters using hierarchical multiple regression led to significant improvement in R2, demonstrating the independent role of

lower limbs parameters in PT prediction. KA and P.shift had a positive standardized coefficient (all $p<0.05$).
Conclusion: Lower limb compensatory mechanisms increase with progressive sagittal malalignment. Antero-posterior translation of pelvis allows T9 vertebra to remain in line with the ankle ("conus of economy"). Lower limb compensatory mechanisms are positive predictors of PT and do not need additional consideration for surgical realignment planning.

SP08

PEAK SCOLIOSIS BRACE CAN REDUCE PAIN IN ADULTS WITH PAINFUL SCOLIOSIS: RESULTS FROM A PROSPECTIVE COHORT STUDY

Zaina F., Poggio M., Donzelli M. , Lusini M. , Minnella S. , Negrini S
ISICO fabio.zaina@isico.it Milan, Italy

Introduction: Adult scoliosis is sometime associated to back pain and severe curves can progress over time. The main approach for these patients is the surgical one, however surgery is not appropriate for all patients, and certain patients do not accept surgery. Despite scoliosis has been estimated to affect up to 68% of the population over 60, there is scant literature about conservative treatment for adult scoliosis. Custom fabricated rigid torso braces, similar to those commonly used for children are sometime used in adult patients, however, the goal of these braces is to correct and/or sustain the sagittal plane of patients, no data have been published on the efficacy of these braces in pain relief, and such braces are typically not well tolerated by adults. Recently a new brace has become available, the Peak™ Scoliosis Brace (Aspen Medical Products) designed to alleviate pain for adult patients with chronic pain secondary to scoliosis.
Aim: to test the efficacy of the Peak™ Scoliosis Brace in reducing pain in adult scoliosis patients.
Materials and Methods: Design: prospective experimental cohort study. Population: 20 adults with back pain secondary to Idiopathic Scoliosis. The sample size calculation based on a pilot study. Inclusion criteria: Adults affected by Idiopathic scoliosis of 30° Cobb or more and chronic low back pain (cLBP). Exclusion criteria: secondary scoliosis. Outcome measures: NRS, Oswestry Disability Index (ODI), Roland Morris Questionnaire (RM), COMI. Statistical analysis: paired t-test. Protocol: patients were evaluated at baseline immediately before starting with the brace and after 1 month. The brace must be worn for at least 2 hours per day.
Results: 20 out of 29 eligible female patients entered the study (age 67.8±10.5, curve 61.9±12.6° Cobb). We had no drop out. Worst pain (back or leg) and leg pain significantly improved from 7.15 to 5.85 and from 5.65 to 3.55 ($p<0.05$), while back pain improvement didn't reach statistical significance. Six patients achieved the minimal clinically important difference of 2 points for worst pain, 12 for leg pain. RM improved ($p<0.05$), no differences for ODI and COMI score.
Conclusion: The Peak Scoliosis brace showed a significant improvement at 1 month of worst pain and leg pain in a group of adult women with scoliosis and cLBP. Back pain slightly improved, but the change was not statistically nor clinically significant. Also the quality of life didn't change in a significant way even if the patients reported satisfaction with the treatment. The follow up time was really short, it's possible that a longer treatment could be more effective.

SP09

PROGRESSIVE PATTERN OF VERTEBRAL DEFORMITY THROUGHOUT FOUR YEARS IN A POPULATION-BASED COHORT STUDY OF VERTEBRAL FRACTURE

Kazuma Nakase,Koji Akeda,Junichi Yamada, Akihiro Sudo
Department of Orthopaedic Surgery, Mie University 514-8507 Tsu-city, Japan

Introduction: Spinal deformity, especially kyphosis deformity, has been shown to be associated with low back pain, quality of life, and also with mortality. Vertebral deformity may progress after vertebral fracture (VF); however, no detailed investigation of the progression patterns of vertebral deformity has been reported. We have previously reported that the progression of vertebral deformity after VF was identified in 26% of subjects during

an average follow-up period of 8.2 years in a population-based cohort study of VF.
Aim: The purpose of this study was to examine the incidence and progression pattern of vertebral deformity after VF for a definite period of four years in a population-based cohort study.
Materials and Methods: Over 10-years (1997-2009), 224 inhabitants (69 men, 158 women: mean age: 70.1 years) of a typical mountain village underwent medical examinations, and were followed for four years (continuous three examinations: baseline and years 2 and 4). Lateral thoracic and lumbar spine radiographs of each subject were taken; the extent (G1: mild, G2: moderate, G3: severe) and type (wedge, biconcave, crush) of the prevalent fractures at baseline, second and final examinations were evaluated using Genant's semi-quantitative technique. Of these, 117 subjects who had prevalent G1 deformity (170 vertebrae) at baseline (30 men, 79 women: mean age: 69.7 years) were subjects of this study. Vertebral levels were divided into three groups: thoracic (T4-T10), thoracolumbar (T11-L2) and lumbar (L3-L4). The progression pattern of VF was evaluated. A logistic regression analysis was used to identify the risk factors associated with the progression of deformity. Potential risk factors, including age, gender, type of deformity, vertebral level, bone mineral density (BMD), and occurrence of new-onset fracture, were assessed.
Results: At baseline, G1 deformity was 170 (84%), G2: 17 (8%) and G3: 17 (8%). Wedge type was 151 (74%), biconcave type 36 (17%) and crush type 17 (9%). The progression of vertebral deformity was identified in 22 vertebrae (12.9%). Among these, 10 vertebrae (5.9%) were identified from baseline to second examination, and 12 vertebrae (7.1%) from second examination to final examination. A logistic regression analysis showed that new-onset fracture during the four-year follow-up period was significantly associated with the progression of deformity.
Conclusion: This study clarified the natural history of vertebral deformity after VF; 5-7% of VFs were seen to change their extent and/or type every two years. The occurrence of new-onset fractures had significant association with the progression of vertebral deformity.

SP10

LESS INVASIVENESS IN MINIMALLY INVASIVE SPINE STABILIZATION (MIST) FOR METASTATIC SPINAL TUMOR

Tomohiro Hikata,Norihiro Isogai,Yuta Shiono, Haruki Funao,Eijiro Okada,Nobuyuki Fujita,Akio Iwanami,Kota Watanabe,Masaya Nakamura, Morio Matsumoto,Ken Ishii
Department of Orthopaedic Surgery, Keio University School of Medicine. Tokyo, Japan

Introduction: Spinal metastasis is a frequent complication in cancer patients, occurring in 30-40%. These metastatic lesion can significantly impact a patients' QOL as a result of disabling pain due to pathological fractures, or paralysis due to spinal cord compression. Surgery may be palliative, rather than curative, for patients with short term life expectancy, aimed to improve their quality of life.
Aim: The aim of this study was to elucidate the less invasiveness and safety of the minimally invasive spine stabilization (MISt) for the patient with metastatic spinal tumor.
Methods: We retrospectively reviewed 50 consecutive patient's data in Keio Spine Research Group (KSRG) registration system, who underwent posterior palliative surgery for metastatic spinal tumors from January 2009 to June 2015. All patients presented with progressive myelopathy or intolerable back pain caused by vertebral metastatic lesion. All patients revealed multiple metastatic lesions with life expectancy of at least 3 months. Twenty five patients underwent MISt surgery (M-group) and another twenty five patients received conventional open surgery (C-group) were included. The MISt procedure was to insert percutaneous pedicle screws into the two levels of unfractured upper and lower vertebral bodies to support the fractured body under fluoroscopic image. After insertion of screws and rods, we made a mini open medial posterior approach to expose the laminae involved segments and decompressed for neural tissues. If the rigid stabilization is not obtained or the anchor vertebra were invaded by the tumor, we inserted the additional screws into the more cranial or caudal vertebrae to gain a stabilization of spine. Peri- and post-operative clinical data were retrospectively

reviewed and compared between the two groups.
Results: There were no significant baseline differences in patients' characteristics between two groups. M-group was associated with significantly less intraoperative blood loss (M vs C group; 340.1 vs 714.3 ml, p=0.005), postoperative drainage (M vs C group; 136.0 vs 627.0 ml, p<0.001) and lower rates of red blood cell transfusion (M vs C group; 3 vs 10 cases, p=0.029), compared with C-group. The rates of intraoperative and postoperative complications were significantly lower in M-group (12%; 3 of 25 patients) than C group (44%; 11 of 25 patients). There were no significant differences in postoperative recovery for neurological deficit and pain improvement between two groups.
Conclusions: MISt procedure for metastatic spinal tumor was a less invasive and safe alternative to conventional open surgery. This procedure should be considered as a first choice treatment especially for the patients with short life expectancy.

SP11

EFFICACY OF ZOLEDRONATE AGAINST METASTATIC SPINAL TUMORS: EVALUATION OF BONE STRENGTH USING FINITE ELEMENT ANALYSIS

Hironari Takaishi,Satoshi Matsumaru,Naruto Fujita,Yoshiomi Kobayashi,Youhei Takahashi, Yoshio Shinozaki,Jun Ogawa
Institute of Med. Sci., Tokyo Medical University Tokyo 160-8402, Japan

Introduction: Bisphosphonates are effective against bone metastasis of malignant tumors, and are thought to work by inhibiting farnesyl diphosphate synthase of the mevalonate pathway to reduce osteoclast function. While the third generation bisphosphonate zoledronate (ZOL) has been reported to reduce significantly the incidence of bone-related events, such as pathological fractures and spinal paralysis associated with osteolytic bone metastasis.
Aim: To this end, we measured bone strength over time after ZOL administration for metastatic spinal tumors, and examined the intervention effect from a biomechanical perspective.
Materials and Methods: Subjects were 3 patients with pulmonary adenocarcinoma that had metastasized to the spine (8 vertebral bodies with tumors and 11 without tumors). Based on MDCT images taken before and 6 months after ZOL administration, and a biomechanically equivalent heterogeneous 3-dimensional fine element model was constructed. The rate of change for volumetric bone mineral density (mg/cm3), bone strength (N), and rigidity (N/mm) using a displacement controlled model before and after ZOL administration were calculated for vertebral bodies with and without tumors, and correlation coefficients were obtained in relation to the tumor volume ratio. Three-dimensional spinal units from L1 to S1 were generated, and minimal compressive strain, equivalent stress (MPa), and stress-strength ratio (%) were analyzed before and after ZOL administration or after spinal instrumentation surgery without fusion based on axial preload and 6.0 N.m dynamic moment.
Results: Compared to vertebral bodies without tumors, those with tumors had a significant rate of increase for volumetric bone mineral density (p<0.01), bone strength (p<0.05), and rigidity (p<0.05) after ZOL administration, with each showing a highly positive correlation with the tumor volume ratio. The predicted fracture site agreed with the distribution of the minimal compressive strain. The tumor region was replaced with trabecular bone structure which hardened due to ZOL administration, leading to an increase in mean equivalent stress upon breaking. With respect to dynamic analysis using spinal units, while the stress-strength ratio of each vertebral body significantly decreased as a result of ZOL administration or spinal instrumentation, the increase in stress from the moment load was focused around the pedicle screw.
Conclusion: Recent advances in conventional anti-cancer drug therapy and the advent of molecular targeted therapy have made possible the long-term control of primary lesions. The present study found that ZOL administration significantly increased bone strength and rigidity of vertebral column with tumors, and displayed similar load sharing effect to posterior instrumentation without fusion using pedicle screw. These findings suggest the possi-

bility that ZOL acts specifically on tumor lesion, and that the size of the metastatic lesion is not associated with short-term clinical outcomes.

SP12

EVALUATION OF THE SAFETY OF USING INTRAOPERATIVE SALVAGED BLOOD IN METASTATIC SPINE TUMOUR SURGERY: USING MICROWELL TECHNIQUE

Naresh Kumar,Aye Sandar Zaw,Bee Luan Khoo, Jean Paul Thiery,Aravind Kumar

National University Health System Singapore, Singapore

Introduction: Intra-operative cell salvage (IOCS) is not widely used in oncological surgery due to theoretical concern of reinfusion of tumour cells.

Aim: To evaluate our hypothesis that tumour cells, which pass through surgical suction system and are processed through the cell saver system, lose viability due to possible injury to the cell membrane during centrifugation and filtration. Hence any residual tumour cells in the salvaged blood are non viable, enabling safe reinfusion.

Materials and Methods - This study was a prospective observational study of patients with metastatic spine disease from known epithelial primary tumours who underwent surgery, at our institution between March and September 2013. Ethics approval for the study was sought from Institutional Review Board prior to commencement of the study. Blood samples (5 ml each) were collected at five different stages during surgery: A: venous blood from the patient during induction; B: venous blood during maximum tumour manipulation; C: blood from the operative field prior to cell saver processing; D: salvaged blood processed by the cell saver prior to LDF filtration; and E: salvaged blood after being processed with both IOCS and leucocyte depletion filter (LDF). All blood samples were stored in sterile Ethylenediaminetetraacetic acid (EDTA)-coated vacutainer tubes (Becton Dickinson) and kept at 4 degrees till processing. The samples were then analyzed for the viability of tumour cells using microwell based culture.

RESULTS: Of fourteen patients recruited, only 13 could be finally analyzed. There were 8 females and 5 males. The median age of the patients was 61 years (range: 37-77 years). The commonest primary tumour was breast, followed by lung. The median blood loss was 800 ml (range: 300-1500 ml). Eleven patients underwent posterior instrumentation and decompression and two underwent anterior corpectomy. Haemonectics cell saver was used in 11 patients and Didecocell saver in 2 patients. Analysis of the cultured samples showed that clusters or cytokerain positive CTCs (CK+ CTCs) were found in the samples taken from stage Ain 3 patients, B in 3 patients and C in 1 patient. However, none of the samples D and E from any patients generated tumour cell clusters or CK+ CTCs after culture.

CONCLUSION:The salvaged blood using the standard cell saver machine may retain some tumour cells but they are damaged and hence unable to replicate and metastasize. The results of this study imply that IOCS processed blood in MSTS is safe for transfusion.

SP13

INTERVERTEBRAL DISC CELLS SECRETE BMP ANTAGONISTS THAT ALTER OSTEOGENESIS OF HUMAN MESENCHYMAL STROMAL CELLS

Adel Tekari,Daniela A. Frauchiger,Samantha CW. Chan,Lorin M. Benneker,Hans-Jörg Sebald, Benjamin Gantenbein

University of Bern, Institute for Surgical Technology & Biomechanics 3014 Bern, Switzerland

INTRODUCTION: Spinal fusion and discectomy represent the gold standard treatments for spinal surgery to relieve pain. Fusion of the spine can be hindered, however, for yet unknown reasons that lead to non-fusions with pseudo-arthrosis. We showed previously that the intervertebral disc (IVD)-derived cells hinder the ossification process of human bone marrow-derived stromal cells (hMSC).

AIM: Within this study, we aimed to determine the factors that might be responsible for a reduced ossification of hMSC in the presence of IVD cells. Here, we hypothesized that BMP-antagonists secreted by IVD cells are responsible for such inhibition and this can be reversed by addition of L51P. L51P is an engineered BMP2 variant that has been recently demonstrated to be a generic antagonist of a

variety of BMP-inhibitors that control osteo-induction of bone.
MATERIAL AND METHODS: hMSCs, primary nucleus pulposus (NPC) and annulus fibrosus cells (AFC) were obtained from patients undergoing spinal surgery, isolated and expanded in monolayer cultures up to passage three. IVD cells were seeded in 1.2% alginate beads (4M/mL) and separated by culture inserts from MSCs in a co-culture (CC)-set-up. MSCs were kept in 1) control medium, 2) osteogenic medium+NPC (±L51P) and 3) osteogenic medium+AFC (±L51P) for 21 days. Relative gene expression of bone-related markers and of BMP antagonists were quantified with qPCR, and histological staining for calcium deposition and alkaline phosphatase (ALP) assay were performed. The endogenous expression of the BMP-antagonists in IVD cells (passage 1) was evaluated by qPCR and protein levels were determined by immunocytochemistry and flow cytometry.
RESULTS: Osteogenesis of MSCs was hindered as shown by reduced alizarin red staining in the presence of IVD cells. However, L51P added to CC of MSCs with either NPC or AFC induced mineralization by blocking the activity of the IVD cell's secreted BMP-antagonists. It was noted that L51P caused a general reduction in ALP activity in all experimental groups. ALP activity was significantly up-regulated in positive control, CC-NPC, and in CC-AFC+L51P relative to negative controls, suggesting osteogenesis in these groups. Endogenous expression of gremlin, noggin and chordin were detected by IVD-derived cells on transcripts and protein levels and were more abundant in NPC.
CONCLUSION: Histological staining for calcium deposition revealed an inhibition of the osteogenic differentiation of MSCs in CC with NPC or AFC. IVD cells expressed endogenous BMP-antagonists and were responsible for such inhibition and L51P enhanced osteogenesis of hMSCs in the presence of IVD cells by blocking the BMP antagonists. L51P could thus be an attractive therapeutic treatment for spinal fusion, where it could enhance bone formation in the presence of IVD tissue.

SP14

SYNERGISTIC EFFECT OF NERVE GROWTH FACTOR AND INSULIN-LIKE GROWTH FACTOR-1 ON ANTI-APOPTOSIS AND EXTRACELLULAR MATRIX SYNTHESIS OF RAT INTERVERTEBRAL DISC CELLS

Jong-Beom Park,Dong-Gune Chang
The Catholic University of Korea 480-717, Korea, South

Introduction: Decreased cellularity due to excessive apoptosis of disc cells is a major predisposing factor for disc degeneration. Therefore, the inhibition of apoptosis of disc cells might be a possible therapeutic approach for modulating the process of disc degeneration.
Aim: We performed the current study to investigate the effect of nerve growth factor (NGF) and insulin-like growth factor-1 (IGF-1) in preventing apoptosis and increasing extracellular matrix synthesis in rat intervertebral disc cells.
Materials and Methods: Expression of tropomyosin-related kinase A (TrkA) receptor for NGF and IGF-1 receptor (IGF-1R) for IGF-1 was examined in rat annulus fibrosus cells. In addition, rat annulus fibrosus cells were isolated, cultured, and placed in either 10% (normal control) or 0% (apoptosis-promoting condition) fetal bovine serum (FBS). We identified and quantified the degree of expression of TrkA and IGF-1R and apoptosis of the cells. Finally, we analysed the effect of NGF (100 ng/ml) and IGF-1 (500 ng/ml) in preventing apoptosis and increasing synthesis of extracellular matrix proteins, such as aggrecan, collagen-1 and -2, in the cells, in 0% FBS.
Results: In situ expression of TrkA and IGF-1R was identified in rat annulus fibrosus cells. In addition, the degree of expression of TrkA and IGF-1R was decreased in the cells treated with 0% FBS but some degree of expression was still maintained. Apoptosis of the cells was increased in 0% FBS compared with 10% FBS ($p < 0.001$). Despite extreme survival condition (0% FBS), each application of NGF (100 ng/ml) and IGF-1 (500 ng/ml) reduced apoptosis of the cells by 2% and 5%, respectively, which led to subsequently increased synthesis of aggrecan, collagen-1 and -2 (all, $p < 0.05$). The combined application of NGF (100 ng/ml) and IGF-1 (500

ng/ml) more significantly decreased apoptosis of the cells by 9% and increased synthesis of aggrecan, collagen-1 and -2 in the cells (all, $p < 0.01$).

Conclusion: The current findings demonstrate that apoptosis of intervertebral disc cells can be attenuated by NGF and IGF-1, which lead to increased extracellular matrix synthesis. Combined application of NGF and IGF-1 has a synergistic effect than single use of NGF and IGF-1. Our result suggests that NGF and IGF-1 may play a therapeutic role in slowing disc degeneration, which is due to inappropriate or excessive apoptosis of intervertebral disc cells.

SP15

GENETIC ATTENUATION OF ATM SIGNALING MITIGATES AGE-ASSOCIATED SPINE DEGENERATION IN MOUSE MODEL OF ACCELERATED AGING

Yingchao Han,Robert Hartman,Qing Dong, Laura Niedernhofer,Gwendolyn Sowa,James Kang, Vo Nam

Ferguson Lab for Orthopaedic and Spine Research, Department of Orthopaedic Surgery, University of Pittsburgh Pittsburgh, United States

Introduction: Stress from time-dependent accumulation of DNA damage causes aging. NF-κB signaling is important in mediating cellular response to stress, but chronic NF-κB activation also promotes many age-related diseases. Previously, we demonstrated chronic activation of NF-κB signaling promotes spine degeneration in a DNA repair-deficient Ercc1− /Δ mouse model of accelerated aging. However, it is not known how NF-κB is activated in spinal tissues of these mice. Ataxia telangiectasia mutated (ATM) is a nuclear protein kinase that determines cell fate, including senescence and apoptosis. NF-κB signaling is known to be up-regulated by DNA damage-dependent activation of ATM. Hence In this study we tested the hypothesis that DNA damage-dependent activation of ATM drives chronic activation of NF-κB signaling in Ercc1− /Δ mice, resulting in vertebral bone loss and intervertebral disc degeneration.

Aim: We investigated the effects of attenuating ATM signaling pathway delaying age-associated spine degeneration in the Ercc1− /Δ mouse model of accelerated aging.

Materials and Methods: Genetic depletion of ATM signaling was achieved genetically by deletion of one allele of the ATM subunit in Ercc1− /Δ mice (Ercc1−/Δ; ATM+/- mice). Spine segments were harvested from Ercc1− /Δ and Ercc1−/Δ; ATM+/- mice at around 16 weeks of age. DMMB assay was used to quantify sulfated GAG in lumbar NP tissue. Lower lumbar spines (L4-L6) were evaluated by micro-CT to assess for vertebral bone health. Immunofluoresence and Western analysis were performed to measure disc aggrecan and aggrecan fragments, and the senescence markers, p16 and p21.

Results: Compared to Ercc1− /Δ mice, Ercc1−/Δ; ATM+/- mice showed increased disc GAG content by DMMB assay. Vertebral bone volume/total volume (BV/TV) and thickness of trabecular bone (Th.Tb) were significantly higher in the heterozygous ATM gene knockout mice. Immunofluorescence analysis revealed greater total aggrecan signal and reduced p16 and p21 in disc tissue sections of Ercc1−/Δ; ATM+/- mice. Western blot analysis also showed reduced disc aggrecan fragmentation and p16 and p21 protein levels in ATM knockout mice.

Conclusion: ATM signaling attenuation delayed vertebral bone loss and intervertebral disc degenerative changes in the DNA repair-deficient Ercc1− /Δ mouse model of accelerated aging. These results support the hypothesis that accumulated DNA damage activates ATM signaling which trigger chronic NF-κB activation, resulting in spine degeneration in these mice. Our findings indicate that chronic ATM signaling promotes spine aging, identifying this signaling pathway as a potential molecular therapeutic target for prevention and treatment of age-related spine degeneration.

SP16

RADA16-I CONJUGATED WITH BMP-7 SHORT PEPTIDE CAN RETARD DEGENERATION OF INTERVERTEBRAL DISC

Yaohong Wu,Dike Ruan,Zhiwei Jia,Chaofeng Wang,Hui Tao

Department of Orthopaedics, Navy General Hospital, Beijing, China 100048, Beijing, China, People's Republic of

Introduction: Recently, endogenous repair has provide new potential for regeneration of intervertebral disc(IVD). However, current endogenous repair for IVD were focused on activation of native nucleus pulposus cell by growth factor which need continuous addition into IVD. Here, we introduced an new functional hydrogel RADA16-I conjugated with BMP-7 short peptide(RBP) and its effect of retardation of IVD degeneration.

Aim: To investigate the effect of prevention of IVD degeneration induced by RBP.

Materials and Methods: IVD degeneration(L3-6) were induced in 24 rabbits by annulus fibrous (AF) puncture and nucleus pulposus(NP) aspiration. Then 20 ul PBS, RADA16-I and RBP were injected into L3-4, L4-5, L5-6 respectively, and L6-7 was set as normal control. X-Ray and MRI examination were evaluated at pre-firstop(first operation), 4, 8,16 weeks post-firstop. Rabbits were euthanatized at 16 weeks post-firstop, targeted IVD samples were stained with HE and safranin O staining, apoptosis in disc samples were detected by TUNNEL kit. Finally, Aggrecan and collagen II content were determined by Elisa assay.

Results: In X-ray, the difference in disc height among three groups was insignificant($P > 0.05$). From MRI results, At 16 weeks post-first op, the RGI in RBP group slightly decreased to 0.338±0.068, also was higher than RADA16-I and PBS group($P < 0.05$. Both HE and safranin O staining showed intact gel-like NP and clear boundry between NP and AF tissue, and amounts of chondrocytes-like cells enriched with much pericelluar matrix stained intensely were observed in normal disc. In RBP group, injection of RBP resulted in relative preservation of structure, and an increasing number of chondrocytes-like cells. In RADA16-I and PBS group, the border between AF and NP became unclear, the NP tissue was gradually replaced by fibrous tissue, and rapid loss of cellularity were observed, many fibroblast-like cells were emerged in PBS group. TUNEL showed that the percentage of TUNEL-positive cells in RBP group was 7.94 ± 3.04%, which was significantly lower than 17.6 ±6.09%, 19.98 ±6.5% respectively in RADA16-I and PBS groups($P < 0.05$. The content of Aggrecan and collagen II in RBP group were 438.165±44.912 ug/mg and 2.873±0.554 ug/mg respectively, RADA16-I group was 183.262±40.11 ug/mg and 1.554±0.573 ug/mg, PBS group was 240.617±48.161 ug/mg and 1.354±0.412 ug/mg, normal control group was 717.062±79.196 ug/mg and 5.495±0.504 ug/mg. Content of glycosaminoglycan in RBP was higher than the other two experimental groups, but lower than normal control group ($P < 0.05$). The difference in the content of collagen II among three experimental groups was minor($P > 0.05$).

Conclusion: RADA16-I conjugated with BMP-7 short peptide can retard IVD degeneration, the retardation of IVD might mediate through preserve of the tissue structure and extracellular matrix and anti-apoptosis, which provide a new biological strategy for IVD regeneration.

SP17

A NOVEL INDUCIBLE SYSTEM TO REGULATE EXPRESSION OF THE THERAPEUTIC TRANSGENE TIMP1 FOR TREATING INTERVERTEBRAL DISC DEGENERATION

Yingchao Han,Robert Hartman,Qing Dong,Bin Wang,Vo Nam,James Kang,Gwendolyn Sowa
Ferguson Lab for Orthopaedic and Spine Research, Department of Orthopaedic Surgery, University of Pittsburgh Pittsburgh, United States

Introduction: Gene therapy with the anti-catabolic factor, Tissue Inhibitor of Metalloproteinase-1 (Timp1), to blunt MMP-mediated disc extracellular matrix proteolysis has previously shown promising efficacy in treating intervertebral disc degeneration(IDD). However, a major limitation of the current technique is the use of a constitutive promoter to drive continuous transgene expression even when not therapeutically necessary, which could result in undesirable side effects. To overcome this barrier to clinical translation, we designed and developed a novel adeno-associated viral gene therapy system that express the therapeutic gene product Timp1 only when the cells experience stress which activates NFκB signaling, a central cellular stress response pathway.

Aim: To develop and test the adeno-associated virus plasmid pAAV-NFκB-hTimp1 which express

human Timp1 transgene under the control of the NFκB inducible promoter in disc cells.
Materials and Methods: Cultured rabbit AF and NP cells were divided into three groups and transfected with the pAAV-NFκB-hTimp1 using the Xfect transfection. After 24 hours, cells were incubated in 1% FBS media without IL-1β; (control), 1% FBS with 10ng/ml IL-1β for 30 minutes, followed by return to 1% FBS media without IL-1β (group 2); or in 1% FBS media with 10ng/mL IL-1β, which was refreshed every 24 hours with IL-1β (group 3). Cells were incubated for a total of 96 hours. Cultured media and cell lysate were collected at 0, 30 minutes, 12, 24, 48, 72 and 96 hours after the first IL-1β stimulation. Production of hTimp1 mRNA and extracellular protein levels of hTimp1 were determined by real time RT-PCR and ELISA, respectively.
Results: RT-PCR analysis demonstrated that mRNA levels of hTimp1 significantly increased after IL-1β stimulation compared to the non-stimulated group after 12 hours both in AF and NP cells. The transient exposure to IL-1β (group 2), mRNA expression began to decline. However, expression of hTimp1 mRNA showed greater persistence through 96 hours in group 3. Consistent with the mRNA results, ELISA assay showed a nearly 4-fold increase in hTimp1 concentration in cultured media compared to the unstimulated group after 24 hours. The hTimp1 protein expression in group 2 gradually decreased after 24 hours; however, group 3 remained elevated after 24hours.
Conclusion: After transfection, hTimp1 mRNA and protein expression showed significant increase after stimulation with IL-1β. Transient exposure to this inflammatory stimulus, which activates NF-kB signaling, elevated hTimp1 mRNA and protein expression with maximal levels at 12-24h after exposure, after which hTimp1 gradually decreased. Persistent exposure to IL-1b elevated hTimp1 expression over 96h. These results demonstrate the novelty and support the feasibility of our strategy in which the NF-κB element containing promoter ensures that the transgene hTimp1 is expressed highly only under conditions of inflammation, and decreases after removal of the inflammatory stress.

SP18

EXPRESSION OF THE RANK/RANKL/OPG SYSTEM IN THE HUMAN INTERVERTEBRAL DISC

Koji Akeda,Norihiko Takegami,Junichi Yamada, Kazuma Nakase,Akihiro Sudo
Mie University Graduate School of Medicine 2-174 Tsu, Japan

Introduction: The receptor activator of nuclear factor kappa B (NF-κB) ligand (RANKL), a member of the TNF ligand superfamily, is well known to regulate bone metabolism. RANKL signaling plays a crucial role in osteoclast differentiation and activation. Binding of RANKL to RANK also stimulates the expression of proinflammatory cytokines through NF-κB pathways. Osteoprotegerin (OPG) is a soluble decoy receptor for RANKL. It has recently been reported that RANKL is also expressed by human articular cartilage and intervertebral disc (IVD). However, the expression of each component of the RANK/RANKL/OPG system in the IVD has not been examined in detail.
Aim: The purpose of this study was (1) to examine the mRNA and immunohistochemical expression of the RANK/RANKL/OPG system in the human IVD, (2) to examine the expression of the RANK/RANKL/OPG system under the stimulation of interleukin-1β (IL-1β).
Materials and Methods: Human IVD tissues (MRI Pfirrmann grades: II-III, average age: 36 years) were used in this study. Annulus fibrosus (AF) cells and nucleus pulposus (NP) cells were separately isolated by sequential enzyme digestion. The isolated cells were cultured in monolayer in DMEM/F12 containing 10% fetal bovine serum (FBS). The expression of the RANK/RANKL/OPG system by human AF and NP cells was examined using real-time polymerase chain reaction and immunohistochemistry. To evaluate the effect of IL-1β stimulation on the mRNA levels of the RANK/RANKL/OPG system, the cells were cultured with or without recombinant human IL-1β (rhIL-1β) at 0.1, 1.0 or 10 ng/ml in DMEM/F12 containing 0.3% FBS for an additional 24 hours.
Results: mRNA expressions of RANK, RANKL and OPG were clearly identified by both AF and NP cells, and all three expression levels were significantly higher in NP cells compared to those in AF cells ($P<0.01$, respectively). Immunoreactiv-

ity to RANK was mainly found in cell membranes of both AF and NP cells, while those to RANKL and OPG were distributed in the cytoplasm of both AF and NP cells (IL-1β [1, 10 ng/ml]: P<0.01 vs. control, respectively). IL-1β significantly stimulated the mRNA expression of RANKL, both by AF and NP cells. mRNA expressions of RANK and OPG were not significantly upregulated by IL-1β stimulation.
Conclusion: This study demonstrated, for the first time, that the RANK/RANKL/OPG system was expressed by human IVD cells. Interestingly, these expressions were significantly higher in NP cells than in AF cells. Because RANKL signaling can stimulate NF-κB signaling pathways, there is a possibility that the enhanced expression of RANKL may be associated with disc degeneration in conjunction with stimulation by proinflammatory cytokines, such as IL-1β.

SP19

ENHANCED DISC/BONE MARROW CROSS-TALK IN MODIC CHANGES

Stefan Dudli,Serena Hu,Shane Burch,Sigurd Berven,Vedat Deviren,Jeffrey Lotz
University of California San Francisco S-1164 94143 San Francisco, United States

Introduction: Modic changes (MC) are highly specific for discogenic pain and are a risk factor for poor outcome in low back pain patients. MC type 1 (MC1) represent inflammation/fibrosis, while MC2 represent fatty degeneration/ fibrosis. MC1 and MC2 associate with endplate damage, are specific for disc degeneration (DD), and MC lesion size associates with DD severity. Therefore, we hypothesize that biologic communication between nucleus cells and vertebral bone marrow (BM) underlies MC.
Aim: To characterize for the first time molecular and cellular changes within MC and adjacent discs and to test if there is an enhanced cross-talk relative to unaffected BM.
Materials and Methods: Surgical samples were harvested from patients undergoing multi-level lumbar body fusion with one MC and one non-MC level. Four samples were collected per patient: 1) BM aspirate from the MC BM; 2) adjacent 'MC' disc; 3) BM aspirate from non-MC BM; and 4) adjacent non-MC disc (MC1: n=12, MC2: n=9). For BM samples, cell populations were quantified using flow cytometry. Myeloid progenitors were quantified as colony-forming units (CFU). Transcription of 46 genes were quantified in all disc and BM samples. For each patient, MC data was normalized to non-MC, gene expression within MC discs were correlated to that within MC BM, and of non-MC disc to non-MC BM. The number of significant correlations (yes/no) at MC and non-MC levels was determine with Fisher exact test in order to test for an enhanced cross-talk with MC.
Results: The following genes were significantly changed relative to non-MC (fold-change in bracket): MC1 BM: neurotrophic tyrosine kinase receptor type 2 (NTRK2) (2.01), IFN-gamma (0.76); MC2 BM: NTRK2 (2.98), NTRK3 (4.33), GRN (0.70), MMP9 (0.20), NFkB1 (0.16); MC1 discs: NTRK1 (6.01), CCL2 (2.69), PPARgamma (0.53), RORc (0.29), NFkB1 (0.41); MC2 discs: NTRK1 (2.69), CCL2 (11.3), PPARgamma (1.83), RORc (0.24), CSF-1 (2.01), IL-6 (21.48), NGF (0.23), OPG (0.36), VCAM1 (4.11). In MC, 11 BM/disc correlated versus 4 in non-MC (Fisher test: p<0.05). In MC1, more lineage negative cells (+2.0%), a lower ratio of mature to progenitor granulocytes (-27%), and more granulocyte CFU (+69%) indicate over-stimulation of the myeloid lineage. In contrast in MC2, less lineage negative cells (-7.6%), less erythroid progenitors (-3.7%), less granulocyte progenitors (-8.7%), more mature granulocytes (+16.3%), less erythroid CFU (-27%), and less granulocyte-macrophage CFU (-29%) indicate depletion of myeloid progenitors.
Conclusion: There is an increased cross-talk between MC BM and discs, possibly due to endplate defects, suggesting that the hematopoietic dysregulation in MC stands in relation to DD. Furthermore, the consistent up-regulation of NTRKs in MC disc and BM may relate to why MC hurt. Although MC1 and MC2 likely present different stages of the same pathogenesis, molecular and cellular changes are different and therefore should be treated as different entities.

SP20

EVALUATION OF WATER RETENTION IN LUMBAR INTERVERTEBRAL DISKS BEFORE AND AFTER EXERCISE STRESS WITH T2 MAPPING

Kou Chokan,Hideki Murakami,Hirooki Endo, Daisuke Yamabe,Itsuko Tsukimura,Minoru Doita
Iwate Medical University Morioka, Iwate 0208505, Japan

Introduction: In recent years, a few case reports describe functional evaluation of articular cartilage with T2 mapping, However T2 mapping to the functional evaluation of intervertebral disks (IVD) has rarely been applied. T2 mapping can be used to quantify IVD water content before and after exercise stress, followed by the determination of water retention or shock absorber function. Here we aim to clarify water retention in IVDs of the lumbar vertebrae by performing MRI before and after exercise stress and quantitatively measuring changes in moisture content of IVDs with T2 mapping

Materials and Methods: Subjects comprised 40 healthy volunteers (males: 26, females: 14) with 200 IVDs of the lumbar spine (L1/2, L2/3, L3/4, L4/5, and L5/S1). The mean age was 25.6 years (21-31 years). MRI was performed three times (before exercise stress, after exercise stress, and after rest). Exercise stress involved performing 15 repetitions each of just over 30° extension, 45° flexion, and 40° left and right rotation, the normal range of motion of the lumbar spine. Image J image analysis software was then used to set regions of interest in the obtained images of the anterior anulus fibrosus (AF), posterior AF, and nucleus pulposus (NP). T2 values were measured and compared according to IVD levels and degeneration grade by Watanabe et al. [1]

Results: T2 values significantly decreased in the nucleus pulposus after exercise stress and significantly increased after rest. According to upper vertebrae position, in all of the upper vertebrae positions, T2 values for the nucleus pulposus significantly decreased after exercise stress and significantly increased after rest. According to the degeneration grade, in the nucleus pulposus of grade 1 and 2 cases, T2 values significantly decreased after exercise stress and significantly increased after rest.

Conclusion: In IVDs with mild degeneration, T2 changes in the NP were observed but such changes were not noted IVDs with advanced degeneration. In conclusion, T2 mapping could be used for the functional evaluation of IVDs.

Reference(s):

1. Watanabe A, Benneker LM, Boesch C,et al: Classification of intervertebral disk degeneration with axial T2 mapping. AJR Am J Roentgenol. 2007 Oct;189(4):936-42.

SP21

RELATIONSHIP BETWEEN MODIC CHANGES, ANTERIOR VERTEBRAL OSTEOPHYTES AND SPINAL INSTABILITY IN THE LUMBER SPINE

Masatsugu Tsukamoto,Tadatsugu Morimoto, Tomohito Yoshihara,Motoki Sonohata,Masaaki Mawatari
Dept. of Orthopaedic Surgery, Saga University 849-8501 Saga, Japan

Introduction: Spinal instability in the lumbar spine is a significant factor in lower back pain and indicates lumbar fusion surgery. Flexion–extension radiography is an important measure for judging lumbar instability. Modic change is associated with disc degeneration. The radiologic findings for degeneration include the presence of anterior vertebral osteophytes (traction spur or claw spur), vacuum phenomenon, and endplate sclerosis. However, few papers have investigated the relationship between lumbar disc degeneration and segmental instability.

Aim: To evaluate the relationships between Modic changes, anterior vertebral osteophytes and spinal instability in the lumbar spine

Materials and Methods: This study included 61 adult patients (31 males, 30 females; mean age, 67 years) who had undergone lumbar spine surgery. The anterior vertebral osteophytes and vacuum phenomenon (VP) (based on CT) and the degree of Modic change (MC) (based on MRI) were evaluated. Anterior lumbar vertebral osteophytes were distributed into six types (Kasai, BMC 2009) and MC was classified into four types (Modic, Radiology 1988). Radiographs of the lateral lumbar spine were taken in the following positions: neutral, flexion, extension, supine and sitting. The disc height (DH),

slip angle (SA) and slip distance (SD) were measured from the radiographs. For each parameter, the differences between the parameter or spur and MC were evaluated by a one-way analysis of variance.
Results: MC was identified in 17% of the intervertebral spaces. Among the patients with MC, 19% had type 1 MC, 51% had type 2 MC, and 30% had type 3 MC. Traction spurs were observed in 80% of the patients with type 1 MC, 47% of the patients with type 2 MC, and 94% of the patients with type 3 MC. The incidence of traction spur was significantly higher among the patients with type 1 and 3 MC than among the patients with type 2 MC ($p<0.05$). The VP was observed in 36% of the intervertebral space, including 100% of patients with type 1 MC, 81% of the patients with type 2 MC and 94% of the patients with type 3 MC. The mean SA and SD were not significantly associated with the type of anterior vertebral osteophytes or the type of MC. The change in DH from the supine to the sitting position was significantly different in the presence of VP and/or type 3 MC.
Conclusion: Traction spurs were most common at the same level as the VP and in patients with type 3 MC in the current study. The VP and type 3 MC were observed in the end stage of disc degeneration. In this study, the change of DH from the supine to the sitting position differed significantly in the intervertebral spaces with these findings. Our results suggest that there is relationship between the incidence of traction spurs and the vertical instability of the lumbar spine.

SP22

ANATOMICAL CHARACTERISTICS OF LUMBO-SACRAL NERVE ROOT AND FURCAL NERVE WITH 3.0-TESLA MR NEUROGRAPHY

Hiroshi Kobayashi,Hajime Tanji,Kinshi Kato, Kazuyuki Watanabe,Takuya Nikaido,Koji Otani, Shoji Yabuki,Shin-ichi Konno,Shin-ichi Kikushi
Fukushima Medical University 960-1295, Japan

INTRODUCTION: Recently, magnetic resonance (MR) neurography of the lumbar spine enables depiction of the spinal nerve root from the intervertebral foramen to the lumbo-sacral plexus. In the previous study, we reported that transverse route of Dorsal Root Ganglion (DRG) associates with foraminal stenosis and disc herniation. However, the significance of image-detected abnormalities still remains unclear because there is no report that shows normal variation. The purpose of this study was to analyze patients with normal image findings and examine the anatomical route of the nerve root and furcal nerve.
METHODS: A total of 144 sides from 72 cases (38 men, 34 women; mean age, 36.9 years; most common age group, 10-19 years old) who underwent MRI showing no intra- or extra-foraminal radiculopathy in affiliated hospitals were included. MRI studies were performed on a 3.0-tesla Philips Intera MRI system. The angle between a perpendicular line from the end plate and axis of the DRG at the L3 nerve root to the S1 nerve root was measured (α angle). We found that MR neurography could not describe the obturator nerve. According to our classification (Kikuchi et al, Spine, 1986), we classified nerve roots accompanying the furcal nerve. Secondly, we observed whether the furcal nerve distributed to the femoral nerve or lumbo-sacral nerve trunk.
RESULTS: Mean α angles were 37.9°±5.8° (L3), 40.6°±6.0° (L4), 36.7°±6.3° (L5), and 21.7°±5.1° (S1). Six sides (4.2%) of the furcal nerve branched off from L3 and merged with the lumbo-sacral nerve trunk. Ninety-nine sides (68.8%) branched off from L4 and merged with the lumbo-sacral nerve trunk. Three sides (2.1%) branched off from L4 and merged with the femoral nerve and lumbo-sacral nerve trunk. Three sides (2.1%) branched off from L5 and merged with the femoral nerve and lumbo-sacral nerve trunk. Thirty-three (22.9%) sides could not be described. These existing levels of furcal nerve largely corresponded with our past anatomical findings.
CONCLUSION: MR neurography enabled elucidation of coronal angles of DRG against the vertical axis in normal patients. In addition, the furcal nerve could be described and evaluated with MR neurography. This study has several limitations in that most subjects were young, we did not compare abnormal and normal findings, and the resolution to detect the furcal nerve was limited. Further investigation is needed.

SP23

ANALYSIS OF MOTION PRESERVATION FOLLOWING TDR AT THE LUMBOSACRAL JUNCTION: A PROSPECTIVE LONG-TERM CLINICAL AND RADIOGRAPHIC INVESTIGATION

Würtinger C., DÀgostino Annes R., Hitzl W. 4, Korge A., Mehren C., M.H. Mayer, Siepe C.J.
Schön Klinik Munich Harlaching 81547 Munich, Germany

Introduction: The role of fusion for the treatment of LBP resulting from lumbar degenerative DDD remains controversially debated. Besides mediocre clinical results, fusion of lumbar motion segments has been associated with a variety of negative side effects such as adjacent level pathologies. The hypothetical goal of motion preserving technologies such as TDR (total lumbar disc replacement) is to avoid these negative side effects by means of motion preservation. Despite of their widespreade use, long-term radiographic data following TDR are lacking.

Materials and Methods: TDR (ProDisc II) was performed for the treatment of LBP resulting from single-level DDD at the lumbosacral junction (L5/S1). Examinations were performed preoperatively, at 3, 6 and 12 months, annually thereafter. The minimum FU for inclusion was ≥ 5 years. Radiological evaluations included ap- and lateral X-rays as well as functional flexion / extension images. Measurements were performed by 2 independent observers and included parameters such as segmental / global lumbar lordosis as well as ROM at the index and cranially adjacent level. The effect on the patients clinical symptomatology was investigated by correlating the clinical and radiographic data at the early (3-6 months), mid- (12-24 months) and late FU stages (≥ 5 years)

Results: 51 patients with a mean FU of 7.8 years (range 5.0-13.3 years) were available for the final FU. The clinical outcome scores revealed a significant improvement from baseline levels ($p<0.05$). TDR demonstrated maintained mobility with a trend towards lower ROM values at later FU stages. Whilst no statistically significant difference was detected between the preoperative and early FU, this reduction in ROM became statistically significant at the mid- and final FU stages ($p <0.001$). The reduction in ROM was not negatively correlated with the patient´s symptomatology ($p<0.05$). An overall increase of the global lumbar lordosis ($p<0.0001$) was predominantly located at the index segment which demonstrated a significant lordotic shift ($p<0.00001$) and which was positively correlated with the implant lordosis ($p<0.05$). Conversely, a compensatory reduction of lordosis was observed at the cranially adjacent segment ($p 7$ years ($p<0,05$).

Conclusions: The present data demonstrate an increase in global lumbar lordosis following TDR which is predominantly located at the index segment. This lordotic shift was strongly dependent on the applied implant lordosis and was accompanied by a compensatory reduction of lordosis at the cranially adjacent segment. Whilst motion was preserved over the entire FU period, the present data reveal a tendency towards a lower mobility at later FU stages. This reduced ROM did not negatively impact the patients clinical symptomatology. Preserved and unchanged mobility of the cranially adjacent segment may possibly be interpreted as a sign of adjacent segment preservation resulting from maintained index segment motion and lordosis reconstruction. Whilst the present long-term investigation provides additional insight into longitudinal radiographic changes, upcoming studies should focus on the adequate quality and quantity of motion with artificial disc replacement implants.

SP24

INDUCTION OF ENDOGENOUS NEURONAL STEM CELLS PROLIFERATION BY EXTRACORPOREAL SHOCK WAVES AFTER SPINAL CORD INJURY

Sang-Il Kim,Young-Hoon Kim,Kee-Yong Ha,Jang-Woon Kim
Department of Orthopaedic Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea 06591 Seoul, Korea, South

Introduction: Besides transplantation of various stem cells for spinal cord injury (SCI), experimental trials to recruit and re-model the endogenous stem cells have been reported. Previous study also presented experimental evidence of

alteration of microenvironments in the chronic phase of SCI using extracorporeal shock waves (ESWs) without clinical deterioration. The purpose of this study is to investigate the effects of ESWs on endogenous neuronal stem cells proliferation after SCI.

Aim: The purpose of this study is to investigate the effects of ESWs on endogenous neuronal stem cells proliferation after SCI.

Materials and Methods: Chronic contusive SCI model was made using 24 Sprague-Dawley rats (6 rats in each group). Post-injury 4 weeks, ESWs was applied with 0.04 mJ/mm2 energy level in different impulses (group I: 500 impulses, group II: 1000 and group III: 1500). The proliferation of endogenous neuronal stem cells (DCX, Sox-2) and axonal sprouting (GAP-43 and MAP-2) were measured at 6 weeks after ESWs. Immunofluorescence staining and western blotting was done for quantitative analysis and these results were compared with those of the control group. For clinical assessment, BBB locomotors rating was also performed. Results: More proliferation of endogenous neuronal stem cells was noted around the central canal and the injured posterior horn in the experimental groups. DCX expression of the group I (0.12±0.01), group II (0.12±0.03) and group III (0.12±0.04) were significantly higher than that of the control group (0.07±0.02) in the western blot. Sox-2 expression in the injured site was also significantly higher in the group I (0.07±0.02), group II (0.07±0.02) and group III (0.05±0.01) comparing to that of the control group (0.03±0.004). For axonal regeneration, GAP-43 expression in the group I (0.75±0.04), group II (0.69±0.23) and group III (0.55±0.16) were significantly higher than that of the control group (0.34±0.17). MAP-2 expression in the injured site also presented higher expression in the experimental group (group I: 0.11±0.04, group II: 0.08±0.02, group III: 0.05±0.01) compared to that of the control group (0.04±0.01). At the last follow-up (post-injury 10 weeks), Significant improvement of BBB locomotors scores were noted in the experimental group (group I: 3.67±2.73, group II: 3.00±2.97, group III: 3.83±2.14) comparing with that of the control group (1.17±0.98).

Conclusion: ESWs application on the chronic phase of SCI presented promotion of endogenous neuronal stem cells proliferation without debilitating clinical function.

SP25

LIFESTYLE RELATED DISEASE INCREASES THICKNESS OF SPINAL EPIDURAL FAT IN THE PATIENTS WITH LUMBAR SPINAL STENOSIS

Shinichi Ishihara,Nobuyuki Fujita,Tomohiro Hikata, Akio Iwanami,Kota Watanabe,Masayuki Ishikawa,Yasuyuki Fukui,Masaya Nakamura, Morio Matsumoto,Ken Ishii,Keio Spine Research Group (KSRG) Keio Spine Research Group (KSRG)

Dept. of Orthopaedic surgery, International University of Health and Welfare, Mita Hospital 108-8329, Tokyo, Japan

Introduction： The thickness of spinal epidural fat (SEF) in lumbar spinal stenosis (LSS) patients is various and its determinative factor is unclear. The degree of visceral fat is known to be correlated with lifestyle related disease (LRD). However, the relationship between LRD and thickness of SEF in LSS patients is not yet known.

Aim: The aim of this study is to determine if coexisting of LRD influences the thickness of SEF in LSS patients.

Materials and Methods: 208 patients who underwent surgery for LSS from May 2013 to October 2014 were retrospectively reviewed. The subjects included 111 men and 97 women with a mean age of 69.4 years. These patients were divided into two groups, L group included the patients who showed SEF thicker than 50% in diameter of spinal canal in axial or sagittal view of preoperative MRI and N group was less than 50%. In two groups, we compared the incident rate of LRD such as hypertension, type 2 diabetes mellitus (T2DM), hyperlipidemia and arteriosclerosis from patients' medical history and preoperative BMI, blood examination including cholesterol, triglycerides (TG) and high-density lipoprotein (HDL) and HbA1c and arteriosclerotic index such as ankle-brachial index (ABI) and cardio ankle vascular index (CAVI).

Results: L group was consisted of 96 cases and N group was 112 cases. The prevalence of hypertension (L: 64.6%, N: 39.3%, P=0.002) and T2DM (L: 24.0%, N: 11.6%, P=0.02) was

significantly higher in L group than N group. The average BMI of L group is slightly, but significantly higher in L group than N group (L: 23.74, N: 22.65, P=0.003). There was significant difference between two groups in the average TG (L: 163.4mg/dl, N: 118.7mg/dl, P=0.001) and HDL (L: 54.2mg/dl, N: 58.1mg/dl, P=0.03), but not cholesterol (L: 203.9mg/dl, N: 207.4mg/dl, P=0.49) and HbA1c (L: 5.92%, N: 5.84%, P=0.42). Bilateral side of CAVI score demonstrated significantly higher in L group (R:9.47 L:9.31) than N Group (R:9.02 L:8.83) (R:P=0.02, L:P=0.01), while ABI score showed no significant difference between two groups.

Conclusion: Our results suggest that LRD increases thickness of SEF in LSS patients. Although excess fat was reported to induce migration of immune cells and activate inflammation in various other tissues, the pathophysiological significance of SEF is still unclear in LSS patients. We are simultaneously progressing the study concerning the interaction between thickness of SEF and clinical outcome in LSS patients.

SP26

THICKNESS OF SPINAL EPIDURAL FAT INFLUENCES SURGICAL OUTCOMES IN THE PATIENTS WITH LUMBAR SPINAL STENOSIS

Shinichi Ishihara,Nobuyuki Fujita,Tomohiro Hikata, Akio Iwanami,Kota Watanabe,Masayuki Ishikawa,Yasuyuki Fukui,Masaya Nakamura, Morio Matsumoto,Ken Ishii,Keio Spine Research Group (KSRG) Keio Spine Research Group (KSRG)

Dept. of Orthopaedic surgery, International University of Health and Welfare, Mita Hospital 108-8329, Tokyo, Japan

Introduction： The thickness of spinal epidural fat (SEF) in lumbar spinal stenosis (LSS) patients widely differs among cases. Excess fat is known to induce migration of immune cells and activate inflammation in other tissues. However, the clinical significance of SEF is still unclear in LSS patients.

Aim: The purpose of this study is to determine whether the thickness of SEF has an impact on surgical outcomes in LSS patients.

Materials and Methods: 99 patients who underwent surgery for LSS from August 2012 to August 2014 and followed up for a minimum 1 year were retrospectively reviewed. The subjects included 74 men and 25 women with a mean age of 70.9 years. These patients were divided into two groups, L group included the patients who showed epidural fat thicker than 50% in diameter of spinal canal in axial or sagittal view of preoperative MRI and N group was less than 50%. In two groups, we compared ages at the operation, sex, BMI, types of surgical procedure (decompression, D or fixation, F), the number of the decompression level, surgical complications and the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) at both pre-operation and final follow-up period. Results: L group was consisted of 50 cases and N group was 49 cases. There were no statistically significant differences in ages at the surgery (L: 72.1, N: 69.8, P=0.26), sex (L: male 41 female 9, N: male 33 female 16, P=0.21), BMI (L: 24.5, N: 24.9, P=0.65), types of surgical procedure (L: D 46 cases , F 4 cases, N: D 44 cases, F 5 cases, P=0.70) and the number of decompression level (L: 2.36, N: 2.04, P=0.12). There was no major surgical complication in both groups. Preoperative JOABPEQ showed no significant difference between two groups in any domains. However, in postoperative JOABPEQ, Walking ability (L: 58.02, N:,78.59 P=0.001), Social life (L: 58.43, N: 67.94, P=0.04) and Mental disorder (L: 52.56, N: 63.16, P=0.004) were significantly lower in L group than N group. Postoperative Pain disorder (L: 69.94, N:,80.94, P=0.06) and Lumbar function (L: 68.62, N: 74.23, P=0.30) were not significantly, but had tendency to be lower in L group than N group. Among postoperative VAS scores, Back pain (L:3.35, N:2.23, P=0.021) and Leg pain (L:2.99, N:1.97, P=0.040) were significantly higher in L Group. Leg numbness (L:3.43, N:2.96, P=0.45) of L group was not significantly, but had tendency to be higher than N group.

Conclusion: Our results suggested that thick SEF had negative impact on surgical outcomes in LSS patients. These findings lend a strong support to the hypothesis that SEF may hamper spontaneous remission of postoperative inflammation and pain.

SP27

EARLY EFFECTS OF MEDICARE'S BUNDLE PAYMENT FOR CARE IMPROVEMENT PROGRAM FOR LUMBAR FUSION ON EPISODE COSTS, VOLUME, AND SAFETY.

Brook Martin,Anna Tosteson,Jon Lurie,Farrokh Farrokhi,Kevin McGuire,Sohail Mirza
Geisel School of Medicine at Dartmouth College Orthopaedics/ HB 7541 03756, United States

Introduction: High-volume orthopaedic procedures like lumbar fusion are increasingly being reimbursed through episode-based bundle payment contracts, an alternative to fee-for-service reimbursement. By providing a predetermined payment for all services related to a targeted diagnosis over a defined period of time, these programs fundamentally shift the financial risk of patient care on to hospitals. The Center for Medicare and Medicaid Innovation initiated the voluntary Bundled Payment for Care Improvement (BPCI) program on January 1st, 2013. Hospitals initially participated in either the preparatory (Phase I) or the risk-bearing (Phase II) program.

Aim: We sought to understand the effects of the BPCI program for lumbar fusion on 90-day episode of care costs, procedure volume, reoperations, and readmissions, before and after the initiation of the preparatory program (i.e. in lead up to the start of the risk-bearing program).

Materials and Methods: We performed a retrospective analysis of Medicare claims linked to public reports of hospital participation in Medicare's BPCI Model 2, which holds hospitals accountable for the cost of post-acute services. We identified fee-for-service beneficiaries over age 65 undergoing a lumbar fusion based on Diagnosis Related Group (DRG) in 2012 or 2013, corresponding to the years before and after the BPCI program was initiated. Linear mixed regression models adjusting for patient age, sex, comorbidity, and hospital size were used to explore changes in episode costs, procedure volume, and surgical safety indicators based on BPCI program participation.

Results: We included 89,605 beneficiaries undergoing lumbar fusion operations, including 36% who were seen by a hospital that enrolled in the BPCI preparatory (Phase I) program and 7.3% seen by a risk-bearing (Phase II) hospital. The mean age of the cohort was 73.4 years, with 59% female, 92% White, and 22% with a Charlson Comorbidity Index of 2 or more. Hospitals participating in the BPCI Phase II program were larger in terms of procedure volume, bed size and total discharges. Relative to non-participants, risk-bearing hospitals increased fusion volume from 2012 to 2013 (2.9% increase versus 1.4% decrease), increased 90-day episode of care costs (1.6% increase versus 1.2% decrease), increased 90-day readmission rate (+0.3 versus -1.3 percentage points), and increased repeat surgery rates (+1.1 versus +0.3 percentage points). Outcomes for Phase I BPCI participants were intermediate to those of non-participants and Phase II hospitals.

Conclusion: Compared to non-participants, hospitals participating in risk-bearing bundle payment program for lumbar fusion had increased 90-day episode of care costs, increased procedure volume, and increased readmissions rates. Given these early, but unintended policy effects, continued monitoring and greater scrutiny of the policy effects of bundled payment models is imperative.

SP28

OBJECTIVE MEASUREMENT OF FREE-LIVING PHYSICAL ACTIVITY (PERFORMANCE) IN LUMBAR SPINAL STENOSIS: ARE PHYSICAL ACTIVITY GUIDELINES BEING MET?

Christy Tomkins-Lane,Justin Norden,Aman Sinha, Richard Hu,Matthew Smuck
Mount Royal University Calgary, T3E 6K6, Canada

Introduction: Research suggests that people with lumbar spinal stenosis (LSS) would benefit from increased physical activity. Yet, to date we do not have disease specific activity guidelines for LSS, and the nature of free-living physical activity (performance) in LSS remains unknown. LSS care providers could endorse the 2008 United States Physical Activity Guidelines, however, we do not know if this is realistic.

Aim: Our goal was to determine the proportion of individuals with LSS meeting the 2008 Physical Activity Guidelines. A secondary goal was to better understand the nature of physical performance in LSS.

Materials and Methods: This was a retrospective study of the Lumbar Spinal Stenosis Accelerometry Database. All participants had both radiographic and clinical LSS and were seeking various treatments for their symptoms. Outcome measures included 7-day accelerometry and demographics. For this study, we analyzed only baseline data that was obtained prior to any new treatments for patients. We determined the proportion of individuals with LSS meeting the 2008 US Physical Activity Guidelines of at least 150 minutes of moderate-vigorous (MV) physical activity per week in bouts of 10 minutes or more. We also used the novel Physical Performance analysis designed by our group to determine time spent in varying intensities of activity.

Results: We analyzed data from 75 individuals with a mean age of 68 (SD 9), and 37% male. Three people (4%) were considered Meeting Guidelines (at least 150 MV minutes/week), and 56 (75%) were considered Inactive with not even one MV minute/week. With the 10-minute bout requirement removed, 10/75 (13%) achieved the 150-minute threshold. The average time spent in sedentary activity was 82%, and of time spent in non-sedentary activity, 99.6% was in the light activity range.

Conclusions: People with LSS are extremely inactive with only 4% meeting current physical activity guidelines. There is an urgent need for interventions aimed at reducing sedentary behaviour and increasing activity in LSS both to improve function and prevent diseases of inactivity. However, existing physical activity guidelines are difficult for this population to achieve. These results suggest that a focus on light intensity activity and shorter bouts of activity are more appropriate and realistic in this population. As this study reveals the need for disease specific activity guidelines and the value of physical performance measurement in LSS, it is an important step in a personalized medicine approach to people with LSS that is focused on increasing physical function through targeted and realistic activity goals.

SP29

USE OF THE L5 SPINAL NERVE ANGLE ON OBLIQUE CORONAL DOUBLE ECHO STEADY STATE MAGNETIC RESONANCE IMAGING AND THE RANGE OF L5/S MOTION FOR FORAMINAL STENOSIS DIAGNOSIS

Yasuaki Murata, Keiji Wada, Ryou Tamaki, Daisuke Numaguchi, Yoshiharu Kato

Tokyo Women's Medical University Shinjuku 162-8666 Tokyo, Japan

Introduction: Foraminal stenosis has often been detected on imaging. However, although this condition is well known, it is occasionally difficult to diagnose, as spinal nerve compression is not always visible on stationary images. It has been reported that most of foraminal stenosis cases occur at the L5/S foramina. The sacral plexus runs along the ventral surface of the sacral bone. That is, the sacral plexus is fixed on a hard tissue. On the other hand, the spinal nerves from L1 to L4 run through the psoas major muscle. The influence of adjacent disc mobility from L1/2 to L4/5 to the spinal nerve is offset by the soft tissue compared with that from the L5/S disc.

Aim: The purpose of the present study was to identify foraminal stenosis as well as the influence of a dynamic factor at the L5/S level, considering the bent L5 spinal nerve on reconstructed oblique coronal double echo steady state (DESS) magnetic resonance imaginges (MRI).

Materials and Methods: Patients diagnosed with L5/S foraminal stenosis (Group F, n = 19) and had no L5/S disc lesion (Group C, n = 19) underwent the oblique coronal DESS MRI of the lumbar spine to measure the angle of the L5 spinal nerve. The L5 spinal nerve angle (L5 angle) around the L5/S foramina was measured on reconstructed DESS MRI and the range of L5/S segment motion were assessed on radiography with the lumbar spine in the extended and flexed positions. The influence of the L5 angle and L5/S segment motion on L5 radiculopathy due to foraminal stenosis was examined.

Results: The average L5 angles were 128° ± 11° on the symptomatic side and 145° ± 12° on the asymptomatic side in Group F. The average L5 angle was 157° ± 10° in Group C. The L5 angle of

140° yielded a sensitivity of 84% and specificity of 86% and that of 141° yielded a sensitivity of 89% and specificity of 84% for the detection of symptomatic foraminal stenosis. The average L5/S disc angles of the gap between flexion and extension (L5/S motion angle) were 4.5° ± 3.3° and 2.8° ± 2.4° in Groups F and C, respectively; these values significantly differed ($p < 0.05$). When the L5 angle was less than 140° or when the L5 angle was between 140° and 145° and the L5/S motion angle was more than 4.5°, L5 radiculopathy was seen in all cases. These parameters showed a sensitivity of 100% and specificity of 89% for this condition.
Conclusion: A combination of the bended L5 spinal nerve at the corner of L5/S disc and the L5/S segment motion can cause L5 radiculopathy

SP30

NATURAL HISTORY STUDY OF OSSIFICATION OF THE YELLOW LIGAMENT: FIVE-YEAR LONGITUDINAL MRI FOLLOW-UP

Jason Pui Yin Cheung,Chris Yuk Kwan Tang,Dino Samartzis,Kenneth Man Chee Cheung
The University of Hong Kong Hong Kong, Hong Kong

Introduction: Thoracic myelopathy causes spastic gait and great functional impact on the patients. More than half of all cases of thoracic myelopathy are caused by ossified yellow ligament (OYL). Knowing whether OYL will progress with time is important to understand its pathophysiology and risk of neurological compromise. However, the natural history of OYL is currently still unknown.
Aim: To assess for any disease progression and risk factors for such progression using a longitudinal follow-up of subjects with OYL.
Materials and Methods: This was a prospective MRI examination of 114 individuals with OYL that were confirmed using baseline computed tomography. Follow-up MRI scans at 5 years from baseline were collected for assessment. Clinical parameters including age, height, weight and body mass index (BMI) were collected. Imaging parameters included the size of OYL (expressed in terms of percentage of anteroposterior diameter of OYL in sagittal cuts divided by the distance from posterior longitudinal ligament to the spinolaminar line at the corresponding level), levels of involvement and morphology (round, triangular or beak type). Images were read by 2 examiners independently and blinded to patient details. Four major features were studied over the 5-year period including OYL size progression, morphology changes, disappearance and de novo development.
Results: At baseline, 114 patients (40 men and 74 women) had OYL. Mean age of patients was 47.5 years old (range 19.7-60.5) and mean BMI was 24.0 (range 14.2-71.6). A total of 317 spinal segments were found to have OYL on the baseline MRI and 557 spinal segments had OYL in the follow-up MRI indicating that an overall progression in OYL was observed. Majority of OYL in the lower thoracic region, especially T9-T10 (70%) and T10-T11 (62%) levels, showed size progression. Average size progressions over lower thoracic spine were 29.8% (growth rate of +13.4%/5 years) and 27.6% (growth rate of +3.8%/5 years) over T9-T10 and T10-T11 respectively. 53.9% of OYL levels have morphology changes and among the beak types, 70.4% became either round or triangular type. OYL disappearance was observed in 24.6% of segments while de novo OYL developed in 57.1% of spinal segments. Majority of the de Novo development occurred in the lower thoracic region and 70% of these subjects had BMI of 30-40 kg/m2.
Conclusion: This is the first and only population based series addressing the natural history of OYL and risk factors for its progression. The strength of the study is in the large number of population based subjects originally screened, and the large number of subjects with OYL that were followed for a period of 5 years with repeat scans. This study shows that OYL has a variable presentation and course is related to patient's BMI, location of the OYL and its morphology. Results show that de novo OYL may be more likely to appear once a segment has already developed.

SP31

MECHANISM OF DEVELOPING SCIATICA EXPERIENCED IN LUMBAR DISC HERNIATION: CHANGE IN INTRARADICULAR OXYGEN SATURATION BY INTRAOPERATIVE SLR TEST

Shigeru Kobayashi,Takumi Yonezawa,Yuuichi Hashishin, Hisanori Matsuoka
Orthopaedics and Rehabilitation Medicine, Faculty of Medical Sciences, The University of Fukui Eiheiji 910-1193+Fukui, Japan

Introduction: The straight-leg-raising (SLR) test has been one of the most significant of clinical signs when making a clinical diagnosis of lumbar disc herniation.4 It is interesting to study to what extent oxygen saturation is disturbed in the nerve roots when sciatica is experienced in lumbar disc herniation.
Aim: In the SLR test performed preoperatively, we evaluated the extent of the intraradicular oxygen saturation disturbed at various angles, which caused sciatica to develop, using a pulse oximeter.
Methods: The subjects were 7 patients with lumbar disc herniation who underwent micro-discectomy (5 men and 2 women aged 34.0 years on average [range, 25-43]). Regarding operated disc levels, all patients were operated on L4/5 disc. A sensor of the pulse oximeter which adhered to nerve root retractor put on the nerve roots above the herniation, and the legs were allowed to descend down to the angle at which sciatica was experienced, and kept at that position for 1 minute to determine the change in intraradicular oxygen saturation. During the SLR test performed pre-operatively, 3 patients developed sciatica at an angle of 10 degrees and 4 patients at 30 degrees. This test was performed only on those who gave informed consent.
Results: The intraoperative SLR test s howed that the hernia compressed the nerve roots to increase their flatness, resulting in a clear disturbance by which gliding distance was reduced to only a few millimeters. During the SLR test, the intraradicular oxygen saturation was decreased by 8.0~39.3% (average ± SEM.: 23.1±12.7%) after initiating the test. When the angle of the legs was returned to zero degrees, oxygen saturation showed an immediate improvement and the value recovered to that obtained before the SLR test. After removal of the hernia, the nerve roots showed smooth gliding in all patients. The intra-operative reverse SLR test conducted after removal of the hernia showed no significant decrease of intra-radicular oxygen saturation in the nerve roots. When the SLR test was performed at 1 week after the operation, all the patients were negative and did not develop sciatica, unlike the results obtained preoperatively.
Discussion: When sciatica was experienced during the SLR test, hernia mass caused relatively strong acute compression and tension to develop at the nerve roots, resulting in about 70-80% decrease in intraradicular oxygen saturation. It was predicted that disturbed blood flow caused by this mechanical stress led to development of edema and anoxemia, constituting an inductive factor of ectopic discharge responsible for pain.1,2,3
Conclusion: When sciatica was experienced during the SLR test, the intraradicular oxygen saturation deteriorated significantly after the SLR test.
References: 1. Howe JF, et al. Pain 3:25-41, 1977. 2. Kobayashi S, et al. Spine 18:1410-1424, 1993. 3. Kobayashi S, et al. Spine 28:1427-1434. 2003. 4. Lasegue EC. Arch Gen de Med 6: 558-580, 1864.
Acknowledgement: This work was supported by Grant-in Aid from the Ministry of Education, Science and Culture of Japan (25460719).

SP32

GENDER DIFFERENCES IN THE SURGICAL TREATMENT OF LUMBAR DISC HERNIATION IN ELDERLY

Björn Strömqvist,Fredrik Strömqvist,Bo Jönsson, Magnus Karlsson
Skåne University Hospital SE-20502 MALMÖ, Sweden

Background: Outcome after lumbar disc herniation (LDH) surgery in middle aged is usually reported to fulfill the criteria for successful outcome. It is also known that women in this age report an inferior outcome than men, probably as being referred to surgery with greater deterioration than men. This study evaluates if the same gender differences exist in elderly.
Method: In the national Swedish spine surgical register (SweSpine) we identified 1250 patients ≥65 years with both pre- and one year postoperative data, 53% males with mean age 70.6±5.0 (mean ± SD) and 47% females with mean age 71.3± 5.2. All were between the years 2000-2012 surgically treated due to LDH. The

registry includes data on age, gender, smoking habits, walking distance, consumption of analgesics and the patient related outcome measurement (PROM) back and leg pain by a Visual Analogue Scale (VAS), quality of life by EuroQol 5 dimensions (EQ5D) and Short Form-36 Questionnaire (SF-36), disability by Oswestry Disability Index (ODI), one year postoperative data on patient satisfaction rate and data on subjective change in back- and leg pain by the surgical procedure.

Results: Both men and women had before surgery, compared to normative data, severe impairment in all PROMs with women having inferior status than men. Improvement by surgery was similar in both genders but neither of them reached normative values in quality of life as compared to normative age matched individuals. Women had as a consequence of this one year after surgery more back- and leg pain, higher consumption of analgesics, greater impairment in walking distances and inferior scoring in virtually all registered PROMs than the men (all $p<0.005$). Women were in spite of this as satisfied with the surgical outcome as the men.

Conclusion: Elderly women with LDH surgery report inferior outcome than males, mainly as a result of being referred to surgery with an inferior status but are in spite of this as satisfied with the outcome as the men. We have found no evidence based data in the literature that support that there ought to be such a gender difference and since the reason is unknown, further studies should explore why this gender difference exist and why women are as satisfied as men in spite of reaching inferior PROM values.

SP33

NUCLEOTOMY ALTERS INTERNAL STRAIN DISTRIBUTION OF THE HUMAN LUMBAR INTERVERTEBRAL DISC

Edward Vresilovic,Dawn Elliott,Amy Claeson, Brent Showalter,Alexander Wright,James Gee, Neil Malhotra

University of Delaware Rm 161 Colburn 19716 Newark, United States

INTRODUCTION: Herniation and potential subsequent discectomy result in reduced nucleus pulpousus (NP) pressure. Reduced NP pressure also occurs with disc degeneration. Internal disc strains are an important factor in disc mechanical function, yet it is unclear how reduced NP pressure affects internal strains. We developed a technique to acquire internal disc strains using MRI and image registration and then transform the strains to an anatomical template.1,2

AIM: Quantify internal disc strain following partial nucleotomy on the incision side and uninjured side of discs during compressive axial loading.

MATERIALS AND METHODS: Grade II L3-L4 human cadaveric discs (n=4) were analyzed intact and after a partial nucleotomy that removed 30-50% of the NP through a left posterolateral incision. Compressive loading consisted of a 50 N reference for 3 hours and a 0.7 MPa load for 8 hours. After each relaxation period, the disc was imaged at 0.3 mm isotropic resolution in a 7T MRI scanner. The reference and loaded images were registered to calculate internal annulus fibrosus (AF) strain. Circumferential, radial and axial strains for each individual disc were transformed to the anatomical template. Five regions were defined – anterior, anterolateral, lateral, posterolateral, and posterior. The effect of nucleotomy was compared to intact data using a repeated measure ANOVA.

RESULTS: Disc nucleotomy altered strains on both the incision and uninjured sides from the intact state. Circumferential Strain varied from 3.1 to 5.2% throughout the intact AF with no regional differences and was unaffected by nucleotomy on the uninjured side. Circumferential strain decreased on the incision side ranging from 1.0 to 2.3% and was significantly lower in the posterior region. Radial Strain varied from 6.8% to 7.7% in the intact AF and decreased to approximately 3% in the anterior, anterolateral, lateral and posterolateral AF on both sides. Posterior region radial strains did not decrease post-nucleotomy. Axial Strain varied between -11% and -19% in the intact AF. Following nucleotomy, the strains in the uninjured side increased in magnitude to approximately -24% in the anterior, anterolateral and posterior regions. The incision side exhibited similar strains to intact.

CONCLUSION: The effects of nucleotomy on internal disc strain in discs undergoing axial compression were successfully determined. Overall, radial strain decreased in discs lacking NP material. The uninjured side of the annulus experienced much greater axial compressive strains than either the intact disc or incision side. Tools used in nucleotomy procedures allow easier NP removal from the side opposite the incision; thus, this lack of NP material leaves only the AF to resist the compressive load. Lastly, near the incision site, the large AF defect prevented the AF from supporting hoop stresses, evidenced by the significant drop in circumferential strain from the corresponding intact and uninjured regions.

References: 1Yoder+ J Biomech Eng 2014, 2Showalter+ J Orthop Res, in press

SP34

QUANTIFYING INTERVERTEBRAL DISC INTER-LAMELLAR AND INTER-BUNDLE MECHANICS

Claudio Vergari,Jessica Mansfield,Jude Meakin, Peter Winlove

School of Physics and Astronomy, University of Exeter EX44QL Exeter, United Kingdom

INTRODUCTION: Intervertebral disc is the key element of spine flexibility; the annulus can resist high and diverse mechanical loadings, but can be severely affected by small defects such as needle puncture. Previous studies concentrated their efforts on evaluating lamellar mechanics, but there is still limited understanding of the interlamellar interactions. Cells are present in the interlamellar space and therefore their viability can be strongly affected by this mechanical environment.

AIM: To quantify the intra- and inter-lamellar strain of intervertebral disc outer annulus under tension.

MATERIALS AND METHODS: Twenty-one cow tail intervertebral discs, obtained from a local abattoir, were measured in this study. Discs were carefully dissected in order to expose the outer annulus (OA) and detach both endplates; the nucleus and part of the inner annulus were also excised, leaving a ring of OA. Samples were mounted on a micro-testing device equipped with two flat hooks to load the OA in circumferential tensile strain. A tension test was performed to 5% strain in 1% strain steps. The sample was imaged during this test with a confocal microscope fitted with a 10x/0.4NA air objective (Olympus UPlanS Apo) and an 800-nm mode-locked femto-second Ti:Sapphire laser. This excites second harmonic generation in the sample, thus allowing visualization of collagen fibres in regions of interest (ROI) of approximately 0.5 x 0.4 mm. The displacement field was measured in the ROI, and it was used to measure linear and shear strain within a lamella, between lamellae and between bundles.

RESULTS: Out of 21 samples, seven showed two adjacent lamellae and nine showed well-separated fibre bundles with the same fibre alignment; the remaining five appeared homogeneous. Fibres formed two groups with average inclinations of 23° ± 13° and 19° ± 11° relative to the disc transverse plane. Maximal local circumferential strain (1.7 %) was much smaller than the imposed 5 % strain. Strain was concentrated between lamellae and between bundles, rather than intra lamellar: final intra lamellar linear strain (at 5% macroscopic strain) was 1.2% (range [0.3% – 3.4%]) while intra-lamellar shear was 2.2° [0.3° - 6.6°]. Final linear strain between lamellae was 2.1% [0.2% – 7.6%] while shear was 0.7° [0.2° - 1.6°]. Final linear strain between bundles was 3.7% [0.4% - 9.4%] while shear was 2.9° [0.8° – 10.5°].

CONCLUSION: Strain between lamellae and between bundles was between 1.4 and 3.2 times higher than within the lamella, apart from inter-lamellar shear strain which was lower than intra-lamella. Lower intra lamellar strains could be expected, because lamellae are strong fibre reinforced structures. However, to our knowledge, this is the first time that this behaviour has been quantified by direct observation of the collagen network during loading. These high strain concentrations, with peaks of 10.5° shearing and 7.6% straining between lamellae, suggest that the catastrophic effects of local injury may originate in the inter-lamellar and inter-bundle spaces.

SP35

TUBULAR DISCECTOMY VS CONVENTIONAL MICRODISCECTOMY FOR THE TREATMENT OF LUMBAR DISK HERNIATION – LONG-TERM RESULTS OF RANDOMIZED CONTROLLED TRIAL

Gijsbert Overdevest,Wilco Peul,Ronald Brand, Bart Koes,Ronald Bartels,Wee Fu Tan, Mark Arts
The Hague Medical Center & Leiden University Medical Center 2512VA The Hague, Netherlands

Introduction: The standard surgical procedure for the treatment of lumbar disc herniation is open microdiscectomy. Minimal invasive discectomy with tubular retractors is hypothesized to cause less tissue damage and result in lower blood loss, less postoperative pain and faster recovery. We previously reported our 1- and 2-year results, and found no better outcomes of tubular discectomy compared with open microdiscectomy. No studies to date have reported results with more than 2 years of follow-up. Studies with long-term follow up are required to determine if clinical outcomes are sustained and to assess specific long-term outcomes such as reoperation rate and iatrogenic low back pain due to impaired spinal integrity.

Aim: The aim of this study is to evaluate the 5-year results of tubular discectomy compared with conventional microdiscectomy

Materials and Methods: The study was designed as a double blind randomized controlled trial. 325 patients with a symptomatic lumbar disc herniation were randomly allocated to tubular discectomy (166 patients) or conventional microdiscectomy (159 patients). Repeated standardized follow-up measurements were performed at 2, 4, 6, 8, 12, 26, 38, 52, 78, 104, 156, 208 and 260 weeks after randomization. Main outcomes are the Roland-Morris Disability Questionnaire for Sciatica (RDQ), Visual Analog Scale for leg pain and low-back pain, self-perceived recovery and reoperation incidence. Results: There was no clinically significant difference between tubular discectomy and conventional microdiscectomy regarding the main clinical outcomes at any time point during the 5-years of follow-up. RDQ scores at 5-years were 4.3 (95% CI 3.3 to 5.2) in the tubular discectomy group and 3.4 (95% CI 2.4 to 4.5) in the conventional microdiscectomy group. The mean difference of 0.9 (95% CI -0.6 to 2.2) was not significant. Mean differences for leg pain and back pain were 0.2 (95% CI -5.5 to 6.0) and 0.4 (95% CI -5.9 to 6.7), respectively. 77% of patients allocated to conventional discectomy reported good recovery of symptoms compared with 74% of patients allocated tot tubular discectomy (p=0.79). The reoperation rate was 18% in the tubular discectomy group and 13% in the conventional discectomy group (p=0.29). 5 (3%) patients in the tubular discectomy group underwent 2 reoperations and 2 (1%) underwent 3 reoperations, compared with 2 (1%) patients in the conventional microdiscectomy group who had 2 reoperations (p=0.09). Conclusion: Long-term functional and clinical outcome did not differ between patients allocated to tubular discectomy and conventional microdiscectomy. Reoperations were more frequent in the tubular discectomy group, but the difference was not statistically significant.

SP36

BONE HEALING ACTIVATION EFFECT OF FREEZE-DRIED PLATELET-RICH PLASMA PRESERVED FOR 8 WEEKS

Yasuhiro Shiga,Go Kubota,Sumihisa Orita, Kazuyo Yamauchi,Kazuhide Inage,Jun Sato, Kazuki Fujimoto,Kouki Abe,Hirohito Kanamoto, Masahiro Inoue,Hideyuki Kinoshita,Kazuhisa Takahashi,Seiji Ohtori
Department of Orthopaedic Surgery, Graduate school of Medicine, Chiba University, Chiba, Japan 260-8670, Japan

INTRODUCTION: Platelet-rich plasma (PRP) contains several growth factors that integrally promote tissue healing. We demonstrated bone healing activation effect of fresh PRP and confirmed preservation of growth factors in freeze-dried PRP for 8 weeks. Here, we examine the effect of freeze-dried PRP preserved for 8 weeks on bone healing in vivo.

MATERIAL AND METHODS: Posterolateral fusion (PLF) was performed in 25 8-week-old male Sprague-Dawley rats. They were then divided into 5 groups based on the graft material used for intertransverse process of L4/5 and L5/6: sham (n=5), autogenous bone

(n=5), artificial bone (artificial bone alone: n=5), PRP (artificial bone + freeze-dried PRP: n=5), and BMP (artificial bone+rhBMP2: n=5). A hydroxyapatite-collagen composite was used as an artificial bone, and freeze-dried PRP preserved for 8 weeks after creation was used. The studied items were: (1) bone healing commencing time, (2) amount of bone formation, (3) total trabecular bone area and number of branches at remodeling site, and (4) bone strength. Bone healing on X-ray images 2, 4, 6, and 10 weeks after surgery were evaluated by 3 spinal surgeons. Hematoxylin and eosin (HE) stain was used for histological evaluation of bone healing and amount of bone formation. Moreover, trabecular bone area and branches per unit area at grafted sites were examined. Vertebral body was removed 10 weeks after PLF and a strength test was performed using a 3-point supporting method. Statistical significance was set at $P<0.05$.

RESULTS: Bone healing was confirmed 4 weeks after surgery in 4 of 5 rats in the PRP group; thus, the time needed for bone healing was shorter in the PRP group than in the artificial bone alone group, consistent with the results for the BMP group. The level of bone formation was significantly higher in the PRP and BMP groups. Histologically, bone-remodeling leading to trabecular bone formation was observed at the bone-grafted sites. Particularly, the trabecular bone was thicker and the total area was wider in the autogenous bone group. Thinner and more number of branches were observed in the PRP and BMP groups. The measured strength was highest in the autogenous bone followed by the PRP and BMP groups, with equal strength. Accumulation of inflammatory cells was seen at the bone-remodeling site in 2 rats in the BMP group.

CONCLUSION: Freeze-dried PRP preserved for a relatively long period of time had an equivalent bone healing activation- and bone formation enhancing-effect as that of fresh PRP, similar to that observed for the BMP group. However, the trabecular bone had more number of branches, was thinner, and had lower strength when compared to the autogenous bone. Graft materials must be chosen based on whether early bone healing or high fixation strength is the aim.

SP37

DISCRIMINATION BETWEEN LUMBAR INTRASPINAL STENOSIS AND FORAMINAL STENOSIS USING DIFFUSION TENSOR IMAGING PARAMETERS

Hirohito kanamoto,Yawara Eguchi,Seiji Ohtori, Munetaka Suzuki,Yasuhiro Oikawa,Hajime Yamanaka, Hiroshi Tamai,Tatsuya Kobayashi, Sumihisa Orita,Kazuyo Yamauchi,Miyako Suzuki, Yasuchika Aoki,Atsuya Watanabe, Kazuhisa Takahashi

Chiba University 260-8670,Chiba, Japan

INTRODUCTION: It is important in the selection of surgical procedure to discriminate between lumbar intraspinal stenosis (IS) and foraminal stenosis (FS), but such discrimination is difficult. We examined fractional anisotropy (FA) values and apparent diffusion coefficient (ADC) values of damaged nerves in these stenoses using diffusion tensor imaging (DTI) and determine the diagnostic accuracy of these parameters for the foraminal stenosis such as threshold, sensitivity, and false positive rate.

METHODS: There were 9 cases of IS, 7 cases of FS, and 5 healthy controls. The regions of interest were established in the lumbar intraspinal zone (Iz), nerve root (N), and extraforaminal zone (Ez). The FA and ADC values were measured on the affected and unaffected sides of the nerves. The FA ratio and the ADC ratio were calculated as the affected side/ unaffected side x 100(%).

RESULTS: In the Ez, the FA value was significantly lower in FS than in IS ($p<0.01$). FA ratio was significantly lower in FS than in IS for the Ez ($p < 0.01$). In the Iz, the ADC value was significantly higher in IS than FS ($p<0.01$). ADC ratio was significantly higher in FS than in IS for the N and Ez ($p < 0.05$). For the Ez, ROC analysis of parameters revealed that the FA values showed a higher accuracy for the diagnosis of FS than the ADC values, and the FA value threshold was 0.42 (sensitivity: 85.7%, false positive: 11.1%) and the FA ratio threshold was 83.9% (sensitivity: 85.7%, false positive: 22.2%).

DISCUSSION: Low FA value and high ADC value indicating neuropathy were dependent on the site of nerve compression. In addition, the low FA value in the extraforaminal zone suggested the presence of foraminal stenosis. When the

FA value and FA ratio thresholds were established as 0.42 and 83.9%, respectively, the accuracy was high for the diagnosis of foraminal stenosis. These parameters can help in the discrimination between intraspinal stenosis and foraminal stenosis.

SP38

ONE YEAR RESULTS OF A PROSPECTIVE RANDOMIZED CONTROLLED TRIAL COMPARING MINIMALLY INVASIVE INTERSPINOUS PROCESS DEVICE (IPD) WITH STANDALONE DECOMPRESSIVE SURGERY: NEUROGENIC INTERMITTENT CLAUDICATION EVALUATION (NICE) STUDY

Jean charles Le Huec,Bernhard Meyer
Hopital Pellegrin Tripode CHU Bordeaux 33000 Bordeaux, France

Introduction: The objective of this study is to show that a minimally invasive IPD is safe and non-inferior to SDS with regards to clinical outcomes in patients suffering from Degenerative Lumbar Spinal Stenosis with NIC (Neurogenic Intermittent Claudication), relieved by flexion (NTC00905359).
Materials and Methods: One hundred and sixty three patients enrolled by 19 sites across 10 countries (mean age 65±11 years, 51% female, mean duration of leg symptoms 2.5 years) were randomly assigned to IPD or SDS group and are followed until 24 months. Physical function, symptom severity and patient satisfaction were assessed by Zurich Claudication Questionnaire (ZCQ) at baseline, 14days, 6 weeks, 6 months and 12 months follow-ups.Leg, buttock/groin and back pain were assessed by VAS scores. SF-36v2 questionnaire was used to assess quality of life. In addition, physical examination data was collected at all-time points. Percentage of re-operations at index level at follow-up was determined.
Results: The most common level operated was L4-L5 (85.5%). The IPD group showed lower mean operation time and mean blood loss (respectively, 24±11 minutes and 6±10 ml, $p < 0.001$) compared to the SDS group (70±39 minutes and 157±145 ml, $p < 0.001$). ZCQ physical function mean percentage change from baseline to 12 months decreased for IPD and SDS group (respectively, -32±32%, -37±23%, $p = 0.158$, CI -5, +15). Symptom severity improved in both groups equally (-31±27%, -36±25%, $p = 0.140$, CI -4, +14). No differences in patient satisfaction were observed. VAS leg pain score improved with 59% for the IPD and 66% for the SDS group from baseline to 12 months follow-up. SF-36 v2 physical and mental aggregated score improved equally over time for both treatment groups. At 12 months, 47 SAEs were reported, in 36 patients. Re-operations at index level occurred in 9%of the patients in the IPD group and in 7% in the SDS group. In 6 patients the IPD was explanted.
Conclusion: This study confirms to 2 prior recent RCTs. Implantation of an IPD as well as open decompression achieve both equally satisfying results in patients with NIC. Both seem to be appropriate procedures with an advantage in secondary outcomes for IPDs. So far the significantly higher reoperation rate for IPDs could not be confirmed in this study. However, 24 months results need to be taken into account before final assessment.

SP39

MORPHOLOGY AND CLINICAL IMPORTANCE OF EPIDURAL MEMBRANE AND PERIRADICULAR FIBROUS TISSUE IN LUMBAR SPINAL STENOSIS

Akira Miyauchi,Tadayoshi Sumida,Hideki Manabe, Mayumi Kaneko,Kurando Nakasaki
Saka-Midorii Hospital 731-0103 Hiroshima, Japan

Introduction: Compared to the ligamentum flavum (LF), the morphological features of the epidural membrane (EM) and the periradicular fibrous tissue (PRFT) have been heretofore largely ignored in lumbar spinal stenosis (LSS).
Aim: To elucidate the morphologies and clinical importance of EM and PRFT in LSS based on our microsurgical experience and a review of the literature.
Materials and Methods: Before starting this prospective study, neural compressive EM (c-EM) and PRFT (c-PRFT) were defined as follows: the c-EM is a constriction band or membrane obstructing dural tube expansion, and the c-PRFT is a fibrous tissue that compresses the nerve root and/or disturbs its mobility. Study patients underwent microscopic decompression at L4-5 and the morphologies of each patient's

EM and PRFT were observed and recorded during surgery. For histology, specimens of EM and PRFT, some of which were attached to the LF, were obtained from randomly selected patients and examined.
Results: This study enrolled 134 patients and the mean age at surgery was 68.9 years (66 men and 68 women). The specimens were obtained from 35 patients. EM and PRFT had a wide range of morphologies from a fine strand to a substantial membrane over the dura, some of which showed interesting histological findings: including many small arteries and various degenerative changes such as chondrometaplacia, ganglion-like cyst formation, and hyalinized collagen fibers. Adhesion between the dura and the LF occurred by the interposition of EM and PRFT. At close adhesion sites, the portion of the LF adjacent to the EM attachment showed highly degenerative changes and the EM was observed as part of the LF. The c-EM alone was observed in 4 cases, c-PRFT alone in 32 cases, and both in 3 cases. The c-PRFT was more frequently observed in patients with degenerative spondylolisthesis (% slip ≥ 10%) than in those without listhesis ($P < 0.05$).
Conclusion: Some of EM and PRFT develop into degenerative fibrous tissues with epidural and periradicular scarring during the process of symptomatic LSS development with aging and spondylotic deformans. Such morphological and histological changes can cause dural tear, symptomatic epidural hematoma, and/or inadequate decompression. A sound understanding of their anatomical features can assist in successful decompression for LSS, especially in a limited field afforded by minimally invasive decompression.

SP40

THE BRANCHES OF THE LUMBAR ARTERY RUNNING VERTICALLY ON THE INTERVERTEBRAL DISC OF THE LOWER LUMBAR SPINE: AN ANATOMICAL STUDY

Hidetoshi Nojiri,Kei Miyagawa,Samii Banno, Masato Koike,Mamiko Sawa,Yoshiyuki Iwase, Ikkou Sakamoto,Kazuo Kaneko

Dept. of Orthopaedic Surgery, Juntendo Tokyo Koto Geriatric Medical Center Tokyo 136-0075, Japan

INTRODUCTION: The lower lumbar spine is the major pathological site in spine disorders and its surgeries were performed frequently. Recent innovation of the method and technology in the spine surgery field makes anterior spinal approach safely performable. Particularly, anterior spinal fusion through the transpsoas approach, so called MIS-LIF (minimally invasive lateral interbody fusion) or XLIF (extreme lateral interbody fusion), rapidly spreads throughout the world. Although bleeding from the branches of the lumbar artery is one of the complications we would encounter during the transpsoas approach to reach the intervertebral disc, there are few published articles regarding a morphological relationship between the branches of the lumbar artery and the intervertebral disc.
AIM: In this study, we demonstrate morphology of the branches of the lumbar artery at the lateral side of the intervertebral disc, and emphasize its clinical importance.
MATERIALS AND METHODS: Eighty-eight lumbar arteries at the 3rd and 4th lumbar vertebrae bilaterally in twenty-two formalin-fixed cadavers were studied. To identify each lumbar artery from the vertebra through the vertebral foramen, lumbar spines were divided into right and left at the midline of the vertebral bodies and placed in the lateral position. The 3rd and 4th lumbar arteries at the L3 and L4 levels were exposed by careful removal of psoas muscle and fat tissues. The branches of the lumbar artery crossing the lateral side of the intervertebral discs, including muscular branches, anastomotic branches and radicular branches, were observed. Furthermore, iliolumbar artery running upward on the L4/5 intervertebral disc was also identified. The capillary branches and muscular branches distributed into the psoas muscle shortly after bifurcation were excluded. Presence of the branches crossing vertically on the intervertebral discs was evaluated.
RESULTS: Three muscular branches having a lum-en structure longer than 2 cm were crossing vertically on the middle one-third part of the intervertebral disc in all eighty-eight sites (3.4%, Figure 1). Thirteen anastomotic branches flowing into the caudal adjacent foramen or connecting with the iliolumbar arteries were running downward on the posterior one-third part of the intervertebral disc (14.8%, Figure

2a). There were two iliolumbar arteries running upward along the L4 spinal nerve on the L4/5 intervertebral disc in eighty-eight subjects (2.3%, Figure 2b). Next, the radicular branches derived from the lumbar artery were seen in 73.9% subjects (65/88 subjects). They run downward either through the posterior one-third part of the intervertebral disc or at an extraforaminal site behind the anterior edge of the spinal nerve. The former pattern was found in 27.7% subjects (18/65 branches, Figure 3a) and the latter was in 72.3% subjects (47/65 branches, Figure 3b). These results concluded that the branches of arteries were crossing vertically on the posterior one-third part of the intervertebral discs in approximately 30% subjects.

CONCLUSION: This study instructs us that a procedure for the contralateral disc release through the disc space should be done carefully. Furthermore posterior disc penetration, posterior cage placement and oblique cage insertion would be one of the risk factors not only for neurological complications due to spinal nerve injuries but also for vascular complications.

SP41

NOVEL USE OF ACCELEROMETRY DATA TO DEVELOP PHENOTYPES OF FREE-LIVING PHYSICAL ACTIVITY (PERFORMANCE) AND DIFFERENTIATE BETWEEN KNEE OSTEOARTHRITIS, LUMBAR SPINAL STENOSIS, AND HEALTHY POPULATIONS

Christy Tomkins-Lane,Justin Norden,Aman Sinha,Richard Hu,Matthew Smuck

Mount Royal University Calgary, T3E 6K6, Canada

Introduction: Musculoskeletal disorders are associated with significant mobility limitations. In particular, lumbar spinal stenosis (LSS) and knee osteoarthritis (OA) are two leading causes of disability. There is a clear need for new personalized therapies aimed at increasing function and mobility in these populations, but there is a lack of objective measures. The identification and implementation of new objective and quantifiable measures of function would improve diagnosis and evaluation of treatment effects in OA and LSS, and it would help identify disease-specific interventions.

Aim: The goal of this study was to apply novel techniques designed for analyzing accelerometry data in populations with musculoskeletal pain to 1) identify characteristics (phenotypes) of free-living physical activity (performance) that are unique to individuals with OA and LSS, and 2) determine the best methods for differentiating between the conditions.

Materials and Methods: All analyses were conducted using existing datasets, including: the Osteoarthritis Initiative 48-month data (OAI), the National Health and Nutrition Examination Survey (NHANES) 2003-4 data, and the Lumbar Spinal Stenosis Accelerometry Database (LSSAD). In order to characterize the accelerometry signals of OA, LSS and NHANES, we examined the data using 1) standard intervals for counts/minute from Freedson et al., and 2) the Physical Performance (PP) analysis designed by our group specifically to interrogate data from mobility-limited pain populations. We evaluated the significance of each accelerometry feature alone in discriminating between the three groups (OA, LSS, NHANES). Then, we determined which set of features together best classifies individuals between the groups.

Results: All Freedson and Physical Performance (PP) intervals discriminated between groups ($p<0.05$ after accounting for multiple hypothesis testing) except for the following intervals: Freedson moderate, Freedson heavy, and PP moderate-heavy for LSSAD vs. NHANES, and Freedson heavy for LSSAD vs. OA. Given age and gender, classification rates were 80% accurate (pairwise) between diseases and pain-free populations (OA vs. NHANES and LSS vs. NHANES). The most important features to distinguish between groups corresponded to sedentary and light activity. On the other hand, the subtler classification between diseased populations (OA vs. LSS) was 72% accurate, with moderate activity as the prominent distinguishing feature.

Conclusions: We show how it is possible to derive new clinical insights from accelerometry data. Namely, we have developed a novel set of features that characterize movement patterns in people with OA and LSS. Many of these features were found to be statistically significant in

discriminating between disease populations, and between disease populations and matched healthy controls. Furthermore, our approach determines a key set of discriminatory features, resulting in a framework for classifying musculoskeletal diseases. These new quantita-tive phenotypes for OA and LSS provide a more comprehensive method for analysis of free-living physical activity (performance), and provide the groundwork for more personalized approaches to improving function.

SP42

COMPREHENSIVE NON-SURGICAL TREATMENTS DECREASE THE NEED FOR SPINE SURGERY IN PATIENTS WITH DEGENERATIVE SPONDYLOLISTHESIS

Sibel Demir-Deviren,Hemra Cil,Emel Ece Ozcan-Eksi, Bobby Tay,Shane Burch,Sigurd Berven
University of California San Francisco MU 320W 94143 San Francisco, United States

Introduction: Even though non-surgical treatments were reported to be less effective than surgery in patients with degenerative spondylolisthesis (DS), none of those studies used comprehensive non-surgical treatment including utilization of non-surgical treatments integrated with each other. Simotas et al. reported successful results in a case series of 49 patients with spinal canal stenosis with comprehensive non-surgical treatment including utilization of oral analgesics, epidural steroid injections and exercise programs all together. It has also been shown that the choice of center could affect the clinical outcomes in patients with DS as a possible result of the physician's experience, approach, and preferences. Non-surgical treatment is still the best first line treatment in patients with DS. We hypothesize that utilization of transforaminal epidural steroid injections (TFE) and/or pain control with medications for acute pain and supporting this less painful period with a comprehensive exercise program is an effective treatment that decreases the need for spine surgery in patients with DS.

Aim: To assess the effectiveness of comprehensive nonsurgical treatments (CNT) in patients with DS.

Materials and Methods: We evaluated patients who underwent CNT for DS at the UCSF Spine Center from 2009 to 2014 using our spine database. We excluded patients with scoliosis, previous spine surgery, and grade 3-4 spondylolisthesis. CNT defined as utilization of multiple non-surgical treatments integrated with each other including oral medications, patient education, bilateral TFEs at the level of DS, and a 6-8 week exercise program initiated in 2-3 days following TFE with home exercise program. We recorded patients' age, gender, comorbidity score, smoking status, duration of CNT, medication use, facet joint widening on T2-weighted axial lumbar spine MRI, and translation on flexion- extension lateral lumbar spine X-rays.

Results: Only 17% of patients with DS chose to have surgery after receiving CNT. Patients who chose to have surgery (female: 16; male: 13) and those who chose to have nonsurgical treatments (female: 104; male: 38) were similar in age, comorbidity scores and follow-up duration (69.49±10.57 years; 1080.74±813.20 days; $p>0.050$). The nonsurgical group had greater pain relief for a longer period of time after bilateral TFEs when compared to the surgical group (76.02±24.18% vs 52.93±34.29%; 1558.95±223.14 vs 26.62±22.82 days $p=0.001$). Opioid use was significantly higher in the surgical group when compared to the non-surgical group. The groups were similar in neuropathic pain medication usage.

Conclusion: CNT should be considered as the first line treatment for patients with DS as it may prevent the need for future surgery. We recommend consideration of surgery earlier instead of trying non-surgical treatments in patients who get less than 50% relief from TFE less than a month since those are the patients who chose to have surgery. We also recommend utilization of CNT prior to considering surgery in patients with DS.

SP43

DECOMPRESSION WITH OR WITHOUT CONCOMITANT FUSION FOR PATIENTS SUFFERING FROM LUMBAR STENOSIS IN COMBINATION WITH DEGENERATIVE SPONDYLOLISTHESIS

Manon Dijkerman,Gijs Overdevest,Carmen Vleggeert-Lankamp

Leiden University Medical Centre 2312 JR Leiden, Netherlands

Introduction: Decompression with concomitant fusion has become the standard procedure for patients with degenerative spondylolisthesis with neurogenic claudication in many clinics. However, decompression alone is still a commonly used technique, which may lead to equally successful clinical outcomes.
Aim: The primary objective of this review is to compare the outcome after decompression with and without concomitant fusion in patients with neurogenic claudication and degenerative spondylolisthesis.
Methods: PubMed, Embase, CENTRAL, Cochrane, Web of Science, CINAHL and Academic Search Premier were searched. Adult patients suffering from neurogenic claudication with degenerative spondylolisthesis who received decompression with or without concomitant fusion were included. Description of clinical outcome for both intervention groups separately was a prerequisite for inclusion. Sample size had to be at least 20 patients and follow-up had to be at least 2 months. Two researchers carried out the selection process and risk of bias assessment independently. Risk of bias was assessed using an adapted version of the Cowley checklist for non-RCTs. Results: Eight studies were included in the analysis involving 1974 patients in total (mean age between 62 and 69 years). Selection and attrition bias existed in all studies. In the majority of articles and patients, the clinical outcome of both patient groups was comparable, and therefore the least invasive and costly procedure, being decompression alone, is preferred. However, all studies were retrospective and no information is available on the considerations of the treating surgeon when to add a spondylodesis.
Conclusion: Literature gives no evidence that adding a spondylodesis to a decompression in patients with neurogenic claudication with degenerative spondylolisthesis gives a better clinical outcome. However, it may be that the treating surgeons are adequate in predicting postoperative instability problems, which led them to add a spondylodesis. In general, decompression alone in the described patient group is a safe and adequate surgical intervention.

SP44

THE IMPACT OF FLAT BACK ON PATIENTS WITH PERSISTENT LOW BACK PAIN AFTER SPINAL FUSION (SHORT SEG. VS LONG SEG.)

KENJI ENDO,Hidekazu Suzuki,Hirosuke Nishimura, Yuji Matsuoka,Hidetoshi Tanaka, Takaaki Shishido,Kengo Yamamoto
Tokyo Medical University Shinjuku-ku, Tokyo 160-0023, Japan

Introduction: Postoperative spino-pelvic malalignment in sagittal plane causes persistent chronic low back pain and gait disorder in patients with lack of lumbar lordosis, hip extension disorder, and gravity imbalance. The purpose of this study was to analyse sagittal spinopelvic alignment and to understand the relationship between low back pain and the flat back deformity after spinal fusion in thracolumbar segments (short vs long segment fusion).
Object and method: Two hundreds ninety five patients (ave.72 y.o.) who passes after two years or more from the operation. We measured their spino-pelivc sagittal alignment before and after the operation, and divided into two groups. The group of low back pain was six and more than at VAS score (LBP: 51 patients). VAS score of the smaller low back pain group was less than six (Less-LBP; 241 patients). Those patients were also divided into the group of long segments fusion (long group: 3 or more segments) and short segment fusion (short group; one or two segments). We measured SVA, lumbar lordotic angle(LL) , pelvic til (P) , sacral slope(SS) and PI, then evaluated sagittal imbalance (SI) by using the SRS Schwab classification (PI-LL> 20 degrees, SVA>95mm, PT>30 degree).
Results: In LBP, the parameters of spino-pelvic sagittal alignment of short group and long group were as follows; SVA 73.4/80.7(mm) TK 28.8/20.4(°), LL 32.8/12.6(°), PT 27.3/32.8(°) and PI-LL 20.7/43.9 (°). In Less-LBP, the results of short and long groups were SVA 44.1/72.8(mm), TK 27.3/26.2(°), LL 36.6/24.2(°) , PT 23.0/27.9(°) , PI-LL 14.7/18.8 (°) respectively. The LBP showed significant large SVA, PI-LL and large PT.

Conclusion: In LBP, the postoperative sagittal spinal alignment was shown as a different character between the short fusion and the long fusion. The long fusion accompanied with flat back (PI-LL>20°) while the short fusion accompanied with less flat back but had large SVA and TK. In case of the short fusion, thoraco-lumbar alignment should be concerned. The cause of postoperative low back pain is known as multifactorial factors, however, our results confirmed SI due to flat back and posterior rotated pelvis was an important element. When performing long fusion, optimal LL should be considered based on the concept that PI would influence a suitable inclination of pelvis and prevent the flat back (forward inclination of trunk).

SP45

CT GRAFT BONE DENSITOMETRY AS A PREDICTOR OF FUSION STATUS IN POSTERIOR LUMBAR INTERBODY FUSION AND ITS CLINICAL SIGNIFICANCE

Kimihiko Sawakami,Takui Ito,Ikuko Takahashi, Seiichi Ishikawa

Niigata City General Hospital 950-1197 Niigata City, Japan

Introduction: Posterior lumbar interbody fusion (PLIF) has been established as an operative procedure for degenerative disease, but its clinical significance in terms of achieving fusion remains unclear. Possible reasons for this include the lack of an established reliable fusion assessment method and the fact that clinical symptom assessments primarily consist of physician-based indices.

Aim: To investigate the achievement of bone fusion in PLIF by quan-titatively assessing the graft bone fusion process via computed tomography (CT), and to assess clinical out-comes from the patient's perspective by using the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ).

Materials and Methods: Forty-four patients who underwent PLIF at a single level with a minimum two-year follow-up were prospectively enrolled. CT was used to assess interbody fusion immediately after surgery and at 3, 6, 12, 18, and 24 months postoperatively. Based on the images of the cage centers in 1-mm thick sagittal multiplanar reconstruction images, we assessed the clear zones surrounding the cages, the locked pseudarthrosis of the bone grafts in the cages, and the CT values for the grafts in the cages. The grafts were divided into three regions (cranial, intermediate, and caudal), with regions of interest (ROI) established for each; CT values (Hounsfield Units) were calculated for each region. CT values at 12 months after surgery were used to divide patients into those with CT values < 70% in any region in the cage (R group) and those with CT values ≥ 70% in all regions (NR group); JOABPEQ scores and Visual Analogue Scale (VAS) before surgery and at 24 months after surgery were then compared between the two groups.

Results: The bone grafts inside the cages had reduced CT values in the regions in contact with the graft bed. The R and NR groups comprised 27 and 17 patients, respectively. No significant differences were observed between the groups in demographic data. Patients who demonstrated neither a clear zone nor locked pseudarthrosis were considered to have achieved fusion. The fusion rates at 24 months were 96% in the R group versus 35% in the NR group ($p < 0.0001$). Low back pain, lumbar function, and walking ability at 24 months were significantly lower in the NR group ($p = 0.0250$, $p = 0.0339$, and $p = 0.0468$, respectively). No significant differences were observed in the VAS scores between the groups for low back or lower limb pain, either before or after surgery.

Conclusion: Reduced CT values in a bone graft indicate the beginning of remodeling, a process that is necessary to achieve fusion. A longitudinal analysis demonstrated that assessing CT values at 12 months yields highly accurate predictions of fusion. The achievement of fusion in PLIF is an important factor in regaining quality of life after surgery.

SP46

ANATOMICAL ANALYSIS OF THE LUMBAR SEGMENTAL ARTERY IN THE OBLIQUE LATERAL INTERBODY FUSION APPROACH

Sumihisa Orita,Kazuhide Inage,Jun Sato,Kazuki Fujimoto,Yasuhiro Shiga,Hirohito Kanamoto, Koki Abe,Kazuyo Yamauchi,Kazuhisa Takahashi, Seiji Ohtori

Dept. of Orthopaedic surgery, Graduate school of Medicine, Chiba University Chiba, 260-8670, Japan

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

Aim: To analyze the anatomical features of lumbar segmental arteries using magnetic resonance (MR) imaging.

Materials and Methods: We reviewed 272 MR images of the lumbar spine. In the sagittal MR images, the intersection of one-third of the anterior and median lines of the IVD was considered the center of the OLIF retractor. According to the size of the OLIF retractor, a circular area, with its center set at the anterior portion of IVD, and a 20-mm diameter was considered the surgical area. Cephalad/caudal distances from the center and branch angles of segmental arteries to the longitudinal axes of the aorta were measured to determine if segmental arteries ran into the surgical area. Statistical significance was set at $P < 0.05$.

Results: In the 272 cases, about 80% of caudal segmental arteries were involved in the assumed surgical area, and significantly more at L4 and L5 levels. Branch angles were observed as significantly sharp (<90°) at the L1-3 arteries and significantly dull (≥90°) at the L4-5 arteries. Two percent of L4 and L5 arteries ran directly across the IVDs.

Conclusions: Segmental arteries can be involved in the surgical field for OLIF, especially the L4 and L5 arteries, which can directly run across IVDs.

SP47

EFFECT OF SPINOPELVIC ALIGNMENT ON ADJACENT SEGMENT DISEASE AFTER MULTI-LEVEL LUMBAR FUSION: RISK FACTOR ANALYSIS

Yuichiro Hisada,Masahiro Kanayama,Fumihiro Oha,Yukitoshi Shimamura,Kei Kuroki,Kahoru Tashiro,Yuki Suzuki,Tomoyuki Hashimoto, Norimasa Iwasaki

Spinal center, Hakodate Central General Hospital 040-8585 Hakodate, Japan

(Aim) The purpose of this study is to investigate the effect of spinopelvic alignment on adjacent segment disease (ASD) after multi-segmental lumbar fusion.

(Material & Method) A total of 133 consecutive patients who underwent a multi-level posterior lumbar interbody fusion (PLIF)/ transforaminal lumbar interbody fusion (TLIF) for degenerative lumbar pathologies from 2008 to 2013 were reviewed retrospectively. They were 52 males and 79 females with a mean age of 71 years. Mean follow-up was 49 months. Spinal trauma, infection, spinal tumor, and other distractive disease were not included in this cohort. In this study, ASD was defined as adjacent segment pathologies that required additional surgeries. The patients were divided into ASD group and non-ASD group (control group). The following parameters were compared between the two groups: pelvic Incidence (PI), lumbar lordosis (LL), pelvic tilt (PT), sacral slope (SS), anterior deviation of sagittal vertical axis (SVA), and fusion-level lordosis. Risk factors for ASD were determined using logistic regression analysis.

(Results) Nine patients (6.9%) required additional surgery for ASD. No statistical differences were observed between the ASD group (n=9) and the control group (n=124) regarding PI (54 vs 51 degrees), LL (35 vs 36 degrees), PT (26 vs 24 degrees), SS (28 vs 27 degrees), and fusion-level lordosis (23 vs 22 degrees). SVA was significantly greater in the ASD group than the control group (79 vs 40 mm, $p = 0.001$). A logistic regression analysis showed that SVA was a significant risk factor for ASD (odds ratio=1.035).

(Conclusion) Risk factors for ASD have been reported in the literatures, but there were few

studies investigating the effect of spinopelvic alignment on adjacent segment disease after multi-segmental lumber fusion. The current results suggested that larger anterior deviation of SVA increases the risk for ASD. Achieving an optimal global spinal alignment might lead to lowering ASD risk in a multi-level lumbar fusion.

SP48

DEGENERATIVE SPONDYLOLISTHESIS (DS)-AN OPPORTUNITY TO IMPLEMENT VALUE BASED SPINE CARE.

Arvind Kulkarni,Shumayou Dutta
Bombay Hospital & Medical Research Centre Dosti Acres Wadala East 400020+Mumbai, India

Introduction: Herkowitz's study reported improved outcomes in DS patients when treated with Decompression and Fusion(DF) as compared to decompression(D) alone.Since then, symptomatic DS has been treated as a homogenous condition requiring fusion for best results. However, a select group of symptomatic DS patients exists where an isolated stand-alone decompression may be adequate.
Aim: To study the outcome of microscopic decompression alone in a subgroup of patients suffering from symptomatic stable DS and the resultant economic implications.
Methods: Single institution, single surgeon. Criteria developed and DS classified into 2 groups, stable and unstable. Surgical intervention in the form of decompression(D) only for stable DS while decompression and instrumented fusion(DF) for unstable DS. Clinico-radiological parameters used to assess patients pre and post op were VASback/leg, ODI, Standing dynamic-radiographs and MRI. A perioperative costs analysis done taking into account hospital cost (operative time, duration of hospital stay, cost of medications, implant cost) and leave from work for both groups. Patients where followed up at 3 months, 6 months and yearly there-after with a minimum follow up period of 3 years.

Results: As tabulated.

Serial-No	D(Decompression)	DF(Decompression and fusion)
Number	41	273,MIS-TLIF-96,Open-177
Sex	F:M=30:11	F:M=152:121
ODI(Pre op/Post Op)	59.42/23.14(P<0.001)	74.62/26.66(P<0.001)
$VAS^{leg/back}$	7.4±1.2to3.2±0.8(leg)	8.2±0.66to2.8±1.329(leg) 6.6±2.7to3.01±0.45(back)
Complication	Dural-Tear-1 Revision to fusion–2	SSI-3
Operative time	74min±12	185mins±22
Blood loss	69ml±12.1	227ml±28.33
Ambulation	Day0	Day2
AverageHospitalStay	1.4days±0.99	5.84±2.29days
Leave from work	12days±3.14	23 days±7.22

Cost-analysis:

Srl-No	Decompression	Decompression and Fusion
Hospital-cost	1,30,000±5488	2,25,000/3,00,000(Indian/Foreign Implants)±8214
Analgesia requirement(after discharge)	10±4	260±107
No of days of leave from work.	40,000±10,465	76,666±24,064
Physiotherapy sessions	0	5000±455
Total	1,70,000±6,604	3,06,926/3,81,926±8210

Conclusion: A subgroup of DS exists where-in surgical intervention in the form of decompression alone gives excellent results. While the clinical results of both group are similar, statistically significant difference exists in the return to activities of daily living and peri-operative costs. In the era of value-added spine care, it is important to identify DS as a heterogenous condition requiring surgical intervention tailored to each patient which has phenomenal economic impact on healthcare.

SP49

LUMBAR DISC DEGENERATION WAS NOT RELATED TO BONE MINERAL DENSITY IN CHINESE POPULATIONS: FACET JOINT DEGENERATION CONFOUNDS THE ASSOCIATION

Yue Wang,Jianjiang Pan,Xiang Tong
Department of Orthopedic Surgery, 1st Hospital of Zhejiang University Hangzhou, ZJ, 571, China, People's Republic of

Introduction: Osteoporosis and intervertebral disc degeneration are common conditions in the lumbar spine. Many studies reported that greater bone mineral density (BMD) was associated with greater degree of disc degeneration, though some others did not observed such a relation. Factors underlying the inconsistency mainly include differences in study populations, measures of BMD and disc degeneration, and adjustment for vertebral hypertrophic changes such as facet joint degeneration, osteophytes, and endplate sclerosis. To date, the association has not been investigated in Chinese population.

Aim: To determine the association between BMD and lumbar disc degeneration in different Chinese populations.

Materials and Methods: From January of 2012 to September of 2015, a total of 484 subjects were included in the current study. Among them, 158 volunteers were samples of general population randomly recruited from a local community (59 male, 99 female, mean age 51 years, range 24-87 years), 161 were subjects who underwent health assessment (117 male, 44 female, mean age 48.8 years, range 31-76 years), and 165 were patients with various lumbar degenerative disorders (30 male, 135 female, mean age 69.9 years, range 47-102 years). All subjects were with lumbar spine magnetic resonance (MR) and spine dual energy x-ray absorptiometry (DXA) studies, and the volunteers had additional femoral neck BMD measurements. On T2-weighted MR images, Pfirrmann score was used to evaluate the degree of disc degeneration and lumbar facet joint degeneration was assessed as none, slight-moderate, and severe. Regression analysis was used to examine the associations between disc degeneration and vertebral and femoral neck BMDs, adjusting for age, gender, body mass index (BMI) and facet joint degeneration.

Results: There was no difference in demographic features between volunteers and those subjects who underwent health assessment, and thus, data were merged for analysis. Greater age ($P<0.01$) and less BMI ($P<0.01$) were associated with less lumbar vertebral and femoral neck BMDs. Greater facet joint degeneration was associated with greater vertebral BMD ($P<0.01$) but not greater femoral neck BMD, adjusting for age, gender and BMI. For the merged general population samples, greater vertebral BMD was statistically significantly associated with greater lumbar disc degeneration ($P<0.05$), adjusting for age, gender and BMI. When facet joint degeneration entered the regression model, however, greater vertebral BMD was associated with greater facet joint degeneration (P0.05). No statistical association was observed between vertebral BMD and lumbar disc degeneration in patients with lumbar degenerative disorders, and between femoral neck BMD and disc degeneration in the general population samples.

Conclusion: BMD may not be a risk factor for disc degeneration in Chinese populations. Facet joint degeneration inflates vertebral BMD measurements and therefore, confounds the association between vertebral BMD and disc degeneration.

SP50

TECHNICAL DIFFERENCES IN MICROSURGICAL, ENDOSCOPIC AND ENDOSCOPICALLY-ASSISTED LUMBAR DISCECTOMIES RESULT IN DIFFERENT COMPLICATIONS BUT DO NOT AFFECT LONG-TERM QOL

Evgenii Belykh,Morgan Giers,Liudmila Bardonova, Mark Preul,Nickolas Theodore, Vadim Byvaltsev

Irkutsk Scientific Center of Surgery and Traumatology 664047, Russia

Introduction: Although endoscopic discectomy is superior to microsurgical discectomy in terms of incision size, postoperative pain, and cosmetic appeal, the effectiveness and indications for endoscopic versus microsurgical discectomy remain active discussion topics. Due to the increasing incidence of discectomies being performed, further assessment of these techniques is needed.

Aim: To perform a comparative analysis of long-term results of microsurgical(MD), endoscopic (ED), and endoscopically assisted(EAD) microsurgical discectomies for patients with lumbar disc herniations.

Patients and Methods: The patient cohort included 131 patients who were enrolled in a prospective, randomized controlled study and 617 patients for whom data were gathered retrospectively. The quality of life was assessed using the Oswestry Disability Index (ODI) and pain severity was analyzed using the VAS for pain at discharge; and at 3, 6, and 12 months postoperatively.

Results: A minimum of 37 patients was needed in each group to achieve 80% statistical power, with $p<.05$ level of significance for detection of minimal clinically significant 10-point difference in ODI score. Microsurgical, endoscopic, and endoscopically assisted microsurgical discectomies were all effective in relieving acute radicular symptoms and improve ODI scores at discharge, 3, 6 and 12 months($p<.01$) without

intergroup differences (p=.08, p=.18, and p=.33 respectively). VAS scores indicated considerable pain relief immediately after surgery (p<.01) and between discharge and the 3 month follow-up(p<.01), remaining low thereafter. Although there was significantly lower pain in the ED group than the EAD and MD groups immediately postopera-tively(p=.03), there was no difference at any later time point (3-months, p=.14; 6-months, p=.92; 12-months, p=.61). During the follow-up period, 31/738 patients(4.2%) had pain reoccurrence due to recurrent herniation at the level of operation and another 31/738(4.2%) had vertebral segment instability. In 30/738 other cases(4.0%) neurological deterioration or pain occurred after a pain-free interval; postoperative fibrosis was likely the cause. Significantly more recurrent herniations occurred after ED(n=16, 7%) than after MD(n=11, 3%) (p=.04). The number of recurrent hernias in the EAD(n=6, 4%) and MD groups tended toward a significant difference, p=.06. In contrast, development of postoperative instability in the operated segment was noted more often in the MD(n=20, 6%) than in the ED(n=5, 2%), p=.03. Deterioration of neurological symptoms due to postoperative fibrosis, occurred in 30 cases without intergroup differences(p=.64).

Conclusion: Our findings indicate that these three surgical techniques are highly effective and have similar clinical results at 1-year follow-up; however, due to the higher rate of herniation recurrence, only certain patients should undergo endoscopic discectomy. The endoscopically assisted discectomy technique allows for minimally invasive surgery while offering enhanced visualization of the anatomy that is hidden from view in microscopic procedures.

Research project was supported by RSF grant, project 15-15-30037.

SP51

HOW RELIABLE ARE THE REPORTED GENETIC ASSOCIATIONS IN DISC DEGENERATION? - THE INFLUENCE OF PHENOTYPES, AGE, POPULATION SIZE AND INCLUSION SEQUENCE IN 809 PATIENTS

S Rajasekaran,Rishi Kanna,Ranjani Reddy,N Senthil, KMC Cheung,Danny Chan,Ajoy Shetty

Ganga hospital Mettupalayam road Coimbatore 641043, India

INTRODUCTION: Genetic associations with disc degeneration have shown high inconsistency, generally attributed to hereditary factors and ethnic variations. However the effect of different phenotypes, size of the study population, age of the cohort etc have not been documented clearly.

AIM: Prospective genetic association study was conducted to document the variations in the genetic associations, when different MRI phenotypes, age stratification, cohort size and sequence of cohort inclusion are varied in the same study population.

Methods: 71 SNPs of 41 candidate genes were correlated to six MRI markers of disc degeneration (annular tears, Pfirmann's grading, Schmorl's nodes, Modic changes, Total Endplate Damage score and disc bulge) in 809 patients with back pain and/or sciatica. In the same study group, the correlations were then re-tested for different age groups, different sample size and sequence of subject inclusion (first 404 and the second 405) and the differences documented.

RESULTS: The mean age of population (M: 455, F: 354) was 36.7 ± 10.8 years. Different genetic associations were found with different phenotypes - Disc bulge with three SNPs of CILP; Annular tears with rs2249350 of ADAMTS5 and rs11247361 IGF1R; Modic changes with VDR and MMP20; Pfirmann's grading with three SNPs of MMP20 and Schmorl's node with SNPs of CALM1 and FN1 and none with TEPS. Subgroup analysis based on three age groups and dividing the total population into two groups also completely changed the associations for all the six radiographic parameters.

CONCLUSIONS: In the same study population, SNP associations completely change with different phenotypes. Variations in age, inclusion sequence and sample size resulted in change of genetic associations. Our study questions the validity of previous studies and demand an urgent need for standardizing the description of disc degeneration, phenotype selection, study sample size, age and other variables in future studies.

SP52

THE PREVENTIVE EFFECT OF DYNAMIC STABILIZATION AGAINST ADJACENT SEGMENT DEGEN-ERATION AFTER POSTERIOR INTERBODY FUSION

Naohiro Tachibana,Naohiro Kawamura,Shigeru Masuyama,Yujiro Hirao,Hiroshi Maruyama, Masaaki Iizuka,Takaki Shimizu,Yukimasa Yamato, Junichi Kunogi

Japanese Red Cross Medical Center Shibuya-ku 150-8935, Japan

Introduction: Hybrid procedures such as dynamic stabilization for adjacent segment in addition to spinal fusion have been developed for reduction of the mechanical stress and prevention of adjacent segment pathology (ASP). However, few reports are available on hybrid procedures and their efficacy is still controversial.

Aim: To investigate the effects of dynamic stabilization with sublaminar taping (ST) on the proximal segment adjacent to posterior lumbar interbody fusion (PLIF).

Materials and Methods: Of 106 patients who underwent L4/5 PLIF between August 2006 and September 2012, 76 patients with minimum 2-year follow-up were included. Fifty three patients underwent L4/5 PLIF with hybrid procedure using ST on L3 lamina (U group), and 23 patients underwent conventional L4/5 PLIF (C group). The main evaluated outcomes were the adjacent segment degeneration (ASDeg), which was determined by measurements of radiograph, CT, and MRI, and the adjacent segment disease (ASDis) evaluated on medical records. Results: The incidence of ASDeg at L3/4 segment of U group (3.7%) was significantly less than that of C group (30.4%) ($p= 0.003$), although there were no significant differences at L2/3 (U group, 7.5%; C group, 13%) or L5/S1 segment (U group, 5.7%; C group, 8.7%). On the other hand, there was no significant difference between 2 groups in the incidence of ASDis at any segments (U group, 1.9-3.7%; C group, 4.3-8.7%), and no patient underwent re-operation. Bi-variable and multi-variable logistic regression analyses for L3/4 segment ASDeg revealed that the difference of surgical procedure was the only significant factor.

Discussion: The present study showed that hybrid procedure using ST on L3 lamina in L4/5 PLIF significantly reduced the incidence of L3/4 ASDeg as compared with conventional L4/5 PLIF. We speculate that ST on L3 lamina effectively stabilized the L3/4 segment reducing the compressive load to the disc and rotatory stress to the facet joint. Although installation of ST on L3 lamina etailed isolation of L3 spinous process and fenestration at L2/3 inter-laminar space which could weaken the L2/3 segment, no adverse effect was observed in the segment. In addition, longer instrumentation of U group did not enhance L5/S1 degeneration. From the above results this stabilizing system seems to be beneficial in case we need additional decompression at the adjacent level in PLIF procedure.

Conclusion: The present study showed that L4/5 PLIF with hybrid procedure using ST on L3 lamina significantly reduced the incidence of L3/4 ASDeg as compared with conventional L4/5 PLIF without compromising L2/3 segment. Although further studies and longer follow up are necessary, hybrid procedure might be effective for preventing ASP.

SP53

DO DEGENERATED HUMAN LUMBAR SPINE SEGMENTS EXHIBIT BIPHASIC VISCOELASTIC PROPERTIES?

John Costi,Dhara Amin,Isaac Lawless,Dana Sommerfeld, Richard Stanley,Boyin Ding

Flinders University 5001 Adelaide, Australia

Introduction: The intervertebral disc is a complex, composite structure that possesses both elastic and energy absorbing properties, which may result from interactions between the solid phase and fluid flow (poroelasticity), as well as from intrinsic viscoelasticity in the solid phase itself. The relative contributions of the solid and fluid phases in each of six degree of freedom (DOF) loading directions of degenerated discs has not been studied. Degenerated discs generally do not have a hydrated functional nucleus, and we hypothesized that the poroelastic behavior of degenerated discs would play a minor role compared to the solid-phase intrinsic viscoelastic behavior of the disc tissue.

Aim: To determine the 6DOF frequency-dependent changes in disc stiffness and phase angle and compare the poroelastic and viscoelastic behavior of degenerated discs.
Materials and Methods: Fifteen intact human lumbar segments were dissected from human lumbar spines (mean (SD) age 76 (11) years, Thompson grades 3 (N=6), 4 (N=6), 5 (N=3)). Each segment was tested along 6DOF directions under hybrid position-load control at four dynamic loading frequencies (0.001 Hz, 0.01 Hz, 0.1 Hz and 1 Hz) while subjected to a physiological preload, hydration and body temperature conditions in a hexapod robot. Non-destructive cycle amplitudes were 1.1 MPa compression, 0.6 mm shear, 3° lateral bending, 5° flexion, 2° extension and 2° axial rotation. Average stiffness over the entire final load-unload cycle and phase angle over all loading cycles was calculated. DOFs were divided into two groups: the poroelastic (poro) group expected to favor fluid flow during loading (compression, bending, flexion/ extension), and the viscoelastic (visco) group expected to exhibit primarily intrinsic (solid phase) viscoelastic behavior (shears and axial rotation). Stiffnesses and phase angles for each DOF were normalized and expressed as %change relative to 0.001 Hz for the other frequencies. Separate repeated measures ANOVAs were performed on the within-subjects effects of frequency and between-subjects effects of the poro and visco groups (poro-visco) and their interactions.
Results: The overall within/between-subjects effects of frequency, frequency x poro-visco and poro-visco were highly significant (p0.05) for stiffness or phase angle. Significant differences between poro-visco groups were observed at 0.1 and1 Hz for stiffness and phase angle ($p<0.05$). Overall, the visco DOFs exhibited larger %changes in stiffness and phase angle at 1 Hz relative to 0.001 Hz, compared to the poro DOFs ($p<0.05$).
Conclusion: Stiffness increased and phase angle decreased with increasing loading frequency for both poro and visco groups, where the effects were more pronounced at 1 Hz compared to the slower frequencies. Strong biphasic differences occurred at 1 Hz as viscoelastic effects were significantly greater than poroelastic effects for both stiffness and phase angle, which could be attributed to a desiccated nucleus.

SP54

THE ANTI-ANGIOGENIC CAPACITY OF RABBIT NOTOCHORDAL CELLS IN THE PROLIFERATION OF HUMAN ENDOTHELIAL CELLS UNDER HYPOXIA

Woo-Keun Kwon,Hong-Joo Moon,Youn-Kwan Park,Joo-Han Kim

Department of Neurosurgery, Korea University Guro Hospital, Korea University College of Medicine, Seoul, Korea 08308 Seoul, Korea, South

Chronic low back pain accompanied with degenerative disc diseases (DDD) can be associated with the ingrowth of blood vessels and nerves into intervertebral discs (IVDs). The notochordal cell (NC) is known to pattern the IVD during development and is a possible key cell that might lead to the regeneration of degenerative IVDs. However, it has not been known whether NCs would have activity for inhibition of symptomatic DDD development. In this study, we hypothesized that NCs might have potentials to inhibit neovascularization, pathologic hallmark of symptomatic DDD, by interaction with endothelial cells (ECs) under hypoxia, which is real environment of IVD. Human nucleus polposus (NP) cells were isolated from degenerated human surgical specimens, and then were cultured under two different oxygen concentrations; normoxia (21%) and hypoxia (3%). The conditioned media of NP cultures were assayed for vascular endothelial growth factor (VEGF), vascular cell adhesion molecule (VCAM) and Interleukin-8 (IL-8) by ELISA. Human microvascular endothelial cells (ECs) from cell line were cultured in the NP conditioned media (NPCM) with and without rabbit notochordal cells (rNCs) co-culture, under two different oxygen levels as well. To investigate the ECs actual migration, as an essential step for angiogenesis, wound-healing migration assays of ECs were performed. NP cells significantly produced higher VEGF under hypoxia (212.14±47.97 pg/mL) compared to normoxic condition (172.82±38.68 pg/mL) while VCAM and IL-8 production from NP cells were decreased under hypoxia. Under hypoxia, rNCs significantly

decreased the production of VEGF from NP cells while VCAM and IL-8 production did not show remarkable change after rNCs exposure. ECs cultured in NP significantly enhanced migration activity under hypoxia compared to normoxia, and ECs co-cultured with rNC in NPCM (156.00±17.17 cells) significantly decreased migration activity, compared to ECs in NPCM without rNC co-culture (200.75±13.47 cells) under hypoxia. The present study investigated the anti-angiogenic effect of rNCs on ECs, and the angiogenic capacity of ECs was significantly inhibited by rNCs under hypoxia. Therefore, our result suggests that rNCs in the juvenile IVD could possibly play a key role in developing an avascular environment by inhibiting vascular growth within the disc, and furthermore it could be a potential promising minimally invasive strategy targeting vascular ingrowth in the symptomatic DDD.

SP55

WHAT DO PATIENTS CONSIDER TO BE AN ACCEPTABLE LEVEL OF SYMPTOMS TO LIVE WITH AFTER SURGERY FOR ADULT SPINAL DEFORMITY?

Anne Mannion,Sarah Wunderlin,Ibrahim Obeid, Ferran Pellise,Joan Bago,Emre Acaroglu, Ahmet Alanay, Francisco Pérez-Grueso, Frank S Kleinstueck

Schulthess Klinik 8008 Zürich, Switzerland

Introduction: A new approach to the interpretation of treatment success comprises the reporting of the percentage of patients whose symptoms have reduced to an acceptable level, i.e., who have reached a satisfactory symptom state.

Aim: We sought to evaluate the acceptable level of symptoms in patients after operative and non-operative treatment for adult spinal deformity (ASD), as measured by the total score of the SRS-22.

Methods: This was a cross-sectional analysis of 12-month outcome data from the database of an international observational study of patients with ASD (European Spine Study Group; ESSG). The following questionnaires were completed at 12 months' follow-up: SRS-22, from which the total score and the sub-domain scores for pain, function, self-image, and mental health were calculated; and the multidimensional Core Outcome Measures Index, containing the symptom-specific well-being (SSWB) item "if you had to spend the rest of your life with the symptoms you have now, how would you feel about it?" (5-point response scale from "very satisfied" to "very dissatisfied"). The answers on the SSWB item 12 months' postoperatively were dichotomised and used as the external criterion in receiver operating characteristics (ROC) analysis to derive the cut-off score for the SRS scores indicating being at least "somewhat satisfied" with the current state. Sensitivity analyses were carried out for various subgroups (age (<50, ≥ 50 yrs), diagnosis (idiopathic vs degenerative)).

Results The data from 559 patients with 12-months' followup (75% followup rate) was available. Overall, 38% reported being at least "somewhat satisfied" with their symptom state (38% for both idiopathic and degenerative groups; 40% for patients 50yrs). The SRS scores corresponding to being in an "acceptable symptom state" were > 3.4 (Se74%, Sp 74%) for self-image, >3.8 for mental health (Se 58%, Sp 74%), > 3.8 for pain (Se 68%, Sp 80%), >4.2 for function (Se 63%, Sp68%) and >3.75 (Se 73%, Sp 75%) for the total score. The ROC area under the curve (AUC) for self-image (0.860) was significantly ($p<0.001$) higher than for the other subdomains (SRS total 0.820; pain, 0.816; mental health, 0.716; function, 0.683), indicating that self-image was the strongest determinant of being in a satisfactory state or not.

Conclusion Many spine interventions can improve the patient's complaints but rarely do they totally eliminate them. Reporting the percentage of patients achieving an SRS score equivalent to the "acceptable state" may represent a more stringent target for denoting surgical success in the treatment of degenerative spinal disorders. For the SRS-22, this value is between 3.4 and 4.2 depending on the specific sub-domain.

SP56

STIFFNESS AFTER PAN-LUMBAR ARTHRODESIS FOR ADULT SPINAL DEFORMITY DOES NOT SIGNIFICANTLY IMPACT PATIENT FUNCTIONAL STATUS OR SATISFACTION

Robert Hart,Jayme Hiratzka,Marie Kane, Virginie Lafage,Eric Klineberg,Christopher Ames, Breton Line,Frank Schwab,Justin Scheer, Shay Bess, D. Kojo Hamilton,Christopher Shaffrey, Greg Mundis,Justin Smith,Douglas Burton, Daniel Sciubba,Vedat Deviren,Oheneba Boach
Oregon Health & Science University 97239 Portland, United States

Introduction: Data suggests that patients undergoing fusion of the entire lumbar spine are at greatest risk of functional limitations from stiffness.

Aim: We sought to determine if stiffness significantly affects function or satisfaction after pan-lumbar arthrodesis in a prospective, multi-center study using the Lumbar Stiffness Disability Index (LSDI).

Materials and methods: The LSDI, Short Form 36 (SF-36), Scoliosis Research Society-22 (SRS-22), and Oswestry Disability Index (ODI) were administered pre-operatively and at 2-year minimum follow-up to 103 adult spinal deformity patients from 11 centers. Patients were separated according to the proximal arthrodesis level; upper thoracic (T2-5) to pelvis (UT-Pelvis) or thoraco-lumbar (T10-T12) to pelvis (TL-Pelvis). Outcome scores were compared using Student's t-test or Tukey-Kramer HSD ANOVA. A regression analysis of final LSDI scores versus SRS-22 Satisfaction scores was performed.

Results: Mean ages, baseline values and final scores of all outcome parameters were statistically equivalent in the 2 groups. Final LSDI scores did not change significantly from baseline in the UT-Pelvis ($p=0.478$) or TL-Pelvis ($p=0.301$) groups. In contrast, highly significant improvements ($p<0.0001$) from baseline were seen in both groups for other health-related quality of life measures. The 2-year SRS-22 Satisfaction scores were statistically equivalent in the 2 groups, and the correlation between final LSDI and Satisfaction scores in the entire cohort was not significant ($R2 = 0.013$, $p=0.146$).

Conclusions: Patients undergoing pan-lumbar arthrodesis for adult spinal deformity did not experience substantial increases in disability due to stiffness of the low back, although they did report significant improvements in other health-related quality of life measures. Further, LSDI scores did not correlate with patient satisfaction. There were no significant differences in stiffness effects whether arthrodesis stopped in the thoracolumbar or upper thoracic regions. We hope these results will be useful to spine surgeons and patients during preoperative planning and discussions.

SP57

THE DARTMOUTH/CONSUMER REPORTS TREATMENT OUTCOMES CALCULATOR FOR SURGICAL AND NONSURGICAL TREATMENT OF DISC HERNIATION, SPINAL STENOSIS AND DEGENERATIVE SPONDYLOLISTHESIS

Tor Tosteson,Jon Lurie,Kristina Mycek,Doris Peters, Susan Schwarz,Wenyan Zhao,Kevin Spratt, Emily Scherer,Loretta Pearson, James Weinstein
Geisel School of Medicine at Dartmouth HB 7927 03756 Lebanon, United States

Introduction: Consideration of surgical treatment for low back pain conditions is an important preference sensitive decision for patients and clinicians. Data from complex longitudinal clinical trials such as the Spine Patient Outcomes Research Trial (SPORT) require careful analysis and interpretation to aid patient decision making. A web-based personalized outcomes prediction calculator was developed for this purpose using SPORT data for three major indications for lumbar spine surgery. The aim was to enable patients and consumers to evaluate personalized evidence in considering treatment options, with results summarized graphically for each treatment goal. Patient and consumers participated in the design process. Web-based studies are currently underway to evaluate the impact of calculator usage on consumer and patient knowledge and decision quality.

Aim: To develop methods and user interfaces for an online calculator to predict physical function (SF-36 PF), sciatica/stenosis pain bothersomeness; and satisfaction with symptoms, sex life, and sleep following surgical or non-operative treatment, given patient-specific baseline prognostic factors.

Materials and Methods: The development process began with extensive analyses establishing predictive models with combined randomized and observational data from the

SPORT trials. Variables were selected from best-fitting models for outcomes at one year based on linear or binary regression models according to penalized variable selection methods using AIC (Akaike) and BIC (Bayesian) information criteria. Two-way interaction terms were included in the selection process. The selected variables then were used in longitudinal models developed for the SPORT main analyses to calibrate parameters for predicting outcomes at 6 weeks, 3 months, 6 months and annually for 8 years following the initiation of treatment. Prediction variances were derived from the models to calculate probabilities of improving, staying the same, or getting worse based on minimal clinically significant differences in physical functioning and pain scores. Interviews with consumers and patients and software experts were conducted to assess needs and evaluate prototype interfaces for usability and effectiveness of data presentations. Interviews and results from a Consumer Reports survey were used to determine which outcomes were of most importance to consumers.
Results: 6,000 subscribers were identified as having considered surgery for lower back related pain using special research questions inserted in Consumer Reports' annual survey. Software was created to embed the final calculator in web-based surveys prior to and following use by consumers and patients. 400 subscribers with the specific conditions studied in SPORT will be selected for participation along with 200 patients and their providers from spine clinics.
Conclusion: The spine treatment outcomes calculator reflects a unique partnership between academic and consumer interest organizations designed with patient and consumer input.

SP58

FULFILLMENT OF EXPECTATIONS TWO YEARS AFTER LUMBAR SPINE SURGERY

Federico Girardi,Carol Mancuso,Frank Cammisa, Andrew Sama,Alexander Hughes, Darren Lebl, roland Duculan
Hospital for Special Surgery New York, United States

Background Context: Patients have multiple expectations of lumbar surgery and fulfillment of expectations is an important but infrequently studied outcome.
Purpose: The objective of this study was to compare patients' preoperatively cited expectations with their postoperative ratings of fulfillment of expectations.
Study Design/Setting: Longitudinal cohort with 2 year follow-up, tertiary spine center
Patient Sample: 366 patients before and 2 years after surgery
Outcome Measures: Hospital for Special Surgery Lumbar Spine Surgery Expectations Survey
Methods: 422 patients preoperatively completed a valid survey measuring amount of improvement expected from lumbar surgery for 20 items addressing symptoms, function, and mental well-being. Function was measured with the modified Oswestry Disability Index (ODI), and psychosocial variables, including depressive symptoms, were measured with valid scales. Two years after surgery patients were asked how much improvement they actually received for items listed in the survey. The proportion of fulfilled expectations was calculated as the sum of improvement received divided by the sum of improvement expected (0%= expectations completely unfulfilled, 100%=expectations completely fulfilled, >100%= expectations surpassed). Additional patient-centered postoperative variables were the ODI and overall satisfaction with the outcome of surgery.
Results: 401 patients were contacted 2.1 years postoperatively (range 1.9-3.1 years). Of these 366 participated in a postop interview to rate fulfillment of expectations (mean age 55 years, 57% men, 78% degenerative conditions). Mean proportion of fulfilled expectations was 66% (range 0%-200%). Greater preoperative expectations were associated with lower proportions of fulfilled expectations postoperatively (p=.002). Other preoperative variables associated with lower proportions of fulfilled expectations were: surgery for a degenerative spine diagnosis [OR 2.8 (1.6-5.0), p=.003]; revision surgery [OR 2.2 (1.4-3.8), p=.006]; more vertebral levels involved [OR 1.5 (1.3-1.8), p<.0001]; more depressive symptoms [OR 2 (1.3-3.10, p=.001]; and not being employed [OR 2.8 (1.8-4.5), p<.0001]. Postoperative variables associated with lower proportions of fulfilled expectations were: less pre-to-postoperative

improvement in ODI scores [OR 9 (5-17), p<.0001]; having a postoperative fracture or infection [OR 4.2 (1.5-11.9), p=.007]; and having a subsequent repeat surgery [OR 3.6 (2.1-6.5), p<.0001]. There were no differences based on age, sex, marital status, use of narcotics, and whether a fusion was performed. In multivariable analysis, greater preoperative expectations, not being employed, revision surgery, more levels involved, less improvement in ODI score, and having a subsequent repeat surgery remained associated with lower proportions of fulfilled expectations (p≤.03 for all variables). Overall 73% of patients were satisfied with the results of surgery; the proportion of expectations fulfilled was highly, but not completely, associated with satisfaction (r=.72).
Conclusions: Fulfillment of expectations varied widely two years after lumbar surgery. Patients with greater preoperative expectations were more likely to have lower proportions of fulfilled expectations postoperatively. Both pre- and postoperative functional and surgical variables were associated with fulfillment of expectations. Fulfillment of expectations and satisfaction were associated but remained distinct patient-centered outcomes.
Category: Allied Health
Keywords: expectations, longitudinal, lumbar

SP59

ANALYSIS OF HOSPITAL LENGTH OF STAY FOLLOWING LUMBAR ANTERIOR/POSTERIOR COMBINED FUSION: IS THERE A DISADVANTAGE ASSOCIATED WITH SHORTER STAYS?

Richard Guyer,Emily Putney,Donna Ohnmeiss, Jack Zigler,Scott Blumenthal
Texas Back Institute Research Foundation Plano, United States

Introduction: Spine surgery is currently in an era of greater focus on reducing costs and also on improving quality metrics such as the readmission rates following surgery. One area impacted by these factors is the length of hospital stay following surgery.
Aim: The purpose of this study w as to investigate factors related to the length of hospital stay following lumbar anterior/posterior combined fusion.
Materials and Methods: A spine surgery log used for quality assurance was reviewed to identify all patients who underwent lumbar 360 fusion at one or 2 levels during an 8 month period at a single short-term stay hospital (generally treat patients with fewer general health risk factors for complications). Patients undergoing additional procedures (such as osteotomy, instrumentation removal) were excluded. Surgeries were performed for painful degenerative conditions unresponsive to nonoperative care. Length of stay data were analyzed for 72 patients.
Results: Among the 72 patients, 40.3% were discharged post-op day 1 (POD 1, n=29), 51.4% were discharged on POD 2 (n=37), and 8.3% were in the hospital >3 nights (n=6). Two patients (2.8%) were readmitted, both for treatment of wound infection. Two additional patients visited the emergency room and were discharged home (one for upper respiratory infection and the other for low grade fever and tachycardia). Other early post-operative problems included one of each of the following: Doppler for possible DVT assessment, nausea, nausea and constipation, pain control (5 day stay) and possible Bells palsy and suicidal ideation (patient discharged to rehabilitation after 8 day LOS). A stepwise regression analysis was performed to determine if factors related to length of stay could be identified. Operative time was significantly related to LOS, none of the other factors included in the analysis were significant including age, gender, body mass index, albumin level, smoking status, diabetes, number of levels operated, and ASA score (a general health status assessment). The mean operative time for patients discharged on POD 1 was 152.0 minutes, for those discharged on POD 2, 169.7 minutes, and for those discharged on POD 3 or later 204.5 minutes. In this series there were no dural tears, blood transfusions, and no drains were used.
Conclusion: Only 8.3% of patients w ere in the hospital 3 or more days following 1-or 2-level lumbar 360 fusion and only 2 were readmitted, both for infection. The only factor identified related to length of stay w as operative time. There appears to be no detrimental effect, or high readmission rate associated with discharging lumbar 360 fusion patients on POD 1 or 2 in appropriately selected patients. It is important

to educate patients and their home care provider on appropriate activities, wound care, and signs of complications.

SP60

THE OCCURRENCE OF ADJACENT SEGMENT PATHOLOGY AND OF ADJACENT DISC DEGENERATION IN ONE-LEVEL LUMBAR FUSION AFTER 5 YEARS FOLLOW-UP; IN COMPARISON WITH THE DECOMPRESSION SURGERY GROUP.

Chang-Hoon Jeon,Nam-Su Chung,Han-Dong Lee
Department of orthopaedic surgery, Ajou university school of medicine Yeongtong-gu 443-380 Suwon, Korea, South

INTRODUCTION: Although the acceleration of adjacent disc degeneration seemed to be related with lumbar fusion, it remains unclear whether the occurrence rate of the radiological adjacent segment pathology (ASP) and of adjacent disc degeneration (ADD) after one-level lumbar fusion is higher than that of lumbar decompression or not. The aim of this study investigated that the one-level fusion in lumbar spine influences the occurrence rate of the radiological ASP and ADD in comparison with the surgery with decompression.
METHODS: Fifty-three patients (average age: 51.5±12.5 yrs) with one-level lumbar fusion and 47 patients (average age: 58.9±16.7 yrs) with lumbar decompression were included. The average MRI follow-up duration was 98.2±18.4 months. MRI was used for the occurrence of ASP and Pfirrmann's classification was used to evaluate the ADD preoperatively and at the time of last follow-up. The Wilcoxon signed ranks test was used to evaluate the occurrence of radiological ASP and ADD between the initial and last follow-up.
RESULTS: The average age of the patients was 51.5±12.5 years (range, 26-73) in the one-level fusion group and 58.9 ± 16.7 years (range, 22-81) in lumbar decompression group (P = 0.167). There were no differences regarding the patients' demographics between one-level lumbar fusion group and lumbar decompression group. The radiological ASP was found in 36.6% at upper levels and 14.8% at lower levels in the one-level fusion group and in 24.7% at upper levels and 11.6% at lower levels in the decompression group (P=0.090 and 0.121, respectively). The ADD was found in 43.4% at upper levels and 16.9% at lower levels in the one-level fusion group and in 27.7% at upper levels and 14.9% at lower levels in the decompression group (P=0.108 and 0.599, respectively).
DISCUSSION: In this study, the occurrence rates of radiological ASP and ASD were not significantly different between one-level lumbar fusion and decompression. Although length of fusion was reported as a significant risk factor in the development of ASP and ASD in the lumbar spine, the results of this study revealed that one-level fusion in lumbar spine has no influences the occurrence of the radiological adjacent segment pathology and the adjacent disc degeneration in comparison with the surgery with decompression.

P01

FACTORS AFFECTING ANTERIOR TRUNK BENDING DURING LEVEL WALKING IN PATIENTS WITH LUMBAR SPINAL STENOSIS

Tatsuya Igawa, Junji Katsuhira, Aiko Sakurai, Akira Hosaka, Yasuyuki Fukui
Department of Rehabilitation, International University of Health and Welfare Mita Hospital 108-8329 + Tokyo, Minato city, Japan

INTRODUCTION: Lumbar spinal stenosis (LSS) causes cauda equine and nerve root compression, resulting in neurological symptoms. Postural change and intermittent claudication caused by the symptoms are often observed in patients with LSS1). Their gait is characterized by a trunk bending posture, and a decrease in gait speed, step length, and hip angle. Although level walking with trunk bending could be effective in symptom alleviation by means of spinal canal decompression, some LSS patients do not bending their trunk while walking.

AIM: The purpose of this study was to determine the kinetic and kinematic variables that affect trunk forward bending in LSS patients during level walking.

MATERIALS AND METHODS: The subjects were 111 patients with LSS. Gait was recorded using a three-dimensional motion capture system (VICON MX) and 6 force plates (AMTI). A total of 49 reflective markers were attached to their bodies. On the basis of the data recorded, walking velocity, cadence, bilateral leg stride, cycle time, maximum anterior trunk bending angle, forward pelvic tilt angle, pelvic rotation angle, maximum and minimum joint angles, and moment and power of the lower limb were calculated. The anterior trunk bending angle was considered a dependent variable, and the others, independent variables. Step-wise multiple regression analysis was conducted to clarify kinetic and kinematic variables affecting anterior trunk bending.

RESULTS: The maximum value of the hip extension angle (β=0.416), the maximum value of hip flexion moment (β=-0.348), and step length (β=0.257) were identified as significant variables affecting the anterior trunk bending angle. The coefficient of determination adjusted for the degree of freedom was 0.294 ($p<0.05$).

CONCLUSION: Anterior trunk bending posture is widely known to contribute considerably to symptom alleviation in LSS patients. The results of the present study suggest that LSS patients might choose one of two strategies to alleviate symptoms during walking. The first is to increase the trunk bending posture in order to increase the hip extension angle and stride with a decrease in the hip flexion moment. The second is to maintain the trunk upright position in order to reduce the hip extension angle and stride with an increase hip flexion moment. Both strategies might contribute to a decrease in muscular tension of the psoas major muscle to decrease lumbar lordosis during walking

P02

THE USE OF TLIF PROCEDURE IN MANAGEMENT OF DEGENERATIVE SPINE DEFORMITIES

Mohamed Mossaad
Zagazig University 34 EL Togareen Tower EL Hegaz Street Heliopolis 11135 Cairo, Egypt

INTRODUCTION: TLIF procedure using a cage with autogenous bone graft and BMP , supported by posterior fusion and pedicle screws construct , is a reliable method to achieve spinal fusion for treatment of degenerative spinal deformities, degenerative spondylolisthesis and degenerative spinal diseases .

AIM: The purpose of this study is to evaluate the clinical results and complications of the transforaminal lumbar interbody fusion (TLIF) procedure in treating severe degenerative dorsolumbar and lumbar spine deformities. Clinical outcomes and complications are evaluated to assess whether or not TLIF procedure, using a cage with autogenous bone graft and bone morphogenic protein (BMP) , is a suitable method for treatment of degenerative spine deformities, degenerative spondylolithesis and degenerative spinal diseases.

MATERIALS AND METHODS: 50 adult patients had open posterior spinal instrumented arthrodesis, augmented with TLIF at 76 discs, with minimum of 3 years follow-up. They included 22 degenerative discs with canal stenosis, 15 degenerative spondylolisthesis, and 13 degenerative scoliosis deformity patients. Patients age ranged from 45 to 78 years. 36 patients have had prior decompression or spinal fusion

procedures. All patients had undergone posterior instrumented fusion and pedicle screws at average 4 levels ranging from 1 to 6 . All patients had TLIF at 1.5 levels (range, 1-3 levels) with BMP and autogenous bone graft using cages.
RESULTS: At average of 38 months follow-up, 3 patients developed pseudoarthrosis, 2 of them at TLIF levels most commonly in cases of long fusion. A significant improvement in clinical results was noticed in patients with degenerative scoliotic deformity, spondylolisthesis, and degenerative disc diseases. After 1 year the ODI was 43.6, 39.9 at 2 years and at 3 years was 34.4 while it was 56.8 preoperatively (P< 001). All patients stopped having medications for pain at the end of three years.
CONCLUSION: TLIF procedures with autogenous bone graft using cages with BMP was suggested in this study. A successful fusion and succeeded outcomes can be expected in patients undergoing TLIF for degenerative spinal deformities , degenerative spondylolisthesis, and degenerative disc diseases. Most common complications occurred in patients with long degenerative scoliotic deformity .

P03

QUANTITATIVE COMPUTED TOMOGRAPHY PROTOCOLS AFFECT QCT/FEA PREDICTED STIFFNESS

Giambini H.[1], Dragomir-Daescu D.[3], Nassr A[2], Yaszemski M.J.[1], Zhao C.[2]
Mayo Clinic Rochester, United States

INTRODUCTION: Quantitative computed tomography-based finite element analysis (QCT/FEA) has become increasingly popular in an attempt to reduce vertebral fracture risk. It is known that varying CT acquisition settings will affect the Hounsfield unit (HU) value of the CT voxels. On the other hand, material properties assignments for QCT/FEA are performed by applying empirical equations relating HU to Young's modulus.
AIM: To evaluate the effect of QCT scanning parameters and postprocessing settings on predicted stiffness values from QCT/FEA models.
MATERIALS AND METHODS: Five vertebrae and a QCT calibration phantom were scanned six times, varying voltage and current, and reconstructed to yield 12 total image data. The calibration phantom was used to convert Hounsfield units (HU) to equivalent bone mineral density (BMD). The vertebrae were experimentally compressed and stiffness was calculated from the linear portion of the force-displacement curve. The highest QCT-DICOM scan resolution was used to create the segmentations of the five vertebrae. For each of the 5 vertebrae, the same 3D mesh was then imported into the 12 corresponding image data to assign material properties, resulting in a total of 60 QCT/FEA models. BMD and elastic modulus were mapped to the QCT/FEA models. Model simulations of each QCT/FEA model were conducted by applying boundary conditions matching the constraints from the experiment. Stiffness from each model was compared to the experimental values.
RESULTS: We found significant differences (P<0.0001) in the regression parameters (slope and intercept) of the calibration phantom used to convert HU to ash density using varying CT settings. The highest percent difference in predicted stiffness was approximately ~480% (80 kVp, 110 mAs and U70 reconstruction kernel); while the lowest percent difference was ~1% (80 kVp, 110 mAs, U30). There was a clear distinction between reconstruction kernels (smooth (U30) vs. sharp (U70)) in the predicted outcomes; whereas voltage, as a main effect, did not present a clear difference between the models.

P04

CORRELATING COMMON HUMAN POSTURES WITH THEIR ASSOCIATED LUMBAR ALIGNMENT – A BETTER UNDERSTANDING OF THE LUMBAR SPINE

Eugene Lau,Dennis Hey,Denise Choong,Leok-Lim Lau,Ka-Po Gabriel Liu,Hee-Kit Wong
NUH Singapore 119228, Singapore

INTRODUCTION: Lumbar spine alignment varies with different postures. Understanding of this dynamism will aid deformity correction and management of spinal instabilities. This is a prospective, comparative study comparing the global and segmental lumbar spine alignments in 6 common human postures. Aim To corre-

late common human postures with their associated lumbar alignments.
MATERIALS AND METHODS: Seventy patients above 45-years-old age with low back pain over a 1-year period were recruited. Each patient underwent X-rays for the first four postures – forward bending, backward bending, slump sitting and half-squatting. Two other postures including erect standing and supine were selectively performed. ANOVA testing was used to identify differences in alignment between postures. Unpaired t-test was performed when comparing erect standing and supine postures. These postures were then ranked in order of global lordosis.
RESULTS: Slump sitting gives the greatest flexion followed by forward bending, supine, half-squatting, erect standing, and backward bending. There were significant differences between slump sitting and forward bending postures ($p<0.001$), forward bending and supine postures ($p<0.001$), supine and half-squatting postures ($p=0.015$) and between erect standing and backward bending postures ($p=0.035$). No significant differences were found between half-squatting and standing erect postures ($p=0.938$). Regardless of the position, L4/L5 and L5/S1 levels remained in lordosis. The angular alignment for slump sitting appears to be vastly different from the rest in each vertebra segment.
CONCLUSIONS: Lumbar spine alignment changes vastly with different postures which reflects the dynamism of the lumbar spine and emphasizes the need to correct deformity while considering all postures. Fusion in lordosis should be performed at L4/5 and L5/S1 levels with habits of slump sitting preferably avoided postoperatively. The ability of optimal flexion and optimal extension using slump sitting and backward bending methods respectively, promises to improve our ability in diagnosing segmental lumbar spinal instabilities.

P05

RISK ASSESSMENT OF LUMBAR SEGMENTAL ARTERY INJURY DURING LATERAL TRANSPSOAS APPROACH IN THE PATIENTS WITH LUMBAR SCOLIOSIS

Yoichiro Takata,Toshinori Sakai,Fumitake Tezuka, Kazuta Yamashita,Mitsunobu Abe, Kosaku Higashino,Koichi Sairyo
Tokushima University Kuramoto-cho 7708503 Tokushima, Japan

INTRODUCTION: Although lumbar interbody fusion using big intervertebral cage through transpsoas approach has a big advantage to correct coronal and sagittal deformity in patients with spinal deformity, the risk for injury of lumbar segmental artery is always concerned.
AIM: To assess the risk of injury of lumbar segmental arteries during transpsoas approach in patients with lumbar scoliosis.
Subjects and Methods: The abdominal-contrast enhanced multi-planar CT scans of 27 subjects with lumbar scoliosis with over 15 degree of Cobb angle were retrospectively reviewed. The coronal views through the posterior one-third of the intervertebral discs were reviewed. The cranio-caudal intervals of the adjacent segmental arteries at each intervertebral level were measured. The recommended working space for the lateral transpsoas approach using extreme lateral interbody fusion (XLIF) retractor is 24mm in the cranio-caudal direction. The cutoff value for an intersegmental Cobb angle that would estimate a cranio-caudal interval of <24 mm was determined using a receiver operating characteristic (ROC) curve.
RESULTS: The average interval between the cranio-caudal lumbar segmental arteries on the concave side was significantly shorter than that on the convex side (29.9 mm vs. 33.6 mm, $p < 0.05$). The differences in the intervals between the convex and concave sides were correlated with the corresponding intersegmental Cobb angle ($r = 0.65$, $p < 0.05$). The cranio-caudal intervals of the adjacent segmental arteries on the concave side were <24 mm at 7 intervertebral levels in 5 female subjects. ROC curve analysis revealed that cutoff value for the best prediction of an interval < 24 mm was 14.5°, with a specificity of 94.3% and sensitivity of 71.4%.
CONCLUSION: This study demonstrated that female patients with lumbar scoliosis with an intersegmental Cobb angle > 14.5° would be at high risk for potential injury to the lumbar artery during a transpsoas approach for XLIF from the concave side.

P06

THE PATHOLOGICAL MECHANISM OF L3 DEGENERATIVE SPODYLOLISTHESIS

Fukushima M,[1] Oshima Y,[1] Oka H,[2] Matsubayashi Y,[1] Taniguchi Y,[1] Chikuda H,[1] Tanaka S,[1]
[1]Department of Orthopedic Surgery and Spinal Surgery at the University of Tokyo Hospital. Tokyo, Japan [2]Medical research and Management for Musculoskeletal pain in 22nd Century Medical and research Center at the University of Tokyo Hospital. Tokyo, Japan

Introduction: Degenerative spondylolisthesis (DS) is defined as the slipping of lumbar vertebra, and occurs mostly at L4 in adults because of anatomical features. However, there are a small number of patients in whom DS occurs not at L4 but only at L3. Accordingly, past reports which elucidate the mechanical factors leading to DS have been mostly concerned with only L4 DS, and few reports are available on DS at L3.

Aim: The object of this study was to compare the differences in parameters between lumbar spinal stenosis (LSS) patients with or without L3 DS and to identify the pathological mechanisms of their L3 DS.

Materials and Methods: There were 369 patients with LSS who underwent surgery at our hospital between January 2010 and April 2015, and we assessed all the 25 patients among them with DS at only L3 and compared them against 50 other age- and gender-matched LSS patients without any DS. The following parameters: pelvic incidence (PI), sacral slope (SS), pelvic tilt (PT), L3 slope, L4 slope, L5 slope and lumbar lordosis (LL) were measured on lateral lumbar radiographs in standing position, and the orientation of the facet joints and disc heights (DH) were measured from computed tomography. We defined low DH as the DH which was less than 50% of that at L5/S and compared the differences in all these parameters between the two groups.

Results: Radiographic analysis showed L3 slope, L4 slope and L5 slope in the L3 DS group were significantly greater than in the non-DS LSS group. Computed tomography analysis showed L3/4 facet joints in the L3 DS group were significantly more sagittally oriented than in the non-DS LSS group, and L4/5 facet joints were not significantly different between the two groups. The number of patients with low DH at L4/5 in the L3 DS group was significantly greater than the non-DS LSS group.

Conclusion: Lumbar slope angle and sagittal orientation of facet joints have been reported to be among the pathological mechanisms of L4 DS, as they influence anterior shear force on vertebra at that level. In the current study, a similar finding was recognized regarding only L3 DS. Greater lumbar slope including L3 together with more sagittally oriented facet joints at only L3/4, and not at L4/5, might lead to DS at only L3. Furthermore, excessive stress at the L3/4 segment resulting from the decreased motion at L4/5 can be an additional cause of L3 DS.

P07

THE PATHOLOGICAL MECHANISM OF L3 DEGENERATIVE SPODYLOLISTHESIS

Masayoshi Fukushima,Yasushi Oshima,Hiroyuki Oka,Yoshitaka Matsubayashi,Yuki Taniguchi, Hirotaka Chikuda,Sakae Tanaka
Department of Orthopedic Surgery, University of Tokyo Bunkyo, Tokyo 113-8655, Japan

INTRODUCTION: Degenerative spondylolisthesis (DS) is defined as the slipping of lumbar vertebra, and occurs mostly at L4 in adults because of anatomical features. However, there are a small number of patients in whom DS occurs not at L4 but only at L3. Accordingly, past reports which elucidate the mechanical factors leading to DS have been mostly concerned with only L4 DS, and few reports are available on DS at L3.

AIM: The object of this study was to compare the differences in parameters between lumbar spinal stenosis (LSS) patients with or without L3 DS and to identify the pathological mechanisms of their L3 DS.

MATERIALS AND METHODS: There were 369 patients with LSS who underwent surgery at our hospital between January 2010 and April 2015, and we assessed all the 25 patients among them with DS at only L3 and compared them against 50 other age- and gender-matched LSS patients without any DS. The following parameters: pelvic incidence (PI), sacral slope (SS), pelvic tilt (PT), L3 slope, L4 slope, L5 slope and

lumbar lordosis (LL) were measured on lateral lumbar radiographs in standing position, and the orientation of the facet joints and disc heights (DH) were measured from computed tomography. We defined low DH as the DH which was less than 50% of that at L5/S and compared the differences in all these parameters between the two groups.
RESULTS: Radiographic analysis showed L3 slope, L4 slope and L5 slope in the L3 DS group were significantly greater than in the non-DS LSS group. Computed tomography analysis showed L3/4 facet joints in the L3 DS group were significantly more sagittally oriented than in the non-DS LSS group, and L4/5 facet joints were not significantly different between the two groups. The number of patients with low DH at L4/5 in the L3 DS group was significantly greater than the non-DS LSS group.
CONCLUSION: Lumbar slope angle and sagittal orientation of facet joints have been reported to be among the pathological mechanisms of L4 DS, as they influence anterior shear force on vertebra at that level. In the current study, a similar finding was recognized regarding only L3 DS. Greater lumbar slope including L3 together with more sagittally oriented facet joints at only L3/4, and not at L4/5, might lead to DS at only L3. Furthermore, excessive stress at the L3/4 segment resulting from the decreased motion at L4/5 can be an additional cause of L3 DS.

P08

TRADE-OFF BETWEEN RESTORING STABILITY AND ENDPLATE STRESSES IN THE LUMBAR SPINE USING DIFFERENT VOLUME GRADES OF A NUCLEUS ARTHROPLASTY SYSTEM: A FINITE ELEMENT STUDY

Uphar Chamoli,Naomi Tsafnat,Ashish Diwan
University of New South Wales 4-10 South Street, Kogarah 2217, Sydney NSW, Australia

INTRODUCTION: Nucleus arthroplasty systems are emerging as a promising treatment option for early stages of symptomatic intervertebral disc degeneration. Implant size is of critical importance as under-sizing may result in an insufficient restoration of segmental kinematics, and over-sizing may result in excessive load-bearing by the implant and higher implant-endplate junction stresses.
AIM: Using finite element (FE) analysis, the main aim of this study was to investigate the relationship between different grades of volume fill of a nucleus replacement implant and their ability to restore kinematics, stresses in the endplates and annulus to normal intact state levels in the lumbar spine.
MATERIALS AND METHODS: A fully calibrated nonlinear FE model of L1-L5 spine was built using computed tomography data from a healthy human subject (26 yo, male). The intact FE model was manipulated to build another model representing complete nucleotomy at L3-L4 level. Subsequently, three more FE models were built representing different grades of volume fill (40%, 80% and 100%) of an in situ curing silicone based nucleus replacement implant (Columna Disc Device (CDD)) in the L3-L4 nucleotomised space. A posterolateral approach pathway was assumed to model implant geometry in the 40% and 80% CDD filled models. Using pure bending moments (10Nm), the models were loaded to simulate flexion (Fx), extension (Ex), right lateral bending (LB), and left axial torsion (AXT) motions.
RESULTS: In the nucleotomised model at the L3-L4 level, flexural loads significantly increased segmental range of motion (ROM) (+23%) compared with the baseline intact state, in addition to an increase in mean annular stress (+28%) and mean capsular strain (+10%). A 40% CDD fill maintained L3-L4 Fx ROM above the baseline (+11%) and restored mean annular stress (+3%), but significantly decreased mean endplate stress (-14%) in the middle region. An 80% CDD fill maintained L3-L4 Fx ROM below the baseline (-4%) and offloaded the annulus (mean stress: -17%), but significantly increased mean endplate stress (+28%) in the middle region. A 100% CDD fill made the motion segment significantly stiff compared with the baseline (Fx ROM: -24%), offloaded the annulus (mean stress: -32%), and increased mean endplate stress (+109%) in the middle region. Similar trends were observed in the other three bending modes.
CONCLUSION: A complete nucleotomy at L3-L4 significantly destabilised the motion segment, increased annular stresses and capsular strains in all loading modes. Subsequent filling of the nucleotomised cavity using different volume fractions of CDD revealed a possible trade-off

between restoring stability and endplate stresses in different bending motions.

P09

BIOMECHANICAL EVALUATION OF A BILATERAL SPONDYLOLYTIC DEFECT AT L5 AND ITS PROGRESSION INTO TWO CLINICALLY OBSERVED SPONDYLOLISTHESIS PATTERNS: A FINITE ELEMENT STUDY

Uphar Chamoli,Naomi Tsafnat,Ashish Diwan
University of New South Wales 4-10 South Street, Kogarah 2217, Sydney NSW, Australia

INTRODUCTION: Lumbar spondylolysis, an osseous defect of the pars interarticularis of the vertebral arch occurs in nearly 6% of the general population, and may progress to spondylolisthesis.
AIM: The main aim of this study was to evaluate biomechanical implications of a bilateral spondylolytic defect at L5 and its progression into two clinically observed spondylolisthesis patterns (Figure 1) using finite element (FE) analysis.
MATERIALS AND METHODS: A fully calibrated nonlinear FE model of L1-S1 spine was built using computed tomography data from a healthy human subject (26 yo, male). The intact model was manipulated to build three more models representing: a bilateral spondylolytic defect at L5, a lytic spondylolisthesis of L5 on S1 (Type-1), and a lytic spondylolisthesis of L5 on S1 alongwith retrolisthesis of L4 on L5 (Type-2) (Figure 1). Using pure bending moments (10Nm), the models were loaded to simulate flexion (Fx), extension (Ex), right lateral bending (LB), and left axial torsion (AXT) motions.
RESULTS: In the lytic defect only model, L5-S1 range of motion (RoM) and mean annular stress increased significantly in Fx (14% and 10% respectively) and left AXT (16% and 17% respectively) compared with the baseline intact state. A Type-1 spondylolisthesis destabilised the L5-S1 level in all bending modes, but no instability was observed at the cephalad levels. A Type-2 spondylolisthesis destabilised the L5-S1 level, accompanied with a greater instability at the L4-L5 level. Only in the Type-2 spondylolisthesis model, a significant increase in global RoM (L1Su - S1Su) was observed in all loading modes. Additionally, in the Type-1 and Type-2 spondylolisthesis models, mean axial strain in the iliolumbar ligaments (ILL) increased significantly in Fx (147% and 132% respectively) and left AXT (293% and 175% respectively). Mean axial strain in the lumbosacral ligaments (LSL) in the Type-1 and Type-2 spondylolisthesis models also increased significantly in Fx (506% and 615% respectively) and left AXT (669% and 354% respectively).
CONCLUSION: A spondylolytic defect in the L5 vertebra significantly increased L5-S1 disc stresses in flexural and torsional loading. A Type-1 spondylolisthesis induced instability only at the defect level, whereas a Type-2 spondylolisthesis induced instability at the defect and cephalad levels. Both Type-1 and Type-2 spondylolisthesis significantly increased axial strain in the ILL and LSL, and as such mechanical integrity of these ligaments may have a critical role in determining the progression of a L5 lytic defect to spondylolisthesis.The two spondylolisthesis types may require different strategies for surgical stabilisation.

Figure 1*. Type-1 lytic spondylolisthesis is characterised by posteroanterior slippage of L5 on S1. Type-2 lytic spondylolisthesis is characterised by posteroanterior slippage of L5 on S1, and anteroposterior slippage of L4 on L5.*

P10

SPINAL MOVEMENT IMPROVED AFTER DECOM-PRESSION SURGERY IN PATIENTS WITH LUMBAR SPINAL STENOSIS ON THREE-DIMENSIONAL GAIT ANALYSIS

Wataru Kuwahara,Nobuhiro Tanaka,Kazuyoshi Nakanishi,Naoto Fujita,Makoto Asaeda,Haruka Nakamura,Yoshifumi Kono,Takuya Okamoto, Hodaka Watanabe,Masataka Deie
Hiroshima University 734-0037 Hiroshima City, Japan

INTRODUCTION: Lumbar spinal stenosis (LSS) patients have limited gait abilities due to the leg pain and neurogenic intermittent claudication, and these symptoms relief by the lumbar flexion posture. Although radiological changes in the sagittal alignment after decompression surgery have been reported, it is not known about the changes of the spinal movement during gait after decompression surgery for LSS.
AIM: To examine the vertebral segmental movement during gait in the patients with LSS and to investigate the changes of the spinal movement during gait after decompression surgery.
MATERIALS AND METHODS: Ten patients with LSS (LSS group) and 10 healthy young volunteers (Control group) participated in this study. Spine kinematics data on the participants during gait were acquired using a three-dimensional motion analysis system with 16 cameras and eight force plates. All participants walked along 10 m walkway at self-selected speed. The flexion angles of the Th1 segment relative to the Pelvis segment (trunk), the Th1 segment relative to the L1 segment (thoracic) and the L1 segment relative to the Pelvis segment (lumbar) were calculated. The Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ) and Visual Analogue Scale (VAS) for back and leg pain were obtained to assess the patient-based clinical outcomes. Spine kinematic data and the clinical outcomes ware collected preoperatively and 1 month postoperatively for LSS group.
RESULTS: The peak flexion angles of trunk and lumbar during stance phase were significantly lower in the LSS group than in the Control group ($p = 0.002$ and $p = 0.001$, respectively). There was no significant difference in the flexion angle of thoracic between the two groups. The mean score for pain-related disorders of JOABPEQ and VAS for back and leg pain improved at 1 month postoperatively, compared to baseline ($p = 0.006$, $p = 0.040$ and $p = 0.011$, respectively). The peak flexion angle of lumbar during stance phase was significantly increased at 1 month postoperatively ($p = 0.015$).
CONCLUSION: Increase of the lumbar flexion angle decreases the epidural pressure during gait. Therefore, the small flexion angle of lumbar during gait in LSS patients could not decrease the epidural pressure and induce neurogenic intermittent claudication preoperatively. With the improvement of neurological symptoms by decompression surgery, the lumbar flexion angle during gait in LSS patients increased on three-dimensional gait analysis.

P11

THE EFFECT OF A SELECTIVE ACID-SENSING ION CHANNELS (ASICS) INHIBITOR ON PAIN-RELATED BEHAVIOR BY NUCLEUS PULPOSUS APPLIED ON THE NERVE ROOT IN RATS

Yoshihiro Kobayashi,Miho Sekiguchi,Shin-ichi Konno

Depertmet of Orthopedaedic Surgery, Fkushima Medical University Scool of Medicine 960-1295, Japan

INTRODUCTION: Acid-Sensing ion channels (ASICs) are associated with acidosis pain in inflamed or ischemic tissues, particularly Acid-Sensing ion channel 3 (ASIC3), which is mainly expressed in sensory neurons. A sea anemone toxin, APETx2, is a selective ASIC3 inhibitor. This inhibits histopathological change in rat acute gastric mucosal lesion model, lowering mechanical threshold in knee osteoarthritis model or postoperative pain model. However, the efficacy of APETx2 for pain relief in the NP allocation model remains unknown.
AIM: To examine the effect of a selective inhibitor of ASIC3 on pain-related behavior induced by the application of nucleus pulposus (NP) onto the dorsal root ganglion (DRG).
MATERIALS AND METHODS: Autologous NP was applied to the left L5 nerve root of 183 adult female Sprague-Dawley rats. Four treatment NP groups (n=42 in each group) were treated with low dose (0.01μg), middle dose (0.1μg), or high dose (1.0μg) of APETx2 (LD, MD, and HD), and saline (SM), respectively. Animals received 0.05ml of each drug and were administered onto DRGs at the same time of surgery. Behavioral testing was performed to investigate the mechanical withdrawal threshold using von Frey hairs. The number of hypoxia-inducible factor-1α (HIF-1α) neurons was evaluated using immunohistochemistry. Expression of ASIC3 expression in the DRG was examined using immunoblotting. Statistical differences among multiple groups were assessed using the Steel

test, the Tukey–Kramer test Dunnett test. P values less than 0.05 were considered significant.
RESULTS: The thresholds in the HD group were higher than the SM group at day 14 and 21 ($p<0.05$). In the MD group, the threshold was higher than the SM group at day 14 ($p<0.05$). High dose APETx2 reduced the expression HIF1α after operative day 14 compare with the SM group ($p<0.05$), but the expression of ASIC3 remained unchanged at each time point.
CONCLUSION: APETx2 significantly improved pain-related behavior dose-dependently. APETx2 might inhibit ASIC3 and partly Nav1.8 channels. ASIC3 channel inhibitor could be a potential therapeutic agent for a nerve root infiltration in early stage of LDH.

P12

COMPUTER-ASSISTED PRE-OPERATIVE PLANNING OF DEFORMITY CORRECTION SURGERY: NUMERICAL MODELING TO GO BEYOND THE CONSOLIDATED IMAGE-BASED APPROACHES

Fabio Galbusera,Tito Bassani,Luigi La Barbera, Claudia Ottardi,Benedikt Schlager,Marco Brayda-Bruno, Hans-Joachim Wilke
IRCCS Istituto Ortopedico Galeazzi 20161 Milan, Italy

INTRODUCTION: Spinal deformities are relatively frequent pathologies which may appear in different stages of the human life, from childhood and adolescence to maturity and old age. Corrective surgical treatment is frequently performed in more severe cases, and generally has high success rates. Nevertheless, complications due to mechanical failure of the fixation or of the instrumentation remain rather common. Indeed, the choice of the optimal surgical strategy for each specific case (i.e. fusion length, most appropriate instrumentation, degree of tolerable correction) may be controversial, and general consensus about clearly defined strategies or rational rules is still lacking. Computer-assisted image-based methods can be precious tools to perform the preoperative planning of the surgeries, but they generally do not provide any biomechanical information which could support the choice of the optimal strategy.
AIM: A software approach for the simulation of the correction of patient-specific spinal deformities allowing for a biomechanical comparison of different surgical strategies via a user-friendly graphical interface is presented.
Patients and methods: The method is based on three dimensional reconstructions of the spinal anatomy obtained from biplanar radiographic images. A graphical user interface allows for the planning of the deformity correction and to virtually implant pedicle screws and posterior rods, perform anterior releases as well as to simulate the desired correction maneuvers. Robust meshing of the instrumented spine is provided by using consolidated computational geometry and meshing methods. Two test cases (reduction of a low grade spondylolisthesis at L3-L4 and correction of a thoracolumbar scoliotic curve (Cobb angle 40 degrees)) were simulated as a proof-of-concept.
RESULTS: Based on a finite element simulation, the program was able to predict the loads and stresses acting in the instrumentation, those in the biological tissues as well as the forces which should be applied to achieve correction. The two test cases showed plausible results in terms of stresses in the pedicle screws and in the posterior rods.
CONCLUSIONS: The proposed method allowed performing a quantitative biomechanical comparison of different surgical treatments to correct spine deformities, thus providing clear advantage with respect to the consolidated image-based approaches in which the biomechanical aspects are left to the personal experience of the surgeon. Despite the limitations of this approach which will be addressed in future implementations, the preliminary outcome is promising and encourages a wide effort towards its refinement and validation.

P13

SIGNIFICANT EFFECTS ON T2 RELAXATION TIMES OF AXIAL LOADING DURING MRI IN LUMBAR DISCS – A FEASIBILITY STUDY ON PATIENTS WITH LOW BACK PAIN

Hanna Hebelka,Kerstin Lagerstrand,Helena Brisby, Martin Nilsson
Institution of Clinical Sciences, Department of Radiology 426 71 Västra Frölunda, Sweden

INTRODUCTION: T2 relaxation time, reflecting biochemical features of tissues, has shown promise in quantifying disc degeneration. The effect of instantaneous spinal load, induced with axial loading during MRI (alMRI), on intradiscal T2 relaxation times has previously not been investigated in patients. Quantification of T2 relaxation time in combination with alMRI might provide a sensitive method to assess the disc´s biomechanical properties and monitor early degenerative signs.
AIM: To investigate if alMRI instantaneously can affect the T2 relaxation time in the disc compared with conventional supine MRI in patients with low back pain (LBP). Material and Methods: Eleven LBP patients (54 lumbar discs) were examined with T2 relaxation time in the sagittal view during unloaded MRI and subsequent alMRI (using the Dynawell® loading device). In the sagittal three most central T2 relaxation time images, each disc was divided into five parts and measurements obtained from these five regions of interests (ROI:s), anterior annulus fibrosus (AF) (ROI 1), the interface anterior AF- nucleus pulposus (NP) (ROI 2), NP (ROI 3), the interface NP-posterior AF (ROI 4) and the posterior AF (ROI 5). The mean T2 relaxation times were summed for corresponding ROI´s in the three sagittal views and compared between conventional MRI and alMRI.
RESULTS: The mean T2 relaxation times (ms) for conventional supine MRI compared with alMRI were for all discs: ROI 1; 92-105 ($p=0.001$), ROI 2; 186-212 ($p<0.001$), ROI 3; 243-262 ($p=0.01$), ROI 4; 225-222 ($p=0.63$), ROI 5; 123-106 ($p=0.001$). When analyzed on disc level, an increase in T2 relaxation time during alMRI was seen in ROI 1 and 2 of L1-L2 ($p<0.05$) and L2-L3 ($p<0.02$), ROI 3 of L2-L3 ($p=0.01$) and ROI 2 of L5-S1 ($p<0.05$). Furthermore, a corresponding decrease in ROI 5 of L1-L2 ($p=0.01$) and L2-L3 ($p<0.02$) was seen.
CONCLUSIONS: With alMRI, significant changes in T2 relaxation times were seen in different parts of the disc. The results reflect biodynamic changes with redistribution of water from posterior to anterior parts of the disc during spinal loading, most prominent in the upper lumbar spine. Quantification of the T2 relaxation time in combination with alMRI, thus, instantaneously reveal biodynamic/biochemical disc features and is a promising diagnostic method to reveal characteristics of degenerative changes of the discs causing lumbar pain. The work motivates larger studies comparing dynamic changes in T2 relaxation times between asymptomatic individuals and LBP patients.

P14

IMPACT OF LUMBAR DEGENERATIVE SPONDYLOLISTHESIS ON LUMBO-PELVIC ALIGNMENT IN SIT-TO-STAND MOTION

Hidekazu Suzuki,Kenji Endo,Hirosuke Nishimura, Yuji Matsuoka,Hidetoshi Tanaka, Kengo Yamamoto
Tokyo Medical University 1600023, Tokyo, Japan

INTRODUCTION: Lumbar disc degeneration leading to segmental instability in the sagittal plane may result in degenerative spondylolisthesis (DS). Mechanical low back pain, which may be caused by degenerated intervertebral disc or the facet joints, is generally referred to as pain related to the posture and activities of daily life. Sagittal spinal alignment is usually analyzed in standing position, however, for understanding of symptoms associated with postural changes, it must be analyzed in various positions.
AIM: The aim of this study was to investigate the radiographic lumbo-pelvic contour in patients with lumbar DS in sit-to-stand motion.
MATERIALS AND METHODS: The study participants were 35 patients with L4 anterior DS (mean age, 72.0) and 33 elderly persons (mean age, 75.4) as control. The following parameters were measured on the lateral radiographs at standing upright (St up) or anteflexed (St ant) and seated upright (Si up) or anteflexed (Si ant) on a chair: lumbar lordotic angle (L1L5), sacral slope (SS), pelvic tilt (PT), pelvic incidence (PI), and slip angle at L4-5.
RESULTS: The measurements of spino-pelvic parameters in STS (Si up, Si ant, St ant, St up) were as follows: DS, L1L5 (14.1, 2.8, 6.0, 24.5), SS (14.1, 17.4, 34.8, 27.9), PT (36.1, 32.6, 15.4, 22.3), control, L1L5 (12.5, 0.6, 6.2, 17.8), SS (19.6, 20.5, 37.0, 27.4), PT (31.2, 30.4, 13.9, 23.6). There was no significant difference in PT values between the two groups in each posture. In DS patients, L1L5 at upright standing was

significantly larger though the L1L5 values at another postures showed no differences. The slip angle in DS showed a significant change after seat off in STS (before seat off, 0.1, after seat off, 5.6).
CONCLUSION: In DS patients, pelvis was temporarily anteverted after seat off and retroverted in standing upright as is the case in elderly control. The slip angle in DS was changed dramatically after seat off in STS, while L1L5 value at upright standing was significantly larger even though there was no difference at other postures. It suggests that the slipping segment takes a heavy burden after seat off. In STS motion, lumbar overflexion before seat off could cause the mechanical low back pain in patients with DS.

P15

AN ASSOCIATION BETWEEN EXPRESSION OF NEUROTROPHIC FACTORS AND PAIN-RELATED BEHAVIOR INDUCED BY NUCLEUS PULPOSUS APPLIED ON THE NERVE ROOT IN RATS

Shinobu Seki,Miho Sekiguti,Shin-ichi Konno
Department of Orthopaedic Surgery Fukushima Medical University 960-1295 Fukushima City, Fukushima, Japan

INTRODUCTION: Cytokines and neurotrophic factors are released from the activated glia cells in the spine cord and they are associated with pain-related behavior. Nerve growth factor (NGF) is one of the neurotrophic factors and induced of production by inflammation. In addition, brain-derived neurotrophic factor (BDNF) is induced to produce by NGF through p38 MAP kinase. The aim of this study was to investigate the relationship between pain-related behavior and the change of expression of neurotrophic factors in both dorsal root ganglion (DRG) and spinal cord using an application of nucleus pulposus rat model.
METHODS: Adult female Sprague-Dawley rats (n=48) were used and divided into two group; NP and sham. NP harvested from the tail was applied to the left L5 DRG of rats in the NP group. In the sham group, the same procedure was performed without NP application on the DRG. Behavioral testing was performed to investigate the mechanical withdrawal threshold using von Frey hairs before surgery and post- operative days 2, 7, 14, 21, 28 and 35. And immunohistochemical localization of NGF, phosphorylated p38 (p38) and BDNF in the dorsal root ganglion (DRG) and spinal cord was assessed. The numbers of their immune-reactive (IR) cells and all DRG neurons were counted. The mean values were expressed as a ratio of the IR cells of immunohistochemistry against all neurons. The statistical analysis was performed by Bonferroni test and p value less than 0.05 was considered significant.
RESULTS: The mechanical withdrawal threshold in the NP group was significantly decreased for 35 days compared with that in the sham group ($p< 0.05$). In the NP group, the ratio of NGF-IR DRG cells were higher from day 2 to 28 than that in the sham group ($p<0.05$). The expression of BDNF and p-p38 increased from day 7 to 35 compared with the sham group ($p<0.05$). NGF and BDNF positive cells were localized with neurons in he dorsal horn of spinal cord.
CONCLUSIONS: The results in this study suggested that the expression of NGF increased and mechanical thresholds reduced from 2 day after surgery in the NP group, and the expression of p38 and BDNF in the DRG increased from 7 day after surgery in the DRG. In the spinal cord, NGF, p-p38 and BDNF expressions increased in both microglia and neurons. These changes of neurotrophic factors might be related with pain- related behavior. Therefore, NGF can be a potential agent of novel analgesics for neuropathic pain.

P16

POSTOPERATIVE CHANGES OF THE GAIT IN PATIENTS WITH LUMBAR SPINAL CANAL STENOSIS

Tsuyoshi Goto,Toshinori Sakai,Youichiro Takata, Kosaku Higashino,Shinsuke Katoh, Koichi Sairyo
Tokushima University Hospital 770-8503+ Tokushima, Japan

INTRODUCTION: Intermittent claudication (IC) is an important feature of lumbar spinal canal stenosis (LSCS) as it can have a detrimental effect on function and quality of life. Surgery often brings patients gait improvement, but the mechanism has not been elucidated. Consequently, the optimal postoperative rehabilitation has not been established. The purpose

of this study was to analyse the feature of postoperative changes of the gait and the muscle activities of the trunk and legs.
METHODS: Six patients with LSCS who underwent surgery were included in this study. Before and at the two weeks after the surgery, gait analyses were performed using the Vicon Motion System®. Spatiotemporal parameters, sagittal thorax and knee kinematics as well as the knee internal moment, paraspinal muscle (PVM) and vastus lateralis (VL) kinematics and electromyographic (EMG) activity were analysed. Before surgery, the analyses were performed before/after patients felt leg symptoms due to the LCSC, and the distance which patient felt too strong leg symptoms to keep walking (IC-D) was measured on the treadmill. After surgery, the analyses were done at the same timing before and at the IC-D.
RESULTS AND DISCUSSION: Before surgery, mean thorax angle were significantly increased after the IC-D. It was significantly decreased after surgery (4.6±4.0deg vs. 3.3±5.2deg; $p<0.05$). After surgery, mean knee angle and knee moment was significantly increased at both timing (22.2±4.5deg vs. 26.1±4.0deg; $p<0.01$, 22.4±4.6deg vs. 25.7±4.6deg; $p<0.01$), (60.6±60.6Nmm vs. 125.0±57.6Nmm; $p<0.01$, 67.0±61.8Nmm vs. 126.0±64.3Nmm; $p<0.05$). Also, mean PVM activity decreased, and mean VL activity decreased after surgery (7.1±2.2% vs. 9.2±1.7deg; $p<0.01$). Changes in the thoracic angle and PVM muscle activity were considered to affect on the gait, which could lead to alleviate leg symptoms by reducing the lumbar lordosis. Postoperative increase of the knee flexion angle and the VL muscle activity might bring improvement of the step forward capacity of lower limbs. These results could lead to increase of walking speed and the cadence.
CONCLUSION: Surgeries for the LSS patient lead to improve their gait by change of the thorax angle and muscle activity of the trunk and legs.

P17

OSTEOPOROSIS WOULD BE A FACTOR THAT CAN PROMOTE THE PROGRESS OF DISC DEGENERATION

Fengdong Zhao,Shengyun Li,Zhi Shan,Tianming Yu, Xuyang Zhang,Maiwulanjiang Mamuti

Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University Hangzhou, Zhejiang, China 310000, China, People's Republic of

INTRODUCTION: The relationship between osteoporosis and intervertebral disc degeneration is still controversial. The mechanism of the difference is still unknown.
AIM: To evaluate the relationship between osteoporosis and intervertebral disc degeneration.
MATERIALS AND METHODS: Thirty SD rats (8 weeks) were used for ovariectomy (OVX), Sham or blank (10 rats each group). Each rat tail was punctured at the intervertebral disc between Co6-7, Co8-9 and Co10-11 coccygeal vertebrae using 22G needle immediately after operation. X-Ray and MR image were evaluated at 6 and 12 weeks for disc height and T2-weighted neculus signal intensity. After sacrifice, the degree of osteoporosis was assessed by micro-CT, and disc degeneration was evaluated with RT-PCR, histological examination and immunohistochemistry.
RESULTS: From 6 weeks after puncture, the disc height in OVX group decreased significantly when compared with sham and blank ($P<0.05$), and the difference progressed over time. No difference can be founded between Sham group and blank group. The MRI grading according to sagittal T2-weithgted images based on Pfirrmann demonstrated more severe disc degeneration in OVX group compared to Sham and blank groups. Micro-CT scan revealed a well-established osteoporosis model. RT-PCR revealed that the OVX group had elevated gene expression of MMP-13 and MMP-9, while the expression of SOX-9 and Col-2 were suppressed. HE-staining showed obvious sign of disc degeneration in OVX group, and immunohistochemistry represented lower concentration of proteoglycan and aggrecan in OVX group than Sham group ($P<0.05$).
CONCLUSION: Osteoporosis was associated to more serious loss of disc height and more severer disc degeneration. Meanwhile, molecular biology, histological examination and immunohistochemistry strengthen above mentioned association. Thus, osteoporosis would be a factor that can promote the progress of disc

degeneration.

P18

THE RELATIONSHIP BETWEEN GAIT AND SPINAL SAGITTAL PARAMETERS IN PATIENTS WITH LOW BACK PAIN

Kazuma Murata,Kenji Endo,Hidekazu Suzuki, Taro Nagai,Hirosuke Nishimura,Yuji Matsuoka, Hidetoshi Tanaka,Kengo Yamamoto

Tokyo Medical University 160-0023, Tokyo, Japan

INTRODUCTION: Gait disorder impedes the quality of life of affected patients with low back pain (LBP). Despite the major concern of activity of daily living, there is a paucity of literature about the relationship between spatio-temporal gait parameters and spinal sagittal parameters, which is considered as a major radiographic characteristics representing the spinal balance.

AIM: Primary aim of this study was to determine the relationship between spatio-temporal gait parameters and spinal sagittal parameters in patients with LBP due to lumbar degenerative condition.

MATERIALS AND METHODS: This is a cross sectional study performed in a single tertiary institution. Thirty-three patients with LBP, 15 men and 18 women aged 69.5 ± 1.8 years, were enrolled in this investigation. Spatio-temporal gait parameters were studied using commercially available gait analysis system (Walkway MW-1000, Anima Co., Tokyo, Japan). Spinal sagittal parameters were studied including C7-S1 SVA, TPA, TK, LL, SS, PI, and PT both in neutral position and forward stepped position. Participants with C7-S1 SVA > 50 mm were classified as truncal imbalance (TI) (N = 11), while those with < 50 mm were defined as truncal balanced (TB) (N = 22). Hierarchical multiple regression analysis were performed to confirm the interaction between spatio-temporal gait parameters and spinal sagittal parameters.

RESULTS: Spatio-temporal gait parameters were not different between the two groups. Among sagittal parameters, TI exhibited increased C7-S1 SVA (TI: 105.6 ± 8.5 mm, TB: 17.4 ± 6.0 mm, P < 0.001) and TPA (TI: 29.5 ± 2.6°, 20.1 ± 1.8°, P = 0.006), and decreased TK (TI: 18.1 ± 3.8°, TB: 32.4 ± 2.7°, P = 0.005) and LL (TI: 21.4 ± 4.2°, TB: 43.6 ± 3.0°, P < 0.001) compared to TB in neutral position. TI also exhibited increased C7-S1 SVA (TI: 137.5 ± 11.9 mm, TB: 53.2 ± 8.4 mm, P < 0.001) and TPA (TI: 28.5 ± 2.8°, 19.8 ± 2.0°, P = 0.017), and decreased TK (TI: 17.6 ± 3.7°, TB: 29.5 ± 2.6°, P = 0.014) and LL (TI: 22.0 ± 5.1°, TB: 41.2 ± 3.6°, P = 0.004) compared to TB in forward stepped position. Hierarchical multiple regression models revealed the interaction among step length, □PT, which was represented by the difference between PT in neutral position and that in forward stepped position, and C7-S1 SVA (adjusted R2 = 0.20, P = 0.023).

CONCLUSION: The present study provides statisti-cally established evidence of relationship between spatio-temporal gait parameters and spinal sagittal parameters. Total spinal alignment in neutral and forward stepped position may aid in assessing the presence of gait disorder in patients with LBP. C7-S1 SVA and □PT may serve as a surrogate outcome for assessing outcomes of intervention for reduction of gait disorder.

P19

MAGNETIC RESONANCE IMAGING OF THE ANULUS FIBROSUS SHOWS CHANGES IN TISSUE DIFFUSION AND ANISOTROPY FOLLOWING MECHANICAL LOADING: A PILOT STUDY IN OVINE TISSUE

J Paige Little,Monique Tourell,Konstantin Momot, Mark Pearcy,Margaret Kirkwood

Paediatric Spine Research Group, IHBI - CCHR, Queensland University of Technology 2 George Street Brisbane, QLD, 4000, Australia

INTRODUCTION: Prior investigations of disc mechanics have suggested the existence of a 'derangement' strain, whereby loading beyond this strain results in damage to the anulus fibrosus ground substance [1]. This damage causes a reduced mechanical stiffness upon repeated loading, but does not prevent the tissue from resisting applied forces upon subsequent loading.

AIM: The current pilot study sought to explore the functional micro-mechanics of the anulus fibrosus using both imaging and experimental methods, in order to better understand the underlying mechanisms which govern the

interplay between disc mechanical function and microstructure.
METHODS: Six axially-aligned samples of anulus fibrosus were obtained from a merino sheep disc (L5-L6). Each sample consisted of vertebral bone-disc-vertebral bone, with cross-sectional dimensions of 2mm x 2mm and an axial height of approximately 5mm (equal to disc height). The samples were mechanically loaded in unconfined axial compression, at a rate of 1%/sec to replicate physiological loading. A maximum strain of 50% was reached during 5 cycles to capture the tissue response following derangement. Magnetic Resonance Diffusion Tensor Imaging (DTI) can be used to measure the restricted diffusion of water molecules in biological tissues. From this, characteristics of the tissue microstructure, such as tissue alignment, can be inferred. Here, DTI was conducted for each anulus sample before and after mechanical testing. Ten gradient directions, with an in plane resolution of 0.1 mm, a 1 mm slice thickness, diffusion time of 18ms and b = 700 s mm-2, were used. From the principal eigenvectors (PEV) and eigenvalues of the resultant diffusion tensors, the direction and average magnitude of water diffusion (mean diffusivity, MD) and the degree of diffusion anisotropy (fractional anisotropy, FA) were calculated for each imaging voxel.
RESULTS: The mechanical response of the anulus fibrosus samples in unconfined compression was nonlinear, with a mean linear stiffness from 0-15% strain of 1.8MPa (Standard Deviation, 1.6MPa) and from 85-100% strain of 4.7MPa (Standard Deviation, 3.3MPa). A comparison of MD, FA and PEV maps for each sample before and after mechanical testing showed:
• Diffusion of water molecules was less restricted following mechanical testing.
• The displacement of water molecules was more directional following mechanical testing
• Analysis of the PEV showed clear striations representative of the different collagen directionality between adjacent lamellae and indicative of the direction of least resistance for molecular diffusion.
• PEV in each lamellae become more closely aligned following mechanical testing.
CONCLUSIONS: A comparison of DTI of anulus fibrosus samples before and after mechanical testing showed clear changes in diffusivity, indicating the tissue becomes more anisotropic following mechanical testing. This increase in anisotropy is possibly due to the collagen fibres becoming more aligned.
1. Little, J. P., et al. (2010) J Mech Behav Biomed Mat, 3, p146-157

P20

LUMBAR INTERBODY FUSION WITH THE APPLICATION OF RHBMP-2 ARE BONE RESORPTION AND OVERZEALOUS BONE GROWTH DOSE- AND/OR CONCENTRATION-DEPENDENT? RESULTS OF A LARGE ANIMAL STUDY

Hans Jörg Meisel,Hans Jörg Meisel,Gerlinde Heil, Gerlinde Heil, Kerstin Gerlach, Peter Vergroesen, Christian Hohaus,Christian Hohaus
BG Klinikum Halle Merseburger Str. 165 06112 Halle, Germany

INTRODUCTION: In this large animal study for lumbar interbody fusion it was analyzed if the effect of rhBMP-2 regarding bone resorption and overzealous bone growth is dose- and/or concentration-dependent.
MATERIAL/METHODS: 33 female Merino sheep underwent right-lateral lumbar interbody fusion with the addition of a polyetheretherketone (PEEK) cage at lumbar levels L1-L2 and L3-L4. The cage was either filled with one of three different concentrations/doses of rhBMP-2 (0,5 mg/ml, total dose of 0,5 mg; 1.0 mg/ml, total dose of 1.0 mg; 2.0 mg/ml, total dose of 2.0 mg) applied to a collagen sponge (ACS) or left empty. In all surgical levels a dorsal spondylodesis using a pedicle-screw system was additionally performed. Thin-cut CT image were taken directly postoperatively, after 3 month, 6 month and 12 month to assess the fusion status as well as possible adverse effects of rhBMP-2, cage subsidence and migration and bone resorption as well as overzealous bone growth.
RESULTS: In comparison with the control group the fusion results were improved if rhBMP-2 was used. Bone resorption and overzealous bone growth was observed more frequently in the rhBMP-2 groups than in the control group. Overzealous bone growth was mainly found at the right-ventral side of the vertebral body, at the site of surgical access. Neither ectopic ossification for new bone growth in the spinal

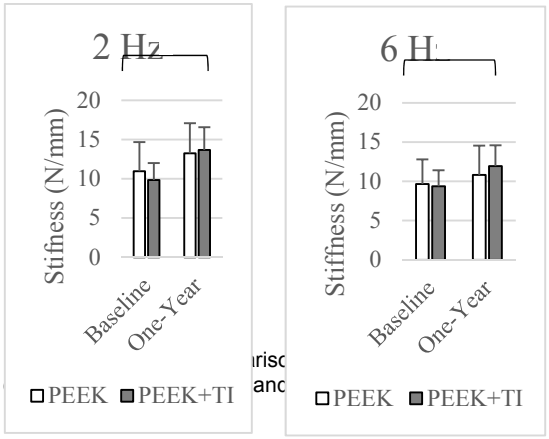
canal was observed. The incidence of cage migration and subsidence as possible indirect marker of transient bone resorption was higher in the interventional groups. No clear dose-/concentration-dependency of these adverse effects could be established although the incidence was lower in the 0,5 mg rhBMP-2 group.
DISCUSSION: In this large animal study good fusion results were found if rhBMP-2 was applied in the studied three concentration/ doses. In the 0,5 mg rhBMP-2 group good fusion results along with a lower incidence of cage migration and subsidence were observed. Still, the adverse effects could not be fully avoided in any of the concentrations/doses of rhBMP-2 used in this preclinical study.

P21

DOES AN INTERBODY FUSION CAGE WITH NANOSCALE POROUS TITANIUM COATING INCREASE SPINAL SEGMENTAL STIFFNESS? AN IN VIVO BIOMECHANICAL ANALYSIS IN AN OVINE MODEL

Robert Gunzburg, Christopher J. Colloca, Jeb McAviney, Mostafa Hegazy Afifi, Claire F Jones, David J Hall, Marek Szpalski, Brian J.C. Freeman,
Belgium, Australia, USA

INTRODUCTION: Objective measures to evaluate spinal fusion are commonly limited to qualitative radiological observations that do not acco-unt for the force-displacement response of the spine under external loading. Confirmation of increased spinal stiffness following arthrodesis is paramount to the underlying aim of the surgical procedure. New surface coatings and textures have been developed for cages to purportedly enhance spinal fusion; however, to our knowledge none have been evaluated in vivo. The purpose of this study was to compare the in vivo biomechanical response of the L4/5 lumbar motion segment after placing two different interbody cages: 1) Polyetheretherketone (PEEK) interbody cage or 2) PEEK interbody cage with a nanosurfaced titanium porous scaffold (PEEK+Ti), Nanovis Inc, Columbia City, IN) in an ovine model.
METHODS: Fourteen skeletally mature Merino sheep (mean 69.6 kg) randomly received either 1) standard PEEK cage or 2) PEEK+Ti cage as part of an L4/L5 interbody fusion with autologous bone graft. Under general anaesthesia, a validated dynamic mechanical testing assessment was conducted in all animals at baseline and at one-year post surgery. A computer-controlled voice coil actuator equipped with a load cell and linear variable displacement transducer (LVDT) randomly delivered (50 N peak, ~15% body weight), oscillatory dorsoventral (DV) mechanical periodic excitations of 2 Hz, 6 Hz, and 12 Hz at the L3 spinous process. Six trials were administered at each frequency while L3 force and displacement and L4-L5 accelerations were recorded at 2500 Hz over a 13 second time interval. The DV secant stiffness (ky = force/displacement, N/mm) and intersegmental accelerations were determined at each frequency. A repeated measures ANOVA with Bonferonni correction evaluated within and between group differences of stiffness and intersegmental acceleration variables at each excitation frequency, alpha = 0.05.
RESULTS: At 2 Hz, both the PEEK and PEEK+Ti cage implants increased spinal stiffness by 21 and 39%, respectively at one-year follow up, ($p<0.005$). Significant, but less pronounced 12 and 27% increases in stiffness were observed respectively with the PEEK and PEEK+Ti groups at 6 Hz ($p<0.0001$). Significantly greater spinal stiffness was observed in the PEEK+Ti group compared to the PEEK group at one-year follow up at both 2 Hz and 6 Hz (Figure 1), ($p<0.05$). No significant differences in spinal stiffness were observed at 12 Hz within or between groups when comparing baseline to one-year follow-up. At 2 Hz, 6 Hz and 12 Hz, L4-L5 y-axis accelerations were significantly decreased one-year following cage placement only in the PEEK+Ti group ($p<0.05$) and greater acceleration decreases were observed in the PEEK+Ti group compared to standard PEEK ($p<0.05$).
Conclusions: At 2 and 6 Hz excitation frequencies, PEEK interbody fusion cages with or without a nanotechnology achieved increased spinal stiffness at one-year follow up. At these frequencies, nanosurfaced titanium porous scaffold cages resulted in greater changes in spinal stiffness and concomitant decreases in L4-L5 accelerations at all frequencies examined at one-year follow-up compared to a standard PEEK cage.



P22

WHY DOES CEMENT LEAKAGE EASILY OCCUR IN BASIVERTEBRAL FORAMEN (BF) DURING VERTEBRAL AUGMENTATION PROCEDURES? A VIEWPOINT FROM TRABECULAR ORIENTATION AND INJURY

Fengdong Zhao,Shengyun Li,Chongyan Wang,Tianming Yu,Xuyang Zhang,Zhi Shan
Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University Hangzhou, Zhejiang, China 310000, China, People's Republic of

INTRODUCTION: Our previous study demonstrated type B (through BF) leakage was the most common in vertebral augmentation, but the mechanism of it was still controversial. How vertebral trabecular bone orientation and injury after compression fatigue fracture influence the cement leakage was still unknown.

AIM: To explore why cement leakage easily occur in BF during vertebral augmentation procedures.

MATERIALS AND METHODS: 12 fresh-frozen human lumbar spines (T12-L5) were collected and divided into 24 three-segment-unit fromT12-L2 OR L3-L5. Mechanical testing was performed to simulate a compression fatigue fracture. All units were soaked in normal saline (NS) to perform Micro-CT scans before and after mechanical testing, microstructure of the superior/middle(contained BF)/inferior 1/3 of vertebral body was analyzed (including SMI, BV/TV, Tb.N, TB.SP, TB.TH, Conn.D, and BMD) . The diameter variation of interspace inter-trabecular before and after compression fatigue fracture was used to quantize trabecular injury. Vertebral augmentation and imageological diagnosis were used to evaluate cement leakage.

RESULTS: SMI, BV/TV, Tb.N, Conn.D, and BMD in middle region was lower than superior/inferior region (P<0.01). It showed that the middle part was the weakest in vertebral body. After compression failure, the 3D-reconstruction of the vertebral body by Micro-CT demonstrated that the counts of greatest size interspace in middle 1/3 increased remarkably, which revealed more serious trabecular injury in middle part when compression fatigue fracture occurred. For the cement leakage, type B leak was the most common as previous study.

CONCLUSION: Because the presence of BF, the middle part is the weakest region in a vertebral body. Trabecular bone in middle part suffered most serious damage when compression failure occurred, which resulted in the highest percentage of type B leakage. The inferior part endured slightest trabecular damage.

P23

AN IN VITRO BIOMECHANICAL COMPARISON OF ANTERIOR THORACOLUMBAR RECONSTRUCTION WITH SLIDING AND RIGID ROD CONSTRUCTS: KINEMATICS AND LOAD-SHARING

Ruozhou Zhou,Zhiping Huang,Xiang Liu,Jie Tong,Sheting Liu,Jianting Chen,Qingan Zhu
Dept. of Spine Surgery, Nanfang Hospital, Southern Medical University Guangzhou, China, People's Republic of

INTRODUCTION: The dynamic plate of cervical spine provided comparable stabilization as the locking plate and more load sharing to the graft. Kinematics and load sharing of an anterior thoracolumbar reconstruction with sliding rod construct remains unknown, particularly under compressive preload.

AIM: To evaluate kinematics of the anterior reconstruction of L1 corpectomy with sliding and rigid rod constructs, and compare load sharing of the graft in flexion and extension between the constructs.

MATERIALS AND METHODS: Eight human cadaveric specimens (T11-L3) were subjected to a pure moment of ±5.0 Nm in flexion-extension

(FE), lateral bending (LB) and axial rotation (AR), and in FE with a compressive preload of 300 N. An anterior reconstruction of L1 corpectomy was performed using a mimetic bone graft embedded with a miniature axial load-cell and an anterior sliding and rigid rod system, respectively. The sliding rod was a rod-in-a-tube construct, like a linear bearing, allowing 5 mm slide axially but no rotation. The sliding rod construct was applied to the specimen at the neutral position allowing elongation and shorten 2.5 mm, respectively. Three-dimensional motion and compressive force in the graft were recorded. Range of motion (ROM) and neutral zone (NZ) of T12-L2 segment, and load sharing were calculated, as well as the anterior and posterior sliding rod length.

RESULTS: Both sliding and rigid rod constructs reduced ROM and NZ in all directions ($P<0.05$) except in AR. The sliding rod construct resulted in more motion than the rigid rod construct in all directions (FE: 3.0±1.3° vs. 2.2±0.8° ; LB in one side:1.8±0.8° vs. 1.5±0.7° ; AR in one side:2.6±0.9° vs. 2.2±0.6°) (P0.05). The graft compressive force with the sliding rod construct was similar to that with the rigid rod construct (69±20 N vs. 63±30 N), but significantly higher under preload (123±51 N vs. 162±62 N, $P<0.05$). The compressive forces of the graft fluctuated in FE without preload, but increased in flexion and decreased in extension under preload. The anterior sliding rod elongated in flexion and shortened in extension (0.44±0.50 mm vs. -0.41±0.49 mm without preload; 0.50±0.22 mm vs. -0.55±0.23 mm under preload), while the length of the posterior sliding rod changed very few. Both anterior and posterior sliding rods elongated in contralateral LB and shortened in ipsilateral LB (Anterior: 0.34±0.20 mm vs. -0.29±0.17 mm; Posterior: 0.32±0.18 mm vs. -0.32±0.10 mm), but remained unchanged in AR (<0.1 mm).

CONCLUSION: The sliding rod construct allowed more motion compared to the rigid rod construct, but still stabilized the anterior reconstruction in all directions except in axial rotation. The sliding rods elongate and shorten in flexion-extension and lateral bending. The anterior graft shared higher load under preload, particularly with the sliding rod construct. The results of this study suggest that sliding rods in the anterior reconstruction provide comparable stabilization, allow more load sharing to the graft and may enhance the instrumentation if subsidence occurs.

P24

INFLUENCE OF DYNAMIC FACTORS IN L5/S1 FORAMINAL STENOSIS; EVALUATION BY 3D FINITE ELEMENT ANALYSIS

Yoshio Shinozaki,Hironari Takaishi,Naruhito Fujita, Satoshi Matsumaru,Yoshiomi Kobayashi, Yohei Takahashi,Jun Ogawa

Shizuoka red cross hospital Aoi-ku 4200853 Shizuoka-shi, Japan

INTRODUCTION: Involvement of dynamic factors in L5/S1 foraminal stenosis (LSFS) was not well known.

AIM: The purpose of this study is to investigate details of dynamic factors involved in symptom onset of LSFS using 3-dimensional (3D) finite element analysis.

MATERIALS AND METHODS: Multidetector-row computed tomography imaging data were used from surgical patients, diagnosed with radiculopathy due to L5/S1 craniocaudal foraminal stenosis based on preoperative imaging and intraoperative findings. Bony elements were rendered inhomogeneous based on formula by Keyak (J. Biomech 1998), Hofmann's ligament was added to dural canal, extraforaminal ligaments were added to intervertebral discs and facet joints, and patient-specific 3D finite element models (L1-sacrum) were established. To simulate standing sagittal balance, based on total length of spine and dynamic plain radiography, preload was applied at C7 plumb line and center of L1 vertebral endplate (Wilke et al., Spine 2003), a 7.5-Nm moment was applied to L1 vertebral endplate under sacral restraint, and anterior and posterior bending of lumbar spine were reproduced. Craniocaudal distance of L4/5/S1 foramina and intervertebral range of motion (ROM) were measured. In addition, foraminal cross-sectional area was equally divided into 4; and 4-mm regions of interest (ROIs) in medial, central, and lateral parts and outer edge of foramen, equivalent stress and minimum principal strain on nerve root were analyzed. A pelvic posterior tilt model with posterior deviation of L1-sagittal vertical axis (SVA) was created, and influence of

load axis changes on dynamic foraminal stenosis was analyzed.
RESULTS: Intervertebral ROM measured with 3D finite element model was in agreement with results from dynamic plain radiography. Craniocaudal distance of foramina decreased with posterior bending, from mean of 3.8 to 3.1mm (18.4% change) at damaged sides and 5.8 to 5.0mm (13.8% change) at undamaged sides. Peak equivalent stress (mean values) at damaged sides with posterior bending moment was 0.04 MPa at medial, 0.05 MPa at central and 0.11 MPa at lateral part. The highest stress was 0.19MPa at outer edge, 4.8-fold greater than that at undamaged sides. Peak minimum principal strain also increased at outer edge with posterior bending moment, reaching value 9.3-fold greater than that at undamaged sides. With posterior deviation of L1-SVA in pelvic posterior tilt model, percentage changes in equivalent stress and minimum principal strain on nerve roots increased after an axial pressure load and posterior bending moment.
CONCLUSION: Our study is the first to visualize dynamic analysis of LSFS using 3D finite element analysis. Radiculopathy due to craniocaudal foraminal stenosis should occur with dynamically compression on exiting outer edge of foramen, where running course of nerve roots are altered and degrees of freedom are restricted by posterolateral osteophytes of L5 vertebra. In addition, with posterior deviation of L1-SVA, stress concentration on nerve root increases synergistically. This suggests that spino-pelvic sagittal alignment may play an indirect role in pathology.

P25

REAL TIME EVALUATION OF SPINAL MECHANICS USING MRI

Alan Parish,Donal McNally,Penny Gowland
University of Nottingham NG7 2RD Nottingham, United Kingdom

Introduction: Currently, the only method of imaging spinal deformations in real time is to use video fluoroscopy which is unable to visualise soft tissues. MRI imaging of the spine under load is restricted to low field open scanners which have image acquisition times of the order biomechanical viscoelastic time constants of intervertebral discs.Aim: To validate the use of an MRI compatible cyclic loading device synchronised with gated video MRI, a pilot validation study was performed on an adult male with healed burst fracture at L4.
Materials and Methods: The subject was loaded cyclically at 40% body weight using an MRI compatible loading device at 0.25Hz. Video sagittal plane 3T MRI data sets, synchronised to the loading device, were captured at 16 time-points. Frame to frame motion of each vertebra was calculated using image correlation, by transforming the imaging in superior- inferior and anterior-posterior directions, as well as local rotation around the centre of each vertebral body. The transformations and following interpolation and remapping of each image was performed using software that was authored in-house. From these transformations image correlation was used to identify the motion and from this the axial compression, A/P shear and flexion/extension angle were calculated at each disc space.
Results: Axial compression and A/P shear of each disc space was measured with a resolution of 66 microns (0.2 of a pixel via interpolation) and 0.5 degrees. Motion of the deformed disc spaces adjacent to the healed fracture was not remarkable. The independent motion of the vertebra was also tracked and as such the transition of motion through the spine can be seen and identified; for example at the point of highest total motion of the spine, the disc at L2/L3 showed the highest axial compression of -0.33mm and the L4/L5 showing the highest A/P shear of -0.139 (mm). The mean and Standard deviation of all the discs can also be computed with the values for the highest total motion of the spine of the axial compression, A/P shear and felexion/extension were measured as -0.089±0.128, -0.005±0.080 and 0.00±0.447 respectively.
Conclusion: This study demonstrates the utility of using video MRI of dynamically loaded spine in vivo using a conventional high field clinical imager. This technique can provide distinct measurements of how each of the individual vertebrae move and allow for the forces on the discs determined.

P26

EFFECT OF LOOSENING AND RETIGHTENING ON PEDICLE SCREW CLOSURE MECHANISM STRENGTH: A BIOMECHANICAL STUDY

David Nuckley, Amir Mehbod, Chris Ferry, Anup Gandhi

Zimmer Biomet Spine Minneapolis 55439, United States

Introduction: Pedicle screw fixation, the standard for spinal fixation after deformity correction, relies on the screw-to-bone purchase and screw-to-rod interconnection strength. Few studies exist which detail the strength of the interconnection of the pedicle screws and rods. The need to adjust screw-to-rod position, bend a rod, or rotate a rod to gain proper spinal correction and alignment necessitates loosening of closure tops and retightening. Unfortunately, the effect of tightening, loosening, and retightening on the resulting screw-to-rod interconnection strength has not been well reported.

Aim: The objective of this research was to evaluate a newly designed pedicle screw closure mechanism for its ability to retain the grip strength of the screw-rod interconnection in the face of secondary loosening and retightening activities intraoperatively.

Materials and Methods: A benchtop repeated measures factorial study design was used to evaluate a pedicle screw design in torsional gripping capacity after: 1) initial tightening, 2) after 3 cycles of loosening and tightening, and 3) after 6 cycles of loosening and tightening. The biomechanical outcomes of this study included the normalized torsional gripping capacity in accordance with ASTM F1798-13. A new pedicle screw design (N=10) was evaluated in torsional grip after: 1) initial tightening, 2) after 3 cycles of loosening and tightening, and 3) after 6 cycles. The screws were tested on Ø5.5 and Ø6.0 rods under the same closure top tightening torque.

Results: After 3 cycles of loosening and tightening on a Ø5.5 rod, the torsion grip strength increased by 8.4%. Subsequent cycling (6 total) resulted in a 2.1% drop in the torsional grip capacity which was still 6.2% above initial tightening. This significant ($p < 0.0157$, ANOVA) pattern of torsional grip strength was similar on Ø6.0 rod, but with an overall higher gripping strength, and all failures were surface slipping only.

Conclusion: After 6 cycles of tightening and loosening, the torsional grip strength of the screw on the rod was retained and slightly improved, portending a strong surgical fixation regardless of manipulation and correction which may require loosening. The current screw design has been optimized for grip on the rod such that its performance after loosening and retightening is not diminished. The significance of this feature has not been well studied, but warrants further investigation and discussion as it relates to spinal deformity correction and fusion.

P27

CHARACTERIZATION OF THE STANDING POSTURE IN ADULT SPINAL DEFORMITY PATIENTS

Mitsuru Yagi,Shinjiro Kaneko,Yoshiyuki Yato, Masafumi Machida,Takashi Asazuma

National Hospital Organization Murayama Medical Center Tokyo 2080011 Tokyo, Japan

INTRODUCTION: Questions regarding to the standing balance and posture in patients with adult spinal deformity (ASD) have not yet been fully answered. The discrepancy of natural posture and hands-on-mandibular (or hands on clavicle) has been reported.

AIM: To assess the balance during natural standing of ASD patients and relate it to the demographic and radiographic factors.

MATERIALS AND METHODS: 40 consecutive adult female patients with ASD but without neurological deficit were included. Charts and Xrays were reviewed. The standing posture and balance of the patients were compared with those of gender, age, and BMI matched 33 healthy volunteers. All patients received standing posture analysis with optical markers in the all joints, the ear canal and spinal processes on a custom-built force platform 60 seconds with open their eyes. To evaluate the lean composition of lower leg, whole body DXA score was obtained from all patients. The sagittal distance from center of gravity (COG), to head (Hd), heel (Hl), and to sacrum (S) were also measured and spinal tilt, pelvic obliquity, and pelvic tilt were calculated. Means were compared with Mann-

Whitney U and chi-square test. P value of <0.05 with confidence Interval 95% was considered significant.

RESULTS: The mean age was 65.4 years (51-72 years) and BMI was 22.6±2.7kg/m2 The Cobb angle was 52.8±18.2 deg., CVA 1.5±3.7cm, C7PL 9.1±6.4 cm, Gravity Line (drawn from the ear canal) 10.3±8.0cm, thoracic kyphosis 17.1±15.9 deg., lumbar lordosis -7.3±21.5 deg. PI-LL 41.1±25.2 deg., and the lean volume of lower leg was 5.5±0.6 kg. Significant difference was observed for envelope area of COG (G), Rt and Lt difference of ground reaction force (dGRF), hip angle (dHip) and knee angle (dKnee) during standing. (Env COG 2.4±2.5cm2, dGRF 15.4±8.6%, dHip 6.0±4.5deg, dKnee 5.1±5.2deg). The Y-axis distance of COG, Hd-G distance, and S-G distance were also significantly worse in ASD patients. (Y-dist. 16.2±12.6cm, Hd-G 5.4±5.3cm, S-G 12.7±4.4cm). Significant correlation was observed between dGRF and radiographic trunk shift or CVA (R=0.22 and 0.21), and between dhip or dknee and trunk shift (R=0.28 and 0.29). Multiple regression analysis showed the significant correlation between 2 dimensional head deviation (Hd-Hl distance) and hip angle, thoracolumbar kyphosis, spinal tilt and head-sacrum distance

CONCLUSION: In ASD patients, standing balance was significantly unstable and the weight bearing was uneven. Head deviation and pelvic shift were most correlated with the outcomes. Spinal deformity was not uniplanar but biplanar deformity, The compensatory lower leg flexion was developed not only to maintain the sagittal balance but also to maintain the coronal balance. Motion analysis will be the next horizon to foster the comprehension of the pathology of ASD.

P28

EFFECT OF POSTURE ON INJURY OF THE THORACOLUMBAR JUNCTION UNDER AXIAL LOADING

Alexandros Christou,Edward Spurrier,Grigorios Grigoriadis,Spyridon Masouros

Imperial College South Kensington SW7 2AZ London, United Kingdom

Introduction: There is evidence that posture of spinal segments affects their biomechanical response [1]. Although spinal injury has been examined previously [2], there has been no association of injury with posture during a high-rate axial loading scenario; axial loading is a common mechanism of spinal injury, particularly for falls and vehicle incidents including explosions. We hypothesise that posture during such incidents affects the type of injury suffered.

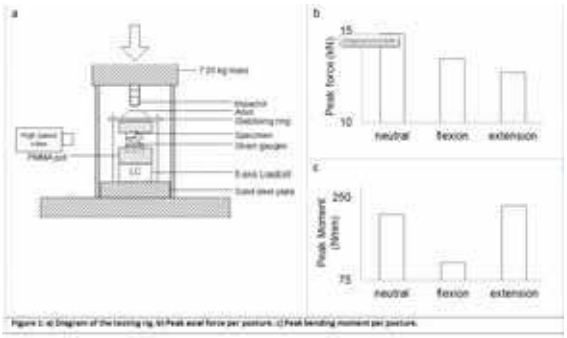
Aim: The purpose of this study was to test the effect of posture of human cadaveric bi-segments on response and injury under axial impact conditions.

Materials and Methods: At the time of writing, three human cadaveric spines had been dissected (age 42-58, male) and T11-L1 bi-segments were isolated. Muscle tissue was removed while the major ligaments remained intact. Three postures were selected: a) 10° flexion, b) 0° flexion (neutral) and c) 5° extension. The caudal and cranial vertebrae of each bi-segment were secured in pots using bone cement. Desired postures were achieved by resting the vertebral bodies on plastic wedges, placed at the bottom of each pot. The pots were secured on tooling plates parallel to one another with bolts to ensure that the pots were parallel to one another. Each sample was tested in a Dynatup 9250HV drop rig (Instron Inc., Norwood, USA) with a 7 kg weight that impacted the sample at 3.5 m/s (Figure 1a). Forces were measured at the bottom using a 6-axis load cell (Sunrise Instruments, USA). A high-speed camera (Phantom V210, Vision Research, Ametek, USA) was used to capture displacements and fracture initiation. The impacted specimens were CT-scanned and dissected to identify the fracture pattern for each posture.

Results: Peak axial and bending moments are shown in Figure 1b and c, respectively. All specimensfractured and showed a superior T12 burst fracture. The neutral posture showed also retropulsion of less than 5 mm.

Conclusion: A first step has been made towards reproducing high-energy injuries and quantifying the response of bi-segment spinal specimens under high-rate axial loading at different postures. Peak axial force to failure was found to be similar for flexed and extended postures for this small sample size; the bending

moments, however, were dissimilar between postures. These preliminary results may suggest that axial force alone is not adequate to predict injury in the lumbar spine. As metrics for spinal injury in surrogates take into account only the axial force [3], this programme of work may provide data for a better injury criterion and allow for a mechanistic understanding of the effects of posture on injury risk.



Reference(s):

1. Adams and Hutton, J. Bone Joint Surg. Br, 1985
2. Yoganandan et al, Ann Adv Automot Med, 2013
3. NATO HFM-090TG 25, 2007

P29

INTERVERTEBRAL DISC AND FACET JOINT CONTRIBUTIONS TO THE SIX DEGREE OF FREEDOM MECHANICAL PROPERTIES OF DEGENERATED HUMAN SPINE SEGMENTS

John Costi,Isaac Lawless,Dhara Amin,Dana Sommerfeld,Richard Stanley,Boyin Ding
Flinders University 5001 Adelaide, Australia

Introduction: The functional spinal unit (FSU) is a three joint multiplex comprised of an intervertebral disc (IVD) and two sagittally symmetrical di-arthrodial synovial facets, which provides strength and flexibility to the healthy spine. The pathological spine can experience deficits in mechanical behavior or pain as a result of injury or degeneration to one or more of these joints. Accordingly, current interventions tend to treat and replace the FSU component-wise. However, there remains limited literature on the complex six degree of freedom (6DOF) mechanical properties of the joints, whose nominal function these interventions should reproduce in order to restore quality of life.

Aim: To determine the component-wise contribution of the IVD and facet joints to the 6DOF mechanical properties of the FSU.

Materials and Methods: Fifteen intact human lumbar FSUs were dissected from human lumbar spines (mean (SD) age 76 (11) years, Thompson grades 3 (N=6), 4 (N=6), 5 (N=3)). Each intact FSU was tested along 6DOF directions under hybrid position-load control at 0.1 Hz using haversine waveforms while exposed to physiologic preload (0.5 MPa), hydration (protease-inhibited, phosphate-buffered saline bath) and temperature (37°C) conditions in a hexapod robot. The testing suite was then repeated after a complete facetectomy, leaving only the IVD. Non-destructive cycle amplitudes were 1.1 MPa compression, 0.6 mm shear, 3° lateral bending, 5° flexion, 2° extension and 2° axial rotation. Average stiffness over the entire final load-unload cycle and phase angle over all loading cycles was calculated for all specimens in each DOF. Bonferroni-adjusted paired t-tests were used to detect significant differences ($p<0.05$) between the intact FSU and IVD tests in each direction. Dependent samples t-test for equality of means was used to assess directional symmetry.

Results: No significant differences were seen for symmetry between left/right lateral shear, lateral bending and axial rotation, and were pooled for analysis. Significant differences in stiffness were found between FSU and IVD in lateral shear ($p<0.001$), axial rotation ($p<0.001$), extension ($p<0.001$), anterior shear ($p=0.002$) and posterior shear ($p=0.005$). For phase angle, significant differences were observed for lateral shear ($p<0.001$), axial rotation ($p=0.001$), extension ($p<0.021$), and lateral bending ($p=0.008$). No significant differences were seen in compression and flexion for both stiffness and phase angle.

Conclusion: The contribution of the facet joints was highly direction dependent and were found to produce nonlinear behaviour in the FSU. Significant differences for stiffness between FSU and IVD were present in all shear directions, axial rotation, and extension, which are DOFs known to engage the facets. The largest differences occurred in anterior shear, extension, and axial rotation. Minor facet contributions to stiffness were seen for

compression, lateral bending, and flexion, implying minimal facet joint interaction.

P30

RAPID AND DISTORTION-FREE DIFFUSION TENSOR IMAGING FOR EVALUATION OF LUMBAR NERVE ROOTS USING DIRECT CORONAL SINGLE-SHOT TURBO SPIN-ECHO DIFFUSION SEQUENCE

Takayuki Sakai,Yasuchika Aoki,Masami Yoneyama, Noriyuki Yanagawa
Eastern Chiba medical center 283-8686 + Chiba, Japan

INTRODUCTION: Diffusion Tensor Imaging (DTI) based on single-shot Echo Planner Imaging sequence (EPI-DTI) is established method to evaluate lumbar nerve roots compression, because several studies have shown that DTI and tractography of human lumbar nerves can visualize and quantitatively evaluate lumbar nerves by fractional anisotropy (FA). Although EPI-DTI might be helpful for evaluating lumbar nerve compression, it has several problems such as long acquisition time and geometric distortion. To solve these problems, we attempt to apply DTI based on single-shot Turbo Spin Echo sequence (TSE-DTI). Additionally, to reduce the total acquisition time, we applied to set direct coronal acquisition.

AIM: The purpose of this study was to measure the FA values of lumbar nerve roots in healthy volunteers and in patients with neurological symptom of legs, by using TSE-DTI. Moreover we also investigated whether tractography is useful for visualizing lumbar nerve roots entrapment by using TSE-DTI.

MATERIALS AND METHODS: All subjects were examined with 1.5T whole-body clinical system (Ingenia, Philips Healthcare). The study was approved by the local IRB, and written informed consent was obtained from all subjects. (1) Parameter optimization of TSE-DTI: A total of six healthy volunteers of lumbar nerve roots (L4 to S1) were examined. We compared b-values and MPG directions by depictabilitty of tractography and the FA values. (2) Comparison of optimized TSE-DTI and EPI-DTI: We compared depictabilitty of tractography and the FA values between TSE-DTI and EPI-DTI in six healthy volunteers and six patients.

RESULTS: In parameter optimization, tractography of b-value of 400s/mm2 depicted well lumbar nerve roots more distally to extraforaminal area compared to other b-values. Furthermore, increasing MPG directions improved the continuity of lumbar nerve roots on the tractography. In EPI-DTI, the fusion image, which was consists by tractography and three-dimension T2-weighted TSE, was misaligned in the direction of phase encode due to the geometric distortion of EPI-DTI. On the other hand, TSE-DTI could improve the reliability of tractography due to its less distortion sensitivity. In TSE-DTI, tractography of the patients with symptomatic side of lumbar nerve roots indicated abnormalities. The FA values of symptomatic side were significantly lower than those of asymptomatic side.

CONCLUSION: TSE-DTI might more accurately evaluate compressed lumbar nerve roots compared to conventional EPI-DTI. Additionally, tractography of TSE-DTI enables visualization of abnormal nerve tracts and has a lower geometric distortion for diagnosing lumbar nerve compression than EPI-DTI.

References:

1. BalbiV, et al. Tractography of lumbar nerve roots: initial results. Eur Radiol 2011;21(6):1153–9.
2. Eguchi Y, et al. Quantitative evaluation and visualization of lumbar foraminal nerve root entrapment by using diffusion tensor imaging: preliminary results. Am J Neuroradiol 2011;32(10): 1824–9.

P31

ASSESSMENT OF MAGNETIC FIELD INTERACTIONS AND RADIOFREQUENCY HEATING ON METALLIC SPINAL IMPLANTS AT 7 TESLA

Itsuko Tsukimura,Hideki Murakami,Norio Numata, Hirooki Endo,Takaaki Saigo,Daisuke Yamabe, Koou Chokan,Minoru Doita
Iwate Medical University 0208505 Morioka, Japan

INTRODUCTION: The safety of these materials in ultrahigh field MR imaging at 7T which has recently been introduced for the purpose of clinical research, has not been examined.

AIM: We measured deflection angles of the spinal implants to evaluate the strength of translational attraction in the static magnetic field and the temperature elevation of spinal

implants by RF in order to investigate the safety of 7T MR Imaging.
MATERIALS AND METHODS:
1. Deflection angle test: This study was conducted according to the method suggested by the American Society for Testing and Materials (ASTM). This study included pure titanium, titanium alloy, and cobalt chrome rods with a diameter of 5.5 mm and full lengths of 5, 10, 15, and 20cm. MR Imaging apparatus of 3T and 7T were used for deflection angle measurements. Each metal to be tested was hung on a self-produced deflection angle measuring instrument. The deflection angle was defined as the angle generated when a rod was attracted in the axial direction within the static magnetic field of the MR Imaging apparatus.
2.Temperature elevation test: A 7T MR Imaging apparatus was used to test rise in temperature by measuring the temperature elevation of specimens embedded within a gel-like human-body-equivalent electromagnetic phantom, comparing metal alone with metal in a setting similar to a clinical situation.
RESULTS:
1. Deflection angle test: The deflection angles (°) generated by the 7T apparatus were 6.2, 7.7, and 21.0 for pure titanium, titanium alloy, and cobalt chrome, respectively; by the 3T apparatus, 2.0, 2.3, and 6.3 for pure titanium, titanium alloy, and cobalt chrome, respectively.
2. Temperature elevation test: The temperature elevations of specimens by the 7T apparatus were 0.76, 0.75, and 0.83 for pure titanium, titanium alloy, and cobalt chrome, respectively. An increase of temperature was observed in all metals (including control) and under all imaging conditions . however, all increases were within a range of 1°C. There was no difference in the temperature elevation in the length.
CONCLUSION:
1. Deflection angle test According to ASTM guidelines, no harm is expected to a patient if the deflection angle is less than 45°. In this study, all deflection angles generated in the metals tested were less than 45°, with no high-risk conditions.
2. Temperature elevation test The temperature elevation range was within 1°C in all metals, and no notable difference was found between the control and the spinal implants. We can therefore confirm that heat generation in the phantom is similar to that in spinal implants. Our findings suggest that the spinal implants used in this study are unlikely to affect the living body in ultrahigh field MR Imaging at 7T apparatus.

P32

ADAPTATION OF THE GLOBAL SAGITTAL BALANCE OF THE SPINE AND THE SEGMENTAL ORIENTATION OF EACH VERTEBRA FROM THE STANDING TO THE SITTING POSITION. A C2 TO S1 STUDY WITH THE EOS SYSTEM

Marc-Antoine Rousseau,Imen Tahar,Brusson Adrien,Jean-Yves Lazennec
Assistance Publique - Hopitaux de Paris 125 rue de Stalingrad 93000 Bobigny, Finland

INTRODUCTION: The sagittal balance of the spine in the sitting position has previously been described, though its influence on the orientation of each vertebra is not well documented. Our interest in the local functional anatomy at every segmental level and specifically the orientation and position of the disc spaces is motivated by its potential interest to define the boundary condition in the study of the mechanical behavior of the disc prosthesis for example or the adjacent disc to an arthrodesis.
MATERIALS AND METHODS: The radiological biplanar EOS images of 30 healthy subjects (11 female and 19 male) aged 25 to 64 were analyzed. One acquisition was done in the standing position and one in the sitting position on a stool (no backrest). The stereos software was used to measure from the 3D reconstructions the global spinal parameters (sagittal vertical axis, CAM plumb line, T1 sagittal tilt, T9 sagittal tilts) and the local spinal parameters at each level from S1 to C2: vertebral slope (VS), vertebral tilt (VT), and incidence-like angle (ILA) such as ILA=VS+VT.
RESULTS: The average SVA was 9.4 mm in the standing and 56.7 mm in the sitting position ($p<0.001$). On average the variations of vertebral slope were below 5° from C2 to T1 and at L3 ; between 5° and 10° from T2 to T8 and between 10° and 15° from T9 to S1 except L3. On average, the variation of the sagittal tilt was below 5° from C2 to T10 ; between 5° and 10° from T11 to L1 ; between 10° and 15° at L2;

between 15° and 20 ° at L3 and between 20° and 25° from L4 to S1.
DISCUSSION: The use of the Eos system provides complete sets of sagittal data at the segmental level. The use of the stereos software with 3D reconstructions allowed taking into account any possible slight bias in term of axial rotation. The thoracolumbar junction and the lower lumbar spine showed the maximal change in the orientation of each vertebra from the standing to the sitting posture. The lower lumbar vertebrae showed the maximal change in the sagittal tilt meaning huge variation in their relative position that shall probably be taken into account for biomechanical studies or simulations. Levels above T9 are less influenced by the standing / sitting adaptation.

P33

SWELLING PRESSURE IN THE NUCLEUS PULPOSUS: DO WE REALLY UNDERSTAND IT?

Kaj Emanuel,Albert van der Veen,Pieter-Paul Vergroesen,Koen van der Laan,Idsart Kingma, Theodoor Smit
VU University medical center room 3f027 1081HZ Amsterdam, Netherlands

INTRODUCTION: So far, no successful replacement of the nucleus pulposus has been introduced. Better understanding of the function of a healthy nucleus is essential to improve this. Currently, the swelling in a nucleus is seen as an osmotic-driven pressure. However, osmosis is a poorly understood process. To better understand how osmosis facilitates swelling, a series of experiments was conducted.
AIM: To determine the role of osmosis in physiological biomechanical behavior.
METHOD AND MATERIALS: Study 1: caprine intervertebral discs were cultured for 6 or 10 days in a Loaded Disc Culture System with or without addition of highly osmotic PEG (13.3% or 26.6%) in the medium. A physiological loading regime was applied and disc height changes were monitored. Study 2: different forces (150, 300, 600, 850 N) were applied statically on discs for 3 days. The discs were submerged in alternating saline and demineralized water. Disc height changes were monitored, and time constants were obtained. Study 3: a constant load of 150 N was applied for 2 days on intervertebral discs with inserted pressure needle. When in equilibrium, different osmotic solvents (salts, uncharged polymers, charged polymers) were added. Influence on intradiscal pressure and disc height was measured.
RESULTS: Study 1: increase of the osmolarity of the medium reduced the disc's water content and disc height dose-dependently. Overall, the biomechanical behavior became less dynamic, and resembled the behavior of degenerated discs. Correction of medium osmolarity restored normal biomechanical behavior (Figure 1).

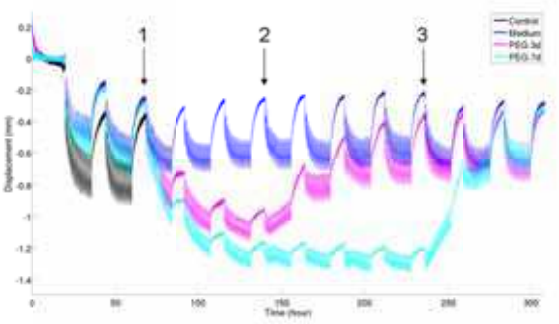


Figure 1. Changes in disc height under physiological load. After two days of preloading (p1), PEG was added for three (p2) or seven (p3) days. Total restoration of biomechanical behavior was observed.

Study 2: although osmotic loading is considered equal to mechanical loading in cartilaginous tissues, time constants of disc height loss due to mechanical loading were averaged 7x smaller than due to osmotic loading. Additionally, no direction-dependent resistance to fluid flow was found in the entire intervertebral disc. Study 3: intradiscal pressure increases instantly under mechanical load, and then reduces over time due to water loss. Increasing the osmolarity of the medium reduces the intra-discal pressure. However, this varied with size and charge of the solvent.
CONCLUSION: The reduction in disc height in the intervertebral disc under mechanical load is much faster than under osmotic load, implying that these are different processes. However, in equilibrium and in recovery, osmosis plays an important role in water imbibition. High-osmotic medium reduces water content in the discus. The biomechanical behavior under physiological load then shows remarkable similarities to degenerated human discs. Interestingly, this is reversible, indicating that increase of osmotic

potential in a disc may restore function in degenerated discs. However, osmosis is a complex process, where size and charge of the solvent play a role.

P34

BIOMECHANICAL EVALUATION OF VERTEBRAL COLUMN REPLACEMENT FOR OSTEOPOROTIC VERTEBRAL COLLAPSE - IMPORTANCE OF ANTERIOR LOAD SUPPORT BY THE LATERAL WALL OF THE VERTEBRA

Hironari Takaishi,Naruto Fujita,Satoshi Matsumaru, Yoshiomi Kobayashi,Youhei Takahashi, Yoshio Shinozaki,Jun Ogawa
Institute of Med. Sci., Tokyo Medical University Tokyo 160-8402, Japan

Introduction: Neurologic deficit caused by osteoporotic vertebral collapse is accompanied by severe spinal deformity and is often difficult to treat. Reconstruction of the damaged anterior column is necessary to restore the support and correct the deformity. Aim: Biomechanical evidence for selecting a surgical procedure has been lacking. We therefore simulated reconstructive surgery for severe vertebral collapse using 3-dimensional (3D) finite element analysis to assess dynamic stability.
MATERIALS AND METHODS: Multidetector-row computed tomography (MDCT) data from patients with osteoporotic vertebral collapse were used to establish a 3D finite element model. Patient-specific standing sagittal balance was simulated based on radiographic images. By applying a preload on the C7 plumb line, trunk muscle strength, and a 6.0-Nm bending moment in the region of interest, a dynamic Th9-L3 spinal unit was reproduced. Under the same conditions of kyphosis correction, vertebroplasty (VP), cylindrical-cage vertebral column replacement (VCR), and end-cap cage vertebral column replacement using an eXtreme lateral interbody fusion approach (XLIF-VCR) of a collapsed Th12 vertebral body were simulated, both with and without pedicle screw (PS) fixation. Changes in the local kyphosis angle with a dynamic moment, and equivalent stress and minimum principal strain on endplate of the adjacent segment and implant were measured. In addition, an in situ model was created without kyphosis correction and C7-SVA >100 mm to analyze the influence of the load axis.
RESULTS: Dynamic change in local kyphosis angle depended on the amount of PMMA filler used in VP and decreased with PS fixation, but the change was 2.9-fold greater than with VCR and 6.8-fold greater than with XLIF-VCR. Compressive stress-strength ratio on endplate of the adjacent segment was highest with VCR, a value 3.5-fold higher than with XLIF-VCR during flexion moment, and decreasing to 13.4% when PSs were used with VP. In the in situ model, with anterior deviation of the C7-SVA, minimum principal strain on the adjacent endplate increased excessively after VP and VCR, but with XLIF-VCR, the stress was equally distributed on the lateral walls of the vertebra and the increase in stress-strength ratio around the PSs at the craniocaudal ends of fusion was limited.
CONCLUSION: With vertebral body replacement by VP or VCR, control of inter- and intra-vertebral instability is poor, whereas with XLIF-VCR, equal distribution of stress over a wide area, including the lateral walls of the vertebra, increases stability of the reconstructed column. This also reduces the mechanical stress on the PS anchor supporting the fragile bone. Moreover, global sagittal imbalance can dynamically increase the strain on the anterior column. Selecting an effective surgical technique was therefore considered important to maintain a stable corrected position in consideration of the surgical invasiveness.

P35

BASIC SCIENCE RESEARCH TOPIC TRENDS IN SPINE-RELATED PUBLICATIONS

David Sing,Stefan Dudli
University of California San Francisco apt 1 94122 San Francisco, CA, United States

Introduction: Basic science research improves patient care through discovery of innovative treatment alternatives. Surgeon-scientists face challenging barriers in the uncertainty of basic science funding support and increasing clinical productivity demands in academic medical centers. Identifying current basic science trends in spine-related research may assist aspiring

investigators and trainees through familiarization with the direction of future research.
Aim: To identify 1) recent research topics in spine-related basic science and 2) topics trending "hot" or "cold" from five spine-related publications over the past 10 years.
Materials and Methods: Complete bibliographic content from the National Library of Medicine PubMed database was extracted from 1978-2015 for all original journal articles published in European Spine Journal (ESJ), the Spine Journal (SpineJ), Spine, Journal of Spinal Disorders and Techniques (JSDT) and Journal of Neurosurgery: Spine (JNS). Latent Dirichlet Allocation (LDA) topic modelling was applied to discover 100 topics, resulting in each abstract being assigned a probability of belonging in a topic1. Topic popularity was assessed using the percentage of abstracts belonging to a topic relative to the total number of abstracts published in each year. Topic names were manually assigned after LDA classification and basic science topics were identified. Simple linear regression and Cochran-Armitage trend testing were used to evaluate the significance of increasing ("hot") or decreasing ("cold") topic popularity over time.
Results: 24,931 original scientific articles published in five prominent spine research journals from 1978-2015 were classified into 100 topics. 33 topics were identified as basic research (29.9% of all articles), 48 topics were identified as clinical research (49.4%), and 19 topics were identified as practice management/ policy (20.6%). Despite growth in the number of basic science journal articles published at a rate of 12.8 articles per year (from 12 in 1978 to 461 in 2014), basic science topics steadily declined from 43% of all abstracts in 1987 to 23% relative to clinical and practice management/ policy topics. From 2005-2015 the top 3 most popular bench research topics were pedicle screw insertion biomechanics (247 articles), vertebroplasty cement biomechanics (228), and intervertebral disc biology (206). The top 3 hot topics were MRI-related (+1.26 articles/year, p=0.002), pedicle screw insertion biomechanics (+1.20 articles/year, p=0.005), and genetic polymorphisms (+0.54 articles/year, p=0.055). The top 3 cold topics were finite element modelling (-0.31 articles/year, p=0.126), disc morphology (-0.42 articles/year, p=0.006), and disc biology (-0.16 articles/year, p=0.699).
Conclusion: In 2015 basic science topics represented 23% of spine-related journal articles published in five prominent spine research journals. Increasing numbers of studies in medical imaging and biomechanical evaluation of pedicle screw insertion likely represent the enthusiasm over the advent of intraoperative navigation. Finite element modelling, disc morphology, and disc biology have become less frequently studied and may represent less competitive research topics in 2015.
References: 1.Griffiths TL, Steyvers M. "Finding scientific topics". Proc Natl Acad Sci. 2004;101 Suppl :5228–35.

P36

COMPARATIVE BIOMECHANICAL STUDY OF ANTERIOR COLUMN SUPPORT BY UNILATERAL PLIF, BILATERAL PLIF AND LIF IN DEGENERATIVE LUMBAR SCOLIOSIS

Hironari Takaishi,Naruto Fujita,Satoshi Matsumaru, Yoshiomi Kobayashi,Youhei Takahashi, Yoshio Shinozaki,Jun Ogawa
Institute of Med. Sci., Tokyo Medical University Tokyo 160-8402, Japan

Introduction: Asymmetric structural changes in the vertebral endplate occur with degenerative lumbar scoliosis (DLS). Use of the concave side is more suitable for a graft bed in corrective interbody fusion. DLS can be treated by lateral interbody fusion (LIF), an indirect decompression procedure that improves neurological disorders by enlarging the intervertebral foramen.
Aim: We examined the superiority of LIF from a biomechanical perspective as it relates to anterior column support in DLS, with the aim to determine the optimal interbody spacer components required for fusion.
Materials and Methods: Multi detector-row computed tomography imaging data from DLS patients (n=6) with a Cobb angle ≥30° were used to allocate bone density values determined from Hounsfield units. This allowed us to create a mechanically heterogenous patient-specific nonlinear finite element models of the L4-5 spinal segment, simulate a corrective interbody fusion by LIF/ bilateral or unilateral

posterior lumbar interbody fusion (PLIF) using PEEK interbody spacer, and analyze intervertebral range of motion (ROM), equivalent stress and strain distribution applied to the implant and the vertebral endplate under 6N.m dynamic flexion, extension, lateral bending or rotation moment with 400N follower preload.
Results: According to the FEA, LIF showed significantly restricted intervertebral range of motion in the fusion segments (31.2% for unilateral and 78.8% for bilateral under concave bending moment). The PLIF group showed high von Mises stress on the interbody spacers of the concave side, and bending toward the convex side yielded significantly higher minimum principal strain on the convex side endplate. However, relative to the bilateral or unilateral PLIF, the LIF group had more homogeneous dispersal of equivalent stress on the interbody spacers (29.6% for unilateral and 57.4% for bilateral), as well as less load on the rods and pedicle screw.
Conclusion: In DLS, mechanical strength of the endplate becomes compressive load unbalance. Performing a unilateral PLIF on the convex side can lead to loss of correction. In contrast, LIF had a great advantage in maintaining a stable anterior support, and reduced the strain on the vertebral trabecular endplate structure under dynamic moment. For LIF, using interbody spacers with a wide contact area spanning the vertebral transverse diameter can disperse the load added to the anterior column in the cortical bone portion of the vertebral body. This procedure may therefore help prevent correction loss of interbody fusion in DLS.

P37

REDUCING ROD BREAKAGE AND NONUNION IN PEDICLE SUBTRACTION OSTEOTOMY: THE IMPORTANCE OF ROD NUMBER AND CONFIGURATION IN 264 PATIENTS WITH 2-YEAR FOLLOW-UP

Munish Gupta,Jensen Henry,Virginie Lafage, Frank Schwab,Christopher Ames,Eric Klineberg, Justin Smith,Vedat Deviren, Christopher Shaffrey, Robert Hart,Richard Hostin,Gregory Mundis, Renaud Lafage,Doug Burton, International Spine Study Group
Hospital for Special Surgery New York, NY 10021, United States

Introduction: Pedicle subtraction osteotomies (PSO) can provide substantial realignment, but are associated with nonunion and rod failure. The addition of supplementary rods and interbody fusion (IBF) may decrease the failure rate.
Aim: To investigate if the addition of supplementary rods, IBF, or rod material/diameter decrease the failure rate.
Materials and Methods: This study is a consecutive, multicentre retrospective review. Adult spinal deformity patients with at least 1 lumbar PSO and 2-year follow-up were included. Demographic, operative, and radiographic data were collected. The number of rods across the PSO site was reviewed; more than 2 rods were categorized as accessory (A: connected to primary rods) or satellite (S: independently anchored). Potential risk factors were evaluated for PSO site failure (rod breakage or revision for nonunion).
Results: In 264 patients included, rod configurations were: 2 rods (2R)=190, 3R=36, 4R=38. There were no differences in demographics or sagittal alignment across groups. 2-3R had a trend of higher rates of failure (28%, 29%) than 4R (18%; P=0.128). In 3-4R constructs, S rods had significantly lower failure rates than A rods (10% vs 31%; P=0.034); accessory rods were similar to 2R (31% vs 29%; P=0.452). In 3-4R constructs, larger rod diameter (≥6.0mm) failed significantly less than 4.5-5.5mm rods (5% vs 33%; P=0.011). In 2R constructs, Ti rods had a significantly higher rate of breakage/nonunion (44%) than CC and SS (25%, 24%; P=0.037). There was no difference in failure by material in the 3-4R constructs (P=0.127). IBF at the PSO level resulted in fewer failures overall (21% vs 33%; P=0.046), and for 2R (22% vs 34%; P=0.112), 3-4R (16% vs 31%; P=0.164), and S (0% vs 27%; P=0.050) constructs.
Conclusions: This study confirms a high rate of nonunion and rod breakage in the 2 years following lumbar PSO surgery. The lowest rates of rod failure/nonunion were found in constructs with satellite rods, IBF adjacent to the PSO, and larger diameter rods.

P38

DO DIFFERENT DICHOTOMIZATION STRATEGIES OF RESPONDERS AND NON-RESPONDERS FIND DIFFERENT CORRESPONDING BIOMECHANICAL RESPONSES FOLLOWING SPINAL MANIPULATIVE THERAPY?

Arnold Wong,Eric Parent,Sukhvinder Dhillon, Narasimha Prasad,Dino Samartzis,Greg Kawchuk

Hong Kong Polytechnic University Hong Kong, Hong Kong

Introduction: Our recent research reveals that after receiving spinal manipulative therapy (SMT) for low back pain (LBP), only individuals who self-report clinically significant improvement in disability demonstrate immediate decreases in spinal stiffness, and increases in lumbar multifidus contractility and lumbar disc diffusion. Unfortunately, it remains unclear if these differential responses are attributed to SMT or the strategy used for dichotomizing responders/non-responders.

Aim: To determine if SMT responders and non-responders, as defined by three different dichoto-mization schemes, differed in their post-SMT responses as compared to asymptomatic controls or untreated LBP controls at baseline and beyond.

Materials and Methods: Participants with LBP and asymptomatic controls attended three sessions over seven days. Participants with LBP received SMT during the first two sessions (+LBP/+SMT, n = 32), while asymptomatic controls (-LBP/-SMT, n = 57) did not. On session 1, apparent diffusion coefficients of lumbar discs were obtained from +LBP/+SMT participants before and after SMT, and from a LBP control group that did not undergo SMT (+LBP/-SMT, n = 16). The coefficient is a proxy for lumbar disc diffusion. Spinal stiffness and lumbar multifidus thickness ratios [(contracted-rest)/rest x 100%] were assessed before and after SMT at each session and during session 3. The +LBP/+SMT participants were dichotomized as responders and non-responders based on: 1) a clinical prediction rule, 2) > 30% reduction in baseline Oswestry disability index (ODI), and 3) > 2 points reduction on an 11-point numeric pain scale (NPRS) on session 3. Various physical outcomes among groups were compared by repeated measures analyses of covariance.

Results: The CPR predicted 14 responders and 18 non-responders. Both ODI and NPRS classifications separately yielded 15 responders and 17 non-responders. After SMT, responders defined by all three dichotomization strategies demonstrated significant temporary/sustained post-SMT spinal stiffness reductions (0.23N/mm-0.59N/mm, $p < 0.05$). Conversely, only ODI and NPRS responders demonstrated significant immediate and sustained post-SMT increases in multifidus thickness ratios (3.49%-4.66%, $p < 0.05$). No significant change in spinal stiffness/multifidus characteristics was noted in the non-responders and asymptomatic controls. Likewise, only ODI and NPRS responders displayed significant between-scan increases in disc diffusion (3.5%-4.4%, $p < 0.05$), whereas the CPR responders, all non-responders and +LBP/-SMT control did not.

Conclusion: The consistent findings of NPRS and ODI responders substantiate a selective effect of SMT on specific biomechanical outcomes that may affect one another and that are responsive in some patients with LBP. While multiple dichotomization strategies may minimize the risk of identifying irrelevant coincidental physical responses of responders, not all strategies can provide biologically relevant information. Specifically, CPR-predicted responders demonstrated different biomechanical responses from the actual responders. Collectively, our approach is an important step toward a better understanding of the mechanisms underlying distinct therapeutic response and biomechanical characteristics of responders and non-responders.

P39

THE ANGIOGENIC CAPACITY OF HUMAN DURA MATER: A POTENTIAL FACTOR PROMOTING PERI-DURAL ADHESION AND FIBROSIS

Hong Joo Moon,Woo-Keun Kwon,Joohan Kim, Youn-kwan Park

Korea University Medical Center 08308, Seoul, Korea, South

OBJECTIVE: Peri-dural adhesion and fibrosis is one of the critical factors which could induce spontaneous neurogenic pain and failed back

surgery syndrome after any type of spinal intervention. However, the pathomechanism of peri-dural adhesion and fibrosis and the role of dura mater in this process have not thoroughly identified. Many researches have demonstrated that angiogenesis is essential factor in fibrosis and adhesion in various circumstances. We hypothesized that dura mater could have specific roles in inducing adhesion and fibrosis through the angiogenic capacity. As the first step, this study investigated that dural cell (DC) produces and secretes pro-angiogenic factors and therefore have potentials to promote angiogenesis-induced peri-dural adhesion and fibrosis by interaction with endothelial cell (EC) in vitro.

METHOD: Human DCs were isolated from the dura mater of fifteen patients obtained during decompressive craniectomy. The conditioned media obtained during DC culture (DC-CM) were assayed for vascular endothelial growth factor (VEGF), Angiopoietin, vascular cell adhesion molecule (VCAM), basic fibroblast growth factor (bFGF), Interleukin-8 (IL-8) by ELISA. Human microvascular endothelial cells (HMEC-1) were cultured in DC-CM and control media (CM). The expression of platelet-derived growth factor (PDGF), F-actin, and anti-FAK (focal adhesion kinase) of ECs in each condition were analyzed by immunofluorescence assay for comparison of EC activation between two groups. Wound-healing migration assay of EC cultured in DC-CM and CM was performed to investigate an actual migration in response to angiogenic factors derived from DC.

RESULT: 264.53±85.98 pg/mL VEGF, 1030.12± 499.42 pg/mL VCAM, 471.65±218.65 pg/mlL Angiopoietin, 38.62±49.50 pg/mL IL-8, and 32.96±19.30 pg/mL bFGF were measured from the DC-CM respectively. Compared to EC cultured in CM, immunofluorescence stains (PDGF, F-actin, and anti-FAK) of ECs in DC-CM showed significant differences in expression pattern and staining intensity (PDGF 12.56 vs 6.14($p<0.01$); anti-FAK 14.81 vs 8.05($p<0.01$); F-actin 13.46 vs 12.95($p=0.073$), DC-CM vs CM). ECs migrated across the scratched wound were counted in migration assay. EC in DC-CM showed more enhanced migration activity during wound-healing assay, compared to EC in CM (103.7 vs 68.3, $p=0.027$).

CONCLUSION: The dural cell secrets angiogenic factors to activate endothelial cell. This interaction between dural cell and endothelial cell can promote angiogenesis in peri-dural space under the various pathologic conditions to enhance peri-dural adhesion and fibrosis.

P40

MECHANICAL BURDEN ON ADJACENT LEVELS VARIES WITH CONSTRUCT LENGTH FOLLOWING LUMBAR FUSION – AN IN VITRO STUDY

Avinash Patwardhan,Ryan Sullivan,Leonard Voronov, Robert Havey,Gerard Carandang, Muturi Muriuki,Saeed Khayatzadeh,William Sears

Loyola University Chicago 60153, United States

INTRODUCTION: The etiology of adjacent segment degeneration (ASD) remains controversial. While in vitro biomechanical investigations have intended to clarify the effects of fusion(s) on adjacent levels, a recent systematic review found that studies' published results depended highly on the test protocol and loading methodology employed. Many studies were done prior to the adoption of hybrid test protocols. Often, they employed eccentric specimen loading, did not apply pure moments, did not apply axial/follower loading and used relatively short specimens. Clinical studies however, have shown a progressive increase in the incidence of ASD above 1-, 2- and 3-level lumbar fusions, respectively. The purpose of the current study was to rigorously evaluate, in vitro, the effects of 1-, 2- and 3-level fusions on segmental biomechanics at non-fused levels and to relate these findings to previous in vivo observations.

METHODS: Kinematics of six cadaveric spines (T10-sacrum, 45±8 years) were assessed intact and progressively following rigid 360° 'fusion' at L5-S1, then L4-S1, and finally L3-S1. Specimens were tested under 400N preload in both load and displacement control conditions, with moment endpoints chosen to minimize risk of soft tissue damage during repeat loading. Segmental motions were compared across all surgical states for spinal ROM corresponding to the flexion/extension endpoints of the T10 vertebra after L3-S1 fusion.

RESULTS: The suprajacent level, directly above a fusion, required more motion after fusion to reach the same total motion endpoints. The percentage increase was 11±6% after 1-level ($p=0.04$), 73±34% after 2-level ($p<0.01$), and 113±48% after 3-level fusion ($p<0.01$). There were significant differences between the 1- & 2- and the 2- & 3-level fusions, in the magnitude of these observed increases in ROM ($p<0.01$ & $p=0.04$, respectively). Similar increases in motion demand were observed at the more proximal mobile levels.

CONCLUSION: The biomechanical data from this long, multi-segmental model confirm previous in vivo observations of progressively increased mechanical burden on intact levels after 1-, 2- and 3-level lumbar fusions, if patients attempt to reproduce their pre-operative total spinal ROM. Of note, we observed that proximal mobile segments share in this increased burden. Other factors must therefore be at play in the clinically observed issue of ASD. This clinical response to the increased mechanical burden will likely depend on other factors affecting the host environment and segments' capacity to adapt. Further investigation is required.

P41

RELIABILITY OF A PELVIC ASYMMETRY MEASUREMENT USING MRI-BASED 3-DIMENSIONAL MODELS

Kazuyoshi Gamada,Kimio Katayama,Hajime Kumagai, Hironori Ogura,Kenji Hoshi

Hiroshima International University Higashihiroshima-shi, Japan

Introduction: Pelvic asymmetry may be associated with low back or sacroiliac pain (LBP). However, a clinically applicable measurement method to accurately measure pelvic asymmetry has not been established.

Aim: The aim of this study was to determine if our measurement method using a mirror plane (the mirror plane method) to determine 6-degrees-of-freedom (6DOF) deviation between right and left innominates using 3-dimensional (3D) bone models are reliable.

Materials and Methods: Ten asymptomatic adults agreed to participate in this IRB-approved study. They underwent MRI scanning with 3D-Balanced SARGE sequence (Hitachi Medico 1.5 tesla) with a slice pitch of 1mm. Bilateral innominates and sacrum were segmented using 3D-Doctor software (Able Software) and the number of polygon was reduced to 10,000 for each of the three bones. Local coordinate systems were embedded using 3D-Alinger software (GLAB Corp.). A mirror plane was defined by (1) the midpoint of both anterior superior iliac spinae, (2) the midpoint of the center of mass of both innominates, and (3) the midpoint between the centers of the pubic symphyses. Right innominate was flipped to measure 6DOF offset between mirrored right and left innominates using a best-fit algorithm of Geomagic Studio (Geomagic Corp.). 95% confident interval (CI) and intra-class correlation (ICC) were used to determine the existence of asymmetry and reliability of the measurement method, respectively. A significant level was set at alpha=.05.

Results: The average [95%CI] for sagittal, horizontal, and frontal rotations were 1.53 [0.94, 2.12], 2.49 [1.22, 3.77], and 2.59 [1.83, 3.35], respectively. ICC for intra-rater reliability in sagittal, horizontal, and frontal rotations were 0.998, 0.997, and 0.817, respectively. ICC for inter-rater reliability in sagittal, horizontal, and frontal rotations were 0.994, 0.953, and 0.955, respectively.

Conclusion: Pelvic asymmetry existed in the asymptomatic adults and the mirror plane method to measure 6DOF offset between both innominates was reliable. Since the morphological asymmetry is assumed to exist between both innominates, measuring the offset using bony landmarks such would involve errors due to the asymmetrical morphology. Our method utilizes all the polygons of the 3D models and reduce error caused by morphological asymmetry. Limitation of this study were (1) utilization of MRI-based models, (3) lack of optimization to determine the mirror plane, and (3) small sample size. Effects of an intervention program to make the pelvis more symmetrical would be measured. In the future, this method may be applicable clinically if an automated program is introduced in the workstation of a MRI or CT scanner.

P42

EFFECTS OF THE PELVIC AND THORACIC REALIGNMENT DEVICE ON PELVIC ASYMMETRY IN PATIENTS WITH LOW BACK PAIN

Kazuyoshi Gamada,Kimio Katayama,Hajime Kumagai,Kazuhisa Takeda,Kenji Hoshi,Hironori Ogura

Hiroshima International University Higashihiroshima-shi, Japan

Introduction: Pelvic asymmetry may be associated with low back or sacroiliac pain (LBP). We developed a pelvic and thoracic realignment device (PTRD) to make the pelvis and thorax more symmetrical. However, no study has revealed that PTRD is effective on reducing symptom and that the PTRD is effective to realign the pelvis in patients with LBP.

Aim: The aim of this study was to determine if the PTRD is effective on reducing symptom and realigning the pelvis in patients with LBP.

Materials and Methods: Nine symptomatic adults with non-specific LBP agreed to participate in this IRB-approved study. They underwent MRI scanning with 3D-Balanced SARGE sequence (Hitachi Medico 1.5 tesla) with a slice pitch of 1mm. Bilateral innominates and sacrum were segmented using 3D-Doctor software (Able Software). Local coordinate systems were embedded using 3D-Alinger software (GLAB Corp.). A mirror plane was defined by (1) the midpoint of both anterior superior iliac spinae, (2) the midpoint of the center of mass of both innominates, and (3) the midpoint between the centers of the pubic symphyses. Right innominate was flipped to measure 6DOF offset between mirrored right and left innominates using a best-fit algorithm of Geomagic Studio (Geomagic Corp.) ReaLine CORE (RLC) (GLAB Corp.) was used to make the pelvis and thorax more symmetrical for 6 sessions over a 2-week period. RLC consists of rigid front frame, back frame and 2 pairs of ratchets and 2 belts to apply maximum of 300N. Two units of RLC were attached to the pelvis and thorax and 6 standing exercises were performed for a maximum of 10 minutes including stationary stepping, pelvic slide, pelvic rotation, forward bending, and backword bending. Outcome measures invluded (1) finger floor distance (FFD), (2) trunk extension mobility, (3) Oswestry disability index (ODI), (4) Roland-Morris Disability Index (RMDQ), and (5) Visual Analogue Scale (VAS). Wilcoxon signed-rank test was used to compare the outcomes at pre- and post-interventions. A significant level was set at alpha=.05.

Results: Significant improvement was observed in ODI (p=.028), RMDQ (p=.018), trunk extension mobility (p=.018), and pain during trunk extension (p=.035). Pelvic asymmetry existed in sagittal (1.5±0.5º), horizontal (3.6±1.0º) and frontal (2.0±0.5º) rotations. No significant differences were observed in the offsets in 3 rotations. Six of nine patients showed a reduction of frontal rotation offset by greater than 3º toward symmetry.

Conclusion: Pelvic asymmetry existed in the symptomatic adults. The intervention with RLC was effective on reducing symptoms and six of nine demonstrated an improvement in symmetry by more than 3º. Limitation of this study were (1) lack of diagnosis of sacroiliac joint pain and (2) small sample size. Effects of the intervention program using RLC to make the pelvis and thorax more symmetrical may be helpful in reducing symptoms and making the pelvis more symmetrical.

P43

SHOX2 IS REQUIRED TO MAINTAIN THE FUNCTION OF NUCLEUS PUOPOSUS CELL: A PROTECTIVE FACTOR FOR INTERVERTEBRAL DISC DEGENERATION?

Zhaomin Zheng

The First Affiliated Hosp.Sun Yat-sen Univ. guangzhou, China, People's Republic of

PURPOSE: To investigate the role of SHOX2 in intervertebral disc (IVD) degeneration.

METHODS: Lumbar IVD samples were collected to detect the expression of SHOX2 in different stage of degenerated discs. Different age of rat IVD tissue were obtained to evaluate the expression of SHOX2 with aging. The role of SHOX2 on nucleus pulposus (NP) cell proliferation and apoptosis was detected by CCK-8 assay and Flow Cytometry Analysis. NP cells were cultured and treated by TNF-α with or without SHOX2 siRNA, qRT-PCR and WB were used to measure MMp3, Adamts5, aggrecan and collagen II mRNA and protein level.

RESULTS: Expression level of SHOX2 is much higher in NP tissue than AF tissue, SHOX2 expression decreased with Rat growth and aging. SHOX2 expression decreased with the severity of in Human IVD degeneration. TNF-α treatment in NP cells resulted in dose and time-dependent decrease in SHOX2 expression, as long as suppressed SHOX2 promoter activity. The silence of SHOX2 can enhance NP cells apoptosis and inhibit NP cells proliferation. Finally, SHOX2 silence lead to decreased aggrecan and collagen II, together with increased ECM degrading enzymes MMP3 and Adamts-5 in NP cells.
CONCLUSION: SHOX2 play an important role in the process of IVD degeneration. SHOX2 expression decreased with aging and the severity of human IVD degeneration. Suppression of SHOX2 led to reduced aggrecan and collagen II expression, together with decreased NP cell proliferation and increased cell apoptosis. This suggested that SHOX2 is a protective factor for IVD degeneration and may provide a reparative choice.

P44

INJECTABLE MICROCRYOGELS REINFORCED ALGINATE ENCAPSULATION OF MESENCHYMAL STROMAL CELLS FOR LEAK-PROOF DELIVERY AND ALLEVIATION OF CANINE DISC DEGENERATION

Chen Chun,Zeng Yang,Ruan Dike,Du Yannan
The First Affiliated Hospital, Wenzhou Medical University 325000, China, People's Republic of

Introduction: In situ crosslinked thermosensitive hydrogel applied for minimally invasive treatment of intervertebral disc degeneration (IVDD) may not prevent extrusion of cell suspension from injection site due to high internal pressure of IVD, causing treatment failure or osteophyte formation.
Aim: In this study, mesenchymal stromal cells (MSCs) are encapsulated in alginate precursor and loaded into previously developed macroporous PGEDA-derived microcryogels (PMs) to form three-dimensional (3D) micro cellular niches, enabling non-thermosensitive alginate hydrogel to be injectable for reparing IVDD.
Materials and Methods: The cell Laden encapsulation and fabrication of 3D microscale cellular niches were preparated to study the ability of chondrogenic differentiation. The mechanical microscale and different diameter of syringe injection was tested. After preparation of Luc-GFP infected MSCs, IVD organ culture and ex vivo Injection experiments were performed to study the cell survival and leak-proof ability. Moreover, the vivo animal experiments were performed to study the effect of PMs loaded MSCs for IVDD. Presence of degenerative changes was controlled with biochemical and histological analysis.
Results: The PMs reinforced alginate hydrogel shows superior elasticity compared to alginate hydrogel alone and can well protect encapsulated cells through injection. Chondrogenic committed MSCs in the injectable microniches express higher level of nucleus pulposus (NP) cell markers compared to 2D cultured cells. In an ex vivo organ culture model, injection of MSCs-laden PMs into NP tissue prevents cell leakage, improves cell retention and survival compared to free cell injection. In canine IVDD models, alleviated degeneration is observed in MSCs-laden PMs treated group after six months which is superior to other treated groups.
Conclusion: Our results provide the first demonstration of injectable alginate hydrogel reinforced by PMs as a leak-proof cell delivery system for augmented regenerative therapy of IVDD in canine models.

P45

INCREASED APOPTOSIS, EXPRESSION OF MATRIX DEGRADING ENZYMES AND INFLAMMATORY CYTOKINES OF ANNULUS FIBROSUS CELLS IN GENETICALLY ENGINEERED DIABETIC RATS

Jong-Beom Park,Dong-Gune Chang
The Catholic University of Korea 480-717, Korea, South

Introduction: Diabetes mellitus is thought to be an important etiologic factor in intervertebral disc degeneration. What is not known is whether diabetes has an effect on annulus fibrosus (AF) cells.
Aim: We performed the current study to investigate effect of diabetes mellitus on apoptosis, expression of matrix degrading enzymes and inflammatory cytokines of AF cells

in genetically engineered OLETF (diabetic) and LETO (control) rats.
Materials and Methods: Lumbar disc tissues (L1-2 through L5-6) were obtained from 6-month old 10 OLETF and 10 LETO rats. We examined the annulus fibrosus (AF) tissues using Masson trichrome stain, TUNEL, Western blot, and reverse transcription polymerase chain reaction. The apoptosis index and the degree of expression of matrix degrading enzymes and inflammatory cytokines of AF cells were evaluated by semiquantitative method.
Results: OLETF rats showed increased body weight and abnormal 2-hour glucose tolerance tests compared to LETO rats. Masson trichrome stain showed more severe fibrosis and degeneration in AF tissues of OLETF rats. The apoptosis index of AF cells was statistically higher in the OLETF rats. The expression of matrix metalloproteinase (MMP)-1, -2, -3 and -13, tissue inhibitor of metalloproteinase (TIMP)-1 and -2, and Fas (apoptosis-related protein) was statistically higher in the OLETF rats. The expression of interleukin (IL)-1 and -6 and tumor necrosis factor-alpha was statistically higher in the OLETF rats.
Conclusion: Our findings demonstrate that diabetes mellitus is associated with increased apoptosis, expression of matrix degrading enzymes and inflammatory cytokines in AF cells. This results in more severe fibrosis of AF, which leads to intervertebral disc degeneration. These results suggest that strict blood glucose control could be important to delay intervertebral disc degeneration in patients with diabetes mellitus.

P46

DIFFUSION OF LUMBAR DISC END-PLATE BY USING DCE-MRI AFTER INTERVERTEBRAL DISC ALLOGRAFT TRANSPLANTATION IN BEAGLE MODEL

Li Hao,Ruan Di-ke,Ji Wei
Navy General Hospital Haidian District 100048 Beijing, China, People's Republic of

Introduction: Nutrition for intervertebral disc is mainly diffused through the endplate. Although intervertebral disc allograft transplantation has been performed in the clinical practice for more than ten years, the changes of nutrition diffusion through the endplate after transplantation is still unclear. Therefore, we used a well-established interbertibral disc transplantation in beagle model to investigate the nutrition diffusion of allografted disc through the end-plate by using DCE-MRI technique.
Aim: To document the temporal pattern of diffusion in lumbar discs by using DCE-MRI and to study the changes of endplate biological function after allograft intervertebral disc transplantation in beagle model.
Materials and Methods: Twenty-five adult dogs were used in this study. A total of 5 dogs were sacrificed to be as allografts and the remaining twenty dogs were used to investigate allograft intervertebral disc transplantation. X-ray and DCE-MRI were performed pre-operative and 4, 6, 8, 12 24weeks after surgery to investigate the diffusion condition of the allograft discs. The height of allograft disc was record and represented as $\bar{x}\pm s$. Compare the data post-operative with the pre-operative respectively and analyze it by means of ANOVA. There is significant difference with $P < 0.05$. T1-weighted images were obtained pre-contrast and post-contrast at 2, 5, 10, 30, 60, 90, 120, 150, 180, 210 and 240min. Record the signal of every ROI at each time-in-point, then calculated the enhancement rate and plotted the curve of time-signal intensity. Analyze the characteristic of the curve.
Results: The mean height of allograft disc after operation was lower than that before operation. However, no significant difference was found ($P > 0.05$). Subluxation was found in 2 discs, but no dislocation was found. In addition, osteophyte formation was found in 2 segements. The signal of normal endplate, nucleus pulposus and vertebral body showed two peak values in the curves of time-signal intensity. No second peak value was found in the curves of time-signal intensity of 4 and 8 week after operation, and the enhanced speed and the maximum enhanced rate were both lower than the control group. They were improved in the curves of 12-week group, but were still lower than that in the control group. In the curves of time-signal intensity of 24-week after operation, the signal of endplate and nucleus pulposus reached the second peak value with statistical significance ($P<0.05$).

Conclusion: Through the observation of the postoperative follow-up by DCE-MRI technique, we found that the diffusion function of allograft intervertebral disc will be affected in the early stage. But with the reconstruction of the vascular network and the recovery of the function of the endplate, the metabolic function of the intervertebral disc was recovered to a certain degree.

P47

EFFECT OF DONOR AGE AND CULTURE PASSAGE ON MESENCHYMAL STEM CELLS DERIVED FROM NUCLEUS PULPOSUS: AN IN VITRO STUDY ON RATS

Yachao Zhao,Zhiwei Jia,Yaohong Wu,Longgang Liu,Deli Wang,Dike Ruan

Navy General Hospital 100048, Beijing, China, People's Republic of

Introduction: Currently, mesenchymal stem cells derived from nucleus pulposus (NPMSCs) have emerged as a promising cell source for intervertebral disc (IVD) regeneration. Accumulating evidence indicates that stimulation or transplantation of endogenous NPMSCs might have advantages over other cell-based therapies for IVD degeneration. However, the functional properties of stem cell are likely to decline with age, which is associated with in vivo aging. In addition, prolonged cell culture required for biological strategies could also comprise the efficacy of stem cell due to in vitro aging. Up to now, on previous study has examined the phenomenon of NPMSCs aging within IVD and little is known about the effect of donor age and culture passage on NPMSCs.

Aim: To examine the presence of aging NPMSCs in IVD and to investigate the effect of donor age and culture passage on NPMSCs using a rat model.

Materials and Methods: The NPMSCs from young (male, 3-month-old) and old (male, 14-month-old) Sprague-Dawley rats were harvested and cultured in vitro. Differences in the morphology, proliferation, differentiation potential, cell cycle, expression of senescence associated β-galactosidase (SA-β-gal) and genes were assessed.

Results: Both isolated NPMSCs met the minimal criteria defined as MSCs, including the plastic adherence, expression of specific surface makers, and multilineage differentiation potential. Young NPMSCs were spindle-shaped, while old NPMSCs exhibited a flat, enlarged morphology with more podia and larger nuclei. In addition, young NPMSCs proliferated more rapidly and formed a larger number of colonies than old NPMSCs did. The multilineage differentiation capacity decreased in old NPMSCs, with the osteogenic differentiation affected more than the adipogenic and chondrogenic differentiation. Old NPMSCs had an increased percentage of cells in the G1 phase and a decreased percentage in S phase. The expression of SA-β-gal in old NPMSCs significantly increased. The expression of genes mediating cellular senescence such as p53, p21, p16, and pRB was up-regulated, but the hTERT transcript associated with telomerase activity down-regulated in old NPMSCs. Irrespective of donor age, with the passage number increasing, NPMSCs gradually lost their typical morphology and also entered into the state of cellular senescence, such as decreased proliferation rate, increased expression of SA-β-gal, and arrest of cell cycle in G1 phase. Furthermore, the culture passage affected the properties of NPMSCs more than the donor age did.

Conclusion: This study demonstrated for the first time that aging of NPMSCs was present within IVD, which may provide a novel concept for the pathogenesis of IVD degeneration. Furthermore, both donor age and culture passage could cause aging effect on NPMSCs and the in vitro aging was likely to play a more important role as compared with in vivo aging, which should be taken into consideration prior to cell-based therapies for clinical application.

P48

MACROPHAGES IN THE DEGENERATED INTERVERTEBRAL DISC PRODUCE INFLAMMATORY CYTOKINES, BUT NOT GROWTH FACTORS, IN A MOUSE MODEL OF DISC INJURY

Masayuki Miyagi,Kentaro Uchida,Hisako Fujimaki, Gen Inoue,Toshiyuki Nakazawa, Takayuki Imura,Wataru Saito,Naonobu Takahira,Masashi Takaso

Department of Orthopaedic Surgery, Kitasato University, School of Medicine 252-0374, Sagamihara city, Japan

Introduction: Intervertebral disc (IVD) pathology is a significant contributor to chronic low back pain (LBP). Multiple human and animal studies have suggested that the up-regulation of inflammatory cytokines and various growth factors in degenerated or injured IVDs may lead to discogenic LBP. However, the identity of the cells that produce these inflammatory cytokines and various growth factors remains unclear.
Aim: The aim of the current study was to investigate the regulation of inflammatory cytokines and various growth factors by macrophages in degenerated IVDs.
Methods: Thirty C57BL/6J mice were used. We characterized the gene expression profiles of inflammatory cytokines (Tumor necrosis factor alpha, TNF-alpha and Interleukin 1 beta, IL-1beta) and various growth factors (Nerve growth factor, NGF and basic fibroblast growth factor, bFGF) in both intact and injured coccygeal IVDs. Additionally, we examined whether macrophage depletion, which was induced by systemic injection of clodronate-laden liposomes, affected the expression of these cytokines and growth factors in injured coccygeal IVDs. Macrophages were isolated from C57BL/6J mice using magnetic beads and were then analyzed by flow cytometry for the markers F4/80 and CD11b. Real-time PCR was used to evaluate the expression of the genes encoding TNF-alpha, IL-1beta, NGF and bFGF. The response of these factors to anionic liposomal clodronate induced-macrophage depletion was also examined.
Results: F4/80+CD11b+ macrophages were decreased by approximately 90% after systemic injection of clodronate-laden liposomes. Expression of TNF-alpha, IL-1beta, NGF and bFGF was also significantly increased in injured IVDs compared to intact IVDs ($p<0.05$). In addition, TNF-alpha and IL-1beta gene expression was significantly decreased in injured IVDs by anionic liposomal clodronate induced-macrophage depletion (p0.05).
Conclusion: Disc injury induced the up-regulation of inflammatory cytokines and various growth factors. Macrophages in the injured IVDs produced inflammatory cytokines, but not growth factors. Inflammatory cytokines and growth factors were produced by different cells in the injured IVDs. These findings demonstrate further complexity in the patho-mechanism of discogenic low back pain.

P49

BIOLOGICAL CHARACTERISTICS OF NUCLEUS PULPOSUS MESENCHYMEL STEM CELLS IN HUMAN DEGENERATIVE INTERVERTEBRAL DISC WITH DIFFERENT PFIRRMANN GRADE

xiaochuan Li,xuedong Bai,yaohong Wu, longgang Liu,deli Wang,dike Ruan
Navy general hospital 100048, China, People's Republic of

Introduction: Degenerated disc disease (DDD) is the main cause of low back pain that significantly affected individual with quality of life and life expectancy. Tissue engineering and regen-eration medicine of nucleus pulposus (NP) are thought to provide a promising approach for this and highlighted by the founding of nucleus pulposus mesenchyme stem cells (NPMSCs). However, the biological characteristics of NPMSCs in degenerated human intervertebral disc with different Pfirrmann grade may be different in certain extend that affect the regeneration ability and need further research.
Aim: This study was to compare the biological characteristics of NPMSCs in degenerated human intervertebral disc with different Pfirrmann grade.
Materials and Methods: Nucleus pulposus were obtained from 15 patients as surplus surgical material. The NPMSCs were harvested through colony screening and grouped according to different Pfirrmann grades (grade I to V with 3 patients in each group).Cell morphology, proliferation rate and the immunophenotype(CD24, CD34, CD44, CD45, CD73, CD90, CD105, CD133, CD166, GD2 and Tie 2)were all evaluated and compared.
Results: NPMSCs were successfully isolated and expanded in vitro. For cell morphology, the cells in grade I to III displayed short spindle or polygonal in shape while the cells in grade IV and V exhibited shapely outline with long fusiform. Regarding the proliferation capacity, the cells in grade I and II showed significant better proliferation abilities than in grade III which has beendemonstrated superior than grade IV and V. For the identification of cell

surface antigen profile, all the NPMSCs were positive for many stem cell markers including CD73, CD90, CD105, CD166, GD2, Tie 3 and negative for CD34, CD44, CD45.However, the expression of CD105(grade I 80.2±12.4 %, grade II 65.2±10.7 %,grade III52.4±10.4 %,grade IV45.2±9.4 %, and grade V 10.2±6.8 %,)and GD2(70.2±28.4 %, 65.2±20.7 %, 42.4±20.4 %, 25.2±19.4 %, and 10.2±6.8 %, from grade I to v) were both decreasing accompanied with degenerated Pfirrmann grade. however, this tendency as a marker of mature nucleus pulposus cells was oppositely detected in the expression of CD 24 (2.7±2.4 %, 5.2±2.7 %, 4.5±3.4 %, 49.2±15.4 %, and 75.1±18.8 %, range grade I to v).

Conclusion: This study firstly compared the difference of the cell morphology, proliferation capability and phenotype change in different Pfirrmann grade. The outcome may imply differ-ent regeneration ability between different Pfirrmann grade of degenerated intervertebral disc(IVD). These results may improve our understanding of IVD pathophysiology and the degeneration process, and could also provide some new strategies for cell-based regenerative medicine.

P50

INFLUENCE OF PRO-INFLAMMATORY STIMULATION BY IL-1β ON CHONDROGENIC DIFFERENTIATION OF HUMAN MESENCHYMAL STEM CELLS (MSCs) VERSUS ADIPOSE-DERIVED STEM CELLS (ASCs)

Neidlinger-Wilke Cornelia,Ines Nagl,Graciosa Q. Teixeira,Dimitris Kletsas,Hans-Joachim Wilke, Anita Ignatius

Institute of Orthopedic Research and Biomechanics University of Ulm D-89081 Ulm, Germany

INTRODUCTION: The pro-inflammatory environment of degenerated discs is a challenge for cell therapy approaches since the increased occurrence of inflammation factors rather impairs mat-rix formation and increases matrix degradation[1]. Purpose of the present study was to compare human mesenchymal stem cells (MSCs) and adipose-derived stem cells (ASCs) with regard to their chondrogenic differentiation capacity at normal versus pro-inflammatory conditions simulated by medium supplementation with IL-1β. We hypothesize that progenitor cells from both tissue sources might differ regarding their sensitivity towards pro-inflammatory conditions and their potential use for cell therapy applications at pro-inflammatory conditions.

MATERIAL/METHODS: Human MSCs and ASCs tested before use with regard to expression of stem cell markers (CD105, CD73, CD44, CD90 and SSEA4), were cultured in pellets of each 200.000 cells in chondrogenic differentiation medium supplemented by TGFβ3 (controls) for a duration of four weeks as described[2]. For simulation of inflammation, the chondrogenic medium of parallel pellet cultures was supplemented by IL-1β during the whole culture period. Cultures without TGFβ3- or IL-1β-supplementation served as controls. At the end of the differentiation period each three pellets were characterized with regard to morphology and matrix formation (alcian blue staining), and for gene expression of chondrogenic target genes (Sox-9, Coll-II, Aggrecan). Groups were compared by descriptive statistics.

RESULTS: In cultures with TGFβ3 medium, pellet formation occurred within the first week with increasing size and optical density of the pellets during the four weeks of culture time. Cultures supplemented with IL-1β showed a 0.5-0.75-fold reduced pellet size. Cultures with standard medium without TGFβ3 failed to form pellets. Differentiation of both MSCs and ASCs could be confirmed by an up-regulation of Aggrecan, Coll-2, and Sox-9 expression at presence of TGFβ3 and this effect was strongly decreased in the IL-1β-supplemented pellet cultures of both MSCs and ASCs with high donor variability of the absolute gene expression levels. The impaired differentiation capacity of ASCs and MSCs at presence of IL-1β could also be confirmed by reduced Alcian blue staining of the pellets. This effect was similar with both ASCs and MSCs.

DISCUSSION: A pro-inflammatory environment impairs differentiation capacity of both MSCs and ASCs and might therefore reduce matrix-formation if they are applied as a cell therapy of disc degeneration at pro-inflammatory conditions. As this effect could be shown for both ASCs and MSCs both cell sources appear to be similar sensitive towards pro-inflammatory

conditions. These findings suggest that an anti-inflammatory treatment previous to cell therapy might improve the microenvironment for successfull cell therapy approaches. REFERENCES: [1] Risbud & Shapiro, Nat Rev Rheumatol, 2014 [2] Kondo et al. PLOS ONE, 2013.

P51

INTERVERTEBRAL DISC NUCLEUS PULPOSUS HAS INTENSIVE INVOLVEMENT OF AUTOPHAGY COMPARED TO OTHER MUSCULOSKELETAL TISSUES AND ITS DEGENERATION IS LINKED WITH DECREASED AUTOPHAGY

Takashi Yurube,Hiroaki Hirata,Masaaki Ito,Yuji Kakiuchi,Kenichiro Kakutani,Koichiro Maeno, Toru Takada,Shingo Miyazaki,Yoshiki Terashima, Masahiro Kurosaka,Kotaro Nishida

Kobe University Graduate School of Medicine Chuo-ku Kobe 650-0017, Japan

Introduction: The intervertebral disc is the largest avascular organ in the body, which is expected subject to nutrient deprivation. Therefore, disc cells may utilize autophagy to cope with stressful conditions. Autophagy, the intracellular process by which cells recycle their own damaged components, is an important cell survival mechanism under limited nutrition. However, little evidence exists regarding autophagy during disc degeneration.

Aim: To elucidate the involvement and roles of autophagy in the disc.

Materials and Methods: [Autophagy during disc degeneration] 12-week-old male Sprague-Dawley rat tails were instrumented with an Ilizarov-type device with springs and loaded statically at 1.3 MPa for up to 56 days (n=24). After radiography, MRI, and histomorphological evaluation, experimental loaded and distal-unloaded control discs were analyzed by immunohistochemistry and Western blotting (WB) for autophagy-related proteins, Beclin1 and LC3, and an autophagy substrate, p62/SQSTM1, in the NP and AF. Additionally, WB assessments were performed in human discs surgically obtained (n=6). [Autophagy between various cells] Lumbar disc nucleus pulposus (NP) cells, annulus fibrosus (AF) cells, knee cartilage chondrocytes, femoral quadriceps myocytes, and brain cells from a single rat were collected and cultured in media with or without serum to simulate nutrient deprivation (n=6). Autophagy levels were analyzed by WB for LC3 and p62/SQSTM1.

Results: [Autophagy during disc degeneration] Static compression induced progressive disc height loss in radiographs, lower intensity in MRIs, and histological degeneration with decreased cellularity in rat discs. Immuno-histochemistry showed sustained decreases in immunopositivity for Beclin1, LC3, and p62/SQSTM1 both in the NP and AF, which corresponded with the loading duration. Then, WB exhibited loading period-dependent decreases in an autophagy-execution marker, LC3-II. Expression of autophagy-related LC3 and p62/SQSTM1 was more abundant in the NP than AF. Autophagy marker expression was also found in human degenerated and herniated disc tissues. These findings indicate the involvement of autophagy in the disc, levels of which decline with the progression of degeneration. [Autophagy between various cells] In vivo WB provided an additional hypothesis of intensive involvement of autophagy in the NP compared to AF and other tissues. In vitro WB then demonstrated higher baseline autophagy levels in NP cells than AF cells and chondrocytes. After 24-h serum starvation, all these cells increased LC3-II and decreased p62/SQSTM1, consistent with enhanced autophagy. LC3-II expression was more pronounced in NP cells than others. Another comparison between NP versus muscle and brain cells also showed similar trends. Involvement of autophagy has been confirmed in many cell types—notably NP cells.

Conclusion: This study suggests roles of autophagy in maintaining disc health, the loss of which can lead to degeneration. Autophagy is a possible, future molecular treatment target for degenerative disc disease.

P52

BIOLOGICAL BEHAVIOR OF PURIFIED HUMAN NUCLEUS PULPOSUS MESENCHYMAL STEM CELLS: A COMPARISON OF HEALTHY AND DEGENERATIVE NUCLEUS PULPOSUS SOURCE

Deli Wang,Yong Tang,Zhiwei Jia,Pushan Yang, Qing He,Dike Ruan

Navy General Hospital 100048, Beijing, China, People's Republic of

Introduction: Currently, mesenchymal stem cells derived from human nucleus pulposus (hNPMSCs) are receiving increasing public interest as a promising stem cell source for the intervertebral disc (IVD) regeneration. There also existing evidence demonstrates that transplantation of hNPMSCs appears to be superior to other cell-based therapies for IVD degeneration. However, the quantity and quality of isolated hNPMSCs hinder their extensive applications, which may influence the treatment outcomes of cell transplantation. Therefore, the purification of hNPMSCs and its biological behavior are crucial for its clinical application.

Aim: This study was to explore a method for purifying hNPMSCs, and to compare the biological behaviour of healthy and degenerative nucleus pulposus derived hNPMSCs.

Materials and Methods: Degenerative nucleus pulposus tissue (Pfirrmann IV) from 3 patients with lumbar disc heriniation was collected, cells were isolated using enzyme digestion method. Adherent method and fluorescence activated cell sorting (FACS) method were used for purification of hNPMSCs (CD73, CD90 and CD105 were selected as surface markers for FACS). Purified hNPMSCs by two methods were cultured in vitro. The cellular morphology was observed under the microscope, and cell proliferation tests were performed using CCK-8. Immunophenotyping of hNPMSCs was detected, and differentiated potential of NPMSCs was investigated by multiple differentiations. Alizarin red staining, oil red O staining, and toluidine blue were performed to reflect the results of osteogenic, adipogenic and chondrogenic differentiation accordingly, and relative quantification was performed with Imag J software. In addition, hNPMSCs were isolated from healthy (6 patients) and degenerative nucleus pulposus (6 patients), and purified by FACS. CCK-8 proliferative test, qPCR for stem cell-related genes (Oct4 and Nanog) were performed.

Results: The hNPMSCs showed spindle shape in the two groups. The ratio of CD73+, CD90+, CD105+ in FACS group reached (89.67±2.52)%, and 80%-90% confluence was reached after 12-15 days. Expression levels of CD73, CD90 and CD105 in FACS group were higher than those in adherent group ($P<0.05$). The multiple differentiation potentials (osteogenic, chondrogenic and adipogenic) of hNPMSCs in FACS group were superior to those in adherent group ($P<0.05$). Using FACS method, hNPMSCs could be purified from both healthy and degenerative nucleus pulposus, and the morphology showed no difference between groups. Cell proliferative assaied by CCK-8 showed that cell proliferation in healthy group was better than that in the degeneration group at 5, 7, 9, 11, and 13 days ($P<0.05$). The Real-Time PCR results showed that Oct4 and Nanog expression in normal group were significantly higher than those in the degeneration group ($P<0.05$).

Conclusion: FACS method was superior to adherent method for purification of hNPMSCs. The hNPMSCs derived from healthy nucleus pulposus show better biological behaviour than that from degenerative nucleus pulposus.

P53

HEPATOCYTE GROWTH FACTOR/C-MET SIGNAL PROMOTES PROLIFERATION, SUPPRESSES APOPTOSIS, AND IMPROVES MATRIX METABOLISM IN RABBIT NUCLEUS PULPOSUS CELLS IN VITRO.

Hidenou Ishibashi,Hitoshi Tonomura,Takumi Ikeda,Munehiro Sakata,Ryota Takatori,Yasuo Mikami,Masateru Nagae,Toshikazu Kubo

Department of Orthopaedics, Graduate School of Medical Science, Kyoto Prefectural University of Medicine. 602-0841, Kyoto., Japan

INTRODUCTION: The intervertebral disc (IVD) dysfunction causes IVD herniation, spinal canal stenosis, and various other spinal diseases; it may also trigger low back pain or neurological symptoms. The etiology of IVD degeneration is closely related to apoptosis and extracellular matrix (ECM) degradation in nucleus pulposus (NP) cells. These defects in NP cells are induced by excessive external stressors such as reactive oxygen species (ROS) and inflammatory cytokines. Recently, hepatocyte growth factor (HGF) has been shown to repair damage in various diseases through anti-apoptotic and anti-inflammatory activity.

AIM: In this study, we investigated the effects of HGF on NP cell abnormality caused by ROS and inflammatory cytokines by using primary cell cultures isolated from rabbit IVD.

MATERIALS AND METHODS: The NP cells were isolated from Japanese white rabbits and cultured as a monolayer. Cell proliferation was measured after administration of recombinant human HGF using a Cell Counting Kit-8. NP cells were treated with HGF under H2O2 or TNF-α stimulation. The apoptosis was detected by TUNEL method and caspase 3 activity. The mRNA expression of COX-2, MMP-3, -9, -13 and ADAMTS-5 was investigated by RT-qPCR. c-Met, a specific receptor for HGF, protein expression was visualized by Western blotting.
Results: HGF dose-dependently enhanced the proliferation of NP cells. Apoptosis of NP cells induced by H2O2 or TNF-α was significantly inhibited by HGF. Induction of mRNA expression of COX-2, MMP-3, and -9 by TNF-α was significantly suppressed by HGF, whereas elevated mRNA expression of MMP-13 and ADAMTS-5 was not inhibited by HGF. The protein expression of c-Met was confirmed in NP cells, significantly increased by TNF-α and decreased by HGF.
CONCLUSION: The present study is the first to reveal c-Met expression in NP cells and the positive effect of HGF on NP cell proliferation. c-Met expression was increased by TNF-α, suggesting that inflammatory cytokines increase sensitivity to HGF as a defense mechanism against tissue damage. HGF could prohibits apoptosis of NP cells through both the intrinsic pathway induced by ROS and extrinsic pathway induced by inflammatory cytokines. HGF effectively suppresses ECM degradation by inhibiting the expression of COX-2, MMP-3, and MMP-9, which is involved in IVD degeneration. These findings demonstrate that activation of HGF/c-Met signaling is effective to suppress damage caused by ROS and inflammation in NP cells through multiple pathways. We further suggest the clinical potential of HGF for IVD degradation involved in NP cell abnormalities.

P54

EFFECT OF A SELECTIVE INHIBITOR OF C-FOS/ACTIVATOR PROTEIN-1 ON INTERVERTEBRAL DISC DEGENERATION

Hiroto Makino, Shoji Seki, Yasuhito Yahara, Yoshiharu Kawaguchi, Hiraku Motomura, Makiko Nogami, Kenta Watanabe, Shunichi Shiozawa, Tomoatsu Kimura

University of Toyama 9300194 Toyama, Japan

INTRODUCTION: Although the etiology of intervertebral disc (IVD) disease still remains to be clarified, several catabolic, anabolic and inflammatory factors have been associated with the pathogenesis of the disorder. c-Fos/AP-1 is a transcription factor which controls the expression of both inflammatory cytokines and matrix metalloproteinases (Mmp) by binding directly to AP-1 motifs in the promoter of these genes.
AIM: We analyzed the effect of orally administered selective c-Fos/AP-1 inhibitor (T-5224)1 on the gene expression of catabolic and anabolic factors in the degenerated IVD and its therapeutic role to prevent the progression of degeneration.
MATERIALS AND METHODS: In ex-vivo, lumbar intervertebral discs of 2-week-old mice were dissected and organ cultured. Those tissues were stimulated by IL-1 and then treated with T-5224 or PVP (vehicle solution). We carried out a histologic and polymerase chain reaction (PCR) analysis. In vivo, 12-week-old male Sprague Dawley rats were anesthetized and tail IVD was punctured with a sterile 20-gauge needle to induce IVD degeneration. T-5224 or PVP (polyvinylpyrrolidone; vehicle solution) was given by single daily oral administration. Rats were euthanized and examined by X-ray (Disc height index2; DHI), MRI, histology (Histologic grading score2) and PCR analysis.
RESULTS: In ex-vivo analysis, the gene expression of Mmp3, 13 and Adamts5 was significantly suppressed by the admission of T-5224 ($P<0.01$). Histologic grade was greater in T-5224 treated mice than in PVP treated ($p<0.05$). In vivo analysis, DHI was significantly higher in the T-5224 group than in the PVP group ($p<0.05$). The value of T2 on MRI was higher in T-5224 treated rats than in PVP ($p<0.05$). Histologic grade was greater in T-5224 treated mice than in PVP treated like mice tissue ($p<0.05$). Among various catabolic factors, the expression of Mmp3 and Mmp13 was moderately to markedly increased in the degenerated IVD. T-5224 treatment significantly suppressed the expression of Mmp13 in the IVD. The expression of Mmp3, Adamts4, 5 was also tended to be suppressed in the T-5224 group compared to that in the PVP group.

CONCLUSION: A selective c-Fos/AP-1 inhibitor prevented disc degeneration in a rat model of IVD degeneration induced by needle puncture, and may have considerable potential as a therapeutic agent for the treatment of IVD degeneration.

REFERENCES:

1. Aikawa Y., Morimoto K., Shiozawa S., et al. Treatment of arthritis with a selective inhibitor of c-Fos/activator protein-1. Nature biotechnology 2008; 26(7); 817-23

2. Masuda K., Aota Y., Howard A., et al. A novel rabbit model of mild, reproducible disc degeneration by an anulus needle puncture: correlation between the degree of disc injury and radiological and histological appearances of disc degeneration. Spine 2005; 30(1); 5-14.

P55

CARTILAGE-DERIVED MORPHOGENETIC PROTEIN-2 SIGNAL VIA SMAD AND MITOGEN-ACTIVATED PROTEIN (MAP) KINASE PATHWAYS DURING EXTRA CELLULAR MATRIX PRODUCTION IN HUMAN DISC CELLS

Ai-qun WEI,Bojiang Shen,Sebald Staff,Lisa Williams, Walter Sebald,Ashish Diwan

Orthopaedic Research Institute NSW 2217, Australia

BACKGROUND: Intervertebral disc degeneration related low back pain is one of major causes of years lived with disability affecting millions of people worldwide. Biological therapies using growth factor is a potential approach to rescue the damaged disc. Our laboratory has demonstrated encouraging results that the signalling molecule cartilage-derived morphogenetic protein-2 (CDMP-2) is able to stimulate extracellular matrix (ECM) production of the disc both in vitro and in vivo.

AIM: To elucidate the molecular signalling pathways and cellular mechanisms of these effects, current study aimed to investigate the role of CDMP-2 and its receptor signaling on stimulation of ECM production of the disc cells in vitro. Methods: Primary culture of human nucleus pulposus (NP) cells was stimulated with or without CDMP-2. Effects of CDMP-2 on NP cell proliferation, proteoglycan and collagen production were assayed. Activation of both BMP SMAD and MAPK pathways at the protein level on phosphorylation of Smads 1/5/8, and P38MAPK /ERK1/2 signaling molecules was measured by using Western blot analysis. Regulation of the intracellular signaling activity on ECM production of NP cells was further estimated by specific signal inhibitors. CDMP-2 protein binding affinity with its potential receptor subunits was estimated by Surface Plasmon Resonance (BIAcore) analysis.

RESULTS: CDMP-2 induced significant proteoglycan accumulation and collagen production in cultured NP cells ($p<0.05$) compared to controls. In addition, the expression BMP receptor II in cultures was increased in response to CDMP-2 treatment and this was associated with increased phosphorylation of SMAD1/5 and P38MAPK /ERK1/2.The ability of CDMP-2 to activate signaling pathways in NP cells was abolished by co-treatment with specific inhibitor respectively.

CONCLUSION: In support our previously study that CDMP-2 stimulation appears able to enhance proteoglycan and collage synthesis on human NP cells in vitro, these effects are dependent on BMP type II receptor activation of both canonical Smad 1/5/8 and MAPK-ERK1/2 signalling, suggesting this action is, at least in part, mediated by BMP signaling. It also indicates a potential biological agent for therapeutic interventions in treatment of degenerative disc diseases.

P56

THE INTRINSIC AND EXTRINSIC APOPTOTIC PATHWAYS ARE BOTH ACTIVATED IN HUMAN DEGENERATED INTERVERTEBRAL DISCS

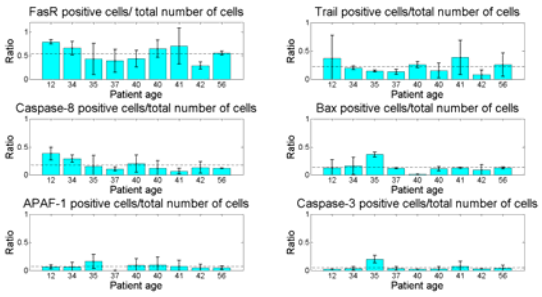
Helena Barreto Henriksson,Emma Jönsson,Sara Tschernitz,Helena Brisby

Inst. of clinical sciences,Dept. of ortopaedics 413 46 Gothenburg, Sweden

INTRODUCTION: Degeneration of the intervertebral discs (IVDs) is believed to be a major cause of low back pain. Increased apoptosis of IVD cells is suggested to contribute to the biomechanical dysfunction of the disc, due to a decrease in extracellular matrix production. Data on apoptosis of human IVD tissues/cells is limited.

AIM: The aim with the present study was to investigate the activity of the extrinsic and the

intrinsic apoptosis pathways in human degenerated IVD tissues and in cell culture models.
METHODS: IVD tissues from nine patients and cells isolated from degenerated human IVDs cultured in two cell culture systems; monolayers and pellet mass systems were investigated. Analyzes were performed by immunohistochemistry (IHC) targeting six different markers (Fas receptor (FasR), TNF-related apoptosis-inducing ligand (TRAIL), cysteine-dependent aspartate-directed protease-8 (Caspase-8), Bcl-2-associated X protein (Bax), Apoptotic protease activating factor 1 (APAF-1) and cysteine-dependent aspartate-directed protease-3 (Caspase-3) involved in apoptosis processes, in the extrinsic, the intrinsic, or in the common final, execution pathway.
RESULTS: Expression was found of all markers in all IVD tissue samples and no clear relationship with age was observed. Further, detection of all the markers was found in both cell culture systems, with the exception of Caspase-3 in the pellet mass culture system.
CONCLUSIONS: These results show that both the intrinsic and the extrinsic pathway are expressed in human degenerated IVD cells both in cell culture systems and in degenerated IVD tissue. These findings indicate that probably both activation ways need to be targeted to influence apoptosis in disc degeneration. However, it remains to be investigated which of them that play the most important role in disc degeneration



P57

HOW CAN WE DEFINE A FACET TROPISM WITH FACET ORIENTATION?; A COMPARATIVE ANALYSIS OF 200 ASIAN YOUNG ADULT POPULATIONS WITHOUT DISC DEGENERATION

Chang-Hoon Jeon,Nam-Su Chung,Han-Dong Lee
Department of orthopaedic surgery, Ajou university school of medicine Yeongtong-gu 443-380 Suwon, Korea, South

INTRODUCTION: Facet tropism has been investigated as a predisposing factor for degenerative changes in the lumbar spine. Biomechanical studies revealed that facet tropism increased shear force which may lead to disc degeneration. There is no study for the orientation of facet joint on young adult without disc degeneration.
METHODS: This study involved 200 consecutive young adult patients who had undergone a lumbar spine magnetic resonance (MR) imaging without intervertebral disc degeneration and facet arthritis. On an axial MR image that bisected the intervertebral disc, two lines were made. The one was a reference line that passed through the center of the disc and the base of the spinous process and the other was facet line that connected the two points, the anteromedial and posterolateral margin of the superior articular facet. All measurements were obtained using a picture archiving and communication system. The angle of facet joint was measured at the each level of the lumbar spine.
RESULTS: There were 100 men and 100 women with a mean age of 20.1±2.0 (range, 18–24). The mean degrees of male and female facet orientation at each levels were 33.2°±10.1° and 32.5°±10.2° at L1-L2, 34.1°±10.5° and 33.9°±9.9° at L2-L3, 43.6°±10.2° and 39.2°±9.2° at L3-L4, 48.5°±9.4° and 44.6°±10.3° at L4-L5, and 50.8°±10.2° and 46.9°±8.8° at L5-S1 level, respectively. Comparisons of facet orientation between males and females showed no sex differences in facet orientation at each level (all $P > 0.05$). The angle of facet tropism is 5.6°±4.3°at L1-2 level, 6.8°±5.2° at L2-3 level, 4.2°±3.7° at L3-4 level, 6.8°±5.9° at L4-5 level, 7.4°±6.1° at L5-S1 level.
DISCUSSION: The currents study implies that there is wide range of distribution regarding facet orientation in normal young adult population. The angle of facet tropism at each lumbar level is different and can be defined as more than 5.6°±4.3°at L1-2 level, 6.8°±5.2° at L2-3 level, 4.2°±3.7° at L3-4 level, 6.8°±5.9° at L4-5 level, 7.4°±6.1° at L5-S1 level

P58

PROPIONIBACTERIUM ACNES CAN INDUCE MODIC CHANGES

Stefan Dudli,Steve Miller,Sibel Demir-Deviren, Jeffrey Lotz

University of California San Francisco S-1164 94143 San Francisco, United States

Introduction: Modic changes (MC) are highly specific for discogenic pain and are a risk factor for poor outcome in low back pain patients. Histologically, MC represent fibrovascular granulation tissue which associates with endplate damage and areas of high bone turnover. However, the etiopathogenesis is unknown. It is suggested that in some cases of occult discitis with Propionibacterium acnes (P.acnes) causes an efflux of cytokines and bacterial metabolites into the adjacent bone marrow where MC is triggered. Clinical studies investigating the intradiscal occurrence of P.acnes are conflicting and the treatment of MC with antibiotics is controversial.

Aim: To test the biological plausibility that P.acnes can cause MC. Materials and Methods: (i) Human disc cells (n=3) from patients undergoing lumbar interbody fusion were co-cultured with P.acnes at a ratio of 10:1 and 100:1. After 3h and 24h, IL-1/-6/-8, and toll-like receptor (TLR)-4/6 gene transcription was quantified.

Results were normalized to disc cells cultured alone. LPS was used as positive control. (ii) Healthy human vertebral bone marrow mononuclear cells (BMNC) were cultured in conditioned media from part (i). After 24h, IL-1/-6/-8 gene transcription was quantified and normalized to BMNC cultured in fresh media. (iii) 1.5 ul P.acnes or PBS (sham) was injected into rat tail discs. After 1 and 3 days, IL-1/-6/-8, and bacterial ribosomal 16S gene transcription was quantified (n=6). After 7 and 14 days, injected discs and adjacent bone marrow were histologically and immunohisto-chemically (TNF-alpha) investigated (n=3/group /day).

Results: (i) IL-1/-6/-8 gene transcription increased with time and P.acnes concentration, but was highly variable between donors. Interestingly, the inflammatory response inversely correlated with TLR4/6 gene transcription ($R2>0.53$, $p<0.05$ for all Pearson's correlations) (ii) BMNC responded with inflammation when cultured in conditioned media from responsive disc cells co-cultured for 24h with high P.acnes concentration (IL-1: 6.6±0.9 $p<0.05$, IL-6: 4.4±0.8 $p<0.01$). (iii) 16S was upregulated after 3 days (31.1±3.4, $p<0.05$) indicating intradiscal proliferation of P.acnes. IL-1 (5.9±2.6, $p=0.09$) and IL-6 (5.8±6.5, $p=0.07$) were up-regulated after 3 days compared to sham. After 7 and 14 days in the P.acnes group, histology and immunohistochemistry revealed disc degeneration, endplate damage, bone resorption, as well as TNF-alpha reactivity and leukocyte infiltration at the disc/bone marrow interface. Additionally at day 14, fibrotic changes were found in the bone marrow of P.acnes injected discs.

Conclusion: These findings demonstrate a biological plausibility that P.acnes can cause MC because (i) disc cells can respond to P.acnes, (ii) BMNC can respond to factors released by disc cells co-cultured with P.acnes (iii) P.acnes can proliferate within the intervertebral disc; and (iv) P.acnes treated rat tail discs recapitulate the hallmarks of MC, which are inflammation, fibrosis, bone turnover, and endplate damage. The variable responsiveness of human disc cells to P.acnes may depend on presensitization or induced tolerance by regulating TLR expression. Whether P.acnes can home to discs in vivo awaits verification.

P59

FIH1-MINT3 AXIS DOES NOT CONTROL HIF TRANSCRIPTIONAL ACTIVITY IN NUCLEUS PULPOSUS CELLS

Yuichiro Hirose,Kazuhiro Chiba,Masaya Nakamura, Morio Matsumoto,Makarand Risbud

Department of Orthopedic Surgery, Keio University School of Medicine 160-8582 Tokyo, Japan

Introduction: The intervertebral disc is a complex tissue that permits range of motion between adjacent vertebrae and accommodates biomechanical forces. It consists of an outer fibrocartilagenous annulus fibrosus (AF) that encloses gel-like nucleus pulposus (NP). While, NP is completely avascular, blood vessels infiltrate only the superficial region of the endplates and the outer third of annulus

fibrosus, making this tissue hypoxic. However, during degeneration and herniation, vascular ingrowth can be seen into the tissue, altering its oxemic status. NP cells have adapted to survive in this hypoxic niche through robust expression of hypoxia inducible factor (HIF), a transcription factor responsive to local oxygen tension. Importantly, HIF-1 is critical for maintenance of NP cell survival, metabolism, and functional activities including proteoglycan rich matrix synthesis. In most cells, HIF activity is regulated by the action of prolyl hydroxylases (PHDs) and factor inhibiting HIF-1 (FIH1).

Aim: The objective of this study was to determine the role of FIH1 in regulating HIF activity in the NP cells, and the control of this regulation by binding and sequestration of FIH1 by Mint3.

Materials and Methods: Rat and human NP cells were isolated. To investigate the effect of hypoxia, cells were cultured in a Hypoxia Work Station (Invivo2 300, Ruskinn, UK) with a mixture of 1% O2, 5% CO2 and 94% N2 for 24 h - 72 h.

Results: FIH1 and Mint3 were both expressed in the NP, and were shown to strongly co-localize within the cell nucleus. While both mRNA and protein expression of FIH1 decreased in hypoxia, only Mint3 protein levels were hypoxia sensitive. Overexpression of FIH1 was able to reduce HIF function as seen by changes in activities of HRE-luciferase reporter and HIF-1-CTAD and HIF-2-TAD. Moreover, co-transfection of full-length Mint3 abrogated FIH1-dependent reduction in HIF activity under both normoxia and hypoxia. Nuclear levels of FIH1 and Mint3 decreased in hypoxia, and use of specific nuclear import and export inhibitors clearly showed that cellular compartmentalization of overexpressed FIH1 was critical for its regulation of HIF activity in NP cells. Interestingly, microarray results after stable silencing of FIH1 showed no significant changes in transcripts of classical HIF target genes. However, expression of several other transcripts, including those of Notch pathway changed in FIH1 silenced cells.

Conclusion: Taken together, these results suggest that possibly due to low endogenous levels and/or preferential association with substrates such as Notch, FIH1 activity does not represent a major mechanism by which NP cells control HIF-dependent transcription, a testament to their adaptation to a unique hypoxic niche. HIF-1 in NP cells is refractory to FIH1-dependent regulation.

P60

LOW-DENSITY LIPOPROTEIN RECEPTOR-RELATED PROTEIN-1 MAINTAINS THE STRUCTURE AND MYELINATION OF SCHWANN CELL IN THE PERIPHERAL NERVOUS SYSTEM

Sumihisa Orita,Kazuyo Yamauchi,Kazuhide Inage, Kazuki Fujimoto,Jun Sato,Yasuhiro Shiga, Hirohito Kanamoto,Koki Abe,Masahiro Inoue, Hideyuki Kinoshita,Kazuhisa Takahashi,Seiji Ohtori, Wendy Campana

Dept. of Orthopaedic surgery, Graduate school of Medicine, Chiba University Chiba, 260-8670, Japan

Introduction: Discogenic lower back pain is associated with nerve injury in the peripheral nerve on the degenerative intervertebral discs. In the peripheral nervous system (PNS), trophic support and axon myelination by Schwann cells (SCs) are essential for normal nerve function. The endocytic transmembrane receptor, low-density protein-receptor-related protein-1 (LRP1), is reported to be a potent regulator of SC physiology and structure in vitro, while it is not clear how LRP1 affects the PNS in vivo, including its morphology.

Aim: The present study aimed to investigate how LRP1 affects PNS morphology using LRP1-deficient transgenic mice.

Materials and Methods: Transgenic mice with LRP1 deficiency in their SCs alone (LRP1-/-) were used to evaluate PNS morphological pathology compared with normal C57BL/6 mice. Uninjured, non-lesioned sciatic nerves from the animals were harvested for light microscopy observation followed by transmission electron microscope (TEM) evaluation. Their morphological features were quantified and statistically evaluated. Significance was set at $P < 0.05$.

Results: First, histologically using light microscopy. The morphology of the sciatic nerves from LRP1-/- mice appeared normal. Axons of various diameters were present at proportions that appeared similar to those observed in LRP1-/- mice. The number of myelinated axons per field was not significantly different in LRP1-/-. Second, the nerves were observed using

TEM in detail, which revealed that the thickness of the myelin surrounding many axons significantly decreased ($P < 0.05$). Moreover, the g-ratio, which reports mean axonal diameters divided by mean fiber diameters, gradually increased in nerves from LRP1-/- mice across the continuum of axon size, suggesting a tendency of increased axonal diameter in LRP1-/- mice.

Conclusions: LRP1 in SCs is involved in the physiology of PNS, especially their myelination. The gradual increase in g-ratio in LRP1-/- indicates swollen axons. In future studies, these relationships should be investigated in more detail by injuring the nerve.

P61

ER STRESS INHIBITOR SUPRESSES INTERVERTEBRAL DISC DEGENERATION

Takeshi Fujii,Nobuyuki Fujita,Satoshi Suzuki, Ryuichi Watanabe,Kota Watanabe,Ken Ishii, Takashi Tsuji,Takeshi Miyamoto,Keisuke Horiuchi, Morio Matsumoto,Masaya Nakamura

Department of Orthopaedic Surgery, Keio University School of Medicine, Tokyo, Japan 160-8582, Tokyo, Japan

INTRODUCTION: Intervertebral disc degeneration (IVDD) is known to be contributed from several factors including aging and inflammatory cytokines. In mammalian cells, there are three major classes of stress sensors located in the endoplasmic reticulum (ER) that are involved in the transmission of ER stress signals to the nucleus: IRE1α, ATF6, and PERK. Unfolded protein response (UPR), which is activated in response to the accumulation of unfolded proteins in ER, have been shown in various metabolic diseases, neurological disorders such as Alzheimer's disease and Parkinson's disease and musculoskeletal disorders including osteoarthritis, however, the interaction between IVDD and ER stress has not been well understood.

AIM: The main objective of this study was to clarify the role of ER stress in IVDD and to determine if the ER stress inhibitor can be a therapeutic option.

Methods and results: Real-time RT-PCR analysis showed that mRNA expression of ER stress markers, ATF4, CHOP and HERP were gradually induced with aging, as well as catabolic factors, TNF-α and MMP-3, in the rodent AF tissue. Furthermore, in the AF tissue of rat punctured degenerative group, the mRNA expression of CHOP as well as that of catabolic factors was significantly increased compared with the sham group. Immunohistochemistry and Western blotting confirmed the increased protein expression of CHOP in the rodent degenerative AF tissue. Human degenerative discs also showed the high expression level of CHOP compared with healthy disc. In order to determine whether ER stress is involved in the degeneration of AF cells, we treated ER stress inducer such as tunicamycin (TM) and Dithiothreitol (DTT) to cultured AF cells. Real-time RT-PCR analysis showed that the inducers significantly increased the mRNA expression of catabolic factors as well as the ER stress markers including ATF4, HERP and CHOP. Interestingly, PERK inhibitor GSK2606414 clearly hampered the induced expression of TNF-α and ADAMTS4, correlated with that of the ER stress markers.

DISCUSSION: The experiments in this investigation demonstrate that ER stress, especially PERK-ATF4-CHOP pathway, plays an important role in IVDD. Our studies also revealed that catabolic response including the increases of disc degenerative markers such as TNF-α and ADAMTS4 is correlated with the induction of ER stress in AF cells. These findings lend a strong support to the hypothesis that ER stress is a critical mediator in the pathogenesis of degenerative disc conditions. Furthermore, it is a novel finding that PERK inhibitor GSK2606414 significantly suppressed the expression of catabolic markers as well as ER stress markers in AF cells. Therefore the inhibitor might be a therapeutic option for IVDD in near future. Further studies of PERK-CHOP pathway in IVDD may lead to the identification of new therapeutic targets relevant to disc degeneration.

P62

WHAT'S IN A NAME: A SYSTEMATIC REVIEW OF USE OF THE TERM 'DEGENERATIVE DISC DISEASE'

Michele Battié,Bradley Weiner

University of Alberta T6G 1W2 Edmonton, Canada

Introduction: Despite wide usage in clinical and research settings, much controversy surrounds the term 'degenerative disc disease' (DDD) and its clinical significance.
Aim: We sought to examine specifically how 'degenerative disc disease' has been defined in the health sciences literature over the past 10 years across different countries and disciplines, to shed light on the current controversy and understanding of DDD.
Materials and Methods: A systematic review was conducted on the term "degenerative disc(k) disease(s)" in publications from 2005 through 2014, including journal articles and proceedings in journal supplements. The databases searched included MEDLINE, CINAHL, EMBASE and SCOPUS. As we were particularly interested in definitions used when DDD was a central concept to the publication, definitions were drawn only from those publications that included DDD in the title. Two reviewers independently reviewed all publications with abstracts in the English language. Publication year, discipline or department of lead author, country of origin, study type, publication type, research or clinical context (e.g. surgery, basic science, etc.), spine region, journal and, most importantly, DDD definition was noted. Results: After duplicates were removed, a total number of 2,316 publications were identified with DDD included in the title or abstract, published in 152 journals. DDD was specifically in the title of 322 of these, which comprised the sample on which the review was based. Preliminary analysis revealed the number of publications on DDD increased over the 10-year period, with the smallest number of publications in 2005 and the greatest in 2014. There were more than twice the number of publications from the US as central Europe or any other country, with the largest number coming from orthopaedic surgery (n=86), followed by neurosurgery departments (n=52). Consistent with this, DDD was investigated most frequently in the context of surgical studies (n=163), followed by basic science (n=58), other interventional studies (n=29) and epidemiological or descriptive studies (n=23). DDD was defined in many ways, but most often as disc degeneration related to axial pain (n=90), followed by simply use of the term DDD with assumed meaning and no further definition (n=69), and 'DDD' with concomitant radiculopathy or myelopathy (n=30). Yet, widely varying, disparate definitions of DDD ranged from the presence of disc signal loss or Modic changes, irrespective of back symptoms, to 'a diagnosis of DDD for chronic LBP for which surgery was planned'. There were also systematic differences in definitions when referring to cervical versus lumbar regions. Conclusion: The wide range of definitions used for DDD in the scientific, health sciences literature explains much of the controversy and confusion surrounding the term. A clearer concept and definition of DDD are critically needed to facilitate accurate communication in medicine and research, avoid unnecessary confusion and allow clearer comparisons and syntheses of related study results to move the field forward.

P63

INHIBITION OF ERK PATHWAY RESTORES THE DISCOGENIC PHENOTYPE OF INFLAMED INTERVERTEBRAL DISC CELLS

Adel Tekari,Marazza Alessandro,Lorin M. Benneker, Benjamin Gantenbein
University of Bern, Institute for Surgical Technology & Biomechanics 3014 Bern, Switzerland

Introduction: The intervertebral disc (IVD) has a limited self-healing potential and disc degeneration is a common cause of chronic low back pain. This represents a leading cause of disability and is associated with significant social and economic burdens. Low back pain is characterized by an imbalance between the extracellular matrix anabolism and catabolism of the disc. Inflammatory mediators, such as tumor necrosis factor-alpha (TNF-α) and interleukin-1 (IL-1) are the key factors in IVD degeneration and are elevated in degenerated human IVDs. Extracellular signal-regulated kinase (ERK), member of the mitogen-activated protein kinases (MAPKs), is described as an important inflammatory signaling pathway that plays a central role in the production of inflammatory mediators and catabolic gene expression.

Aim: Within this study, we aimed to assess the role of the ERK signaling pathway in nucleus pulposus cells as a response to TNF-α.
Material and Methods: The experimental work was ethically approved and written consent of patients was obtained. Primary nucleus pulposus cells (NPC) were obtained from patients undergoing spinal surgery, isolated and expanded in monolayer cultures up to passage two. Thereafter, NPC were pretreated with the ERK-inhibitor, U0126 (0.5 μM and 5 μM) for one hour, followed by stimulation for three days with 10 ng/mL TNF-α with and without U0126. Control group was NPC treated with vehicle (dimethyl sulfoxide) alone. Subsequently, the cells were harvested for gene expression analysis. In a preliminary experiment, the doses of U0126 used were shown not to be toxic to NPC.
Results: Stimulation of NPC with TNF-α increased the expression of the matrix metalloproteinases (MMPs) 3 and 13 in addition to IL-6 by 600, 10 and 1000-fold, respectively. Simultaneous treatment with TNF-α and U0126 at 5 μM down-regulated the increase in MMPs and IL-6 to levels comparable to untreated control group. The expression of the NPC-specific extracellular matrix proteins, collagen type 2 and aggrecan, decreased by two fold in TNF-α-treated cells and increased by two and three-fold in U0126 (0.5 μM and 5 μM). Similarly, cytokeratin-19 (KRT19) showed 10-fold downregulation by TNF-α and increased from three to 80-fold while NPC were exposed to U0126 at 0.5 and 5 μM, respectively. The insulin-like growth factor expression also decreased by two fold in TNF-α treatment and increase up to two-fold in NPC treated with U0126 at 5 μM.
Conclusion: TNF-α is a potent pro-inflammatory mediator in NPC and the ERK pathway plays an important role in catabolic events mediated by this cytokine. U0126 blocked successfully the TNF-α mediated increase in catabolism and restored the NPC phenotype.

P64

ESTABLISHMENT OF A BOVINE NUCLEUS PULPOSUS TISSUE CULTURE MODEL WITH EARLY PHYSIOLOGICAL DEGENERATION MODEL

Marian Hlavna,Olga Krupkova,Keita Ito,Stephen Ferguson,Karin Wuertz

Institute for biomechanics 8025 Zurich, Switzerland

Introduction: Back pain is a major public health problem in all developed societies and is connected with intervertebral disc degeneration. To study novel therapeutic agents, suitable disc degeneration models are essential. The most widely used models are either too simple (cell cultures), hence not representing the clinical situations in human, or too complex (animals) with low through-put, higher financial costs and ethical restrictions. Over the last decade, organ culture systems have become increasingly used because they combine relatively high through-put and affordability with high clinical relevance.
Aim: The goal of this study was to develop a novel model of physiological, early disc degeneration based on a bovine nucleus pulposus (NP) tissue culture system with an artificial annulus fibrosus (AF).
Materials and Methods: NP explants was harvested from fresh caudal discs (CC2-CC5) from 4 donors. NP cultures with an artificial AF were prepared as previously described [1]. To induce inflammatory degeneration, NP cultures were incubated for 72 hours with 10 ng/ml IL-1β and 100 ng/ml TNF-□ in serum-reduced media (1 % FCS). Samples subsequently underwent biochemical and histological evaluation and gene expression analysis (collagen-1/-2, aggrecan, MMP-1/-3/-113, TIMP-1/-2 and IL-6,-8-1β).
Results: Culture of NP tissues in the artificial AF without exposure to inflammatory mediators resulted in a mRNA decrease of aggrecan (5-fold), collagen-1 (3.3-fold) and collagen-2 (4.5-fold) compared to freshly harvested NPs (samples were analyzed after 1, 3, 7, 14 and 21 days). Changes were stable over 21 days. After 21 days, biochemical (water, DNA, GAG and HYPRO content) and histological analysis revealed no major changes. Exposure to inflammatory mediators resulted in a significant down-regulation of aggrecan and collagen-1, whereas the expression of collagen-2 remained unchanged (preliminary data). With the current set-up IL-6, IL-8 IL-1β) and MMP-1,-3,-13 were under the detection limit in both, control and stimulated samples, indicating that the stimulation mode may need to be optimized.

Conclusion: We are able to establish a biochemically and histologically stable NP culture system with an artificial AF, which proved suitability for further inflammation induction. Preliminary data from induction of inflammation revealed partial degenerative changes, which could be observed for extracellular matrix genes, but not for catabolic or inflammatory genes. Upon optimization of the stimulation regime, this model may be highly beneficial for experiments testing the long-term efficacy of novel intervertebral disc anti-inflammatory/regenerative therapies.

Reference(s):
1. van Dijk B.G., Potier E., Ito K. Long-term culture of bovine nucleus pulposus explants in a native environment. Spine Journal, 2012; 13(4):454-63

P65

THE FATE OF TIE2+ NUCLEUS PULPOSUS PROGENITOR CELLS INJECTED INTO A PAPAIN DEGEN-ERATED ORGAN CULTURE MODEL WITH AND WITHOUT HYDROGEL

Daniela Angelika Frauchiger,Adel Tekari,Lorin Michael Benneker,Daisuke Sakai,Benjamin Gantenbein

University of Bern 3014 Bern, Switzerland

Introduction: Nucleus pulposus progenitor cells (NPPC) were recently described as Tie2+ cells and to possess multipotency, i.e. to be able to differentiate into chondro-, osteo- and adipogenic cell lineages. NPPC should in theory represent an outstanding source of cells for intervertebral disc (IVD) regeneration. However, the best culture conditions for these NPPC are yet unknown nor is it known whether a few thousands of these cells can rescue a mildly degenerated disc.

Aim: To demonstrate feasibility of regenerative potential of NPPC (Tie2+ cells) injected into an allogeneic degenerative full organ culture model.

Material and Methods: Fresh bovine tails were obtained from a local abattoir as described previously. In the degenerative groups (DG) IVD degeneration was induced by injection of ~100µl of 60U/mL papain solution and incubation for 8 days. In parallel on day 7, cells were isolated from allogeneic coccygeal tail and NP tissue using sequential digestion protocol with 0.19% pronase and 64.5 U/mL collagenase 2 overnight. On day 8 Tie2+ cells and Tie2–- cells were sorted using antibody against Tie2 by FACS (Facsaria, BD). Subsequently, about 20k Tie2+ and 200k Tie2– cells (control) were labelled with DiL (red fluorescence dye, Molecular Probes) and both cell types were injected (25G, Hamilton) with fibrin hydrogel (Tisseel, Baxter) or in phosphate buffered saline (PBS) into the cavity of DG discs and non-degenerated control discs. The discs were kept in the absence of mechanical loading for seven days. On day 154, organ culture was stopped and endplates were removed and NP was separated from the AF with an 8mm biopsy punch. Outcome measurements were cell viability of injected and native cells by cLSM microscopy and semi-automated cell counting (imageJ, NCBI software) and GAG/DNA ratio. All cells were stained with green fluorescence calcein AM staining and DAPI, which allowed to distinguish living exogenous and native cells.

Results: The 3D cLSM stacks taken in the healthy discs injected with Tie2+ showed a cluster-like spheroid-like arrangement of the NPPC in the NP region in contrast to the native allogeneic cells. In the NP-region of non-degenerated discs cell viability (CV) of exogenous Tie2+ cells in PBS was estimated to be 71 ± 29.2% and 64.5 ± 46.12% for the AF, respectively. Tie2–- cell's CV was considerably lower in PBS (~13% for NP). In the DG discs with fibrin hydrogel, CV of Tie2+ dropped from ~90% down to ~33%. Conclusion: NPPC cell survival was considerably reduced after 7 days of organ culture embedded in fibrin gel. Nutrition of fibrin hydrogel or IVD degeneration model could be a factor to reduce cell survival. Future studies should focus on identifying a suitable carrier for the NPPC.

P66

PHYSICAL LIMITATIONS TO TISSUE ENGINEERING OF INTERVERTABRAL DISC: EFFECT OF TRANSFORMING GROWTH FACTOR (TGF)-B, BONE MORPHOGENETIC PROTEIN (BMP)-2 AND 7 UNDER HEALTHY AND LOW OSMOTIC CONDITIONS SEEN IN DEGENERATED DISCS

Shigeru Kobayashi,Kenichi Takeno,Tyuyoshi Miyazaki,Katsuhiko Hayakawa,Adam Meir

Orthopaedics and Rehabilitation Medicine, Faculty of Medical Sciences, The University of Fukui Eiheiji 910-1193+Fukui, Japan

Introduction: Proteoglycan loss is one of the first signs of disc degeneration; there is increasing interest in developing biological methods for its replacement both by in vivo repair and through tissue engineered constructs. Regeneration of disk tissue with sufficient mechanical strength particularly requires the production of glycosaminoglycan (GAG), which accounts for 7-10% of healthy disk tissue.

Aim: In this study, we examine how growth factors influence the rate at which proteoglycans can be accumulated in a three dimensional cell culture system under healthy and low-osmotic conditions as seen the degenerated disc.

Methods: Cells were isolated from the nucleus pulposus of 18-24 month bovine caudal discs. They were cultured for 5 days in alginate beads in DMEM containing 6% FBS under 5% O2 at cell densities of 4 million cells/ml. Medium osmolality was altered by addition of 5 mol/l sodium chloride(NaCl) and was monitored using a freezing point osmometer (Semi-micro osmometer, Knauer, Germany). NP cells were cultured in culture fluid with a normal osmotic pressure (400 mOsm) as seen the healthy disk or a low osmotic pressure (270 mOsm) as seen the degenerated disc. The medium was changed every day and transforming growth factor-β (TGF-β: 20µl/ml), bone morphogenetic protein-2 (BMP-2: 100µl/ml) and -7 (OP-1:100µl/ml) was added to both groups every day. Lactate production was measured enzymatically as a marker of energy metabolism. Rate of sulfate GAG synthesis was measured using a standard 35S-sulfate radioactive method. GAG accumulation (as a measure of proteoglycan) was measured using a DMB assay.

Results: At low osmoralities as seen degenerated disc, cells may be functioning optimally but the low osmoralities limits the rate of GAG accumulation. Regeneration of disk tissue with sufficient mechanical strength particularly requires the production of GAG, which accounts for 7% (viz. 70mgs/ml) of disk tissue. The average of GAG accumulation per day in culture shows the control group was about 0.07 mg/ml/day under the healthy disc environments. GAG production was increased about 2-3 times by addition of TGF-β, BMP-2 or 7, respectively. Calculated times to produce a concentration equal to the in vivo concentrations of 70 mgs/ml assuming initial rates were maintained and there was no loss of GAG, were > 900 days. This concentration could be increased to 0.12, 0.15 and 0.19 mg/ml/day by TGF-β, BMP-2 and 7, respectively. Thus, growth factors support could increase rates of GAG production by up to 2-3 fold. However the theoretical time necessary to produce a construct with the same concentration as the disc matrix even under ideal conditions would still be >>1 year.

Conclusions: In this study, addition of TGF-β, BMP-2 or 7 to constructs was found to have big effect on the concentration of accumulated GAG under healthy disc environments. However, matrix turnover is very slow even if the growth factors use, and increasing cell metabolism potentially should increase GAG deposition, but leads to a more nutrients demands. Thus, the clinical application of disc regeneration medicine needs to be advanced by providing appropriate physiological conditions with consideration of age-related disc changes.

P67

IMPLICATIONS FOR CELL SURVIVAL AND REGENERATION IN THE INTERVERTEBRAL DISC: FACTORS AFFECTING NUTRIENT TRANSPORT

Morgan Giers,Bryce Munter,George Ide,Kyle Eyster, Anna Newcomb,Vadim Byvaltesv,Brian Kelly, Neil R. Crawford,Mark Preul,Nicholas Theodore

Barrow Neurological Institute Phoenix 85210, United States

Introduction: The intervertebral disc (IVD) is the largest avascular structure in humans. One major barrier to IVD regeneration in humans is creating an environment conducive to cell survival in a low transport structure. Most knowledge of nutrient transport in human IVDs comes from mathematical models, but there are little physical data available, particularly for whole IVDs.

Aim: To determine the effect of biomechanical and physiological factors on nutrient transport

in the IVD to increase the effectiveness of regenerative therapies.
Materials and Methods: Spines were harvested from 4 deceased 90-150lb Yorkshire pigs. A saw was used to remove 70 whole cervical, thoracic, and lumbar discs with endplates attached. Discs were placed in histological stains Safranin O (SO) or Fast Green FCF (FG). Discs were divided into diffusion or compression tested groups and tested 1,3,5,or 7 days (n=3). Loaded discs were placed under a static 50 lb/disc load in a diurnal cycle. Changes in disc height during a diurnal cycle were assessed (n=3). To study the endplate polyurethane was used to block the endplate in 3 compressed discs. Discs were cut through the transverse plane and photographed. Images were analyzed in ImageJ for depth of annulus fibrosus (AF) stained. The nucleus pulposus (NP) was assigned a staining score of 1-3. A simple fickian diffusion mathematical model was created using COMSOL Multiphysics. A diurnal convection/ diffusion model was also prepared. Models contained either concentration or no flux boundary conditions to simulate open vs. blocked endplates. Disc height data was used to determine fluid velocities.
Results: The results showed there was no difference in AF staining between the two stains (p=0.60) (Figure 1). There was no increase (p=0.60) in depth of AF staining due to the addition of convection via diurnal loading. The nucleus pulposus (NP) in all open endplate samples were completely stained by day 3. There was decreased, though not significant (p=0.067), NP staining in blocked endplate samples. The diffusion only mathematical model successfully modeled the trajectory of the stain. The convective velocities were well matched to in vitro disc height measurements and were near zero within 1 minute of loading. The addition of this short time of convective flow did not change concentration distributions compared to the diffusion model. Conclusions: This method found that most small molecule transport occurs via the endplate, but some also occurs through the AF. Furthermore, there was negligible benefit or hindrance to transport from the addition of compressive load. This is a simple method to study strategies for increasing nutrient transport in the IVD, which is a critical barrier to the development of regenerative therapies in the IVD.

P68

THE ALTERATIONS OF ADIPONECTIN RECEPTOR EXPRESSION WITH DISC DEGENERATION IN RAT INTERVERTEBRAL DISC CELLS

Yoshiki Terashima,Kenichiro Kakutani,Toru Takada, Takashi Yurube,Hiroaki Hirata,Koichiro Maeno,Shingo Miyazaki,Masaaki Ito,Yuji Kakiuchi, Masahiro Kurosaka,Kotaro Nishida
Kobe University 650-0025, Japan

Introduction: Adiponectin is adipocyte specific hormone known to have anti-diabetic, anti-atherogenic, and anti-inflammatory effects.
Aim: The aim of this study was to examine the expression of Adiponectin receptor 1 and 2 (Adipo R1 and R2) in rat intervertebral disc (IVD) cells and its changes with disc degeneration. Further, we investigated anti-inflammatory effects of Adiponectin on rat IVD cells.
Materials and Methods: Immunohistochemical staining: Skeletally matured male SD rats were affixed with an Ilizarov-type device with springs between the 8th and 10th coccygeal vertebrae, loaded statically at 1.3 MPa, and divided into three groups by the duration of loading. D1 group; loaded for the first 1 day and later unloaded for 55 days, D7 group; loaded for the first 7 days and later unloaded for 49 days, and Sham group; unloaded for 56 days after surgery. Each IVD tissues were immunostained with Adipo R1 or R2. Their immunopositive cell percentage was calculated. Cell culture and treatments: Coccygeal IVD were aseptically dissected from eight skeletally matured male SD rats. The nucleus pulposus (NP) and anulus fibrosus (AF) were separeately isolated and were pre-cultured for 7 days. Then they were treated with recombinant Adiponectin (0.1 or 1.0μg/ml) and/or IL-1β (0.2μg/ml) for 24 hours. It was divided into four groups as following. Control group; without any treatment, IL-1β group; treated with IL-1β only, IL-1β+Ad 0.1 group; treated with both IL-1β and Adiponectin (0.1μg/ml), and IL-1β+Ad 1.0 group; treated with both IL-1β and Adiponectin (1.0μg/ml). RT-PCR was performed to evaluate the mRNA expression of TNF-α and IL-6. Results: Adipo R1 and R2 were widely observed in rat IVD cells.

There was no significant difference in the expression between Adipo R1 and R2. Whereas, the expression of Adipo R1 and R2 were gradually decreased according to the disc degeneration. The percentage of the positive immunostained cell with Adipo R1 decreased from 82.8±6.3% (Sham group) to 49.5±9.1% (D1 group) and 6.5±4.5% (D7 group). Also the percentage with Adipo R2 decreased from 82.5±11.0% (Sham group) to 24.3±10.3% (D1 group) and 4.0±2.9% (D7 group). The mRNA expression of TNF-α and IL-6 were significantly up-regulated by IL-1β in both NP and AF cells. The TNF-α expression of IL-1β+Ad 1.0 group were significantly lower than that of IL-1β group in both NP and AF cells ($P<0.05$). The same trend was also seen in IL-1β+Ad 0.1 group compared with IL-1β group but did not reach statistically significant differences. The IL-6 expression was not affected with Adiponectin.
Conclusion: The TNF-α expression induced by IL-1β stimulation was significantly down-regulated by Adiponectin in both NP and AF cells. The expression of Adiponectin receptors in the IVD cells decreased according to the disc degeneration, so that the effect of Adiponectin might be gradually reduced by the disc degeneration.

P69

MESENCHYMAL STEM CELL TREATMENT OF INTERVERTEBRAL DISC LESION PREVENTS FATTY INFILTRATION AND FIBROSIS OF THE MULTIFIDUS MUSCLE, BUT NOT CYTOKINE AND MUSCLE FIBER CHANGES

James Greg,Linda Blomster,Leanne Hall,Annina Schmid,Cindy Shu,Chris Little,James Melrose, Paul Hodges
The University of Queensland 4072 Brisbane, Australia

Introduction: Lesion and degeneration of IVDs causes structural remodeling of the multifidus muscle. Pro-inflammatory cytokines are thought to contribute. MSC-treatment restores IVD health after lesion but its effects on surrounding tissues remains unknown. Using an animal model of IVD degeneration, we assessed the effects of MSC-treatment of IVDs on the structural remodeling and cytokine expression within the multifidus muscle.
Aim: To investigate effects of mesenchymal stem cell (MSC) treatment on multifidus muscle remodeling after intervertebral disc (IVD) lesion.
Materials and Methods: An anterolateral lesion was performed on the L1-2, L3-4 and L5-6 IVDs in sheep. At either 4 (early treatment) or 12 (late treatment) weeks after IVD lesion, MSCs were injected into the lesioned IVD. Multifidus muscle was harvested from L2 (gene expression analysis) and L4 (histological analysis) at 3 or 6 months after IVD lesion and naïve controls for histological analysis of muscle, adipose and connective tissue cross sectional areas (CSA), and immunohistochemistry to study muscle fiber types. Real-time polymerase chain reactions quantified expression of TNF, IL-1β and TGF-β1.
Results: MSC-treatment of IVD lesion prevented the increased adipose and connective tissue CSA expected after IVD lesion. MSC-treatment did not prevent slow-to-fast muscle fiber type transformation. Gene expression of pro-inflammatory cytokines within the muscle was altered by the MSC-treatment of IVD. Increased IL-1β expression was prevented in the early treatment group and TNF and TGF-β1 expression was upregulated at 6 months.
Conclusion: Results show that although MSC-treatment prevents fatty infiltration and fibrosis of the multifidus muscle after IVD lesion, it cannot prevent a muscle inflammatory response and muscle fiber transformation. These findings highlight the potential role of MSC therapy after IVD injury, but reveals that other interventions may also be necessary to optimize recovery of muscle.

P70

SMALL INTERFERENCE RNA (SIRNA) TARGETING FOR FAS INHIBITS APOPTOSIS OF RAT NOTOCHORDAL CELLS

Jong-Beom Park, Eun-Young Park
The Catholic University of Korea 480-717, Korea, South

Introduction: The small interference RNA (siRNA) is a novel experimental technology to suppress expression of specific target genes. Excessive or inappropriate apoptosis of intervertebral disc cells results in intervertebral disc

degeneration. Previous studies reported role of Fas on enhanced apoptosis of notochordal cells, resulting in premature intervertebral disc degeneration. However, little information is available for siRNA targeting for Fas to inhibit apoptosis of notochordal cells.
Aim: We investigated the inhibitory effect of siRNA targeting for Fas on apoptosis of notochordal cells.
Materials and Methods: Rat notochordal cells were isolated, cultured, and placed in either 10% (normal control) or 0% (apoptosis-promoting condition) fetal bovine serum. We identified and quantified the expression of Fas and the presence of apoptotic cell death. In addition, the cells were transfected with siRNA oligonucleotides specific for Fas (Fas siRNA), negative (negative siRNA) and MOCK. We assessed the suppression of the Fas gene by siRNA transfection using real-time polymerase chain reaction (RT-PCR). Finally, we analysed the degree of anti-apoptotic effect of siRNA transfection for Fas on the cells in 0% fetal bovine serum using TUNEL and flow cytometry.
Results: The percentage of apoptosis and Fas expression in the cells incubated in 0% fetal bovine serum were increased compared with those in the cells incubated in 10% fetal bovine serum. Fas gene was significantly suppressed by siRNA transfection compared to negative siRNA and MOCK in 0% fetal bovine serum. Fas siRNA significantly reduced apoptotic cell death of the cells compared to negative siRNA and MOCK in 0% fetal bovine serum.
Conclusion: Our results demonstrated that Fas siRNA reduced the apoptosis of rat notochordal cells. The efficacy of siRNA in attenuating or preventing apoptosis of notochordal cells suggests that such tool may potentially represent a novel therapeutic treatment of disc degeneration due to inappropriate or excessive apoptosis of disc cells.

P71

INTERPLAY OF MICRO-TOPOGRAPHIES AND GROWTH FACTORS IN MESENCHYMAL STEM CELL BASED ANNULUS TISSUE ENGINEERING

Yon Jin Chuah,Soon Nan Wee,Hui Ting Daphne Lim,Khaing Mon Nanda Kyaw,Jin Rong Tan, Ching Ann Tee,Hwan Tak Hee,Yuejun Kang

Nanyang Technological University 70 Nanyang Drive Singapore 637457, Singapore

Introduction: Intervertebral Disc (IVD) is a complex tissue between two vertebral bodies, and comprises of Annulus Fibrosus (AF), Nucleus Pulposus (NP), and Endplate as its three major constituents. Degeneration of IVD can lead to chronic and debilitating discogenic pain in the neck or lower back. Tissue engineering presents a potential regenerative strategy to restore the biological function of the IVD. To date, the architecture of the currently developed AF tissues often lack the series of concentric rings and aligned anisotropic nature of the AF annular lamellae, a unique biological feature that confers its mechanical properties. Furthermore, limitation of autologous AF cells hinders the engineering of a physiologically relevant IVD for treatment of disc degeneration. The use of micro patterned mesenchymal stem cells (MSCs)-cell sheets together with growth factors and physical cues may serve as a potential strategy in AF tissue engineering.
Aim: To investigate the roles of micro-topographies and growth factors in MSCs-cell sheets based AF tissue engineering.
Materials and Methods: Non-patterned and patterned MSCs based cell sheets were developed in the presence of different growth factors. A segment of AF tissue construct was formed by rolling up the cell sheets and further cultured under differentiation medium. AF-associated markers were evaluated in both the cell sheets and tissue constructs by histological staining and gene expression analysis.
Results: The use of micro-topographies to align MSCs exhibited alignment of both cells and secreted collagen similar to that of native AF tissues. The expression of AF associated markers in aligned MSCs-cell sheet was also higher than non-patterned MSCs cell sheet. Different growth factors induce differing capabilities of MSCs to influence the formation of aligned MSCs-cell sheet, which influence the later development of three dimensional AF constructs.
Conclusion: The combination of micro-topographies and growth factors may contribute to the development of MSCs-cell sheets with high expression level of AF-associated markers that

benefit later AF tissue construction. These finding enables the development of engineered IVD similar to that of the native tissue in terms of microarchitectures and functionalities, which can be further har-nessed in future AF tissue repairs.

P72

MICROFABRICATION STRATEGY TO DEVELOP THE ANNULAR MICROSTRUCTURE OF AN INTERVERTEBRAL DISC COMPOSITE

Chee Seong Lim,Yon Jin Chuah,Yingnan Wu,Li Min Tay,Hwan Tak Hee,Yuejun Kang
Nanyang Technological University 70 Nanyang Drive Singapore 637457, Singapore

Introduction: The ideal strategy of inter-vertebral disc (IVD) regeneration relies on used biomaterials, growth factors and cell sources that are able to produce the IVD matrix for the purpose of restoring the integrity and function of human native discs. The key challenges are the complex biological environment and mechanical property of the IVD constructs. With the advent and rapid development of microscale technologies, microfabrication techniques have generally become feasible and potentially powerful techniques in addressing challenges in tissue engineering. The phenomena of contact guidance by which the physical shape of substratum induces the alignment and directional growth of cells were reported as an effective way in manipulating cell orientation. This study features IVD tissue engineering that uses multipotent mesenchymal stem cells (MSCs), synthetic biodegradable polymer, and anisotropic topographic features to resemble the native microarchitecture of IVD.

Aim: Develop a tissue engineered IVD construct through micro-fabrication techniques and multipotency of human MSCs.

Materials and Methods: Synthetic porous film polymer was fabricated through either solvent casting/particle leaching techniques/soft lithography or 3D printing. Human MSCs were seeded on the porous film for 2 weeks, in order to develop a cell laden polymer film. The cell laden polymer film was then further cultured under differentiation medium. The expression of annulus fibrosus (AF) associated markers were identified by gene expression analysis and histological staining. Mechanical properties of the constructs were also evaluated.

Results: Material characterization revealed the uniform anisotropic pattern and high inter-connectivity of the porous polymer film. Scanning electron microscopy (SEM) showed that MSCs integrated and exhibited confluence well within the PLC film. Fluorescence micro-graphs showed that grill topographic substrate promoted directional growth of MSCs. Histology revealed the multilayer concentric polymer constructs and distribution of annulus fibrosus associated markers. Real-time PCR showed higher gene expressions of AF associated markers on grill-topographic constructs than the control. The mean tensile modulus of grill-topographic PLC constructs was also significantly higher than that of the control.

Conclusion: By adopting an interdisciplinary approach involving universal micro-fabrication technique to fabricate uniform microscale pattern substrate, solvent casting/particle leaching method, and multipotent MSC, this novel patterned scaffold construct can be a platform for future tissue engineered IVD construct.

P73

CHARACTERIZATION OF CELLS IN DIFFERENT REGIONS OF INTERVERTEBRAL DISC THROUGH MICROFLUIDIC CELL SORTING

Ching Ann Tee,Yon Jin Chuah,Tong Glenda Teo,Lu Yin,Hwan Tak Hee,Joonyoon Han,Yuejun Kang
Nanyang Technological University 70 Nanyang Drive Singapore 637457, Singapore

Introduction: Intervertebral disc (IVD) degeneration is a significant musculoskeletal disease burden and the interdisciplinary efforts between bioengineers and clinicians have been focusing on tissue engineering to develop an engineered IVD for disc replacement. However, the biological complexity of the intervertebral disc still remains poorly understood, especially in the different regions of the nucleus pulposus (NP) and annulus fibrosus (AF) region. Without these data, it is difficult to develop a native-like disc composite that facilitates different cell responses in the different regions. To date, the isolation and characterization of cells from

different regions of IVD is often tedious and challenging. Recently developed microfluidic chip may have the ability to sort cells based on different cell sizes allowing later cell characterization.

Aim: The aim of this study is to sort out different cell populations within the annulus fibrosus and nucleus pulposus through convention dissection or microfluidic cell size based sorting, and further characterize their genetic and biochemical properties in different culture systems. Materials and Methods: Whole discs were harvested from the lumbar region of the porcine spine. Whole discs were dissected into 4 regions (inner AF, middle AF, outer AF, and NP), and subjected to enzymatic digestion to obtain individual cell populations. On the other hand, whole discs were digested to obtain the cells, and later sorted out by sizes through microfluidic cell sorting technology. Different cell population were then analyzed for their gene expression profile, and their behaviour on different culture systems(e.g. aligned cell sheet culture and pellet culture). Gene expression profiling was analyzed by real time PCR, while disc associated protein markers were evaluated by histological staining. Results: Cell populations obtained from manual dissection displayed differences in their gene expression and cell morphologies, when compared to microfluidic cell sorting. These cell populations when cultured in different culture system exhibited different expression profiles of disc associated gene and protein markers. Further comparison between the cell populations obtain through microfluidic cell sorting and manual dissection demonstrated that different disc regions display differences in size and behaviour of the cells. Conclusion: The fundamental understanding of different cell population properties in the various regions of the disc may help us gain insights into the anatomical and physiological functions of the IVD region. This can help in future treatment of intervertebral disc degeneration.

P74

PERCUTANEOUS KYPHOPLASTY (PKP) INDUCES PROTEOGLYCAN LOSS IN THE ADJACENT DISC: PRELIMINARY EVIDENCE FROM A RABBIT MODEL

Yue Wang,Zhiyun Feng,Lunhao Chen,Zhong Chen

Department of Orthopedic Surgery, 1st Hospital of Zhejiang University Hangzhou, ZJ, 571, China, People's Republic of

Introduction: PKP is a commonly used clinical approach in treating painful osteoporotic vertebrae fractures. The augmentation of vertebral body with bone cements (polymethylmethacrylate, PMMA), however, changed stress distribution in the spinal segment, and predisposed the proximal adjacent vertebra to fracture, as evidenced by clinical observations. The adjacent disc undertook the same mechanical change yet related consequence remains unknown. Moreover, the fill of PMMA in the vertebral body damaged capillary net beneath the endplate and thus, may block the nutrient supply to the adjacent disc. We hypothesize that PKP may accelerate the degeneration process in the adjacent disc.

Aims: To establish a PKP rabbit model and to evaluate the effects of PKP on the adjacent disc.

Material and methods: Thirteen rabbits (male, age 2 months) were used to establish a PKP animal model. Under anesthesia, the upper lumbar spine (L1-L3) was exposed via an anterolateral approach. A hole was drilled in the vertebral body, through which the vertebral trabeculae was excavated to fill 0.5-1ml PMMA. Using a 1.5T scanner, spine magnetic resonance (MR) images were obtained at 1 and 3 months postoperatively. Nucleus signal intensity was obtained and an average disc height was measured from anterior, middle and posterior of the disc space on sagittal T2W MR images. Three rabbits were sacrificed at each follow-up to evaluate histological disc degeneration. Safarinin O staining was performed to assess proteoglycan loss in the disc with a semi-quantitative score. A lumbar disc without intervention was taken as a control for each animal.

Results: One animal paralyzed and died, leaving 12 rabbits in the study. For the discs adjacent to PKP, nucleus signal intensity decreased mildly from postoperative month 1 (1.29±0.07) to month 3 (1.19±0.08), as compared to a slight increase in the control discs (from 1.18±0.08 to 1.28±0.09). While the height slightly increased from 3.45±0.10 to 3.49±0.10 for the discs adjacent to PKP, it increased from 3.50±0.12 to

3.76±0.12 for the control discs. Histologically, nucleus pulposus in the discs adjacent to PKP were shrunken and less stained, and annulus fibrosus were disorganized. Histological disc degen-eration score was greater in the discs adjacent to PKP (5.11±0.31) than in the control discs (4.50±0.26), though did not reach statistical significance (P=0.15). Proteoglycan loss was more prominent in discs adjacent to PKP (6.73±0.40) than in the control discs (4.60±0.45, $P < 0.05$).

Conclusion: Even in short term, PKP lead to proteoglycan loss and annulus distortion in the adjacent disc. PKP may accelerate adjacent disc degeneration, though long term effects need to be further investigated using a larger sample.

P75

RELATIONSHIP BETWEEN SPINAL DEFORMITY AND JOINT CONTRACTURE OF LOWER EXTREMITIES

Tetsuya Kobayashi,Mutsuya Shimizu,Hiroshi Ito
Asahikawa Medical University 0788510 Asahikawa, Japan

Introduction: Degenerative spinal deformities usually start with decreasing lumbar lordosis, which primarily could be compensated with pelvic retroversion and modified lower extremities alignment. Previous studies showed change in pelvic position lead to change in range of motion (ROM) of adjacent joints, and this might lead to hip-knee joint contracture as a result of structural spinopelvic malalignment. Aim: Purpose of this study was to investigate relationship between sagittal spinopelvic alignment (SSA) and hip-knee joint ROM using community-based volunteers.

Materials and Methods: This study was a component of our ongoing prospective cohort study, and 80 female subjects, aged 51-75 years and without hip pathology, were included. All the participants were subjected to upright entire spine radiographs and examinations by physicians and physical therapists. Measurements of SSA included lumbar lordosis (LL), pelvic tilt (PT), sagittal vertical axis (SVA), pelvic incidence (PI), and femoral oblique angle (FOA; Le Huec, ESJ2011). In order to evaluate the extent of spinopelvic deformity, number of sagittal modifiers of SRS-Schwab classification was recorded (PI-LL 20˚=2; SVA 95mm=2; PT 30˚=2). ROM measurements included hip extension (Ext), internal rotation (IR), external rotation (ER), and knee extension. Isometric muscle strength was also measured for trunk extensor/flexor and quadriceps femoris (QF) muscles.

Results: Subjects' age was 63.0 years in average, and mean±SD values of SSA and ROM measurements were; LL39.1±15.9°, PT23.1 ±10.1°, SVA1.4±3.2cm, FOA6.6±3.9°, hip Ext 38.8±14.3°, hip IR 69.4±15.4°, hip ER 85.6± 13.5°, knee Ext -1.1±8.3°. Hip ER showed the best correlation with SSA parameters, followed by hip Ext and knee Ext; hip ER -LL (r=0.247/p=0.0468), -PT (r=-0.438/p=0.0009), -SVA (r=-0.399/p=0.0028), -FOA (r=-0.473/ p=0.0003); hip Ext -LL (r=0.346/p=0.0108), -SVA (r=-0.296/p=0.0311), -FOA (r=-0.399/p=0.0028); knee Ext -LL (r=0.287/p=0.0369), -FOA (r=-0.450/p=0.0006). Hip ER also showed significant correlation with QF (r=0.241/p=0.0359). Reduced hip ER was associated with increased PT, SVA, and Schwab sagittal modifier. In summary, 1SD decrease in hip ER was equivalent to PT of +6.0°, SVA of +3.0cm, and added Schwab sagittal modifier of 1.5. FOA was associated more with knee (r=-0.456, p=0.0006) and hip (r=-0.464, p=0.0004) ROM than with PT (r=0.360, p=0.0084), as has been formerly indicated (Lee, ESJ 2013). Conclusion: Spine-hip-knee joints act accordingly for maintaining balanced posture. Our results showed that spinal deformities predominantly affected hip ER. Previous biomechanical studies showed that 1° of pelvic retroversion induced 0.5° of acetabular anteversion, which caused decreased femoral neck rotation and hip ER. Evaluation of hip contracture might express structural modification of SSA, and further studies are expected to expand understanding of spine-hip-knee relationship.

P76

PHYSICAL AND RADIOLOGICAL INFLUENCE OF VERTEBRAL FRACTURE UPON ADULT SPINAL DEFORMITY: POPULATION-BASED COHORT STUDY

Tetsuya Kobayashi,Issei Senoo,Hiroshi Ito
Asahikawa Medical University 0788510 Asahikawa, Japan

Introduction: In adult spinal deformity classification by Schwab, sagittal modifiers such as pelvic incidence (PI), sagittal vertical axis (SVA), pelvic tilt (PT) and lumbar lordosis (LL) are important factors to keep sagittal balance. Although vertebral compression fracture (VCF) is considered to affect sagittal imbalance, few papers reported the relationship between the sagittal modifiers and VCF.
Aim: The purpose of this study is to clarify the impact of VCF on sagittal alignment with X-ray and clinical functional factors.
Materials and Methods: 193 adult female volunteers who had neither spinal surgery nor hip surgery were recruited from population register (mean age 65.0±6.8). After performed informed consent, all subjects were instructed to take upright whole spine X-ray for radiographic measurements of PT, PI, LL and SVA. Sagittal modifiers of SRS-Schwab classification (PI-LL 20˚=2; SVA 95mm=2; PT 30˚=2)[1] were evaluated. VCF was diagnosed using both quantitative and semi-quantitative methods. Following physical parameters were also evaluated; range of motion (ROM) of lumbar spine by back extension test (BET), back muscle (EX) and abdominal muscle (FL) strength by isometric dynamometer, and trunk inclination angle (TIA), which is the difference of trunk angle using surface markers between standing and walking. Low back pain and health-related quality of life were also evaluated by visual analog scale (VAS) and Roland-Morris Disability Questionnaire (RDQ). ANOVA was used for statistical analyses. Significance level was set at $p<0.05$. Results: The number of subjects with no VCF (NC) was 144, one VCF (1VCF) was 30, and more than two VCFs (VCFs) were 19. Radiographic parameters showed significant differences according to the number of VCF (NC/1VCF/VCFs); PT 22.5/25.7/36.9˚ ($p<0.001$), SVA 13.0/39.5/49.5mm ($p<0.001$), LL 40.4/35.0/26.8˚ ($p<0.001$), SRS-Schwab sagittal modifiers 1.8/2.6/3.9 ($p<0.001$). Physical parameters also exhibited significant differences; BET 12.2/8.4/5.6cm ($p<0.001$), EX 49.4/40.4/42.5kg ($p=0.005$), TIA 3.8/4.8/8.3˚ ($p<0.001$). PI, FL, VAS and RDQ had no significant differences.
Conclusion: Subjects with VCF showed decrease in lumbar extension ROM by 40% and back extensor muscle strength by 17%. Our results showed that vertebral compression fractures caused both radiographic deformity using SRS-Schwab classification and physical dysfunction of lumbar spine. When treating adult spinal deformity, especially in the elderly population, evaluation of osteoporosis and sarcopenia should be among important factors, and further understanding of physical characteristics, as well as radiographic modifications, are mandatory for successful management of this ever-increasing clinical problem.

P77

THE TIME COURSE CHANGES IN BONE METABOLIC MARKERS AFTER ADMINISTERING THE ANTI-RANKL ANTIBODY AND DRUG COMPLIANCE AMONG PATIENTS WITH OSTEOPOROSIS

Kazuhide Inage,Sumihisa Orita,Kazuyo Yamauchi, Miyako Suzuki,Jun Sato,Kazuki Fujimoto, Yasuhiro Shiga,Koki Abe,Hirohito Kanamoto, Masahiro Inoue,Hideyuki Kinoshita, Kazuhisa Takahashi,Seiji Ohtori
Dept. of Orthopaedic Surgery, Graduate School of Medicine, Chiba University 260-8670 Chiba, Japan

Introduction: The anti-receptor activator of nuclear factor-kappa B ligand (RANKL) antibody shows a strong inhibitory effect on bone resorption. And drug compliance is expected to be effective.
Aim: We conducted a study to investigate the time course changes in bone metabolic markers after the administration of the anti-RANKL antibody and to assess drug compliance among osteoporotic patients.
Materials and Methods: We included 40 osteoporotic patients after menopause who received the anti-RANKL antibody at our medical facility. The inclusion criterion for osteoporosis was a young adult mean (YAM) level < 70% in accordance with the Japan Osteoporosis Society's guidelines. To determine the time course changes in the bone metabolic markers, we measured the serum tartrate-resistant acid phosphatase 5b (TRACP 5b) level (a bone resorption marker) and the serum N-terminal propeptide of type 1 collagen (P1NP) level (a bone formation marker) before and at 1 month after administrating the anti-RANKL antibody. To evaluable drug compliance, we

assessed the dropout rate during treatment and at 6 months after treatment.
Results: The average TRACP 5b level was significantly lowered to 153.2 mU/dL at 1 month after treatment compared to 574.8 mU/dL before treatment ($P < 0.05$). The average improvement rate for 1 month after treatment was 68.2%. The average P1NP level did not indicate a significant difference; it was 35.1 μG/L at 1 month after treatment compared to 56.9 μG/L before treatment ($P > 0.05$). The average lowering rate for 1 month after treatment was 22.1%. As for drug compliance, we did not have any dropouts during the treatment or after 6 months (dropout rate: 0%).
Conclusion: Our study findings suggest that there would be a regulatory influence on a good bone metabolic environment, because strong bone resorption suppression and the maintenance of bone formation were observed after administering the anti-RANKL antibody.

P78

HEPARIN BASED POLYELECTROLYTE COMPLEX ENHANCES THE THERAPEUTIC EFFICACY OF BONE MORPHOGENETIC PROTEIN-2 FOR POSTEROLATERAL FUSION IN A LARGE ANIMAL MODEL

Ming Wang,Raymond Wing Moon Lam,Sunny A. Abbah,Tao Hu,Soo-Yein Toh,Simon Cool, Kishore Bhakoo,Jun Li,James C.H. Goh,Hee-Kit Wong
National University Hospital Singapore, Singapore

Introduction: Posterolateral fusion is important yet challenging procedure in spine surgery due to its high fusion failure rate. Bone Morphogenetic Protein-2 (BMP-2) was used “off-label” to enhance posterolateral fusion, however extremely high doses of this molecule were often required which contributed to various complications including inflammatory response and heterotopic ossification. This was attributed to the poor modulation capacity of the traditional carrier absorbable collagen sponge (ACS). To reduce the efficacious dose of BMP-2 and its associated complications, heparin based polyelectrolyte complex (PEC) was then introduced.
Aim: The study aims to prove that PEC carrier could enhance the efficacy and safety profile of BMP-2 on porcine posterolateral fusion model.
Materials and Methods: L3/L4 and L5/L6 two level posterolateral spinal fusion was performed on 6 pigs using two doses of BMP-2 with PEC or ACS: (1) PEC with 800 μg BMP-2 (n=2); (2) PEC with 400 μg BMP-2 (n=2); (3) ACS with 800 μg BMP-2 (n=1); (4) ACS with 400 μg of BMP-2 (n=1). The construct was loaded into a rigid bioabsorbable cage for implantation. Manual palpation, micro computed tomography (micro CT) and histology were performed 2 months after operation. Radiological fusion score was calculated based on micro CT on a three point scale.
Results: Manual palpation revealed fusion in all groups. However, radiological fusion score of PEC groups was higher than that of ACS groups (Group 1: 2.5±0.53; Group 2: 2.38±0.51; Group 3: 1.75±0.5; Group 4: 1.5±0.58). In micro CT and histology image, the newly formed bone in PEC groups appeared to be well integrated into the native bone with no overgrowth into the adjacent structure. On comparison, in ACS groups, large gaps were observed between the newly formed bone and the fusion bed with heterotopic ossification into the psoas muscle. The micro CT quantitative data showed that bone volume/total volume, bone surface/total volume, trabecular thickness and trabecular number in groups 1 and 2 were generally higher than that in groups 3 and 4. Groups 1 and 2 had lower trabecular separation compared to groups 3 and 4. These findings indicate microarchitecture of the newly formed bone in PEC groups was superior to that of ACS groups.
Conclusion: Current study demonstrated that BMP-2 delivered by PEC induced successful posterolateral fusion in porcine model. The efficacy of BMP-2 was improved and bony overgrowth was reduced. The microarchitecture of BMP-2 induced bone tissue was also enhanced by PEC.

P79

EXPOSURE OF THE SPINE SURGEON TO RADIATION DURING MYELOGRAPHY

Kentaro Yamane,Nobuo Kai
Fukuyama Medical Center 720-8520, Japan

INTRODUCTION: Fluoroscopy has been increasingly used for a large number of interventional and surgical procedures. The spine surgeon also has more opportunities to be exposed to radiation in recent years because of the new fluoroscopically assisted surgical methods. Myelography is a traditional radiographic examination, and it remains one of the most useful examinations to evaluate spinal condition before surgery. On the other hand, large numbers of myelography examinations increase radiation exposure for the spine surgeon.
Aim The purpose of this study was to assess radiation exposure to the spine surgeon during myelography.
MATERIALS AND METHODS: The examiner wore a torso protector, a neck protector, radiation protection gloves and radiation protection glasses. Dosimeters were placed with both of the inside and the outside of each protector. Radiation dose to the examiner's torso, neck, right hand, and eyes were measured for two months. The dosimeter was exchanged every month. Twenty-nine examinations were performed, and 9 of them received radiculography concurrently. The effective dose and the equivalent doses of hand skin and eyes were investigated.
RESULTS: The mean radiation exposure time was 98 seconds. The exposure doses of each dosimeters placed with the inside of protectors were ;Torso 0.29mSv, neck 0.61mSv, hand skin 32.6mSv, eyes 1.62mSv. By contrast, the exposure doses of each dosimeters placed with the outside of protectors were ;Torso 4.04mSv, neck 6.29mSv, hand skin 49.8mSv, eyes 5.81mSv. The calculated effective doses were 0.33mSv with a torso and a neck protector, 0.95mSv with only a torso protector, and 4.29mSv without any protectors.
CONCLUSION: The spine surgeon is said to be exposed to greater radiation than other non-spinal musculoskeletal surgeons. This study showed that the effective dose with a torso and a neck protector decreased by approximately one third compared with that with only a torso protector. The examiner's hands received the greatest amount of radiation. An examiner without radiation protection gloves can exceed annual recommended dose limits. The effects of repeated exposure to low-dose radiation are still largely unknown. However, careful attention should be paid to radiation exposure, and receiveing full protection by wearing all protectors is an easy and reliable means to reduce radiation exposure.

P80

EVALUATION OF QUALITY OF LIFE AND NEUROPATHIC PAIN IN PATIENTS WITH LOW BACK PAIN USING JAPANESE VERSION OF THE PAINDETECT QUESTIONNAIRE

Akihiko Hiyama,Masahiko Watanabe,Daisuke Sakai, Hiroyuki Katoh,Masato Sato,Joji Mochida
Department of Orthopaedic Surgery, Surgical Science Tokai University School of Medicine 2591193+ Isehara, Japan

Introduction: Neuropathic pain in patients with low back pain (LBP) has been associated with psychosocial factor as well as physical factor, and to be associated with a decline in Quality of life (QOL).
Aim: The purpose of this study was to evaluate the effects of neuropathic LBP on the physical and mental QOL.
Materials and Methods: 650 new patients were treated at our institution for LBP. All patients between the ages of 20 and 79 were asked to complete a set of questionnaires including the Japanese version of the PainDETECT Questionnaire (PDQ-J), the JOABPEQ, and the Short Form 36 (SF-36). Based on the PDQ-J scores, participants were classified into three groups: a neuropathic pain group, a nociceptive pain group, and an intermediate mixed pain group. Among them, patients with clear neuropathic and nociceptive LBP were selected. To investigate the differences between neuropathic and nociceptive LBP, self-reported general health (SF-36 and JOABPEQ) were compared between the neuropathic and nociceptive LBP groups.
Results: Of 650 patients with LBP, 331 completed the questionnaires and were enrolled in the study. There were 193 men (58.3%) and 138 women (41.7%) with a mean age of 54.5 years. From the PDQ-J survey, 49 patients (15%) were classified as having neuropathic LBP, and 190 (58%) were categorized as having nociceptive LBP. Evaluation of SF-36 scores demonstrated that in patients with neuropathic LBP, all eight scales showed lower scores compared with those for nociceptive LBP. JOABPEQ scores also

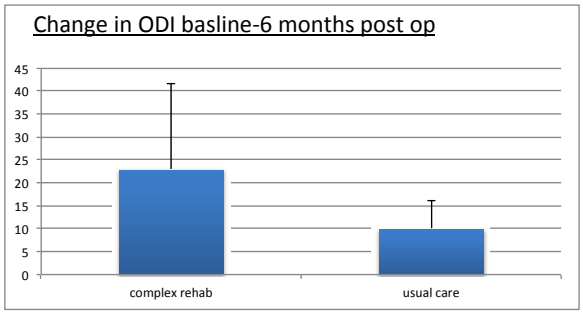
revealed that patients in the neuropathic LBP group had lower QOL scores compared with the nociceptive LBP group. The median scores in neuropathic LBP were 29 for Low Back Pain; 33 for Lumbar Function; 21 for Walking Ability; 38 for Social Life Function, and 36 for Mental Health, while in the nociceptive LBP group, the results were 43 for Low back Pain; 58 for Lumbar Function; 64 for Walking Ability; 51 for Social Life Function, and 51 for Mental Health.
Conclusion: We examined the impact of nociceptive or neuropathic LBP on QOL. Patients with neuropathic LBP had significantly reduced QOL compared with the nociceptive LBP group.

P81

REHABILITATION FOLLOWING LUMBAR FUSION SURGERY; A FEASIBILITY PROTOCOL WITH INTERIM RESULTS

Greenwood, J,, McGregor, AM,, Johnson, J, Webley, KW, Hurley, MV.
National Hospital for Neurology and Neurosurgery London WC1 3BG, United Kingdom

Introduction: Following lumbar fusion surgery as many as 40% of patients have ongoing back related disability. 'Complex rehabilitation' comprising exercise and cognitive behavioural therapy (CBT) may help improve these outcomes. We are conducting a randomised, controlled, feasibility study evaluating the provision of 'complex rehabilitation' following lumbar fusion surgery. We present our study protocol and interim results.
Aim: To establish the feasibility of providing 'complex rehabilitation' in small groups following lumbar fusion surgery. To identify the characteristics (midpoint, variance and effect size) of the selected outcome measures.
Materials and Methods: A 'complex rehabilitation' strategy was designed in our centre. Participants are randomised to either 'complex rehabilitation' or usual care. The 'complex rehabilitation' protocol involves 10 group sessions (90 minutes duration) of education (safe and beneficial to exercise, pacing, managing flare ups, use of analgesia, pain physiology, thoughts feelings and behaviour), exercise (to improve limb and spine strength, cardiovascular fitness and range of movement) and peer support employing principles of CBT. Usual care involves a single session of inpatient advice regarding exercise progression with referral to local physiotherapy services at the discretion of the surgical team. All rehabilitation is commenced 3 months post op following successful clinical and radiological review. A previous exploratory study informed a successful NIHR application for funding and recruitment began in July 2014. Outcome measures include compliance and the Oswestry Disability Index (ODI).
Results: Results to date show a greater reduction in ODI score from baseline at 6 months in those randomised to rehabilitation versus usual care (23 point reduction v 10). This represents a clinically meaningful improvement. Compliance is excellent with all participants attending more than 50% of the sessions. There have been no adverse reactions to rehabilitation.
Conclusion: Our interim results suggest there is a positive effect favouring the provision of 'complex rehabilitation' over usual care following technically successful lumbar fusion surgery. These results suggest that providing group rehabilitation in this manner is both acceptable and safe. Longer term follow up will establish the duration of any positive effect.



P82

VALIDATION STUDY OF REINFORCEMENT METHODS TO ELICIT KNEE JERK

Morimoto T, Tsukamoto M, Yoshihara T, Sonohata M, Masaaki Mawatari M*Department of Orthopaedic Surgery, Faculty of Medicine, Saga University 849-8501 Saga city, Japan*

Introduction: Notwithstanding the Jendrassik method, which is the most famous reinforcement methods to elicit knee jerk, techniques

included upper viewing (U method) and plantar flexion (PF method). However, few papers have investigated the sensitivity of these methods in eliciting knee jerk.

Aim: The objective of this study was to detect the sensitivity of different methods of eliciting knee jerk.

Methods: This study included 68 healthy medical students randomly selected (41 males and 27 females, average age 24 years). The four knee jerk tests were performed with subjects in the sitting position with the legs hanging freely over the edge of the desk were carried out by an experienced surgeon with the same hammer. The four knee jerk tests were performed normally without any reinforcement method (normal method), and with the U method, PF method and Jendrassik method. All tests were performed video recorded to determine the knee extension angle by using a video analysis software program (Kinovea). After each procedure was performed three times, the maximum angle was defined as the PTR angle. The results were considered to be PTR positive when over 5 degrees of the PTR angle and PTR reinforcement which was increased by more than 5 degrees above the normal method. The frequency of PTR negative cases becoming PTR positive by reinforcement knee jerk methods was defined as the PTR positive rate. For each parameter, differences between the groups were evaluated by an unpaired t-test or ANOVA. $P< 0.05$ was considered to be significant.

Results: The frequency of PTR positive in the normal method was 58%. The sensitivity of PTR reinforcement was 19% in the U method, 46% in the PF method and 75% in the Jendrassik method($P<0.01$). Comparing the PTR angle in each method, the PF and Jendrassik methods were significantly larger than the normal and U methods($P<0.01$); there was no significant difference between normal and U methods. The PTR positive rates were 81% in Jendrassik method, 58% in PF method and 19% in U method ($P<0.01$).

Conclusion: The reinforcement method of knee jerk might occur because of excitement of the spinal cord anterior horn due to the disinhibition mechanisms of the upper spinal cord and/or expansion mechanisms of the spinal cord anterior horn The effect of the U method reflects the disinhibition mechanisms of the spinal cord by upper viewing to divert the consciousness, while the effect of the PF method is the expansion mechanisms of the spinal cord anterior horn by plantar flexion by tension in the different muscles. The results of the PTR angle and PTR positive rate demonstrate that the reinforcement effect of knee jerk with the Jendrassik method is the best, followed by the PF method, then the U method. Therefore, the Jendrassik method might have a synergistic effect with the the disinhibition mechanisms and expansion mechanisms of the spinal cord.

P83

SAGITTAL SPINO-PELVIC ALIGNMENT IN RAPIDLY DESTRUCTIVE COXARTHROSIS

Morimoto T, Tsukamoto M, Yoshihara T, Sonohata M, Masaaki Mawatari M

Department of Orthopaedic Surgery, Faculty of Medicine, Saga University 849-8501 Saga city, Japan

Introduction: Rapidly destructive coxarthrosis (RDC) is a rare syndrome of unknown etiology that typically causes rapid destruction of the hip joint in elderly women. Although several authors have reported the influence of the pathogenic condition of the hip joint on the sagittal spino-pelvic alignment (SSPA), few papers have investigated about the role of SSPA on RDC.

Aim: The objective of this study was to investigate SSPA in patients with RDC.

Methods: SSPA was investigated in 60 patients with RDC and 70 patients with hip osteoarthritis (HOA). All patients were restricted to female and >70 of age years due to matching for sex and age. The parameters of SSPA were analyzed with lumbar lordosis (LL), lumbar range of motion (ΔLL), sacral slope (SS), pelvic incidence (PI), and pelvic tilt (PT). The pelvic inclination angle (PIA) in the supine position and the change in PIA from the supine to the standing position (ΔPIA) were measured by using the anteroposterior pelvic radiographs. These parameters were compared between the two groups. Modifiers of the SRS-Schwab classification were used to investigate the degree of sagittal malalignment. For each parameter,

differences between the groups were evaluated using an unpaired t-test. Correlations between the parameters were evaluated by a regression analysis. P< 0.05 was considered to be significant.
Results: There were significant differences for lower LL, ΔLL, SS, and greater PT, ΔPIA in the RDC group compared with the HOA group (P<0.01). Forty-three patients (72%) in RDC and four patients (10%) in HOA had a ΔPIA of more than 10 degrees (P<0.001). According to the sagittal modifiers in the SRS-Schwab classification for RDC and HOA, PI minus LL more than 20 degrees and PT more than 30 degrees were seen in 78%, 19% and 73%, 10% of the patients, respectively. The RDC group showed significantly worse sagittal modifier levels in PI minus LL and PT than the HOA group (P<0.01).
Conclusion: This study suggests that a reduction in the lumbar lordotic angle and posterior pelvic tilt and sagittal malalignment in the SRS-Schwab classification as a static factor, small ΔLL and large ΔPIA as a dynamic factor, and complex, may play an important role in the development of RDC because these all factors could cause the increasing stress of the femoral head in standing. This is the first work to focus on the ΔLL and ΔPIA to determine the dynamic factors of SSPA associated with RDC. The frequency of PI minus LL more than 20 degrees, which was defined as PI/LL mismatch, is significantly higher in the RDC group compared to in the HOA group. PI/LL mismatch is also considered to be an important and new factors to understand the etiology of RDC. These recognitions of specific SSPA of RDC may help to predict and prevent of this disease.

P84

INNOVATIVE EQUIPMENT FOR ABDOMINAL TRUNK MUSCLE EXERCISES WITH A BUILT-IN MEASUREMENT SYSTEM FOR MUSCLE STRENGTH FOR PATIENTS WITH CHRONIC LOW BACK PAIN

Satoshi Kato,Hideki Murakami,Satoru Demura, Katsuhito Yoshioka,Noriaki Yokogawa,Moriyuki Fujii,Takashi Igarashi,Naoki Takahashi,Noritaka Yonezawa,Hiroyuki Tsuchiya
Kanazawa University 920-8641, Kanazawa, Japan

Introduction: Chronic nonspecific low back pain (LBP) and the disability associated with it impose a health and economic burden on the society. Trunk muscle exercises are often recommended as the first-choice treatment. However, performing the exercises is often difficult for chronic LBP patients, especially older adults, because of an increasing LBP during the exercises or their muscle weakness. We developed innovative equipment for abdominal trunk muscle exercises with a built-in measurement system for muscle strength. This equipment enables the patients to perform abdominal trunk muscle exercises in a sitting or standing position, and allows measurement of their muscle strength.
Aim: Our study aimed to examine whether they can measure their abdominal trunk muscle strength and perform muscle exercise adequately using the equipment.
Materials and Methods: This study included 30 volunteers without LBP (all men; mean age, 30.7 years; age range, 24–42 years). We recorded their anthropometric measurements (body height, body weight, body-mass index, and abdomen perimeter), grip strength, and back muscle strength by using a dynamometer. The frequency of sit-ups in 30 s as a measure of abdominal muscle strength was also recorded. We measured their abdominal trunk muscle strength by using the equipment. Correlations between the abdominal trunk muscle strength and other variables were analyzed using the Pearson correlation coefficient analysis. Using the equipment, 5 volunteers performed abdominal trunk muscle exercises after they were intravenously administered 18F-fluorodeoxyglucose (FDG). Positron emission tomography-computed tomography images were obtained 50 min after FDG injection to evaluate whole-body muscle activity after the exercises.
Results: The mean value of the abdominal trunk muscle strength measured by the equipment was 17.8 ± 4.0 kPa (range, 12.7–28.6 kPa). Only the frequency of sit-ups in 30 s showed a significant positive correlation with the values of the abdominal trunk muscle strength. In all of the 5 patients, local accumulation of FDG was observed in the abdominal rectus, abdominal oblique, and diaphragm muscles, all of which stabilize the lumbar spine.

Conclusion: The results indicate that our innovative equipment for trunk muscle exercises can adequately measure the strength of the abdominal trunk muscles that stabilize the lumbar spine. Using this equipment, LBP patients can comfortably perform abdominal trunk muscle exercise because it does not impose strain on their painful low back.

P85

DOES BISPHOSPHONATE-BASED ANTI-OSTEOPOROTIC MEDICATION AFFECT OSTEOPOROTIC SPINAL FRACTURE HEALING?

Sang-Il Kim,Young-Hoon Kim,Kee-Yong Ha
Department of Orthopaedic Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea 06591 Seoul, Korea, South

Introduction: Among anti-osteoporosis medications, bisphosphonates have been and remain among the most commonly used. However, recent reports on the negative effects of excessive suppression of physiologic bone turnover have raised concern about their long-term use. In addition to these long-term effects, possible effects on fracture healing have been noted. However, no clinical studies have examined the effect of anti-osteoporosis medication (bisphosphonate-based) on acute OSFs.
Aim: The purpose of this prospective study is to investigate whether bisphosphonate-based anti-osteoporosis medication affects fracture healing and clinical outcomes of conservatively treated osteoporotic spinal fractures (OSFs).
Materials and Methods: A total of 105 patients who were diagnosed with acute OSFs were prospectively enrolled. According to their previous medication history, the patients were allocated into group I (n=39, no history of bisphosphonate use) or group II (n=66, history of bisphosphonate use). Clinical outcomes were assessed using visual analogue scale (VAS), and Oswestry disability index (ODI). Radiographic parameters including changes in height loss and kyphotic angle at the index vertebra were measured, and radiographic findings suggesting impaired fracture healing such as the intravertebral cleft (IVC) sign and fracture instability were evaluated. Univariate and multivariate regression analyses were used to identify related factors.
Results: Type your text here. There were no significant differences in the last VAS and ODI between groups. There were also no significant differences in the radiographic parameters. Although the IVC sign was seen more commonly in group II (30.3 %) than in group I (20.5 %), fracture instability combined with IVC was noted in the same number of cases. On multiple regression analysis, medication history showed no significant relationship with the clinical parameters. However, the presence of the IVC sign was related to medication history (odds ratio 4.8; 95 % confidence interval [CI] 1.02–22.69).
Conclusion: Bisphosphonate use does not significantly affect the clinical results during conservative treatment for OSFs. However, the occurrence of the IVC sign was related to medication history. Although further studies are needed to verify our findings, these results suggest that suspension of bisphosphonate use should be considered during the fracture healing period for acute OSFs.

P86

IS JACKKNIFE STRETCH EFFECTIVE ON THE IMPROVEMENT IN FLEXIBILITY OF THE LEG AND TRUNK?: A COMPARATIVE AND CONTROLLED STUDY

Naoki Ishigaki,Takato Aihara
Funabashi Orthopedic Hospital 274-0822 Funabashi-city, Japan

INTRODUCTION: There have been reported that tight hamstrings increased the risk of the onset of low back pain. However, there have been few studies concerning the effective stretch methods for the tight hamstrings. The purpose of this study was to compare the flexibility of the leg and trunk among the jackknife stretch (JS), the conventional static stretch (SS), and without the stretch.
METHODS: Approval of this hospital's ethics committee and informed consent to inclusion in this study from 47 healthy adults were obtained. They were allocated to the JS group (n=17), the SS group (n=18), and the control (C) group (n=12). The subjects in the JS group were fully extended the knees from the squat down

position with their ankles holding. The subjects in the SS group were sat on a chair with their hip joint at moderate flexion and their knee joint at extension, and were leaned forward their pelvis. These were alternated with left leg and right leg. They were repeated these stretches for 10 seconds and 10 times over. The subjects in the C group were rested at supine position for 5 minutes. Finger-floor distance (FFD) and right (R) and left (L) straight-leg raising angle (SLA) were measured as the indexes of the flexibility of the trunk and leg. We also calculated the differences in FFD and SLAs between before and after the stretch or resting. The results were statistically compared between before and after the stretch or resting, and compared among the 3 groups. A P value < 0.05 was considered statistically significant.

RESULTS: FFDs, RSLAs, and LSLAs were significantly increased after the JS and SS. However, those were not significantly increased after the resting. The increase in FFD in the JS group (mean, 6.0cm) was significantly larger than in the SS group (mean, 3.2cm) and C group (mean, 0.5cm), and the increase in FFD in the SS group was significantly larger than in the C group. The increase in RSLA in the JS group (mean, 11.8°) was significantly larger than in the SS group (mean, 7.2°) and C group (mean, 1.3°), and the increase in RSLA in the SS group was significantly larger than in the C group. The increase in LSLA in the JS group (mean, 12.6°) was significantly larger than in the SS group (mean, 6.4°) and C group (mean, 1.3°), and the increase in LSLA in the SS group was significantly larger than in the C group.

CONCLUSION: There have been reported that the increased flexibility of the hamstrings after JS was caused by reciprocal inhibition of the contraction of the quadriceps femoris as an antagonist muscle. Therefore, we think that the jackknife stretch is a useful active-static stretch technique that leads to efficiently increase the flexibility of the hamstrings for patients with low back pain which was caused by the tight hamstrings.

P87

EVALUATION OF LUMBAR INSTABILITY WITH DIGITAL TOMOSYNTHESIS

Katsumasa Tanimoto, Tsuneo Takebayashi, Mitsunori Yoshimoto, Noriyuki Iesato, Shuto Hamada, Toshihiko Yamashita

Takikawa Municipal Hospital Omachi 073-0022, Takikawa, Japan

Introduction: Evaluating the instability of the lumbar spine is crucial to the decision of the surgical procedure for lumbar spine disorders. Although X-ray is usually used to evaluate lumbar instability, some cases have difficulty in identifying the margin of vertebral body as a reference point for the measurement, due to spinal deformity, bone quality, and various artifacts such as overlap of pelvis and intestinal gas. Digital tomosynthesis is an alternative for providing an arbitrary number of slice images, based on the development of flat-panel detectors. This technique has been expanding demand in the orthopaedic fields.

Aim: To investigate the utility of digital tomosynthesis for evaluating lumbar instability

Materials and Methods: A total of 54 patients (57 vertebras) with lumbar degenerative spondylosis between June 2012 and February 2014 were included in this study. Of those, 23 were males and 31 were females. The mean age was 68.1 years, ranging from 42 to 86 years. The most frequent level was L4 in 41 patients, followed by L3 in 14, and L2 in 2. Using digital tomosynthesis and X-ray, the lateral view of lumbar spine was assessed in neutral, flexed and extended positions. The digital tomosynthesis images were acquired with Discovery XR650 (GE Healthcare) whose settings were 90kV, automatic exposure control, a sweep angle of 30°, and a dose ratio of 4. Sagittal translation was measured using the method previously described by Posner et al. Three raters, who were a spine specialist, an orthopaedic surgeon and a resident, evaluated whether to detect the posterior lip of the vertebral body and measured value of sagittal translation in each image. Range (highest value – lowest value) was calculated and compared between the two groups.

Results: In all positions, digital tomosynthesis significantly provided better delineation of the

wedge of vertebral body as compared with X-ray (Wilcoxon signed-rank test; p<0.01). In the neutral position, dispersion of measured values in digital tomosynthesis (1.58±0.11mm) was significantly smaller than that in X-ray (2.19±0.23mm) (Student's t-test; p=0.015). Also, there were the same tendency in the other positions (flexion: 1.96±0.16mm vs 2.53± 0.24mm p=0.055, extension: 1.81± 0.12mm vs 2.06±0.21mm p=0.251).

Conclusion: This study showed that digital tomosynthesis could improve image quality to evaluate lumbar instability. Additionally, digital tomosynthesis uses less radiation than computed tomography and fulfills dynamic examination. Digital tomosynthesis might be a useful tool adopted in image measurement to assess various spinal disorders.

Reference

Posner I, White AA III, Edwards WT, Haynes WC. A biomechanical analysis of the clinical stability of the lumbar and lumbosacral spine. Spine 1982; 7; 374-389.

P88

GENDER TRENDS IN AUTHORSHIP OF SPINE-RELATED ACADEMIC LITERATURE – A 38-YEAR PERSPECTIVE

David Sing,David Ouyang,Serena Hu

University of California San Francisco apt 1 94122 San Francisco, CA, United States

Introduction: Despite recent advances in gender equity in medicine, the representation of women in orthopaedic and neurosurgery remains particularly low. Furthermore compared to their male colleagues female faculty members are less likely to publish research, limiting opportunities in the academic promotion process. Understanding disparities in research productivity provides insight into the "gender gap" in the spine surgeon workforce.

Aim: To determine the representation and longevity of female physician-investigators among the authors of five spine-related research journals from 1978 to 2015.

Materials and Methods: First and last authors of all original research articles from five prominent spine-related journals (European Spine Journal, the Spine Journal, Spine, Journal of Spinal Disorders and Techniques and Journal of Neurosurgery: Spine) were extracted from PubMed. For authors with a complete first name listed, gender was determined by matching first name using an online database containing 216,286 distinct names across 79 countries and 89 languages. The proportion of female first and senior authors was determined during the time periods 1978-1994, 1995-1999, 2000-2004, 2005-2009, and 2010-2015. Authors who had their first paper published between 2000-2009 were included in additional analyses for publication count and longevity (whether additional articles were published 5 years after first publication). Student's t-test, chi-squared analysis, and Cochran-Armitage trend test were used to determine significance between groups.

Results: From 1978-2015, 24,930 original research articles were published in the five spine-related journals. 17,951 abstracts (72.1%) had first names listed, of which 15,510 unique authors were identified. 11,725 (75.6%) author names were matched to a gender (81.2% male, 18.8% female). Female representation increased for first and senior authors from 5.2% and 3.6% (1978-1994) to 18.3% and 11.5% (2010-2015, p<0.001). Female senior author representation plateaued after 2000 (11.3% vs. 11.9% vs. 11.5% between 2000-2004, 2005 – 2009, and 2010-2015). Upon further analysis of 7,072 authors who first published during 2000-2009, 1,302 authors (18.4%) continued to publish 5 years after their first publication. Women were less than half as likely to continue publishing after their first article (9.1% of female authors vs. 19.6%, RR 0.46, 95% CI [0.44,0.49], p < 0.001). This difference between female and male authors was more pronounced as senior authors (0.7 vs. 1.4 articles, p < 0.001) than as first authors (1.2 vs. 1.4 articles, p < 0.001).

Conclusion: Female representation in academic spine research increased over threefold over the past 4 decades, although growth of representation in female senior authors has plateaued since the early 2000s. Female physician-investigators are half as likely to continue participating in spine-related research longer than 5 years and on average publish half as many articles as senior author. In addition to recruiting more women into research, efforts should be made to identify and address barriers in research advancement and promotion for female physician-investigators.

P89

RELATIONSHIP BETWEEN KYPHOSIS AND FALLS IN COMMUNITY-DWELLING MEN AND WOMEN: THE LOCOMOTIVE SYNDROME AND HEALTH OUTCOME IN AIZU COHORT STUDY

Ryoji Tominaga,Shingo Fukuma,Shin Yamazaki, Miho Sekiguchi,Koji Otani,Shin-ichi Kikuchi, Shunichi Fukuhara,Shin-ichi Konno

Department of Orthopaedic Surgery, School of Medicine, Fukushima Medical University 960-1295,Fukushima City, Fukushima, Japan

Introduction: In our literature review, we found no studies focusing on sex differences in the association between kyphosis and falls.

Aim: To clarify the association between kyphosis and falls, and to investigate the presence or absence of sex differences.

Materials and Methods: We used data from the Locomotive Syndrome and Health Outcome in Aizu Cohort Study, a population-based prospective cohort study of residents of the towns of Tadami and Minamiaizu in Fukushima Prefecture, Japan. Subjects aged more than 40 years who participated in annual health check-ups from 2009 to 2010 are included. We analyzed the effects of kyphosis, measured using the wall-occiput test (WOT), on falls, with adjustment for potential confounders, such as age, body mass index (BMI), symptoms of depression, sedative medication, and other comorbidities.

Results: We enrolled a total of 1418 subjects into primary analyses (593 men, 825 women; mean [standard deviation] age, 68.1 [7.7] years). We then stratified subjects into the following groups according to the degree of kyphosis: non-kyphosis (n=1138, 80.3%), mild kyphosis (n=172, 12.1%), and severe kyphosis (n=108, 7.6%). We observed no significant difference in the severity of kyphosis between men and women (P=0.18). Overall, 284 subjects (20.0%) experienced at least one fall during the one-year period. After adjustment for potential confounders using a logistic regression model, we observed a significant association between severe kyphosis and falls for men (odds ratio [OR] 2.14 [1.01–4.57]; P=0.048). In contrast, we observed no significant association for women (OR for severe kyphosis 0.80 [0.43–1.50], OR for mild kyphosis 0.91 [0.53–1.57]).

Conclusion: We identified a sex difference in the association between kyphosis and falls in community-dwelling adults. In particular, severe kyphosis might only increase the incidence of falls in men.

P90

ARE DEEP AND SUPERFICIAL LUMBAR MULTIFIDUS DIFFERENTIALLY ACTIVATED DURING WALKING AT DIFFERENT SPEEDS AND INCLINATIONS?

Rebecca Crawford,Leonardo Gizzi,Áine Ni Mhuiris,Deborah Falla

Zurich University of Applied Sciences Winterthur, Switzerland

Introduction: Lumbar multifidus is a complex muscle with a multi-fascicular morphology shown to be differentially controlled in healthy individuals during sagittal-plane motion. However, very few studies have examined activation within multifidus' regions during common functional activities like walking, despite walking being commonly promoted as beneficial for low back health.

Aim: Determine activation patterns for deep and superficial multifidus at the level of the fifth lumbar vertebra in young adults during walking at varied speed and inclination.

Materials and Methods: Ten healthy volunteers in their twenties (3F,7M) walked on a treadmill in eight conditions; at 2km/h and 4km/h, each at 0, 1, 5, and 10° of inclination. Subjects were instructed to walk continuously for 2 min per condition, with a 45-60s rest between each. Intramuscular electromyography (EMG) recordings were acquired from the deep and superficial multifidus unilaterally using bipolar Teflon-coated stainless steel fine wire electrodes inserted under ultrasound guidance according to established methods. Activity for each muscle region was characterized by: the amplitude of the peak of activation (normalized to the maximal activity in the slow speed and 0% inclination), the position of the peak within the gait cycle (0-100%), and the duration of muscle activity as a percent relative to the full gait cycle. Peak amplitude, peak position and activity duration were computed for each of the central 41 gait cycles considered for each condi-

tion, and average values were retained for statistical analysis by analysis of variance.
Results: Across all conditions superficial fibres of multifidus showed higher normalized EMG amplitude compared to deeper fibres ($p<0.01$). For instance, relative to the average amplitude during walking at slow speed without inclination, superficial multifidus peak amplitude was 232 ± 115% higher when walking at the faster speed with 10° of inclination, versus only 172 ± 77% higher for the deeper multifidus ($p<0.001$). The percentage of gait cycle where peak EMG amplitude was detected (average across both muscles and all conditions: 49 ± 13%) did not differ between muscles ($p=0.80$). Deep multifidus duration of activation was longer when walking at all inclinations at the faster speed compared to the slow speed ($p<0.01$); this finding was not evident for superficial multifidus. Thus, a significantly longer activation of deep multifidus was observed compared to superficial multifidus when walking at 4km/hr ($p<0.05$).
Conclusions: Differential activation of deep and superficial lumbar multifidus was shown in young healthy volunteers with varied walking conditions. The prolonged, more tonic, activation of the deep relative to superficial regions of multifidus during gait supports a postural function of the deeper fibres. Further studies are warranted to examine the influence of factors such as age or pain on the differential activation within multifidus during common functional activities.

P91

DOES THE ASYMMETRIC MORPHOLOGY OF THE FACET JOINT AFFECT BILATERAL L5 SPONDYLOLYSIS?

Hayato Ishitani,Takato Aihara,Naoki Ishigaki, Tomofumi Ezure
Funabashi Orthopedic Hospital 274-0822 Chiba, Japan

Introduction: Spondylolysis is a fatigue fracture of the pars interarticularis which occurs most commonly at L5. We reported that the L4/5 facet joint angles (FJA) were significantly more coronally orientated in bilateral L5 spondylolysis cases than in control cases (’15, ISSLS). However, there were some L5 bilateral spondylolysis cases that the L4/5 facet joints were not coronally orientated.
Aim: This study was undertaken to determine whether the asymmetric morphology of the facet joint contributes to bilateral L5 spondylolysis.
Methods: Seventy junior athletes (JA) with low back pain were reviewed. They were classified into two groups according to CT and MRI: B group (40 JA [33 males and 7 females] with L5 bilateral spondylolysis) and C group (30 JA [22 males and 8 females] without spondylolysis, and finally, their low back pain disappeared). The ages of the B and C groups ranged from 9 to 21 years and from 11 to 18 years, respectively, showing no significant differences between them. JA with previous spine surgery and multilevel spondylolysis were ineligible. Using multislice CT, we measured the sagittal orientation of the L4/5 and L5/S1 FJA from the axial sections. L4/5 and L5/S1 FJA were statistically compared by paired t-test between the larger and the smaller sides of the left and right sides in the B and C groups. In addition, the differences between the left and right angles were statistically compared between the B and C groups by unpaired t-test. A P value < 0.05 was considered statistically significant.
Results: The mean L4/5 FJA of the larger and the smaller sides were 57.0° and 48.6° in the B group, and were 50.0° and 45.0° in the C group, respectively. The mean L5/S1 FJA of the larger and the smaller sides were 59.3° and 52.3° in the B group, and were 55.0° and 47.1° in the C group, respectively. The L4/5 and L5/S1 FJA in the B and C groups were statistically different between the larger and the smaller sides ($P<0.001$). The differences between the left and right L4/5 FJA were significantly larger ($P=0.006$) in the B group (mean, 8.4°) than in the C group (mean, 4.9°). However, there was no statistical difference concerning the differences between the left and right L5/S1 FJA between the B (mean, 7.0°) and C (mean, 7.7°) groups.
Conclusion: From the results of this study, the L4/5 and L5/S1 facet joints were statistically different between the larger and the smaller sides in the B and C groups, however, asymmetry in L4/5 facet joint orientation was significantly greater in the B group than in the C group. We think that a more asymmetry in the

L4/5 facet joint orientation is likely to increase the point loading through the L5 pars interarticularis in extension and rotation. Therefore, if a subject has asymmetrically orientated L4/5 facet joint, this may be the risk of L5 spondylolysis.

P92

POLYELECTROLYTE COMPLEX CARRIER FOR OSTEOGENIC GROWTH FACTOR WITH HEPARIN BINDING DOMAIN

Wing Moon Raymond Lam,Ming Wang,Felly Ng,Mathanapriya Naidu,Tao Hu,Kang Ting,Cho Hong, James Goh,Hee Kit Wong

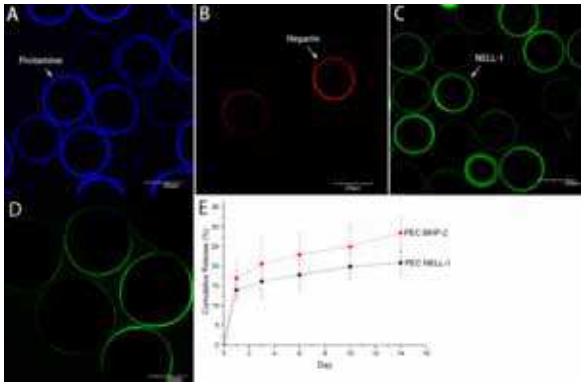
National University of Singapore 117510, Singapore, Singapore

INTRODUCTION: Heparin based polyelectrolyte complex (PEC) carrier was developed for the controlled release of osteogenic growth factor with heparin binding domain such as BMP-2. PEC could effectively reduce BMP-2 dose related complications in both rodent and porcine spinal fusion models. NELL-1 is a new potent osteogenic growth factor which acts on Runx2. However, NELL-1 has an initial burst release effect similar to BMP-2. Interestingly, NELL-1 contains heparin binding domains and when paired with heparin based PEC carriers, it could potentially deliver NELL-1 and control its initial burst release phenomenon, eventually promoting the osteogenic effect of this growth factor.

Aims: To investigate the feasibility of using PEC as a NELL-1 carrier via measuring uptake and release, cytotoxicity and bioactivity. METHODS: PEC was fabricated by surface coating alginate microbeads with protamine and heparin using a layer-by-layer method. NELL-1 was subsequently coated onto the outermost layer. Different layers of the chemical coating were visualized by fluorescent analogue under confocal microscopy CF-405 labelled protamine (blue), CF-595 labelled heparin(red) and FITC BMP-2(green) FITC NELL-1(green). The uptake and release of NELL-1 was evaluated by immersing the NELL-1 coated PEC (20μg of NELL-1/8mg PEC dry weight basis) into phosphate buffer saline. NELL-1 release profile was evaluated using the CBQCA method. Cytotoxicity was evaluated by the MTT assay whereas the bioactivity of NELL-1 was evaluated by alkaline phosphatase (ALP) activity assay using rabbit bone marrow stem cell.

RESULTS: The layer-by-layer structure was confirmed by confocal microscopy (Figure 1). FITC NELL-1 binding was dependent on the thickness of heparin coated on the beads; beads with higher heparin content showed a stronger fluorescent signal. NELL-1 uptake was higher than BMP-2 (NELL-1 86.7±2.7%; BMP-2 70.5±3.1%). The confocal microscopic examination also confirmed that PEC has higher binding capacity to NELL-1 compared to BMP-2. Both NELL-1 and BMP-2 had initial burst release (NELL-1: 14.0±4.4%, BMP-2: 17.0±2.6%) followed by a sustained release (NELL-1:20.0% vs. BMP-2:28.0%) over the following two weeks. No cytotoxicity effect was observed in MTT assay. A significantly higher ALP activity in PEC-NELL-1 group compared to blank PEC control was observed (2.2fold at day 14).

Discussion: From confocal image, NELL-1 is localized on heparin layer. The NELL-1 bioactivity was well maintained after the uptake and release from PEC. This indicates that PEC could potentially deliver NELL-1 in an effective manner and enhance its uptake and release profile.



P93

LOCATION AND CHARACTERISTICS OF VERTEBRAL COMPRESSION REFRACTURE AFTER HEALING OF ACUTE VERTEBRAL COMPRESSION FRACTURE

Kazuji Aoki[1], Toru Uehara[2], Shota Yamada[2], Atsushi Inada[3]

Nagoya Gakuin University 480-1298 Seto city, Japan

INTRODUCTION: Osteoporotic vertebral compression fracture has recently been found to

result from not only acute vertebral fracture, but also vertebral compression repeat fracture (refracture). Refracture causes spinal malalignment, and information on refracture may thus be useful in preventing spinal malalignment. We therefore examined the location and characteristics of refracture.

AIM: Examination to prevent spinal malalignment due to refracture.

MATERIALS AND METHODS: Of 574 patients with fracture over the 12-year period from 2000 to 2012, refracture was identified in 90 patients (15.7%). Subjects in this study comprised 14 patients, with a single vertebral refracture occurring >6 months after healing, from among 90 patients with refracture. Treatment of vertebral compression fracture performed by body-cast fixation. Mean age was 75.4 years at the time of acute fracture, and 77.6 years at the time of refracture. All cases of refracture were female. The mean period until refracture was 26.5 months. Radiological measurements were made to investigate: 1) Locations of the first fracture and refracture; 2) Collapse rate of first fractures and refractures; 3) Local kyphosis angle of the first fracture; 4) T11 to L2 angle; 5) Posterior Shift; 6) Sacral Slope; and 7) Lumbar Lordosis.

CONCLUSION: Among fractures of the thoracic spine (T8-12), refracture was divided into higher and lower thoracic types. Local kyphosis angle differed significantly between these types ($p<0.05$). Cases of thoracic fracture with large local kyphosis angle occurred more frequently in refracture to the lower thoracic spine. With fracture of the lumbar spine (L1-4), refractures occurred at the thoracolumbar junction (T12) in all cases. These cases showed large posterior shift and presented with a swayback posture. We therefore suggest that patients with thoracic spine fracture may avoid kyphosis with exercises to strengthen back muscles, and patients with lumbar spine fracture may avoid swayback posture by learning correct posture from a therapist. These actions may prevent malalignment after refracture.

P94

RELATIONSHIP BETWEEN CLINICAL SYMPTOMS OF OSTEOPOROTIC VERTEBRAL FRACTURE WITH INTRAVERTEBRAL CLEFT AND RADIOGRAPHIC FINDINGS

Toshio Nakamae,Yoshinori Fujimoto,Kiyotaka Yamada,Takeshi Hiramatsu,Takashi Hashimoto, Osami Suzuki,Yuji Tsuchikawa

Department of Orthopaedic Surgery, JA Hiroshima General Hospital Hatsukaichi 738-8503, Hiroshima, Japan

Introduction: With aging of the population, the numbers of osteoporotic vertebral fractures (OVF) with intravertebral cleft (IVC) have been increasing. However, the pathology of OVF with IVC is poorly understood.

Aim: The purpose of this study was to evaluate the relationship between clinical symptoms of OVF with IVC and radiographic findings.

Materials and Methods: Twohundredseventeen patients with single-level OVF with IVC were examined. IVC accompanying OVF was defined as an intravertebral radiolucent area on radiograms or computed tomography images, or as presence of intravertebral fluid or gas on T2-weighted magnetic resonance images. Clinical symptoms were evaluated using visual analogue scale (VAS) for back pain and the Oswestry Disability Index (ODI) for physical disability. The presence of delayed neurologic deficit (DND) was also detected. Radiography and computed tomography were used to measure local kyphotic angle and intravertebral instability and to detect the presence of posterior wall fracture of the vertebral body. Correlations between clinical symptoms of OVF with IVC and radiographic findings were investigated. The relationship between DND and the radiographic parameters was also evaluated.

Results: Mean VAS and ODI were 7.4 and 58.0%, respectively. DND was occurred in 41 patients (19%). The mean local kyphotic angle, intravertebral instability, and rate of posterior wall fracture of the vertebral body were 19.4°, 7.3°, and 91%, respectively. VAS and ODI were statistically correlated with intravertebral instability ($r = 0.378$, $P < 0.001$ and $r = 0.369$, $P < 0.001$, respectively) but not with local kyphotic angle and presence of posterior wall fracture. In

the patients with DND, intravertebral instability was significantly higher and posterior wall fractures were significantly more frequent than in the patients without DND. Local kyphotic angle was not correlated with DND. In addition, all the DND patients had posterior wall fractures of the vertebral body.
Conclusion: Intravertebral instability is a factor causing symptoms of OVF with IVC. In addition, intravertebral instability may be the predominant cause of DND. To manage OVF with IVC and DND efficiently, it may be important to control intravertebral instability of OVF.

P95

A STUDY ON THE SHAPE OF THE VERTEBRAL BODY AND THE INTERVERTEBRAL LUMBAR DISC IN PATIENTS WITH CROWE TYPE 4 COMPLETELY DISLOCATED HIPS

Yoshihara T, Mizuta K, Morimoto T, Tsukamoto M, Sonohata M, Mawatari M
Department of Orthopedic Surgery, Faculty of Medicine, Saga University, Japan 8498501 Saga city, Japan

Introduction: A posterosuperior shift of the femoral head in the hips in patients with Crowe type 4 completely dislocated hips (CDH) is compensated for by the anterior angulation of the pelvis and lumbar hyperlordosis. However, there have been few reports on the influence of compensated hyperlordosis on the hypoplastic vertebral body and the anterior widening of the intervertebral disk.
Aim: The purpose of this study was to investigate the spino-pelvic alignment and the shape of vertebral body and the intervertebral disc in patients with CDH.
Materials and Methods: The subjects included 60 CDH patients (average age: 63 years) who underwent subtrochanteric shortening in total hip replacement (THA) to achieve an adequate reconstruction with restoration of the anatomical hip center and 50 patients with idiopathic osteonecrosis of the femoral head (ION) (average age: 58 years) who underwent THA. All of the patients were female. Lateral whole spine radiographs of all patients were prospectively taken before surgery. The sagittal spino-pelvic alignment parameters that were examined included lumbar lordosis (LL: L1-S1), sacral slope (SS), the angle of the segmental vertebral body (VB angle: L1-L5) and the intervertebral disc angle (ID angle: L1/2-L5/S). Angles that opened anteriorly, had positive values; while those that opened posteriorly, had negative values. These pre- and post-operative parameters were compared among 39 cases of CHD. The significance of the differences among the two groups was evaluated by Student's t-test. P values of <0.05 were considered to indicate statistical significance.
Results: The mean LL, SS, VD angle and ID angle in the CDH and ION groups were 66°and 48°, 52°and 38°, L5 : 12.1°and 8.5°, L1/2 : 7.2°and 4.4° L2/3 : 10.1°and 6.5° L3/4 : 11.7°and 7.0° L4/5 : 10.8°and 8.5° L5/S : 15.9°and 11.7°, respectively ($P<0.01$). In 39 cases of CDH, the mean pre- and post-operative LL, SS and ID angles were 67° and 52°, 53° and 40°, L1/2: 6.8° and 5.8° L5/S1: 15.9° and 11.6°, respectively ($P<0.01$).
Conclusion: Our study had 3 main findings. In patients with CDH:
1) The sagittal alignment of the spine in patients with CDH was characterized by the anterior angulation of the pelvis and lumbar hyperlordosis. Complete hip dislocation could cause lumbar hyperlordosis and these may be compensatory changes that occur to maintain the body balance.
2) Skeletal hypoplasia (L5) and the anterior opening of the intervertebral disc caused lumbar hyperlordosis in patients with CDH. Among the patients with L5 hypoplasia, there seemed to be a group in which developmental compensation occurred during the gestational period as a result of genetic or other factors which resulted in pelvic anteversion and skeletal hypoplasia from the lumbosacral spine to the pelvic and hip joint.
3) The replacement of the femoral head of the hips by subtrochanteric shortening THA improved the SS, LL and ID angle values. These results also suggested that the intervertebral disc shape was a contributing factor to lumbar hyperlordosis.

P96

ORTHOPEDIC INTERVENTION IN THE INITIAL DIAGNOSIS OF MULTIPLE MYELOMA

Yu Toda,Tadatsugu Morimoto,Masatsugu Tsukamoto,Motoki Sonohata,Masaaki Mawatari
Dept. of Orthopaedic Surgery. Saga University 849-8501 Saga, Japan

Introduction: Multiple myeloma (MM) is a relatively rare disease that typically presents with lumbago as the primary symptom in elderly individuals. Therefore, MM is often misdiagnosed as degenerative spinal disease in the early stages by orthopedists. However, few papers have investigated lumbago and the participation of orthopedists in the diagnosis of MM.

Aim: The objective of this study is to investigate the characteristics of the initial diagnosis of MM.

Materials and Methods: The subjects consisted of 103 patients (47 females and 56 males, average age: 72 years, range: 46-89 years) with an initial diagnosis of MM from 2004 to 2014 in our institution. The orthopedic intervention of the initial diagnosis and misdiagnosis rate, chief complaint, clues for the diagnosis and MRI findings were investigated. Results: The orthopedic intervention of the initial diagnosis and misdiagnosis rate were 35% and 67%, respectively. The most common misdiagnoses in males and females were compression fracture, lumbago, and degenerative spondylosis, respectively. The chief complaints were back pain (41%), and of these patients 60% (25/42) were firstly examined by orthopedists. Only two patients (3%) had any associated neurological findings. The most helpful clues for the diagnosis included hyperproteinuria (45%), anemia (30%), renal dysfunction (7%), urinary Bence Jones protein (15%), and MRI (10%). Approximately 35% (n=38) of the patients underwent MRI; the most common finding was compression fracture (58%, n=22), although 8% demonstrated non-specific findings. Fracture cases in males and females were 23% (n=13, average age: 74 years, range: 62-87 years) and 19% (n=9, average age: 70 years, range: 49-88 years), respectively.

Conclusion: The frequency of the initial examined and misdiagnosis rate by orthopedists of MM were 35% and 67%, respectively. Therefore, orthopedists can play an important role in the initial diagnosis of MM and should be aware of the characteristics of MM. The common and remarkable findings of MM were back pain (41%) and compression fractures (58%). The prevalence of vertebral fracture in a Japanese population study of patients in their 70s was 10% in males and 22% in females (Yoshimura, Arch Osteoporos 2006). The prevalence of vertebral fracture in male patients with MM might be higher than that of the previous study population. This current study also revealed that the most helpful clues for the diagnosis of MM can be the serum, urine test and MRI findings. Therefore, MM should be included in the differential diagnosis of middle-aged or elderly patients suffering from back pain and/or with compression fractures according to image findings, especially male patients, and a detailed examination with serum and urine testing and/or MRI could be recommended.

P97

THE COURSE OF PAIN INTENSITY IN PATIENTS UNDERGOING HERNIATED DISC SURGERY: A LONGITUDINAL OBSERVATIONAL STUDY

Hans Meisel,Marie Dorow,Margrit Löbner, Janine Stein,Alexander Pabst,Alexander Konnopka, Lutz Günther,Jürgen Meixensberger, Katharina Stengler,Hans Helmut König,Steffi Riedel-Heller
BG Klinikum Halle Merseburger Str. 165 06112 Halle, Germany

Introduction: Degenerative disc disease is commonly accounted as causal in acute and chronic back pain in the general population. In fact, 15% of individuals diagnosed with herniated disc require surgery. The literature currently reports widely differing success rates for disc surgery and postoperative longitudinal studies are lacking.

Aim: This study evaluated the success of disc surgery with regard to postoperative pain intensity. The main questions were: (1) how does the pain intensity of patients having undergone disc surgery change within a postoperative time frame of 5 years? (2) which sociodemographic, medical, work-related, and

psychological factors are associated with post-operative pain intensity?
Patients and Methods: The baseline survey (T0) was conducted 3.6 days (SD 2.48) post-surgery by trained psychologists in the form of a face-to-face interview. Initially, 534 disc-operated patients from three different hospitals in Leipzig and Halle, Germany were interviewed and evaluated. The telephone follow-up interviews were conducted at 3 months (T1; N=486 patients), 9 months (T2; N=457), 15 months (T3; N=438), and 5 years (T4; N=404) post-surgery. Patients included in this study ranged 18 to 55 year-old, all of whomhad surgery to treat lumbar or cervical herniated disc. Pain intensity was measured on a numeric rating-scale (NRS 0-100). Taking the heterogeneity of the sample, estimated changes to and influences on postoperative pain by random effects were accounted by regression models.
Results: Patients with cervical herniated disc reported higher pain intensity than patients with a lumbar herniated disc in the total course of the follow-up. Patients in which severe pain persisted 5 years post-surgery (NRS>70) was represented by 11% in the lumbar group and 21% in the cervical group. Specifically, in the group of patients treated for lumbar disc herniation, the average pain intensity decreased continuously over time ($Chi^2=28.67$, $p<0.001$). In the group of patients with cervical herniated disc however, average pain intensity, even though showing a slight decrease, did not reach significance over time ($Chi2=7.96$, $p=0.093$). Two different predictors were signi-ficantly associated with postoperative pain in both groups: the subjective prognosis of gainful employment ($p<0.001$) and depression ($p<0.001$).
Conclusion: In the majority of disc surgery patients, a long-term reduction in pain was observed. Regarding the postoperative pain intensity, the cervical disc surgery patients seemed to benefit less from surgery than the lumbar surgery patients. In the long-term follow-up a significant number of patients from both groups still reported high levels of pain. A negative prognosis of gainful employment and more severe depression symptoms correlated as significant influencing factors for postoperative pain. The results highlight the importance of multimodal rehabilitation concepts including psychological and work-related support.

P98

TRANSFORMING GROWTH FACTOR-ACTIVATED KINASE 1 INDUCES AN INFLAMMATORY RESPONSE IN SPINAL MICROGLIA IN VITRO.

Hisako Fujimaki,Gen Inoue,Kentaro Uchida, Masayuki Miyagi,Hiroyuki Sekiguchi,Jun Aikawa, Wataru Saito,Masashi Takaso
Dept. of Orthopaedic Surgery, Kitasato University School of Medicine 252-0375, Japan

Introduction Activated microglia within the spinal cord play a crucial role in the development of neuropathic pain. In pathogenic conditions, microglia are a cellular source of pro-inflammatory cytokines including TNFα, and this signaling induces microglial activation. Transforming growth factor activated kinase 1 (TAK1) is a member of the mitogen activated protein kinase (MAPK) family. TAK1 is a regulatory factor in TNFα signaling pathways and is increased in hyperactive astrocytes. Although TAK1 is reported to induce mechanical hypersensitivity through astrocyte activation, the association between TAK1 and microglia remains unknown.
Aim To investigate the role of TAK1 in the inflammatory response of spinal microglia.
Materials and Methods CD11b+ cells from six-week-old rat spinal cords were isolated by immunomagnetic separation and cultured. Flow cytometry was used to confirm that the isolated cells were microglia. Cells were then treated with tumor necrosis factor-α (TNFα) as an inducer of microglial activation, and the effects of TAK1 and inflammatory factors on activated microglia were assessed based on mRNA expression. We also investigated whether blocking TAK1 regulates inflammatory responses in the microglia. Results Expression of mRNA for the microglial inflammatory markers TAK1 and TNFα increased within 1 hour of TNFα stimulation in microglia. Expression of the ionized calcium binding adaptor molecule (iba1) mRNA, used as a microglial marker, was increased subsequent to the increase in TNFα and TAK1. Furthermore, co-treating microglia with TNFα and TAK1 blockers resulted in reduced expression of iba1 and TNFα.

Conclusion We demonstrated that TAK1 and TNFα rapidly increased in TNFα-stimulated microglia, whereas a TAK1 blocker suppressed microglial activation via TNFα inhibition. Our results suggest that increased microglial TAK1 expression may lead to inflammatory responses and conversion to the activated form of microglia under pathogenic conditions such as neuropathic pain. This study should lend new insights into the mechanisms underlying microglial activation. It may also provide a new therapeutic strategy for reducing activated microglia in various neuropathological conditions.

P99

PREVALENCE AND CHARACTERISTICS OF OSTEOPOROTIC VERTEBRAL FRACTURES IN ELDERLY PATIENTS WITH SPINAL KYPHOSIS

Akito Yabu,Masatoshi Hoshino,Hidetomi Terai, Hiromitsu Toyoda,Akinobu Suzuki,Shinji Takahashi, Kazunori Hyashi,Koji Tamai,Shoichiro Oyama, Masaki Terakawa,Tadao Tsujio,Seki Masahiko, Hiroaki Nakamura

Shiraniwa hospital 6300136 Ikoma-city, Japan

Introduction: Osteoporotic vertebral fracture (OVF) is one of the widely known causes of spinal kyphosis in elderly people, but its prevalence and characteristics remain unclear.

Aim: The aim of this study was to determine the prevalence and characteristics of OVF in elderly patients with spinal kyphosis.

Patients and Methods: One hundred women ≥65 years of age having sagittal vertical axis (SVA) of ≥50 mm were randomly selected from among patients who had visited our hospital or related institutions. Prevalent vertebral fractures were assessed using whole spine radiography. Age and each sagittal spinopelvic parameters (SVA, lumbar lordosis [LL], thoracic kyphosis [TK], pelvic incidence [PI], pelvic tilt [PT], and each intervertebral disk angle between L1 and S1) were measured, and the association of these parameters with the number and level of prevalent fractures was evaluated.

Results: Prevalent vertebral fractures were present in 37 cases (92 vertebral bodies); therefore, the prevalence of OVF was 37% in elderly patients with spinal kyphosis. Of 42 cases patients with SVA 100 mm or more, prevalent vertebral fractures were found in 15 (45 vertebral bodies), indicating a prevalence of 36%. Between the fracture and non-fracture groups, there were significant differences in age (79.7 vs. 76.3 years) and intervertebral disc angle between L4/5 (7.3 vs. 4.4 degrees), and marginally significant differences in the intervertebral disk angle between L1/2, L2/3, and L5/S1. No significant difference was found in other sagittal spinopelvic parameters: SVA, LL, PI, PT, and intervertebral disk angle between L3/4. In the fracture group, 15 cases with SVA of 100 or more had more prevalent vertebral fractures than 22 cases with SVA < 100 (3.3 vs. 1.8). In the fracture group, there were 14 cases of one prevalent fracture in 14 vertebral bodies, 13 cases of two fractures in 26 vertebral bodies, and 10 cases of three or more fractures in 52 vertebral bodies. The proportion of middle and lower lumbar spine (L3-5) in each group was 50%, 38%, and 19%, respectively.

Conclusion: The prevalence of OVF in elderly patients with spinal kyphosis was 37%. A similar prevalence was found in patients having extensive misalignment (SVA of 100 or more). The patients in the fracture group were older, while the patients in the non-fracture group had decreased angle of lumbar intervertebral disk. The fractures of the middle and lower lumbar spine, even those in a single vertebral fracture, affected spinal kyphosis. This study suggested that while planning the operation for kyphosis, just over 60% patients have no deformity of the vertebral body and could be treated with interbody correction, while nearly 40% of the patients should be treated for deformity of the vertebral body.

P100

THE DIAGNOSTIC VALUE OF BONE SPECT/CT FOR LOW BACK PAIN-CAUSING PATHOLOGY

Naoki Takahashi,Satoshi Kato,Hideki Murakami, Satoru Demura,Hidenori Matsubara,Katsuhito Yoshioka, Noriaki Yokogawa,Moriyuki Fujii, Takashi Igarashi, Noritaka Yonezawa,Hiroyuki Tsuchiya

Department of Orthopaedic Surgery, Kanazawa University Hospital 920-8641 kanazawa-shi, Japan

Introduction: The exact cause of nonspecific low back pain (LBP) is known in only about 15% of cases. The use of diagnostic imaging with single-photon emission computed tomography/ computed tomography (SPECT/CT), which combines scintigraphy and CT, has become widespread recently. However, little has been published about its diagnostic accuracy and usefulness in LBP.

Aim: This study aimed to assess the usefulness of bone SPECT/CT in localizing the pain site in LBP. Patients and Methods: This study included 15 patients (9 men and 6 women; mean age, 67 years) who underwent preoperative bone SPECT/CT using 99mTc-MDP and a lumbar spinal fusion surgery between January 2014 and November 2015. They had moderate or severe LBP along with a neurological symptom due to lumbar degenerative instability. We evaluated the concordance rate between the integrated site on bone SPECT/CT and the lumbar level with instability that caused the clinical symptoms as diagnosed by using radiography, magnetic resonance imaging, and clinical examinations. In a clinical follow-up, LBP severity was evaluated according to a numerical rating scale (NRS).

Results: Ten cases were diagnosed as degenerative spondylolisthesis, 2 as spondylolysis, and 3 as degenerative scoliosis. In all the cases, abnormal uptake on bone SPECT/CT was in agreement with the facet joint or vertebral body, which was clinically diagnosed as the LBP-causing lesion. All the patients underwent lumbar interbody fusion and experienced a significant improvement in their NRS scores within 1 month after the surgery.

Conclusion: For all the patients in this study, who required a lumbar fusion surgery for degenerative instability, the abnormal uptake on bone SPECT/CT matched with the lesion clinically responsible for LBP. We also obtained good postoperative results by performing interbody fusion to that level. Bone SPECT/CT is useful in identifying the lesions responsible for LBP in lumbar degenerative disease. In nonspecific LBP, the responsible lesion may be identified by using bone SPECT/CT according to the same mechanism, which can provide information to the guiding clinicians on the use of adequate treatment. Bone SPECT/CT can be a useful imaging study for identifying the lesion responsible for nonspecific LBP.

P101

PRELIMINARY DATA OF IN-VIVO MAGNETIC RESONANCE IMAGING MEASUREMENT OF SPINAL CORD DISPLACEMENT IN THE THORACOLUMBAR REGION OF SUBACUTE LUMBAR INTERVERTEBRAL DISC PROTRUSION PATIENTS

Janne Pesonen,Marinko Rade,Mervi Könönen, Jarkko Marttila,Ritva Vanninen, Markku Kankaanpää, Olavi Airaksinen

Kuopio University Hospital 70029 KYS, Finland

Introduction: Straight leg raise (SLR) test is a widely used clinical test to evaluate neural tightness in patients with low back pain, sciatic symptoms or radiculopathy. Earlier studies have shown that during the SLR test in asymptomatic volunteers the conus medullaris in the thoracolumbar region slides distally in response to the clinically applied SLR test 1,2. To the authors' knowledge no previous noninvasive, in vivo data has shown whether the same phenomenon occurs with patients with sciatic symptoms due to lumbar intervertebral disc protrusion (LIDP).

Aim: To test the displacement of conus medullaris with SLR performed on the symptomatic side and compare the data with those from the asymptomatic side and from our normative database.

Materials and methods: In this controlled radiological study we tested ten voluntary patients with sciatic symptoms due to subacute IDP with a 1.5T magnetic resonance (MR) scanner (Siemens Aera, Erlangen, Germany). First a spine specialist diagnosed the lumbar disc protrusion with clinical evaluation and MRI scan using conventional scanning sequences. Following this the subjects were scanned with the same 1.5T MR scanner using different scanning sequences for planning and for measurement. Planning: T2 weighted turbo spin echo sequence (TR 3530ms, TE 96ms, 17 slices, slice thickness 3mm, FOV 300mm, in plane resolution 0.8x0.8mm, flip angle 150 degrees). Measurement: T2 weighted spc 3D-sequence (TR 1800ms, TE 128ms, slice thickness 1mm, sagittal scan, FOV 300mm, phase encoding direction proximal to caudal, in plane resolution

0.6x0.6mm, flip angle 160 degrees). Coronal, axial and sagittal slices (slice thickness 1mm, approximately 70 slices in each plane) were reconstructed from the native 3D sagittal scans using the MPR program available in Sectra PACS program (Sectra Workstation IDS7, version 15.1.8.5-2013 – Sectra AB, Sweden). The displacement of the conus relative to the upper intervertebral surface of the adjacent vertebra during the unilateral passive symptomatic, asymptomatic and bilateral SLR was quantified and compared with the position of the medullar cone in the neutral (anatomic) position. Each movement was performed twice for evaluation of reproducibility.

Results: Compared to the neutral (anatomic) position, the medullar cone displaced caudally in the spinal canal by 0,68 mm with the SLR performed on the symptomatic side ($p \leq 0.001$), 2.15 mm with SLR on the asymptomatic side ($p \leq 0,001$) and 2.89 mm with bilateral SLR ($p \leq 0,001$). Pearson correlations proved higher than 0.99 for both inter and intra observer reliability as well as results reproducibility for each tested maneuver. Observed power was 0.99 for each tested maneuver.

Conclusion: The data collected suggests that in patients with LIDP the medullar cone displaces significantly less in response to SLR on the symptomatic side compared to the asymptomatic, contralateral one ($p \leq 0,001$). We conclude that on patients with LIDP the neural displacement on the symptomatic side is impaired possibly due to the compressive forces action on the nerve root by the LIDP. To our knowledge we are the first to present data supporting the limitation of neural movements into the vertebral canal with LIDP in in-vivo and structurally intact human subjects.

P102

USEFULNESS OF THE LUMBAR SPINAL STENOSIS SPECIFIC SYMPTOM SCALE: EVALUATION OF SURGICAL EFFICACY

Kazuyuki Watanabe,Koji Otani,Takuya Nikaido, Kinshi Kato,Hiroshi Kobanashi,Shoji Yabuki,Shin-ichi Kikuchi,Shin-ichi Konno,Miho Sekiguchi *Fukushima Medical University Fukushima City 960-1295, Japan*

Introduction: The lumbar spinal stenosis (LSS)-specific symptom scale (FLS-25 [Fukushima LSS Scale 25]) is a self-administered questionnaire designed to comprehensively cover various symptoms of LSS. The FLS-25 was developed to address the need to measure symptoms specific to this disorder. The purpose of this study was to clarify the usefulness of the FLS-25 for evaluating the surgical efficacy of lumbar decompression for LSS.

Materials and Methods: A total of 120 consecutive LSS patients (73 men, 47 women; predominant age group, 70s) who underwent decompression surgery were included in this study. The FLS-25 (0–100, higher scores indicating worse condition), Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ), and numerical rating scales of low back pain (LBP), leg pain, and leg numbness (0–10, higher scores indicating worse pain), as well as satisfaction with surgery (0: unsatisfied, 10: completely satisfied), were examined before and 1 year after surgery. Results: The preoperative average FLS-25 score was 60.1±17.7. The correlation coefficient between the FLS-25 score and the NRS of the symptoms was 0.23 ($p<0.05$) for LBP, 0.19 ($p<0.05$) for leg pain, and 0.3 ($p<0.01$) for leg numbness. The correlation coefficients between the FLS-25 score and the JABPEQ scores were significant for all 5 domains (LBP, lumbar function, walking ability, social life function, and mental health) ($r= -0.41$–-0.53; $p<0.01$). The postoperative FLS-25 score was 44.2±21.9. The change of the FLS-25 score from baseline showed statistically significant correlation with the changes of NRS of LBP (0.32) and leg numbness (0.30), and all JOABPEQ 5 domains ($r = 0.30$-0.48) ($p<0.01$).The correlation coefficient between the change of the FLS-25 score and satisfaction with surgery was 0.46 ($p<0.01$).

Conclusion: The results of this study show that the FLS-25 score correlated with every JOABPEQ subscale and with satisfaction with surgery. FLS-25 could comprehensively evaluate the efficacy of surgery for LSS symptoms.

P103

NON-SPECIFIC LOW BACK PAIN IS REALLY A HIGHLY SPECIFIC GROUP AND NOT A HOMOGENEOUS ONE

Greg McIntosh,Hamilton Hall,Chris Gregg,Chris Hoffman,Tom Carter
CBI Health Group Toronto M8X 2X2, Canada

Introduction: The purpose of this study was to compare clinical characteristics of low back pain (LBP) based on a syndrome approach to classification.
Methods: This retrospective study of prospectively collected low back pain (LBP) cases was a collaborative effort of spine-care rehabilitation clinics in New Zealand and 4 Canadian provinces. Patient enrolment occurred between January 2008 and October 2012. The syndrome approach to the classification of LBP recognizes patterns of pain based on clinical presentation rather than demographics, anatomic site or pathological process. There were 1912 patients: Pattern1=1653 (86.5%), Pattern2=196 (10.3%), Pattern3=62 (3.2%), Pattern4=1 (0.1%). Pattern4 was not included in this study.
Results: For pain location, those with Pattern3 had significantly more with leg pain (71%) compared to Pattern1=2% leg pain and Pattern2=1% ($p<0.01$). Aggravating position of each pattern was significantly different ($p<0.01$); Pattern1, increased with flexion=73%, Pattern2, increased with extension=57%, Pattern3, increased with both flexion and extension=80%). Relieving position of each pattern was significantly different ($p<0.01$); Pattern1, reduced in extension=91%, Pattern2, reduced in flexion=85%, Pattern3, reduced lying down=55%). The neurological profile of each pattern was significantly different ($p<0.01$). Pattern1 had 27% with at least one positive neurological finding, Pattern2=12%, Pattern3= 72%). There was no statistically significant difference in baseline numeric pain rating between patterns; perceived level of functional ability was significantly different between all three patterns ($p<0.01$). Pattern1 had the highest, then Pattern2, and Pattern3 had the lowest perceived function.
Conclusion: Pattern1 is back dominant pain, worse in flexion, Pattern2 is back dominant pain, improved or unchanged in flexion, Pattern3 is constant leg dominant pain affected by back movement/position. These multi-provincial and international data suggest that LBP is heterogeneous with recognizable and unique clinical markers. It contradicts a categorization of LBP as one homogeneous 'non-specific' entity.

P104

RADIOGRAPHIC NATURAL COURSE OF LUMBAR DEGENERATIVE SPONDYLOLISTHESIS AND ITS RISK FACTORS RELATED TO THE PROGRESSION AND ONSET IN A 15-YEAR COMMUNITY-BASED COHORT STUDY: THE MIYAMA STUDY

Yoshio Enyo,Noriko Yoshimura,Hiroshi Yamada, Hiroshi Hashizume,Munehito Yoshida
Wakayama Medical University 641-8510 Wakayama city, Japan

Introduction: The lumbar degenerative spondylolisthesis (DS) is a common spinal condition in controversy with or without fusion surgery. Because little information is available on the progression and onset of DS in the general population, natural history and the risk factors of DS remain unclear although the physicians should take them into account for making decision with the surgical method.
Aim: This study aimed to elucidate the natural course and risk factors for the progression of DS.
Materials and Methods: This is a prospective observation and a case control study of a rural mountainous cohort followed-up for 15 years in Wakayama, Japan. A total of 200 participants (base-line age: range 40–75, mean 54.8±8.4 y.o.) was subjected to antero-posterior and lateral radiographs of the lumbar spine at standing position in 1990 and 2005. The prevalence of DS (slip≥3 mm) at baseline and incidence of DS at 15 years follow-up was described. Beside this, the radiographic parameters (disc height, lumbar lordosis angle, lumbar axis sacral distance, sacral slope, intervertebral angle, osteophyte formation, facet joint shape, sclerosis of the endplate, vertebral body fracture index) were measured in the 200 radiographs in 1990 to determine the radiographic risk factors for the progression of L4 slip (≥ 3 mm). The risk factors at baseline for progression of L4 slip in the 15 years were determined by a multiple logistic regression analysis. The statistical significant level was set at $p < 0.05$.

Results: The prevalence rate of overall DS was 10% (20/200) in 1990. The prevalence of DS at each spinal level was 1 at L3, 14 at L4, and 5 at L5. In 2005, the prevalence rate of overall DS was changed to 22.5% (45/200). Therefore, the incidence of de-novo DS in 15 years was estimated as 14% (25/180). The progression of the L4 slip (≥3 mm) regardless of the base-line condition was observed in 23 participants at 15 years follow-up. The multiple regression analysis revealed the significant risk factors for L4 slip progression as age less than 60, female gender, lumbar axis sacral distance, facet sagittalization, and existence of slip at baseline.
Conclusion: We successfully elucidated the risk factors for the progression of DS in a general population. The results of this study also indicated the preventive factors as well as the risk factors for the slip progression. This study provides useful information to the physicians treating DS. In the future, the further large population cohort study will be needed including assessment of low back pain and the change of neurological status.

P105

DOES A RETROSPECTIVE "GLOBAL ASSESSMENT" OF LONG-TERM TREATMENT OUTCOME ACCURATELY REFLECT CHANGES IN SERIAL MEASURES OF SELF-RATED DISABILITY IN PATIENTS WITH CHRONIC LBP?

Anne Mannion,Jens-Ivar Brox,Jeremy Fairbank
Schulthess Klinik 8008 Zürich, Switzerland

Introduction: Transition scales measuring the global change in a patient's status (e.g. "much better" through to "worse") are often used in the retrospective assessment of treatment outcome. They are assumed to deliver the same information as change-scores in symptoms/ function measured before and after treatment, but this is often not the case, because recall bias and motivational bias can influence the retrospective ratings. A valid transition rating should show correlations with the pre and post scores of equal magnitude and opposite sign and, in multiple regression, coefficients of similar magnitude (1).
Aim: This study examined the validity of a global outcome assessment in relation to prospectively recorded changes in Oswestry Disability Index scores at long-term follow-up.
Methods: At an average 11 years' follow-up, 261 patients (53.2 yrs old; 137 (52%) female) who had participated in three randomised controlled trials of fusion versus nonoperative treatment for chronic low back pain completed the Oswestry Disability Index (ODI) (as first completed pre-treatment) and a 4-point Global Assessment (GA) Likert scale indicating how their back problem had changed compared with pre-treatment. Construct validity was evaluated by examining relationships between GA and pre, post, and change scores in ODI.
Results: The ODI change-scores (mean ± SD) for the GA categories were: "much better", 26.6±17.2 points; "better", 18.7± 16.1 points; "unchanged", 4.5 ±11.7 points; and "worse", -3.9±11.8 points and GA hence appeared to show face validity. However, post scores correlated much more strongly with GA ($r=0.72$, $p<0.0001$) than did pre scores ($r=0.23$, $p=0.0002$). The pre scores or the change scores accounted for only a small amount of additional variance in GA (increase in adjusted R2, 0.7%) when added to a regression model including the post scores (adjusted R2, 51.3%). Findings were similar when fusion and nonoperative groups were evaluated separately.
Conclusion: The GA ratings at 11 years post-treatment were far more strongly influenced by the "current status" at 11 years than by the change in status from baseline. A similar finding has been reported previously, with the effect being more obvious as follow-up time lengthens. When transition measures such as the GA are used as an outcome in follow-up studies, their validity for the given time of follow-up should firstly be ensured by evaluating relationships with pre and post scores of relevant domain scores. Without such assurance, the conclusions of studies based on such measures (2) should be interpreted with caution.

(1) Guyatt GH, Norman GR, Juniper EF, et al. A critical look at transition ratings. J Clin Epidemiol 2002;55:900-8
(2) Hedlund R, Johansson C, Hagg O, et al. The long-term outcome of lumbar fusion in the Swedish Lumbar Spine Study. Spine J 2015.

P106

PART 1: DEVELOPING METHODS OF IN VIVO MRI MEASUREMENT OF SPINAL CORD DISPLACEMENT IN THE THORACOLUMBAR REGION OF ASYMPTOMATIC SUBJECTS WITH UNILATERAL AND BILATERAL STRAIGHT LEG RAISE TESTS

Marinko Rade,Michael Shacklock,Mervi Könönen, Jarkko Marttila,Ritva Vanninen, Markku Kankaanpää,Olavi Airaksinen

Josip Juraj Strossmayer University of Osijek, Faculty of Medicine, Orthopaedic and Rehabilitation Hospital "Prim. dr.Martin Horvat", Rovinj, Croatia 52210 Rovinj, Croatia

INTRODUCTION: Normal displacement of the conus medullaris with unilateral and bilateral SLR has previously been presented and the "principle of linear dependence" linking magnitude of conus medullaris displacement to displacement of L5 and S1 nerve roots and number of nerve roots involved into the movement has been proposed. However, in those studies, due to the device architecture, only 50° of hip flexion could be achieved.

AIM: To verify (i) whether conus medullaris displacement varies with range of hip flexion ii) if the acquired data support the 'principle of linear dependence', iii) present relevant methodological advances which have produced data that surpass previous studies.

MATERIALS AND METHODS: In this controlled radiologic study 10 asymptomatic volunteers were scanned with 1.5T magnetic resonance (MR) scanner (Siemens Magnetom Aera, Erlangen, Germany) using different scanning sequences for planning and for measurement purposes. Planning: T2 weighted turbo spin echo sequence (TR 3530ms, TE 96ms, 17 slices, slice thickness 3mm, FOV 300mm, in plane resolution 0.8x0.8mm, flip angle 150 degrees). Sagittal slices were aligned with the spinal cord to allow better identification of the medullar cone. Measurement: T2 weighted spc 3D-sequence (TR 1800ms, TE 128ms, slice thickness 1mm, sagittal scan, FOV 300mm, phase encoding direction proximal to caudal, in plane resolution 0.6x0.6mm, flip angle 160 degrees). Coronal, axial and sagittal slices (slice thickness 1mm, approximately 70 slices in each plane) were reconstructed from the native 3D sagittal scans using the MPR program available in Sectra PACS program. The displacement of the medullar cone relative to the upper intervertebral surface of the adjacent vertebra during the unilateral passive right, left and bilateral SLR was quantified and compared with the position of the conus in the neutral (anatomic) position. Each movement was performed twice for evaluation of reproducibility. The measurements were repeated by two observers. Three practitioners performed the manoeuvres in a random sequence in order to avoid possible series effects. All the metric values were rounded to the next lowest decimal integer (2.55=2.5) to provide more conservative and reliable data.

RESULTS: Compared to the neutral (anatomic) position, the medullar cone displaced caudally in the spinal canal by 3.54±0.87 mm (μ±SD) with unilateral ($p \leq 0.001$) and 7.42±2.09 mm with bilateral SLR ($p \leq 0.001$). Pearson's correlations proved higher than 0.99 for both intra and inter-observer reliability, as well as results reproducibility for each tested manoeuvre. Observed power was 1 for each tested manoeuvre.

CONCLUSION: To the authors' knowledge these are the first data on non-invasive, in vivo, normative measurement of spinal cord displacement with the SLR test at 60° of hip flexion. Conus displacement increased with hip flexion angle, while maintaining the relationship between magnitude of conus displacement and number of nerve roots involved into the movement, supporting the "principle of linear dependence" presented earlier. Compared to earlier studies, the use of T2 weighted spc 3D-sequence proved valuable for i) better identification of conus medullaris, ii) shorter time for analysis, iii) higher values of intra and inter observer reliability testing, iv) relevant increase in the clinical feasibility of the experimental methods.

P107

PART 2: IN VIVO MRI MEASUREMENT OF SPINAL CORD DISPLACEMENT IN THE THORACOLUMBAR REGION OF ASYMPTOMATIC SUBJECTS WITH UNILATERAL AND SHAM STRAIGHT LEG RAISE TESTS

Marinko Rade,Mervi Könönen,Jarkko Marttila, Michael Shacklock,Ritva Vanninen,Markku Kankaanpää,Olavi Airaksinen
Josip Juraj Strossmayer University of Osijek, Faculty of Medicine, Orthopaedic and Rehabilitation Hospital "Prim. dr.Martin Horvat", Rovinj, Croatia 52210 Rovinj, Croatia

INTRODUCTION: Normal displacement of the conus medullaris with unilateral and bilateral SLR has been quantified and the "principle of linear dependence" has been described and supported at different angles of hip flexion and with different magnetic resonance (MR) scanning methods.
AIM: Investigate whether previously recorded movements of conus medullaris with the unilateral and bilateral SLR are i) primarily due to transmission of tensile forces transmitted through the neural tissues during SLR, ii) adjustment of the vertebral canal around the conus, or iii) the result of reciprocal movements between vertebrae and nerves.
MATERIALS AND METHODS: In this controlled radiologic study, a cadaver experiment done by Alf Breig in 1978 was replicated and implemented with the use of non-invasive modern scanning techniques in in-vivo and structurally intact human subjects. Ten asymptomatic volunteers were scanned with 1.5T magnetic resonance (MR) scanner (Siemens Magnetom Aera, Erlangen, Germany) using different scanning sequences for planning and for measurement purposes. Planning: T2 weighted turbo spin echo sequence. Measurement: T2 weighted spc 3D-sequence. Coronal, axial and sagittal slices (slice thickness 1mm, approximately 70 slices in each plane) were reconstructed from the native 3D sagittal scans using the MPR program available in Sectra PACS program (Sectra Workstation IDS7, version 15.1.8.5-2013 – Sectra AB, Sweden). The displacement of the medullar cone relative to the upper intervertebral surface of the adjacent vertebra during the unilateral passive right, left and sham SLR was quantified and compared with the position of the conus in the neutral (anatomic) position. Each movement was performed twice for evaluation of reproducibility. The measurements were repeated by two observers. Three practitioners performed the manoeuvres in a random sequence in order to avoid possible series effects. All the metric values were rounded to the next lowest decimal integer (2.55=2.5) to provide more conservative and reliable data.
RESULTS: The conus displaced caudally in the spinal canal by 3.54±0.87 mm (μ±SD) with unilateral ($p \leq .001$) and proximally by 0.29±1.83 mm with sham SLR ($p \leq .542$). Pearson's correlations were higher than 0.99 for both intra- and inter-observer reliability and the observed power was 1 for unilateral SLRs and 0.052 and 0.149 for left and right sham SLR respectively.
CONCLUSIONS: While conus movements with SLR are relevant and predictable, magnitude and direction of conus movements during the Sham SLR seem to be consistent within subjects, but not between subjects and cannot be predicted. Three relevant points emerge from the presented data: i) reciprocal movements between the spinal cord and the surrounding vertebrae are likely to occur during SLR in asymptomatic subjects, ii) conus medullaris displacement in the vertebral canal with SLR is primarily due to transmission of tensile forces through the neural tissues, iii) when tensile forces are transmitted through the neural system as in the clinical SLR, the magnitude of conus medullaris displacement prevails over the amount of bone adjustment.

P108

PART 3: NORMATIVE DATA OF MULTIDIRECTIONAL SPINAL CORD DISPLACEMENT WITH UNILATERAL AND BILATERAL STRAIGHT LEG RAISE TESTS IN ASYMPTOMATIC SUBJECTS

Marinko Rade,Mervi Könönen,Jarkko Marttila, Michael Shacklock,Ritva Vanninen,Markku Kankaanpää,Olavi Airaksinen
Josip Juraj Strossmayer University of Osijek, Faculty of Medicine, Orthopaedic and Rehabilitation Hospital "Prim. dr.Martin Horvat", Rovinj, Croatia 52210 Rovinj, Croatia

INTRODUCTION: Normal vertical displacement of the conus medullaris with unilateral and bilateral SLR has been quantified and the "principle of linear dependence" has been described and supported at different angles of hip flexion and with different magnetic resonance (MR) scanning method.

AIM: Provide a full set of normative data of conus medullaris displacement within the vertebral canal in all three planes with unilateral and bilateral SLR tests to allow for clinical comparison with patients with IVD herniation.
MATERIALS AND METHODS: In this controlled radiologic study 10 asymptomatic volunteers were scanned with 1.5T magnetic resonance scanner (Siemens Magnetom Aera, Erlangen, Germany) using different scanning sequences for planning and for measurement purposes as in earlier experiments. Conus displacement in both antero-posterior direction (saggital slices) and latero-lateral direction (axial slices) was quantified within the vertebral canal during unilateral passive left, right SLR and bilateral SLR and compared with the position of the conus in the neutral (anatomic) position. Each movement was performed twice for evaluation of reproducibility. The measurements were repeated by two observers. Three practitioners performed the manoeuvres in a random sequence in order to avoid possible series effects.
RESULTS: Lateral displacement: the conus displaced toward the right into the spinal canal by 0.52±0.23 mm (mean±SD) with unilateral right SLR (p≤.001), toward the left by 0.05±0.28 mm with a left SLR (p≤.634), and toward the right by 0.37±0.34 mm with a bilateral SLR (p≤.008). Anteroposterior displacement: the conus displaced anteriorly into the spinal canal by 0.55±0.34 mm with unilateral right SLR (p≤.001), by 0.73±0.36 mm with a left SLR (p≤.001), and again anteriorly by 0.82±0.38 mm with a bilateral SLR (p≤.001). Pearson's correlations were higher than 0.95 for both intra- and inter-observer reliability and the observed power was higher than 0.99 for all the variables tested.
CONCLUSIONS: Lateral and antero-posterior displacement of conus medullaris into the vertebral canal occurs consistently with unilateral and bilateral SLRs following directions predicted by tension vectors, but that due to their low magnitude they may be clinically irrelevant. From the summative information collected in this line of research it emerges that the i) conus medullaris moves consistently in a caudal direction in response to SLR ii) this displacement is primarily due to direct transmission of forces through the lumbosacral nerve roots and the adjacent dura to the spinal cord, iii) when tensile forces are transmitted through the neural system as in the clinical SLR, the magnitude of conus medullaris displacement prevails over the amount of bone adjustment iv) that the conus medullaris displacement with unilateral SLR is doubled by the bilateral SLR (principle of linear dependence), v) that more displacement occurs with higher degrees of hip flexion, vi) that some lateral and antero-posterior displacement occurs consistently with unilateral and bilateral SLRs but that due to their low magnitude they may be clinically irrelevant. We believe we have presented the first conclusive and complete full set of normative data on non-invasive, in vivo, normative measurement of spinal cord displacement with the SLR ever presented.

P109

LUMBAR FACET JOINT ORIENTATION & OSTEOARTHRITIS: ASSOCIATION WITH DEGENERATIVE SPONDYLOLISTHESIS AND INTERVERTEBRAL DISC DEGENERATION

Yan On Yvonne Lau,Lai Yee Chan,James Francis Griffith,Kin On Kwok
Tseung Kwan O Hospital 000 Hong Kong, Hong Kong

Introduction: Relationship between lumbar facet orientation & degenerative spondylolisthesis was well-known. There is currently limited information on the association of facet orientation, osteoarthritis and lumbar disc degeneration. Purpose of this study is to evaluate such association on MRI of symptomatic patients.
Method: We performed a cross-sectional study of 550 consecutive patients who underwent MRI for back or radicular leg pain. 153 patients were included and evaluated for disc degeneration by Modified Pfirrmann (MP) grading on T2-weighted mid-sagittal MRI at the last three lumbar segments. Patients were divided into 6 groups of degenerative disc feature: 'Bright disc', 'Black disc', 'Collapse disc', 'Herniated disc', 'Spondylolisthesis' and 'Non-slip level' of spondylolisthesis. We assessed facet joint angles on T1-weighted axial scans and osteoarthritic severity by Fujiwara's 4-point

scale. Mean facet angles and proportions of osteoarthritis were compared between 6 groups of degenerative disc using one-way ANOVA and Chi-square test. Multi-normial logistic regression analysis was used to determine the association of independent predictors: age, sex, facet joint orientation and osteoarthritis with the development of different degenerative disc features at L4-5. Results: Lumbar disc degeneration ('Black', 'Collapse' & 'Herniated' discs) demonstrated more sagittally oriented facets ($p<0.05$) and higher proportion of osteoarthritis ($p<0.05$) than 'Bright disc'. 'Spondylolisthesis' showed more sagittal facet angle ($p<0.001$) and facet osteoarthritis ($p<0.001$) than other groups at all studied levels. Sagittal facet orientation was also present in 'Non-slip level' of spondylolisthesis. Old age and sagittal facet orientation were associating factors of "Black' disc' and 'Spondylolisthesis' (p55 degrees demonstrated 3.2 times (odds ratio, 95% CI: 1.4-7.1, p=0.006) more likely to develop degenerative spondylolisthesis. Positive association between facet orientation & osteoarthritis was shown on linear regression lines. Strong association was present in spondylolisthesis (coefficient correlation, R2=0.7), not in controls (R2=0.3).

Conclusion: Sagittal facet orientation and advanced osteoarthritis related to lumbar disc degeneration, and strongly associated with spondylolisthesis. The increase in facet angles at 'Non slip level' may represent a developmental anatomy of degenerative spondylolisthesis. This contributed to the instability of a functional spine unit when degenerative disc lost its anterior column support.

P110

ASYMMETRICAL LUMBAR SPINE FACET JOINT OSTEOARTHRITIS AND SPONDYLOLYSIS IN PROFESSIONAL BASEBALL PLAYERS

Kinshi Kato,Kenichi Otoshi,Shoji Yabuki,Koji Otani,Takuya Nikaido,Kazuyuki Watanabe, Hiroshi Kobayashi,Ryoji Kobayashi,Shin-ichi Kikuchi,Shin-ichi Konno

Fukushima Medical University Fukushima, Japan

Introduction: Asymmetrical facet joint osteoarthritis (OA) reportedly develops frequently in throwing athletes, due to repeated, localized asymmetrical mechanical stress on the facet joints. However, the association between low back pain (LBP) and radiographically observed facet joint OA remains controversial. The purpose of this study was to assess the prevalence, distribution, morphology and symptom of lumbar spine facet joint OA among professional baseball players compared with age- and sex-matched controls.

Materials and Methods: Group B comprised 35 professional baseball players (16 pitchers and 19 fielders; mean age, 25.1 years; range, 18-33 years) who had seen our institution. The recruitment period was the 3 years from October 1, 2012 to October 31, 2015. Lumbar images from CT and MRI were evaluated for all players. Group C comprised 102 age- and sex-matched controls (102 males; mean age, 24.1 years; range, 18-30 years) who had undergone whole-spine CT for examination of multiple high-energy injuries in the emergency department of our institute between April 2010 to July 2014. Subjects with a history of lumbar spine surgery were excluded. The prevalence, distribution, morphology and symptom of lumbar spine facet OA were reviewed. Wilcoxon and chi-square tests were used for statistical analyses.

Results: Facet OA of lumbar spine was significantly more frequent in Group B (54.3%) than in Group C (5.8%; $p<0.0001$). Facet OA most commonly occurred at L4/5 in both groups. Moreover, asymmetrical facet OA of the lumbar spine was significantly more frequent in Group B (45.7%) than in Group C (2.9%; $p<0.0001$). Asymmetrical facet OA was significantly more common among players with lumbar spondylolysis (87.5%) than among players without spondylolysis (44%; $p=0.023$). However, only one pitcher with asymmetrical facet OA experienced symptomatic OA that was evaluated by intra-articular diagnostic injections.

Conclusion: The prevalence of lumbar spine facet OA was increased among professional baseball players compared with age- and sex-matched controls. Dynamic rotational mechanical stress may thus influence the development of asymmetrical lumbar spine facet joint OA in professional baseball players. Asymmetrical facet OA frequently coexisted with lumbar

spondylolysis. However, the causal relationship between the asymmetrical facet OA and lumbar spondylolysis remains unclear, due to the cross-sectional study design. Moreover, few cases of symptomatic facet OA were included in our study.

P111

INFLUENCE OF LUMBAR DISC DEGENERATION AND SPODYLOLYSIS ON CAREER OUTCOMES IN PROFESSIONAL BASEBALL PLAYERS

Kinshi Kato,Kenichi Otoshi,Shoji Yabuki,Otani Koji,Takuya Nikaido,Kazuyuki Watanabe,Hiroshi Kobayashi,Ryoji Tominaga,Shin-ichi Kikuchi, Shin-ichi Konno

Fukushima Medical University Fukushima, Japan

Introduction: Both lumbar disc degeneration and spondylolysis are pathological conditions that suggested to represent as sources of low back pain (LBP). Both conditions reportedly develop frequently among high-level baseball players due to repeated, localized mechanical stress on the lumbar spine. However, which condition has greater effect on disabilities due to LBP in professional baseball players remains controversial. The purpose of this study was to assess the incidence of being placed the disabled list due to LBP in Japanese professional baseball players for lumbar disc degeneration and spondylolysis.

Materials and Methods: Participants comprised 35 professional Japanese baseball players (16 pitchers and 19 fielders; mean age, 25.1 years; range, 18-33 years) who had seen in our institution. The recruitment period was the 3-year period from October 1, 2012 to October 31, 2015. Lumbar images from CT and MRI were evaluated for all players. The prevalence, distribution, and symptoms of lumbar disc degeneration (Pfirrmann grade 3 or more) and spondylolysis were reviewed. To assess the independent influences of lumbar disc degeneration or spondylolysis on being subsequently placed on the disabled list for more than 1 week due to LBP relied upon multivariatefor more than 1 week of putting on the disabled list due to LBP relied upon multivariate logistic regression analysis.

Results: Lumbar disc degeneration and spondylolysis were confirmed in 16 (45.7%) and 8 (22.9%) of the 35 players, respectively. Sixteen players (45.7%) were placed on the disabled list due to LBP in their professional career. Logistic regression analysis demonstrated that lumbar disc degeneration was a significant predictor of being placed on the disabled list (odds ratio (OR): 6.13; 95% confidence interval (CI): 1.49–29.3; P =0.0111*), whereas spondylolysis was not (OR: 1.17; 95% CI: 0.19–6.99; P = 0.86).

Conclusion: The presence of lumbar disc degeneration may influence the incidence of baseball players being placed on the disabled list more than lumbar spondylolysis.

P112

BONE MINERAL DENSITY OF THE SPINE IN SPINAL STENOSIS PATIENTS IN COMPARISON TO HIP ARTHROPLASTY PATIENTS AND CONTROLS

Helena Brisby,Camilla Bergh,Ann-Charlott Söderpalm, Lisa Johansson

Institute of Clinical Sciences, University of Gothenburg 41345 Gothenburg, Sweden

Introduction: Patients undergoing lumbar spinal stenosis (LSS) surgery have a decreased walking distance, which implies an increased risk of developing osteoporosis due to a low physical activity level. A large proportion of LSS patients have been reported to have reduced bone mineral density (BMD). Spine BMD measurement in the anterioposterior (AP) view is considered to be a poor osteoporosis screening method in this patient group due to the influence of high bone mineral content in the arthrotic facet joints.

Aim: The aims of the present study were to explore the BMD of the spine and femoral neck (FN) in patients undergoing LSS surgery and to compare this patient group to two different aged matched groups; one group with hip arthroplasty (HA) patients with similarly affected activity level and one group with healthy controls. Furthermore, to compare measurements of AP and lateral lumbar spine BMD between the LSS and HA groups.

Materials and methods: Thirty-one patients admitted for LSS surgery (age 67 years SD 10, 61%, women), 20 patients undergoing HA surgery (71 years SD 10, 60% women) and 30 healthy controls (67 years SD 5, 100 % women) were included. BMD measurements of the AP lumbar spine (APS) and the femoral neck (FN) were performed on a Hologic QDR bone densitometer® in all study subjects. Additionally lateral lumbar spine (LS) BMD was measured in the LSS and HA patients. T-score of <-2,5 was considered as osteoporosis. Students t test was used for comparison between the LSS group and other groups.

Results: When comparing the total LSS group (n=31) as well as the women in the LSS group (n=19) with the controls (n=30), no significant differences were seen in BMD or T-score for neither the APS nor the FN measurements. Nor were there any significant differences between the LSS and the HA groups. BMD (g/cm2) and T-score for the APS were; 1.07±0.21/ 0.17±1.9 (mean±SD) for the LSS, 1.05±0.17/ 0.04±1.54 for HA and 0.93±0.15/ -1.05±1.33 for the controls, respectively. For the LSS group 45%, 33% and 13% reached the cut-off level for osteoporosis for the LS, APS and FN measurements. In the HA and controls the corresponding numbers were 45%/ n.a. (LS), 5%/10% (APS) and 0%/3% (FN).

Conclusion: The LSS patients (total group as well as women only) did not differ significantly in mean BMD compared to neither controls nor HA patients, indicating limited effect of the decreased activity level in LSS patients on BMD in the spine and the FN. A similar proportion of vertebral osteoporosis was seen in LSS and HA patients when LS BMD was measured, but somewhat surprisingly a higher proportion in LSS when APS were investigated. A larger patient group is needed to explore these findings further.

P113

CHARACTERISTIC MAGNETIC RESONANCE IMAGES OF FRESH OSTEOPOROTIC VERTEBRAL FRACTURES WERE ASSOCIATED WITH POOR LONG-TERM PROGNOSIS.

Masatoshi Hoshino,Hidetomi Terai,Tadao Tsujio, Akinobu Suzuki,Takashi namikawa, Minori Kato,Akira Matsumura,Hiromitsu Toyoda, Kazushi Takayama,Shinji Takahashi, Hiroaki Nakamura

Dept. of Orthopedic Surgery, Osaka City University Graduate School of Medicine 545-8585 Osaka, Japan

Introduction: Previously, we reported the factors affecting short-term outcomes 6 months after osteoporotic vertebral fracture (OVF) in a prospective multicenter study. In that study, characteristic magnetic resonance images (confined-high intensity or diffuse low-intensity areas on T2-weighted magnetic resonance imaging) was a significant risk factor for nonunion. However, the long-term prognosis in patients with these characteristic images was not elucidated.

Aim: To determine the factors affecting long-term prognosis in OVF patients followed up for ≥5 years.

Materials and Methods: One-hundred and seven OVF patients (17 men and 90 women; mean age, 75.5 years) were enrolled. Outcomes were evaluated at final follow-up (mean follow-up period, 7.1 years) on the basis of survival, activities of daily living (ADL), and back pain, which were used as response variables. To evaluate the independent effects of characteristic magnetic resonance images (confined high-intensity or diffuse low-intensity areas on T2-weighted magnetic resonance imaging) on patient outcomes, multivariate logistic regression analyses were done to obtain odds ratios adjusted for the potential confounding effects of sex, age, body mass index, previous spine fracture, bone mineral density, level of fracture, cognitive function, regular exercise before fracture, smoking, and previous stroke.

Results: At final follow-up, 26 patients had died. Also, 11 patients were bedridden, 19 were nearly bedridden, and 51 were living independently; and 32 patients had residual pain in their back (numeric rating scale ≥5.0). Multivariate analyses revealed characteristic magnetic resonance images (odds ratio [OR], 25.5; P=0.023) to be significantly associated with ADL (bedridden), but not significantly associated with mortality or residual pain in the back. Advanced age (≥75 years) (OR, 4.85; P=0.016) and frailty (OR, 4.20; P=0.036) were significantly associated with mortality.

Conclusion: We investigated the long-term prognosis of OVF, in particular, mortality, ADL (bedridden), and residual pain in the back. This is the first report to show that characteristic magnetic resonance images (confined high-intensity or diffuse low-intensity areas on T2-weighted magnetic resonance imaging) to be a risk factor for becoming bedridden. These characteristic magnetic resonance images were associated with a poor long-term prognosis.

P114

DEVELOPMENT OF AN OUTCOMES QUESTIONNAIRE FOR LOW LITERACY PATIENTS IN UNDERSERVED POPULATIONS THE WORLD SPINE CARE (WSC) CHARITY

Geoff Outerbridge,Timothy Ford,O'Dane Brady, Maria Hondras,Eric Hurwitz,Scott Haldeman, Deborah Kopansky-Giles,Margareta Nordin
World Spine Care Suite 202 92705 Santa Ana, United States

Introduction: Low back pain (LBP) is the major cause of disability in both developed and emerging countries. The barriers to recovery are recognized and understood in literate patients. However, the literature on outcome measurements for patients with LBP in low literacy communities is sparse.
Aim: The purpose was to: (1) develop an outcomes instrument, the Clinical Follow-Up Questionnaire (CFQ) documenting LBP recovery for low literacy patients in underserved areas and (2) test the feasibility of the CFQ in patients reporting LBP in primary rural spine clinics in Botswana.
Materials and Methods: A literature review of existing outcome instruments for LBP was performed in 2015 (PubMed) and synthesized into domains important for LBP recovery. Five domains identified were selected for the CFQ: pain, depression, function (activities unable to perform), activities of daily living (ADLs), and adverse events. The CFQ went through several iterations by a multidisciplinary task force for content and conceptual understanding. Body diagram, Likert scales and Wong-Baker faces were used for simplicity. The CFQ was administered to 57 consecutive LBP patients in the rural clinics. All participants who completed the CFQ from the initial visit to discharge or patients who completed 8 CFQs were included in the descriptive analysis. Exclusion criteria were established. The CFQ was self-administered or administered by trained support staff. The criteria for feasibility were administration of the CFQ, patient understanding of the CFQ, patient fatigue of repeated CFQ administration, and clinician acceptance.
Results: Overall, the CFQ was well received for patient-understanding with help. Few patients were able to complete the CFQ themselves due to language barriers (English, official language of Botswana). Some patients were intimidated by the length of the questionnaire, had poor eye-sight, or developed questionnaire fatigue on subsequent visits. This was the first time patients in these villages were subjected to a questionnaire. Some patients had difficulties describing 'occupational' activities as there was no clear distinction between wage work and everyday work activities. Wong-Baker faces to assess pain had to be explained. Other patients found it difficult to quantify how pain affected their ADLs. Clinicians were pleased with the CFQ but recommended changes in administration frequency and translation to the national language (Setswana).
Conclusion: An outcomes questionnaire for spine pain patients in an underserved, low literacy community was developed and tested for feasibility in rural Botswana. Overall the questionnaire was well received by patients and clinicians and provided important feasibility assessments. This outcomes instrument needs further simplification and translation to the national language.

P115

CLINICAL AND ELECTROPHYSIOLOGICAL EVALUATIONS INCLUDING PARASPINAL EMG HAVE PROGNOSTIC ROLE IN THE RESPONSE TO TRANSFORAMINAL EPIDURAL INJECTIONS IN UNILATERAL L5 RADICULOPATHY

Tülay Erçalık,Merve Akdeniz Leblebicier,Başak Mansız Kaplan,Osman Hakan Gündüz
Marmara University kurtköy, pendik 34912-İstanbul, Turkey

Introduction: Transforaminal epidural steroid injection (TFESI) is an effective treatment option for patients with lumbar radicular pain

caused by disc herniation. Electromyography (EMG) including paraspinal EMG has an established role in the diagnostic confirmation of lumbar radiculopathy.
Aim: The aim of this study was to evaluate the efficacy of TFESI and to determine the prognostic role of including paraspinal EMG in lumbar radiculopathy after TFESI.
Materials and Methods: Forty four patients, who were diagnosed with clinical examination and MRI findings, were enrolled in this study. Before TFESI, patients were evaluated by lower extremity and paraspinal muscle needle EMG findings in addition to paraspinal mapping. Evidence of radiculopathy on EMG reports was classified as positive or negative abnormal spontaneous activity for paraspinal muscles and lower extremity muscles, separately. After EMG, patients received unilateral L5 TFESI. Patients were evaluated by physical examination and patients answered numeric rating scale (NRS) for pain, Oswestry Disability Index Questionnaire and Beck Depression Inventory before the injection and repeated at1st week, 3rd week and 3rd month. As a secondary analysis, clinical improvements in pre to post- TFESI in the EMG groups were compared. Also we compared the clinical examination of patients who gave response to treatment with patients who went to surgery.
Results: Clinically significant improvement was observed after TFESI compared to before injection. After injection the straight leg raise (SLR) test, NRS, Oswestry Disability Index Questionnaire and Beck Depression Inventory were improved at 1st week, 3rd week and 3rd month ($p<0.01$). Motor examination improved at 3rd week and 3rd month ($p<0.01$). Sensory examination improved at 3rd month ($p<0.01$). The clinical examination especially the SLR test before TFESI was significantly different in patients who went to surgery compared to those who did not. Also, the patients who went to surgery had higher NRS value before injection. After the injection, decrease in pain (NRS) was lower in the patients who went to surgery compared to those who did not. Lastly, the average decrease in NRS at 3rd month was significantly lower in patients who had abnormal spontaneous activity in L5 paraspinal EMG compared to patients who had no abnormal spontaneous activity ($p<0.05$).
Conclusion: TFESI is effective treatment in patients with lumbar unilateral single-level root compression. TFESI provides significant improvements in physical examination, not only NRS for pain but also in functional parameters. Needle EMG, especially paraspinal EMG is important for selecting patients for this procedure, and for predicting the prognosis.

P116

LBP IN ADOLESCENT TOP LEVEL ATHLETES: IMPACT OF PHSYCOLOGICAL FACTORS

salvatore minnella,elena grillo,sabrina donzelli, monia lusini,fabio zaina,stefano negrini
Italian Scientific Spine Institute-ISICO 20141 Milan, Italy

Introduction: Low Back Pain (LBP) is one of the most frequent pain disorders even in childhood. In young athletes it's influenced by gender, sport type, training intensity,frequency and technique.In football players we know that psychological characteristics might influence the risk of injury.
Aim: To assess the link between psychological distress and chronic or recurrent LBP in young athletes after match win or defeat.
Material and Methods: This is a prospective longitudinal controlled cohort study on young top level athletes of an Italian professional soccer team from January to June 2015. Inclusion criteria: age between 14 and 19 years old; chronic or recurrent low back pain from at least 6 months; being top level athletes of a Professional Football Club from at least 6 months. We divided the subjects in two groups: one included the athletes with chronic or recurrent LBP (LBP group) and the second all the other healthy athletes (Control Group). Both were assessed by psychometric and quality of life scales (HADS- Hospital Anxiety and Depression Scale; SF 12-Short Form Health Survey), but only the LBP group by pathology specific scales (ODI- Oswestry Disability Index; TSK- Tampa Scale of Kinesiophobia; VAS- Visual Analogic Scale). The assessment was done at time T0 (study start), Td (after double match defeat) and Tw (after double match win). The LBP group underwent no treatment during the study period. We compared variations of the scales among T0, Td and Tw in both groups.

Primary outcome: significative variations of ODI, TSK and VAS in LBP group over time. Secondary: significative variations of HADS and SF 12 values between the two groups in T0, Td and Tw. Statistical analysis: Friedman test (ANOVA), Fisher's exact test: when we found both significative values ($p<0.005$), we made comparison among T0, Td and Tw for each scale by Mann-Whitney test.
Results We included 46 subjects (males), mean age 16,97 years (16,96 in LBP group and 17 in Control Group). 8 drop out (2 of them LBP) for musculoskeletal injuries during the study. So finally we had 12 LBP (3 chronic and 9 recurrent) and 26 controls. As regard primary outcome we found significative increase of ODI in LBP group in comparison Tw vs T0 and also a significative increase of TSK in comparison Tw vs Td. As secondary outcome we found only at the baseline a significative lower value of SF 12 in LBP group in comparison to controls.
Conclusion In consideration of increasing disability and kinesiophobia after a winning time in top level athletes with LBP, we may suggest that this is probabily the best period to clinically check up them in order to prevent pain exacerbations.

P117

MAGNETIC RESONANCE IMAGING ACCURATELY MEASURES VERTEBRAL MARROW LESION SIZE

Galateia Kazakia,Aaron Fields,Ellen Liebenberg, Kaitlin Gary,Julio Carballido-Gamio,Misung Han, Roland Krug,Jeffrey Lotz
UCSF Suite 360 San Francisco, United States

Introduction: Vertebral bone marrow lesions visualized by MRI ("Modic changes") are among the most specific observations for predicting discogenic pain. However, current MRI-based biomarkers for pain are qualitative and do not visualize or quantify features that associate with painful pathology, for example richly innervated fibrovascular marrow. The underlying premise of our research is that advanced MRI techniques will better quantify and classify anatomic features associated with low back pain.
Aim: To validate MRI measurements of vertebral marrow lesions against histology in cadaveric lumbar spines.
Materials and Methods: Five cadaveric lumbar spine motion segments with a total of 10 MRI-visible marrow lesions were evaluated. Motion segments were imaged on a GE 3T MR scanner using an eight-channel phased-array wrist coil. Imaging was performed with T1-weighted (T1w) 2D fast spin-echo (FSE), fat-suppressed T2-weighted (T2w) 2D FSE and fat-suppressed 3D ultrashort echo-time (UTE) sequences. FSE sequences used a FOV of 8x8 cm2, 256x192 matrix size, 1.5 mm slice thickness, and TR/TE of 730 ms/14 ms (T1w) or 6-10s/90 ms (T2w). For 3D UTE, imaging parameters included 8x8x7.2 cm3 FOV, 0.5x0.5x1.5 mm3 resolution, 12 ms TR, 76 μs TE, and 15 deg flip angle. Reconstructed voxel size was 0.5 mm isotropic. Following MRI, motion segments were processed for histology. Haematoxylin and eosin stained sections were used to manually outline bone marrow lesions. Lesions were automatically delineated independently on the T2w and UTE scans using in-house developed software written in MATLAB. Histology sections were spatially aligned with the MR image slices by comparison of morphological landmarks. For the UTE scans, an average of 7 histology section-MR image slice pairs were compared per lesion. For the T2w scans, multiple histology section area measurements were averaged to obtain approximately 3 histology-MR pairs per lesion. Lesion area measurements calculated from the T2w and UTE images were compared to those obtained from histology using paired t-tests and linear regressions.
Results: Lesion area measurements from MRI were highly correlated with measurements from histology. T2w and histology measurements correlated with r2=0.85 (y=0.70x+7.30; RMSE=10.6 mm2). Paired t-test determined no significant difference between these area measurements. UTE and histology measurements correlated with r2=0.86 (y=0.79x+3.01; RMSE=12.0 mm2). The UTE measurements significantly overestimated lesion size by an average of 6.6 mm2 (20%).
Conclusion: MRI-based lesion area quantification is accurate and captures the majority of variation in lesion size. Current Modic classification based on MRI is qualitative and

subjective, which could in part explain the high specificity but only modest sensitivity for predicting lower back pain. Advanced MRI techniques, for example UTE imaging, may help to more accurately classify lesions than traditional Modic classification protocols. Quantitative and objective assessment of lesion size, morphology, location, and composition could aid in interpreting relationships between MRI findings and symptoms.

P118

THE PSYCHOLOGICAL COMPONENT HAS IMPORTANT IMPACT ON THE QoL AND ADL CHANGE IN THE COURSE OF ACUTE OSTEOPRORTIC VERTEBRAL FRACTURE

Nobuyuki Suzuki,Muneyoshi Fukuoka,Jun Mizutani, Seiji Otsuka,Yoshihisa Matsumoto, Akira Kondo

Department of Orthopaedic Surgery, Nagoya City University Graduate School of Medical Sciences 4660849, Nagoya, Japan

Introduction: The osteoporotic vertebral fracture is the most frequent type of osteoporotic fractures. The prognosis of this fracture has been believed good but we founded most of the patients had suffered lowered ADL and QoL over the year. The postural change after the fracture might relate to that worsened condition, but also the mental problem, for example depression after the fracture or fear for falling, might also relate to those bad conditions.

Aim: The purpose of this study is to assess the change of the mental condition after the fracture and clarify the reason of long lasting lowered ADL and QoL condition after the fracture.

Materials and Methods: All the patients over 40 years who visited our department and were diagnosed having acute osteoporotic vertebral fracture were enrolled in this study. Pain, ADL and QoL were evaluated by 4 different questionnaires at 3 weeks, 3 months and 6 months. The questionnaires were von Korff pain intensity score, EQ-5D, SF-36 and JOABPEC. The change of the mental component of each questionnaire and relation to the other components were evaluated.

Results: A total of 20 patients were enrolled in this study. Mean age was 79.4. The mean mental score of JOABPEC was 25.0 at first visit, 34.7 at 3weeks, 35.9 at 3months and 42.5 at 6months. The mental health score in SF-36 was 38.8 at first visit, 35.9 at 3weeks, 41.4 at 3months and 40.7 at 6months. The frequency of the patients who reported moderate or severe problems in anxiety and depression component of EQ5D was78.6% at first visit, 47.1% at 3weeks, 38.5% at 3months and 45.5% at 6months. In all questionnaires expect EQ-5D the recovery rate of mental component was worse than the pain and physical function component.

Conclusions: The other study has reported improvement of the mental components after this fracture was worse than the other osteoporosis fractures. Before this study the mental component of this fracture has not been focused on, but the fear of falling, kinesiphibia or depression might occur after the fracture and those might have important impact on ADL and QoL after the fracture.

P119

EXPECTED SURGICAL INTENSITY AND ITS COMPLICATION OF 14 MODEL CASES IN HEALTHY CONTROL VS PATIENTS WITH LUMBAR SPINAL STENOSIS

Jae-Ho Yang,Seong-Hwan Moon,Hwan-Mo Lee, Chul-Hyun Ki,Kyung-Soo Suk,Hak-Sun Kim KIm, Tae-Hyun Kim,Seong-Hwan Hong

Yonsei University College of Medicine 120-752, Seoul, Korea, South

Introduction Musculoskeletal conditions affect throughout whole body including spine, pelvis, upper and lower extremities. Fear of the surgery and its related complications is a main obstacle for selecting surgical treatment. Patient's own affliction might affect fear of one's specific surgery. Hence to test hypothesis, common sense-based grading of orthopaedic surgical intensity and its complication was conducted in control group of otherwise healthy subjects and in patients with symptomatic lumbar spinal stenosis (LSS).

Materials and Methods Fourteen model-case surgeries were listed including finger, toe, joint replacement (knee, hip), small mass, shoulder,

elbow, wrist, ankle, knee meniscus, disc surgery (lumbar, cervical), LSS, and multilevel scoliosis surgery using layman's term. Two specific scales were asked, first, expected intensity of surgery, second, expected scale of complication. Control group (145 subjects F:M 98:47) was exposed to list of model case surgeries and allowed to scale numerically (1-10, 10 as most intense, severe). Then patients with symptomatic LSS (35 patients F:M 24:9) were also exposed to same list. SPSS was utilized for statistics with significance level $p<0.05$.

Results In healthy control, intensities of surgery ranged from toe (3.7) to total hip replacement (THR) (7.6) with 5.7±1.5 (mean ± standard deviation). Spine related operations (scoliosis, LSS, cervical and lumbar disc operation) ranked 2nd to 5th among 16 model cases. Increase in age correlated with more severe intensity of model case surgery, especially in THR, shoulder, elbow, and cervical disc ($p<0.05$). Expected scale of complication ranged from toe (2.8) to LSS (6.5) with 4.6±1.4. Increase in age also correlated with expected scale of complication ($p<0.05$). In patients with LSS, intensities of surgery increased especially lumbar disc, scoliosis, LSS operation compared to healthy control ($p<0.05$) However expected scale of complication such as in scoliosis, LSS, lumbar and cervical disc operation, decreased significantly ($p<0.05$)

Conclusion In healthy subjects' grading of operation related intensity and complication, spine related procedures (4 out of 14 model cases) ranked 2nd to 5th, 1st-2nd, 4th-5th, respectively. Patients with symptomatic LSS overestimated surgical intensity, especially in spine related procedures, however, they undergraded expected scale of complication, especially their own affliction (LSS). Hence patients with LSS were using heuristic mechanism to dampen psychological stress of expected surgery.

P120

RADIOLOGICAL FEATURES OF FORAMINAL STENOSIS AFTER OSTEOPOROTIC LUMBAR COMPRESSION FRAC-TURE

Takaki Shimizu,Junichi Kunogi,Shigeru Masuyama, Naohiro Kawamura,Yujiro Hirao,Hiroshi Maruyama, Naohiro Tachibana,Masaaki Iizuka,Yukimasa Yamato

Japanese Red Cross Medical Center 150-8935, Tokyo, Japan

Introduction: Although there are some cases who develop foraminal stenosis after osteoporotic lumbar compression fracture and complain radiculopathic leg pain rather than back pain, there are few studies focusing on the pathomechanism of such cases.

Aim: The purpose of this study was to investigate the radiological features of foraminal stenosis after osteoporotic lumbar compression fracture.

Materials and Methods: This study included 30 cases (7 men, 23 women) who developed foraminal stenosis after osteoporotic lumbar compression fracture and complained radiculopathic leg pain between October 2008 and May 2015. We investigated fracture types, radiological features other than fracture types, and the level of radiculopathy. Fractures were classified into three types (superior, superior-inferior, and inferior type) according to the position of the fracture line based on CT or MRI. To determine the level of radiculopathy and diagnose the foraminal stenosis, we comprehensively analyzed the physical and radiological findings, nerve root block, intraoperative findings, and postoperative clinical course.

Results: The mean age at the time of injury was 78.5 years (range; 63–88 years). The fracture location of the 30 cases was as follows: L2 (n=1), L3 (n=7), L4 (n=15), and L5 (n=7). In the analysis of fracture types, there were 10 cases with inferior type, 12 cases with superior-inferior type, and 8 cases with superior type. 22 cases with inferior and superior-inferior type had the same level of radiculopathy with the collapsed vertebra which thought to be resulted from decreased foraminal height caused by the fracture of inferior part of the vertebra. 6 out of 8 patients with superior type presented radiculopathy of 1 level proximal nerve root to the collapsed vertebra, which accompanied spondylolisthesis of the superior vertebra. There were 16 fresh fractures, 2 nonunions, and 12 malunions. 20 cases had inter-vertebral instability, such as spondylolisthesis. Most of cases had these intra- or inter-vertebral

instability which thought to be related to the cause of radiculopathic leg pain. All but 2 patients needed surgery to relieve the radiculopathic leg pain.
Conclusion: We need to suspect foraminal stenosis in the oseteoporotic compression fractures with radiculopathy which include fracture of inferior part of the vertebrae or superior type fractures with spondylolisthesis of the superior vertebra because intra- and inter-vertebral instability can be responsible for the pathomechanism. It is important to make treatment strategies under comprehensive consideration of such radiological findings as well as physical findings, the degree of osteoporosis, and comorbidities related to advanced age.

P121

EFFECTS OF HIP DISEASES ON THE MEASUREMENT OF PELVIC TILT PARAMETERS

Shintaro Shoji,Masayuki Miyagi,Kensuke Fukushima, Gen Inoue,Toshiyuki Nakazawa,Takayuki Imura,Wataru Saito,Takanori Namba,Eiki Shirasawa, Naonobu Takahira,Masashi Takaso
Department of Orthopaedic Surgery, Kitasato University, School of Medicine 252-0374, Sagamihara city, Japan

Introduction: It is important to measure the spinal alignment parameters including Pelvic tilt (PT) for sagittal balance accurately when treating adult spinal deformities. However, it is usually difficult to determine the position of the center of both sides of femoral head when measuring patients with hip osteoarthritis (OA) and leg length discrepancy. We hypothesized that the observers errors measuring PT are increase in such patients. We also evaluated the reliability of the Doiguchi technique (the ratio between the vertical and the horizontal diameter of the pelvic foramen) and the Sacro-femoral-pubic (SFP) angle, which were reported to approximate PT.
Methods: Subjects were 100 patients with a chief complaint of hip pain. We used plain X-rays including the both AP and lateral views of the whole spine, AP and lateral views, as well as standing AP images of both hips. Two orthopedic surgeons measured PT, approximated PT using the Doiguchi technique and SFP angle, the grade of OA (no deformity: 0, pre-arthritis: 1, early disease: 2, advanced disease, terminal: 4) and leg length discrepancy. Each orthopedic surgeon performed all the measurements twice. We calculated the intra-observer error and inter-observer error for measuring PT and approximated PT. Furthermore, we statistically evaluated whether hip OA and leg length discrepancy affect for measuring PT. Results: The interclass correlation coefficient (ICC) for PT for two-way random single measures (absolute agreement/consistency as 1.2; consistency/absolute agreement as 2.1) were 0.83 and 0.80 respectively. The values for approximated PT using Doiguchi technique were 0.93 and 0.95 for ICC 1.2 and 2.1, respectively. The values for the SFP angle were 0.91 and 0.90 for ICC 1.2 and 2.1, respectively. The absolute risk for intra-observer and inter-observer errors for measuring PT had no obvious correlation to OA degree or leg length discrepancy.
Discussion: The results of this study show that relatively high consistency in PT measurements was observed. However, measuring the Doiguchi technique for approximating PT and the SFP angle were shown to be more highly reliable than measuring PT. There was no obvious correlation between the errors occurring during PT measurement and the degree of advan-cement hip OA or the difference in leg length. However, there is the possibility that PT measurement error could occur in patients with hip pain. In future, we would like to investigate the calculation formula to approximate PT accurately using the SFP angle and PT measured using the Doiguchi technique, which shows a low incidence of error.

P122

PREVALENCE AND LOCATION OF NEUROPATHIC PAIN IN LUMBAR SPINAL DISORDERS: ANALYSIS OF 1,804 CONSECUTIVE PATIENTS WITH PRIMARY LOWER BACK PAIN

Sumihisa Orita,Toshihiko Yamashita,Seiji Ohtori, Kazuo Yonenobu,Mamoru Kawakami,Toshihiko Taguchi,Shin-ichi Kikuchi,Takahiro Ushida,Shin-ichi Konno,Masaya Nakamura,Keiji Fujino, Shuichi Matsuda,Kazunori Yone,Kazuhisa Takahashi
Dept. of Orthopaedic surgery, Graduate school

of Medicine, Chiba University Chiba, 260-8670, Japan

Introduction: Clinical spinal disorders can involve pathological neuropathic pain (NeP) as well as physiological nociceptive pain (NocP), as they have varied pathology, including spinal cord injury, stenosis, and compression. A study conducted by the Japanese Society for Spine Surgery and Related Research (JSSR) has determined a prevalence of 29.4% for NeP in patients with lumbar spinal disorder. However, the data did not include information on pain location.

Aim: To investigate the prevalence of pathological pain and its distribution features in patients with chronic lumbar spinal disorders.

Materials and Methods: Patients aged 20–79 years with chronic lower back pain (≥3 months, visual analog scale score ≥30) were recruited from 137 JSSR-related institutions. Patient data included an NeP screening questionnaire score and pain location (lower back, buttock, and legs). The association between the pain pathology and its location was analyzed.

Results: Low back pain subjects showed 31.9% of NeP prevalence, and the pain distribution showed (NocP(%)/NeP(%)), low back pain only cases: 44/22, while low back pain with leg pain cases showed a prevalence of: 56/78. This indicates that low back pain alone can significantly induce NocP rather than NeP ($P<0.01$). Buttock pain was revealed to significantly induce both lower back pain and leg pain with NeP properties ($P<0.01$). Leg pain was revealed to be predominantly neuropathic, especially when it included peripheral pain ($P<0.01$).

Conclusion: Low back pain with no buttock pain induces NocP rather than NeP. Buttock pain is significantly associated with NeP prevalence whether or not leg pain exists. Leg pain can increase the prevalence of NeP, especially when it contains a peripheral element.

P123

IMPACT OF THE ATHLETIC ACTIVITY AND MUSCULAR TIGHTNESS ON LOW BACK PAIN IN YOUNG FEMALE FIGURE SKATERS

Ai Abe, Takato Aihara, Kenji Sato, Susumu Mitsueda, Midori Kimura

Funabashi orthopedic Ichikawa clinic 272-0033, Ichikawa-city, Chiba, Japan

Introduction: The purpose of this study was to investigate the impact of the athletic activity and muscular tightness on LBP in young female figure skaters.

Methods: Thirty-seven female single figure skaters (mean age, 12.1 years) were examined. Eighteen of them had previous or present LBP (LBP group) and 19 of them had been no LBP (NLBP group). We investigated the ability of skating (grade of the badge test), career of skating, frequency of skating per week, and whether training the triple jumps and Biellmann spin using a questionnaire. The flexibilities of the legs were evaluated with use of the Thomas test concerning the iliopsoas muscle, Ober test concerning the tensor fasciae latae muscle, the heel buttock distance concerning the rectus femoris muscle, and straight leg raising angle concerning the hamstrings. The mobility and strength of the trunk were also evaluated using the trunk rotation score and abdominal muscle test. The age, ability of skating, career of skating, frequency of skating, heel buttock distance, straight leg raising angle, and trunk rotation score were compared between the LBP and NLBP groups by Mann-Whitney U test. The training ratios of triple jumps and Biellmann spin, and the positive ratios of the Thomas test, Ober test, and abdominal muscle test were compared between the LBP and NLBP groups by Chi-square test. A p value < 0.05 was considered statistically significant. The odds ratios for significant variables and the 95% confidence intervals were calculated by multivariate logistic regression analysis.

Results: The age, ability of skating, frequency of skating, training ratio of triple jumps, and the heel buttock distance in the LBP group (mean, 13.2 years, 5.6 grades, 5.6 times a week, 94.4%, 3.6cm, respectively) were significantly greater than those in the NLBP group (mean, 11.2 years, 4.2 grades, 5.1 times a week, 47.3%, 1.0cm, respectively). No significant differences were observed between the LBP and NLBP groups concerning the other data. Multivariate logistic regression analysis showed that the heel buttock distance (odds ratio=1.45, p=0.036) and training of triple jumps (odds ratio=16.5, p=0.021) were the important factors of LBP.

Conclusion: The results indicated that the large heel buttock distance (=tightness of rectus femoris muscle) and high training ratio of triple jumps were significantly associated with LBP in young female figure skaters. It has been reported that lumbar lordosis and pelvic tilt, which were caused by the tightness of rectus femoris muscle, were the risk factors of LBP. We think that the triple jumps may provide greater stress on the lumbar spine which can lead to LBP. These findings suggest that it is important to pay attention to the tightness of rectus femoris muscle and training the triple jumps, and the flexibility of the rectus femoris muscle is called for the prevention of LBP.

P124

ARE TARLOV CYSTS BEING IDENTIFIED ON LUMBAR SPINE MRI SCAN IN PATIENTS WITH SCIATICA

Gareth Clarke,Vikas Kapoor,Jon Baxter
University of Manchester Manchester, United Kingdom

Introduction: Following advances in surgical technique sacral Tarlov Cysts (TCs) are now a treatable cause of back pain and sciatica. Many surgeons and radiologists still view them as an incidental finding. This audit was carried out to raise awareness of TCs within the hospital and further afield, assess the extent to which TCs are present in patients with sciatica and assess if they are being identified and reported by the radiologist and surgeon in every case.

Materials and Methods: Following a literature review a list of all spinal MRI scans requested by the three consultant spinal surgeons working at the hospital between 1/1/2013 – 31/12/2014 was compiled by the radiology department. All patients with complaints of radicular pain or altered sensation in one or both lower limbs in their initial clinic letter had their MRI scan reviewed using the hospital PACS system for the presence of TCs. The radiologist's report and follow-up clinic letter were reviewed in patients with a TC present on their scan to see if the radiologist and surgeon reported it.

Results: In total 1499 patients underwent lumbar-sacral MRI scan under the care of the spinal surgeons. Of these, 1070 fitted the inclusion criteria. 6 MRI scans were not accessible, in total 1064 MRI scans were reviewed for the presence of TCs. 158 scans showed sacral TCs present, an incidence of 14.85%. Of the 158 only 33 (21%) had TCs in the radiologists' report. 4 were reported as possibly symptomatic and the rest as an incidental finding. Only the 4 potentially symptomatic TC patients were notified of the presence of the cysts during their clinic appointment following the MRI scan. No other patients notified of the presence of TCs on their MRI. Therefore of the 158 patients with sacral TCs present only 4 (2.5%) were made aware of the lesion. Only one case of symptomatic cyst was identified as the patient's symptoms decreased following excision of the cyst.

Conclusion: Several things were apparent from the literature review; the exact anatomical area supplied by each of the lumbar-sacral dermatomes is not known and as such pathology compressing the S2 nerve root can cause symptoms suggestive of an S1 or even L5 radiculopathy, TCs can be progressive in nature, microsurgical treatment offers the best symptom relief and early intervention gives the best prognosis. The audit showed in almost 80% of cases TCs were not being reported. This could lead to patients continuing with symptoms, or developing them as the cyst enlarges. It seems that for many Tarlov Cysts are still viewed as an asymptomatic incidental finding, causing a delay in diagnosis and therefore treatment resulting in a poorer prognosis. Until this opinion is changed patients will continue to suffer a potentially treatable spinal pathology.

P125

EFFECTS OF THE DYNAMIC FACTOR IN LUMBOSACRAL FORAMINAL STENOSIS WITH THE OSTEOPHYTE AT THE DISC LEVEL

Yoshio Shinozaki,Tomohiro Hikata,Naruhito Fujita, Satoshi Matsumaru,Yoshiomi Kobayashi, Yohei Takahashi,Hironari Takaishi,Jun Ogawa, Masaya Nakamura,Morio Matsumoto,Ken Ishii
Shizuoka red cross hospital Aoi-ku 4200853 Shizuoka-shi, Japan

Introduction: Involvement of dynamic factors in lumbosacral foraminal stenosis (LSFS) was not well known.

Aim: The purpose of this study is to evaluate the radiographic factors associated with the onset of radiculopathy caused by LSFS with posterolateral vertebral osteophytes at L5-S1 intervertebral disc level.
Materials and Methods: Subjects comprised 109 patients (69 men, 40 women) showing radiographic L5-S1 foraminal stenosis with posterolateral vertebral osteophyte at the disc level and for whom favorable surgical outcomes (JOA recovery rate ≥50%) were obtained. Fifty-three patients (37 men, 16 women; mean age, 69.4 years) underwent L5-S1 foraminal decompression or fusion and were diagnosed with LSFS (FS group). Fifty-six patients (32 men, 24 women; mean age, 72.0 years) had L4-5 canal stenosis, underwent L4-5 single level decompression or fusion and were diagnosed with L4-5 canal stenosis (CS group). CS group was divided into 2 subgroups according to spontaneous fusion at L5-S1: CS with fusion (CS-w/F); and without fusion (CS-w/o F). Minimum interval between L5 pedicle and posterolateral vertebral osteophyte (L5P-VO) was measured in FS, CS-w/F and CS-w/o F groups using sagittal-view of MDCT. In FS and CS-w/o F groups, we evaluated L5-S1 disc height, wedging angle and anterior or posterior spondylolisthesis on MDCT, and L5-S1 intervertebral angle, range of motion, LL, SS, PI and L1-sagittal vertical axis (L1-SVA), defined as the horizontal offset from the posterosuperior corner of S1 to the vertebral body of L1, on standing lateral-view X-ray.
Results: No significant difference in minimum L5P-VO was seen between FS (4.3 mm), CS-w/F (4.4 mm) and CS-w/o F (4.2 mm) groups. FS and CS-w/o F groups showed no significant differences in L5-S1 disc height, range of motion, wedging angle, complications of L5 posterior spondylolisthesis, LL or PI. Comparing FS and CS-w/o F groups, complications of L3 or L4 anterior spondylolisthesis (11% vs. 46%: $p<0.01$) and SS (19.9° vs. 24.1°: $p<0.01$) were less in FS group, and complications of L5-S1 wedging (34% vs. 13%: $p<0.05$), L1-4 posterior spondylolisthesis (56% vs. 8%: $p<0.01$), intervertebral angle (7.9° vs. 6.3°: $p<0.05$), and negative values of L1-SVA (72% vs. 2%: $p<0.01$) were greater in FS group.
Conclusion: The lack of significant difference in L5P-VO between FS and CS groups and the absence of onset in patients with L5-S1 spontaneous fusion indicate that LSFS is not affected by the degree of stenosis, as a static factor, but rather by dynamic factors. Indicators for the onset of LSFS appear to be complications of L1-4 posterior spondylolisthesis, greater L5-S1 intervertebral angle, lower SS and a negative value for L1-SVA. In patients with negative values for L1-SVA, the plumb line should shift posteriorly and axial compression force on L5-S1 foramen should increase.

P126

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

Tomofumi Ezure,Takato Aihara
Funabashi orthopedic hospital 274-0822 Chiba, Japan

Introduction: The purpose of this study was to determine the relation between the low back pain (LBP) and rotation range of motion of the hip joint and trunk in female professional golfer (FPG).
Methods: Thirty-two right-handed FPGs in our country (mean age, 34.2 years, mean height, 161.8 cm, and mean weight, 57.3 kg), who parti-cipated in our periodical physical check-up, were examined. Twenty of them had previous or present LBP (LBP group: LG) and 12 of them had been no LBP (NLBP group: NG). We measured the internal rotation angles (IRA) and external rotation angles (ERA) of the bilateral hip joints which were 90° flexed, and the right and left trunk rotation angles (TR) in the sitting position. All angles were compared between LG and NG, and between the right and left sides by Mann-Whitney U test. A P value < 0.05 was considered statistically significant.
Results: The left IRA was significantly smaller in LG (mean, 47.3°) than in NG (mean, 51.7°). There were no significant differences between LG and NG concerning the right IRA (LG mean, 54.0°; NG mean, 53.3°), the left ERA (LG mean, 53.5°; NG mean, 53.3°), and the right ERA (LG mean, 53.0°; NG mean, 54.2°). The left TR was significantly larger in LG (mean, 60.6°) than in NG (mean, 53.3°). There was no significant difference between LG (mean, 50.0°) and NG (mean, 48.3°) concerning the right TR. The left

IRA (mean, 47.3°) was significantly smaller than the right IRA (mean, 54.0°) in LG. However, there were no significant differences between the right and left sides in regard to the IRA in NG (right mean, 53.3°; left mean, 51.7°), the ERA in LG (right mean, 53.0°; left mean, 53.5°), and the ERA in NG (right mean, 54.2°; left mean, 53.3°). The left TR was significantly larger than the right TR in LG (right mean, 50.0°; left mean, 60.6°) and NG (right mean, 48.3°; left mean, 53.3°).

Discussion: From the results of this study, the left IRA was restricted and the left TR was excessive in right-handed FPG who had previous or present LBP. We think that the restricted internal rotation of the left hip joint prevents the weight shift to the finish position, then the FPG compensates those by the left trunk rotation which can lead to LBP. These findings suggest that it is important to pay attention to the hip joints and trunk rotation range of motion in FPG, and the flexibility of the hip joint rotation is called for the prevention of LBP.

P127

MRI CONSIDERATIONS IN A UNIVERSITY VS NON-UNIVERSITY SETTING

srdjan mirkovic

Northshore University Health 60093 Northfield, United States

Introduction: The quality and accuracy of MRI imaging plays a vital role in the diagnosis and treatment of spinal disorders.

Aim: The aim of the study was to compare MRIs performed at tertiary university or university affiliated centers (UCM) and those performed at other MRI facilities (OM).

Materials and Methods: 100 MRIs performed at UCM were compared to 100 MRIs performed at OM. All 200 MRI reports and actual images were reviewed. MRIs were evaluated and compared between the two groups to determine whether they were:

1. Open or Closed
2. Performed on a high (greater than or equal to 1.5T) or low (less than 1.5T) field magnet
3. Read by a board certified Neuroradiologist
4. Of adequate diagnostic quality The incidence and type of unreported clinically relevant findings in the MRIs of adequate diagnostic quality was assessed. The study also evaluated whether the review of the actual images versus reliance on the MRI report only, affected treatment decisions. A history of claustrophobia was obtained from patient who had an open MRI.

Results:

	UCM%	OM%
Open	4	27
Closed	96	73
High Field	94	63
Low Field	6	37
Neuroradiologist	98	57
Unreported findings	5.4 (5/92)	15 (12/79)
Adequate diagnostic quality	92	79

In 38% of UCM and 52% OM patients, treatment decisions were affected by whether the actual images were reviewed versus relian-ce on MRI reports only.

Unreported Findings

	Foraminal/Extra Foraminal Disc	Sequestered Disc	Synovial Cyst
UCM #	2	2	1
OM #	8	3	1

The most common unreported finding was a disc herniation at a foraminal or extra foraminal level (10), followed by a sequestered disc fragment at the pedicle level (5), and a facet synovial cyst (2). 81% of patients who had an open MRI were not claustrophobic and 90% were unaware of open versus closed MR quality considerations.

Conclusions: MRIs at UCM were more likely to be performed in a closed high field magnet, to be interpreted by a neuroradiologist and to be of acceptable diagnostic quality. This correlates with the lower incidence of unreported clinically significant imaging findings in the UCM group. Diagnostic quality was more likely to be compromised if the MRIs were obtained in a closed low field magnet as seen in the OM group. This study emphasizes the importance of the MRIs being personally reviewed by the treating physician and correlated with the clinical presentation and cautions against over-reliance on the MRI reports only. Patients who are not claustrophobic should be given the choice of a closed high field MRI

P128

CROSS-SECTIONAL STUDY FOR MRI FINDINGS AND LOW BACK PAIN IN THE COMMUNITY

Koji Otani,Takuya Nikaido,Kazuyuki Watanabe, Kinshi Kato,Hiroshi Kobayashi,Shoji Yabuki, Shinichi Kikuchi,Shinichi Konno
Fukushima Medical University 960-1295 Fukushima City, Japan

Introduction: Although it is well known that image findings are not equal to symptom, degenerative change such as disc degeneration may induce low back pain (LBP). It is still unclear what type of degeneration affect low back pain.

Aim: The purpose of this study was to assess the relationship between MRI findings and LBP.

Materials and Methods: 207 people (male:64, female:138, average age 64 years old, most frequent ages 70s) in community individuals agreed to participate in this study. They were received conventional MR imaging of lumbar spine (T1 sagittal, T2 sagittal and axial). Fatty degeneration of paraspinal muscle (T2 axial view of L4/5) was evaluated by three grades (none, slight, severe) (Kim 2013). Paraspinal muscle atrophy (T2 axial view of L4/5) was evaluated by T-back value (Takayama 2012). And other anatomical factors such as vertebral fracture (T1 sagittal view) (Genant 1993), endplate change (T1 sagittal view) (Viedeman 1995) and DDD score (T2 sagittal view) (Kawaguchi 1999, Cheung 2006) were also assessed. Existence of LBP and ADL disturbance induced by LBP was evaluated subjectively. What type of MRI findings influence on existence of LBP and activity of daily living (ADL) disturbance induced by LBP were analyzed using logistic regression analysis.

Results: PVM atrophy was only detected as the related factor for the existence of LBP. In addition, any MRI findings related to ADL disturbance induced by LBP were not detected.

Conclusion: It is difficult to explain the existence of LBP and ADL disturbance induced by LBP by MRI findings. In order to understand pathogenesis of LBP, image findings and other information should be needed.

P129

DO METABOLIC MARKERS PREDICT UNION STATUS OF THORACOLUMBAR OSTEOPOROTIC VERTEBRAL FRACTURE UNDER BISPHOSPHONATE TREATMENT?

Akira Iwata, Masahiro Kanayama, Fumihiro Oha, Tomoyuki Hashimoto, Takahata Masahiko, Norimasa Iwasaki
Hokkaido University 060-8638 Sapporo, Japan

Introduction: Tartrate resistant acid phosphate type 5b (TRAP5b) is a bone resorption marker presenting osteoclast activity; bone-specific alkaline phosphatase (BAP) is a bone formation marker showing osteoblast function. However, it remains unclear how these bone metabolic markers will change during the healing process of osteoporotic vertebral compression fracture (OVCF) under bisphosphonate treatment. This study aimed to determine whether or not bone metabolic markers could predict the union status of OVCF under bisphosphonate treatment.

Methods: We prospectively enrolled twenty-eight patients who underwent non-operative treatment for a single-level thoracolumbar fresh OVCF using soft lumbosacral orthosis and 35 mg of weekly alendronate (ALN). Fresh OVCF was diagnosed using MRI. BAP and TRAP5b were measured before the ALN use, and at 4, 8, 12 and 24 weeks after the treatment. Three independent observers assessed the union status at 24 weeks in a blind fashion. Radiographic union was defined as presence of trabecular continuity on CT and/or no motion in flexion-extension radiography.

Results: Nineteen patients achieved a radiographic union (union group), and nine patients were diagnosed as delayed or non-union (non-union group). Changes in TRAP5b were -39±5% in the union group versus -1±8% in the non-union group at 4 weeks (P=0.0003, t-test), -41±5% versus -2±8% at 8 weeks (P=0.0004), -45±6% versus -3±9% at 12 weeks (P=0.0008), and -48±6% versus -22±9% at 24 weeks (P=0.022). Changes in BAP were +2±9% in the union group versus +34±13% in the non-union group at 4 weeks (P=0.049), -13±7% versus +5±10% (P=0.153), -24±8% versus -1±11% at 12 weeks (P=0.113), and -34±7% versus -25±10% at 24 weeks (P=0.504). These results showed

that rapid decrease in TRAP5b was related to the likelihood of radiographic union. Regarding the decrease in TRACP5b at 4 weeks, receiver operating characteristic (ROC) curve determined the optimal cut-off value as 16% (area under the curve was 0.914, sensitivity was 89.5%, and specificity was 87.5%).
Discussion: The current study demonstrated that bone metabolic markers could be used to predict the union status of OVCF under ALN treatment. The union group showed significant larger decrease in TRACP5b at early phase of fracture healing. Elevated TRACP5b level throughout the healing process was a risk for non-union, and might reflect repeated microfracture. As well, OVCFs are predisposed to non-union when the decrease in TRACP5b does not reach 16% at 4 weeks after ALN treatment.

P130

THE EFFECT OF WEIGHT BEARING AND NON-WEIGHT BEARING GROUP EXERCISING ON FEMALES WITH NON-SPECIFIC CHRONIC LOW BACK PAIN

Youssef Masharawi,Nedal Nadaf
Tel Aviv university 69978 Tel Aviv, Israel

Background: Non-specific chronic low back pain (NSCLBP) is a common cause of disability in everyday functioning in the modern world and a financial burden on the patient and society. Most studies on active group exercises in NSCLBP used a mixture of body positioning in their protocols with no preferences for weight-bearing (WB) or non-weight-bearing (NWB) exercises although it may have different biomechanical and clinical effects on the lumbar region.
Purpose: To examine the effects of WB and NWB group exercising on lumbar range of motion, pain intensity, and function parameters in females with NSCLBP.
Methods: Two randomized controlled studies were conducted separately under the same conditions, on females aged 40 to 70 who have suffered from NSCLBP. The exercise protocols were given bi-weekly for 4 weeks and were based on a WB (sitting) and NWB positions. The exercises involved the entire lumbo-pelvic spine aimed at improving lumbar mobility/flexibility and stability. All participants in the exercise (N= WB-25, NWB-20) and control (N = 20) groups were examined once before the program started, and once at the end of the program. The exercise groups were examined again after 2 months as a follow-up. All groups received training on the right lifestyle for caring for the lower back. The control groups had a four week wait until the second session. Following reliability trials, the study tested range of motion of the lower back (flexion, extension, right and left rotation), pain intensity at rest (VAS) and assessment of functional capacity after NSCLBP by Roland Morris Disability Questionnaires (RMQ).
Results: Intra- and inter-rater reliability for each dependent variables was high with an ICC ranging between 0.86 and 0.98 ($0.004 < p < 0.001$). There were significant improvements in most dependent variables in both, WB and NWB positions compared to the control groups as follows ($p<0.05$): an increase in lumbar flexion and extension (mean differences of 6◦ for flexion and 4◦ for extension; reduction in VAS score (mean difference = 4.21); an increase in RMQ total score (mean difference= 10.76). Changes in the VAS score was highly correlated with changes in the RMQ score ($r = -6.35$). Unlike the improvement in VAS and RMQ, the improvement in the ROM's was below the requested minimal clinical important difference (i.e. cutoff score).
Conclusions: A functional program of group-exercising performed in WB and NWB positions, improves back disability, pain intensity and lumbar ranges of motion of women suffering from NSCLBP.

P131

THE EFFECT OF PILATES GROUP EXERCISES ON TRANSVERSE ABDOMINAL MUSCLE THICKNESS AND FUNCTIONAL AND POSTURAL PARAMETERS IN FEMALES WITH NON-SPECIFIC CHRONIC LOW BACK PAIN AND HEALTHY

Youssef Masharawi,Noelia Goldberg,Gali Dar
Tel Aviv university 69978 Tel Aviv, Israel

Introduction: LBP is a common health problem in the western world. About 70-85% of the population will experience LBP at least once during their lives. There are many ways and treatments concerning LBP which their efficacy

isn't high and even quite low when they become chronic. On the other hand, rehabilitative exercises have significant advantages when treating LBP in terms of pain management and function. The Pilates method has become popular in the last decades. It gives an answer to the physical and mental aspects of pain and combines strengthening, flexibility and concentration. The Pilates method now days is combined into the treatment fields for CLBP but the efficacy and positive effect on CLBP has yet been proved on pain, function, ranges of motion and most of all the cross section of the transversus abdominus (TrA).

Aim: The aim of the study was to examine whether training in the Pilates method as a defined protocol effects the cross section of the TrA, postural and functional aspects in CLBP and healthy population.

Methods: The research included women with CLBP (n=22) and healthy women (n=18) between 25-60 years old who were first introduced to the Pilates method. The measurements included pain (vas), function (Roland Morris disability questionnaire, thoracic kyphosis angle, TrA cross section during rest and ADIM (active drag-in maneuver) with ultrasound in three different locations. All measurements were taken before and after 6 weeks of group practice.

Results: No difference was found between right and left in all TrA cross section measurements in both groups ($p>0.05$). Before the Intervention no difference was found in TrA cross section between both groups. After the Intervention there was a significant Increase ($p<0.05$) in TrA cross section in rest in both groups, except for two locations. The TrA cross section in these locations was significantly smaller in the CLBP group. In ADIM after the Intervention there was a significant increase in TrA cross section. Moreover there was no TrA cross section difference between groups and locations ($p<0.05$). No significant change was found in pain, function and kyphosis angle before and after the intervention.

Conclusions: Pilates group practice increases TrA cross section during ADIM in CLBP & healthy women. In rest, TrA cross section increases in all locations after intervention in healthy women but only in one location in CLBP women. Function, pain and kyphosis did not change. It can be concluded that 6 weeks of Pilates group practice does not influence function in CLBP women although the TrA changes morphologically.

P132

COMPARISON OF THE RELIABILITY OF SAGITTAL AND TRANSVERSE CT-BASED CLASSIFICATION OF STRESS FRACTURES OF THE LUMBAR SPINE FOR CONSERVATIVE TREATMENT

Mitsuhiro kamiya,Shuntaro Hanamura, Norimitsu Wakao,Mikinobu Takeuchi,Atsuhiko Hirasawa,Kenta Murotani,Masataka Deie
Department of Orthopaedicis 480-1195 Nagakute, Aichi, Japan

Introduction: Lumbar spondylolysis is a stress fracture of the lumbar pars interarticularis. Discontinuation of exercises over the long-term is necessary in order to achieve bone union. Diagnosis at the early stage of lumbar pars interarticularis using magnetic resonance imaging and prediction of the rate of bone union using computed tomography (CT) determines the treatment strategy. Studies have reported that sagittal CT, which evaluates the fracture line posteriorly from the side of the belly, aids in the selection of appropriate treatment.

Aim: We investigated the bone union rates using sagittal CT-based classification of pars interarticularis injury and compared the reliability of diagnosis between sagittal and transverse CT imaging.

Materials and Methods: A total of 63 patients (100 fractures) under 18 years of age with stress fractures of the lumbar pars interarticularis were instructed to wear a semi-hard corset and discontinue exercises until imaging no longer revealed edema of the pedicle around the pars. Sagittal CT-based disease classification was graded from 0 to 3 [1].Transverse CT-based classification was as follows: 0, no separation;1, first stage; 2, advanced term; 3, end term. Herein, 31 patients (38 fractures) were classified by three orthopedics doctors using 5-slice transverse CT images and 3-slice sagittal CT images. In the first stage of analysis, we first interpreted the findings form the transverse CT image, and a

few days later, we interpreted the findings from the sagittal CT images. In the second stage, the findings were interpreted while the sagittal and transverse images were placed side to side on a monitor. During both interpretations, the reliability of the same examiner (Cohen's kappa coefficient) and reliability among the three examiners (Fleiss' kappa coefficient) was calculated.

Results: On the basis of sagittal CT images, bone union was achieved in 60 cases of Grade 1 and 2 (78.9%) disease and 4 cases of Grade 3 (16.7%) disease. At both the first and second stages of analysis, the examiner reliability was higher when using sagittal CT images (0.426, 0582) than with transverse CT images (0.371, 0.488). In terms of between-examiner reliability, at both stages of analysis, the reliability was higher when using sagittal CT images (0.426, 0582) than when using transverse CT images (0.371, 0.488). However, the reliability was higher when both sagittal and transverse CT images were used at the same time (0.582, 0.488).

Conclusion: Sagittal CT images were found to be more useful for evaluation of bone union and selecting the appropriate treatment. In order to reduce the differences in interpretations between radiologists, we recommend disease classification based on findings observed in the sagittal CT image.

Reference(s): 1. Dunn A., Campbell R.D., Mayor P., Rees D. Radiological findings and healing patterns of incomplete stress fractures of the pars interarticularis. Skeletal radiology. 2008; 37:443-50.

P133

LUMBAR PARASPINAL MUSCLE ATROPHY AND FATTY INFILTRATION FOLLOWING BOTULINUM TOXIN INJECTIONS IN A RABBIT MODEL

Popovich J.M. Jr, Klosterman E.L, Hubert J.D, Tonson, A, Meyer, R.A, Arnoczky S.P

MSU Center for Orthopedic Research West Fee Hall 48824, United States

Introduction: Skeletal muscle atrophy and fatty infiltration are associated with the clinical manifestations of disease and are poor prognostic factors for healing. For example, muscle atrophy and fatty infiltration are hallmark characteristics of Duchenne muscular dystrophy, diabetes and orthopedic conditions such as rotator cuff tears and lumbar herniated disc lesions. Botulinum toxin type-A (BTX-A) has been shown to produce muscle atrophy and fatty infiltration when injected into skeletal muscle; however, the time course by which this happens has not been well documented.

Aim: The aim of this project was to determine the progression of muscle atrophy and fatty infiltration following BTX-A injections into the paraspinal muscles using a well-controlled animal model.

Materials and Methods: Eight New Zealand White (NZW) rabbits were unilaterally injected with BTX-A (BOTOX®, Allergan Inc.) into the left lumbar paraspinal musculature. Magnetic resonance imaging (MRI) was serially perform-ed using a pre-clinical 7-Tesla MRI system (BioSpec 70/30 USR, Bruker) at baseline and every 2 weeks for a total of 8 weeks. NZW rabbits were anesthetized and placed in a supine position while axial T1 (T1-FLASH) and T2 (T2-Turbo-RARE) images of the paraspinal muscles were acquired using a transmit and receive volume coil. OsiriX image processing software (version 6.5, Pixmeo) was used to analyze the MR images. Paraspinal muscle cross-sectional area (CSA) was measured for left and right paraspinal muscles, and percent asymmetry in CSA was calculated as: [(CSAright – CSAleft) / CSAright]*100. Following euthanasia, MRI and histological analyses were also performed on a subset of paraspinal tissue.

Results: Paraspinal muscle atrophy, quantified as percent asymmetry, was observed at 2 weeks and progressed over the 8-week period (Figure 1). Fatty infiltration following BTX-A injections was observed as early as 4 weeks and also continued to progress over the 8-week period. Histological analysis confirmed the presence of adipocytes in the paraspinal muscles, validating the MRI fatty infiltration findings.

Conclusion: Following BTX-A injections, there is progressive paraspinal muscle atrophy and fatty infiltration through 8 weeks. This well-controlled model demonstrates the potential to be used to investigate the effects of paraspinal muscle weakness on the spine, as well as the pathophysiology and molecular signaling of muscle atrophy and fatty infiltration as it

relates to orthopedic conditions. Additional studies will allow for the development of therapeutic interventions aimed at treating these conditions.

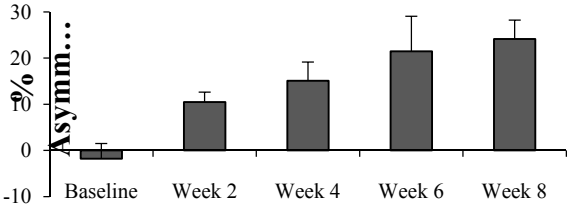


Figure 1. Eight-week progression of paraspinal muscle atrophy-/asymmetry following BTX-A injections.

P134

CHORDOMA: A SYSTEMATIC REVIEW OF INCIDENCE AND CLINICAL PROGNOSTIC FACTORS PREDICTING (DISEASE-FREE) SURVIVAL

Sierk Bakker,Wilco Jacobs,Willem Pondaag,Hans Gelderblom,Remi Nout,Sander Dijkstra,Wilco Peul,Carmen Vleggeert-Lankamp
Leiden University Medical Center 2593 XA Den Haag, Netherlands

Introduction and aim: Chordoma is considered a low grade primary malignancy of the skull base and spine. Despite the fact it's a relatively slow-growing tumor, its local destructiveness and its close relation to vital structures such as the brain and spinal cord make it a challenging entity to treat, even for the experienced surgeon. Because of the plethora of studies on the subject and lack of a systematic analysis thereof, the aim of this review is to provide a thorough overview of chordoma that may direct future treatment decisions.

Methods: An extensive literature search in four medical databases was performed with the help of a specialised health care librarian. In addition to this, reference and citation tracking were performed. A selection of studies was made according to a prespecified protocol. All studies included were subjected to risk of bias analysis. Pooled analyses were planned, if homogeneity of studies would allow. Each part of the review was carried out by two reviewers and a third mediated when disagreement arose.

Results: Incidence rates ranged between 0.18 and 0.84 per 106 persons per year and varied between countries, races and ethnicities. The two largest studies (n= 962 and n= 544) reported different anatomical distributions, one reporting the spheno-occiput as most frequently affected (42.1%), whereas the other found the sacrococcygeal area to be most commonly affected (45%). Statistically significant prognostic factors for (disease-free) survival include gender, age, tumor volume, level of invasion, tumor location, presence of metastasis, local recurrence, ethnicity and dedifferentiated subtype.

Conclusions: Incidence varies by country, race and ethnicity. The different incidence rates and anatomical distributions in the two largest studies are likely due to misclassification of skull base chordoma as chondrosarcoma in England and to differences in population, database coverage and quality of case collection. The incidence rate of 0.84 per 106 persons per year is therefore most likely to be the most accurate approximation of the actual incidence rate of chordoma. Most chordomas occur in the spheno-occipital and sacrococcygeal areas. Nine adverse prognostic factors were identified, of which old age, female gender and presence of metastasis were most commonly reported. Based on these prognostic factors and the wishes of the patient and surgeon, treatment plans can be altered if so desired.

P135

IMPROVING THE OUTCOME OF SPINAL INJURED PATIENTS IN THE DEVELOPING WORLD

Kimani White,Ian Neil,Ashish Diwan
Spine Service NSW2217 Kogarah, Australia

Introduction: There exist many deficiencies in the developing world, which limit the management and hence outcome of the spinal injured patient, resulting in elevated morbidity and mortality rates as compared to the developed world. These deficiencies, often resulting from financial limitations, include not only human resource, but also training, infrastructure and cultural differences. Further aggravating the problem is the heavy burden of more easily addressed non-spinal trauma, often faced by these countries. The Kingston Public Hospital (KPH) is a tertiary care hospital in Kingston, Jamaica where such limitations exist. Spinal cord injured (SCI) patients, from any cause, represent a disproportionately large part of the

resource with respect to their numbers. The excessive high mortality rate of this group can however be diminished by the introduction of simple improvements of spinal care. Additionally, the international community can contribute by identifying at risk regions and targeting specific deficiencies by way of funding, training or loaning of expertise expertise.

Aim: To assess the mortality risk among spinal-injured patients in a developing country, as well as the causes of death, associated risk factors and to suggest ways to reduce mortality.

Materials and Methods: This is a retrospective cohort study reviewing the outcome of spinal injured patients before and after a centralized, quasi-specialized approach to management. Hospital admission records and audit data were reviewed from two hospital periods (Period A, 2005-2008 and Period B, 2010-2012) and spinal-injured cases from any cause, admitted to the orthopaedic wards were identified. Demographic and clinical data was extracted from the available records. Univariate, bivariate and multivariate analyses were done to determine mortality risk and the independent variables associated with mortality.

Results: In period A, 308 cases were identified of which 227 had significant SCI from all causes. There were 55 deaths overall with a mortality risk of 23.8% among those with SCI. Cord syndrome (OR 1.5, 95%CI: 1.0-2.2, p=0.045), complications (OR 6.1, 95%CI 3.4-10.9, p<0.001), age-group (OR 1.8, 95%CI 1.3-2.4, p<0.001) and length of hospital stay (OR 0.2, 95%CI 0.1-0.4, p<0.001) were associated with mortality after controlling for other covariates. Complication rate was 37.7% with respiratory related complications occurring in 21.1%. In period B, the mortality rate was reduced to 4.7% (8/170) although complications (OR 7.4: 95%CI 2.6-21.1: P<0.001) and age-group (OR 1.46: 95%CI 1.21.79: p<0.001) were again major risk factors for mortality, after controlling for other co-variates. Hospital stay was not statistically significant as a factor impacting mortality. Complication rate was 22.4% with respiratory causes representing 5.1% of cases and urinary tract infections representing 7.6%. In both cohorts data analysis was limited significantly limited by missing data.

Conclusion: Although mortality risk remains very high in this cohort in the developing world, with the dedication of resource to improvement of spinal care and the reduction of complications, this outcome may be impro-ved significantly. Public health interventions, creation of a centralized spinal care unit and installing a system of continuous audit are simple, cost-effective measures to effect change.

P136

RISK MANAGEMENT FOR AVOIDANCE OF MAJOR VASCULAR INJURY DUE TO LATERAL TRANSPSOAS APPROACH

Toshinori Sakai, Fumitake Tezuka,Mitsunobu Abe, Kazuta Yamashita,Yoichiro Takata,Kosaku Higashino,Koichi Sairyo

Tokushima university 7708503 Tokushima, Japan

INTRODUCTION To avoid critical complications such as major vessel injury, it is essential examine anatomical information related to preoperative risk management that is specific to the lateral transpsoas approach. In this study, to identify risk factors for injury to the major vessels in the lateral transpsoas approach, we performed a retrospective study using 323 contrast-enhanced multi-planner 3D-CT scans.

METHODS The abdominal contrast-enhanced multi-planner 3D-CT scans of 323 consecutive subjects (203 males and 120 females, 15 to 89 years old) were retrospectively reviewed. The true axial views were used for evaluation of the locations of the major vein and artery at L3–4 and L4–5. According to the Moro system, the axial view was divided into 6 zones from the front side (A, I II, III, IV, P) and the locations of the dorsal tangential line of the major vessels were evaluated.

RESULTS AND DISCUSSION At the L3–4 level, the dorsal tangential line of the major vein located in zone A was found in 18% of subjects, in zone I in 74%, and in zone II in 8%. The line of the major artery was located in zone A in 92.6% of subjects and in zone I in 7.1%. At the L4–5 level, the line of the major vein was located in zone A in 5% of subjects, in zone I in 75%, in zone II in 20%, and in zone III in only 1 subject. The line of the major artery was identified in zone A in 87% of subjects, in zone I in 12%, and

in zone II in 1%. Women had significant dorsal-migrated veins and arteries at both spinal levels ($p<0.01$).

CONCLUSION To avoid critical complications in extreme lateral lumbar interbody fusion, careful preoperative radiological evaluation of the major vessels and intraoperative care are important.

P137

DOES LOW BACK PAIN IMPROVE AFTER LUMBAR DISCECTOMY FOR DISC HERNIATIONS?

Michael H. Moghimi,Kempland C. Walley, Rishabh D. Phukan,Dana A Leonard,Christopher M. Bono,Kevin J. McGuire

Brigham and Women's Hospital 02115 Boston, MA, United States

Introduction: Lumbar disc herniations are one of the most common conditions treated by spine surgeons. For those patients in whom nonoperative care is not successful, lumbar discectomy has been demonstrated to be effective with durable outcomes. These results are based on functional outcome and measures of leg symptoms. Although low back pain (LBP) is a commonly associated presenting complaint, data is limited regarding improvement following discectomy.

Aim: The primary purpose of this study was to investigate whether lumbar discectomy performed in patients with radicular leg pain results in clinically important improvements in LBP and post-operative disability. In addition, we sought to understand whether factors such as age, herniation type, or incising the annulus correlate with improvement in LBP after surgery.

Materials and Methods: This retrospective comparative study included 77 patients (33 female, 44 male; mean age 43.6 years) with a single-level intervertebral disc herniation (IDH) who underwent lumbar discectomy were included. Seventy-six of 77 patients (99%) were available for final follow-up (1 or 2 years). Back and leg pain was measured on a continuous 0 to 10 point visual analog scale (VAS) at baseline (preoperative), 3 months, 1 year, and 2 years (if available) after surgery. Modified Oswestry Diability Index (MODI) scores were recorded for each patient at each time point. We compared raw scores to each patient's baseline status and also assessed dichotomized outcomes, distinguishing between patients who did or did not achieve a minimally clinically important difference (MCID).

Results: Significant improvements in leg VAS, back VAS, and MODI were observed at all time points during follow-up. A minimally clinically important difference (MCID) in back VAS was observed in 60% of patients at final follow-up (95% CI 49-71%) and the average improvement was 3.2 points (95% CI 2.5- 4 VAS). MCID in leg VAS was observed in 82% of patients at final follow-up (95% CI 73- 90%) and the average improvement was 5.1 points (95% CI 4.4-5.7). MCID of MODI was observed in 83% of patients at 2 years (95% CI 75-92%). Logistic regression showed no correlation between MCID of back VAS and disc size, height, age, sex, or type of herniation. Annulotomy ($p=0.075$) and a preoperative Carragee classification of 1 showed a trend towards significance ($p=0.064$).

Conclusion: LBP improvement can be expected in a proportion of patients undergoing surgery, albeit less likely than leg pain. It is our hope that these findings can help surgeons better counsel their patients regarding the likelihood and impact of back pain improvement following discectomy for lumbar IDH.

P138

RELATIONSHIP BETWEEN SIZE OF DISC AND EARLY POSTOPERATIVE OUTCOMES AFTER LUMBAR DISCECTOMY

Derick C. En'Wezoh,Dana A Leonard,Andrew J. Schoenfeld,Mitchel B. Harris,Jay M. Zampini, Christopher M. Bono

Brigham and Women's Hospital 02115 Boston, MA, United States

Introduction: Previous studies suggest that patients with larger disc herniations, as measured on preoperative imaging studies, will have superior clinical outcomes following lumbar discectomy. We sought to empirically evaluate this in a series of patients who had data collected prospectively as part of a rando-mized trial.

Aim: To determine if the size of a disc herniation as measured on preoperative MRI influ-

ences postoperative outcome following discectomy.
Materials and Methods: This was a retrospective review of prospective data collected as part of a randomized trial. Sixty-three adult patients who underwent a single-level, primary lumbar discectomy for a disc herniation were included in this analysis. Outcome measures included the Modified Oswestry Disability Index (MODI) and visual analogue scale (VAS) leg and back pain. Two-tailed unpaired T-tests were used to compare patients who did or did not achieve a substantial clinical benefit (SCB) for back pain, leg pain, and MODI. The same test was used to compare patients with preoperative disc diameters with cutoffs set at 5 mm, 6 mm, 7 mm, or 8 mm; the same analysis was performed dividing patients based on volume of disc material removed intraoperatively (0.25, 0.50, 0.75, 1.00, or 1.25 cc). Multivariable linear regression analysis was performed to determine if there was a significant relationship between clinical outcomes and anteroposterior disc diameter, disc space height, and volume of disc removed.
Results: Patients who achieved SCB for MODI had, on average, disc herniations with larger anteroposterior diameters than those who did not achieve SCB (7.8±5.8 versus 5.5±1.7, p=0.030). None of the three measurements (diameter, disc height, or volume) were significantly different when comparing patients who did or did not achieve SCB for leg or back pain. Using 5, 6, 7, or 8 mm as a cutoff criterion, no differences were found in any of the outcome measures. Multivariable linear regression analysis did not demonstrate a statistically significant relationship between volume of disc material extracted and final MODI scores.
Conclusion: While patients with larger disc herniations on average might have a greater likelihood of superior clinical outcomes, the previously suggested “6 mm rule” was not supported in the present study.

P139

GOOD CLINICAL OUTCOMES IN NONUNION CASES AFTER FACET FUSION WITH A PERCUTANEOUS PEDICLE SCREW SYSTEM FOR DEGENERATIVE LUMBAR SPONDYLOLISTHESIS

Tomohiro Miyashita,Hiromi Ataka,Kei Kato, Takaaki Tanno
Matsudo City Hospital 2718511 Matsudo, Japan

Introduction: In a long-term clinical and radiological follow-up study of posterolateral fusion (PLF) for degenerative lumbar spondylolisthesis (DLS), we observed good clinical outcomes after PLF in terms of in situ fusion, a low incidence of adjacent segment disease (ASD), and the lack of a need for slippage reduction. Furthermore, we previously found that facet fusion (FF) using a percutaneous pedicle screw (PPS) system as a minimally invasive evolution of PLF also resulted in good clinical outcomes.
Aim: To compare nonunion and union cases after FF.
Patients and Methods: One hundred seven patients (64 women, 43 men; average age, 68.9 years) who underwent FF for single-level DLS were retrospectively reviewed after a minimum follow-up of 1 year. The surgical method involved making a 5-cm skin incision, bilateral laminar fenestration, and FF with autologous bone harvested from the spinous process. PPS were then inserted through the fascia. We evaluated the FF rate using computed tomography (CT), range of motion (ROM) at the fused level on a flexion-extension lateral X-ray film preoperatively and at the final follow-up, and the therapeutic effectiveness of FF using the Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ), Roland-Morris Disability Questionnaire (RMDQ), and Visual Analogue Scale (VAS). The revision surgery rate was also evaluated.
Results: The FF rate was 89.7% (96/107 cases). At the final follow-up, all patients with adequate FF on CT had no recognizable motion at the fused level. In 11 nonunion cases, the average ROM significantly decreased from 14.2 degrees preoperatively to 4.4 degrees postoperatively. In these cases, therapeutic effectiveness on the JOABPEQ was demonstrated in the Walking ability score in 100.0% of the patients and in the Low back pain score in 88.9%. The average RMDQ value and VAS score significantly decreased postoperatively. There was no statistically significant difference between the union and nonunion cases for any variable. Of

the union cases, 3 were cases of revision surgery for ASD more than 1 year after the first surgery; there was only 1 such case among the nonunion cases. Revision surgery for complications or poor clinical outcomes immediately after the operation was not required in any of the cases.

Conclusion: We think that preserving the intervertebral disc is very important and that surgery with intervertebral disc preservation is the least invasive. Nonunion cases likely did not need revision surgery because there was no cage migration or pain in cases without a cage. Good clinical outcomes were noted even in the nonunion cases, likely because the ROM significantly decreased postoperatively, indicating stabilization of unstable spondylolisthesis. There are potential revision surgery options, such as PLF and lumbar interbody fusion, in case of FF failure. Thus, FF has several advantages for spinal fusion and is useful in the management of DLS.

P140

IS AN INSTRUMENTED FUSION REQUIRED WITH DECOMPRESSION FOR LUMBAR FORAMINAL STENOSIS AND SINGLE LEVEL DISC DISEASE? A RCT WITH 12-18 YEARS FOLLOW-UP

Nicholas D. Clement,Sophia S Muschik,J.N. Alastair Gibson

The Royal Infirmary of Edinburgh Edinburgh, United Kingdom

Introduction: There is sparse evidence within the literature supporting instrumented fusion as an adjunct to decompression in the absence of segmental instability and deformity. This statement was supported by conclusions from our own initial report1 that there was no obvious additional benefit evident from instrumenting the spine in patients with foraminal stenosis and single level disc disease at up to 5 years. Potentially however it was recognised that instrumentation might prevent recurrent stenosis in the long term by limiting disc collapse.

Aim: To compare long-term outcomes following decompression (Group 1) with those following decompression and an instrumented posterolateral fusion (Group 2) and decompression and an instrumented posterolateral fusion plus transforaminal interbody fusion (Group 3).

Patients and Methods: Following completion of a standardized physiotherapy program, 44 patients with single-level disc disease were randomly assigned by computer to one of the three surgical groups. In those patients undergoing instrumentation, segmental pedicle screw fixation was used to stabilize the spine. Titanium interbody cages filled with autologous bone were inserted into patients in Group 3. Spinal disability (by Dallas Pain - DPQ, Roland Morris - RM, and Low Back Outcome score - LBOS) was quantified along with quality of life (EQ-5D and SF-36) before and after surgery. Using standard deviations for initial study cohorts of 14 the current study with 10 patients per group was 80% powered (beta) to demonstrate a 22 point difference between groups with an alpha of 0.005 (adjusted for multiple testing).

Results: At a mean 15 years follow up (range 12-18 years), 33 patients were available for assessment. Group 1 demonstrated significantly better functional outcomes according to their DPQ, RM, LBOS, and EQ-5D (3L and VAS) scores when compared to the other two groups ($p<0.15$), Roland Morris ($p>0.37$), or the LBOS ($p>0.32$). Three patients had secondary surgery for adjacent level stenosis (Group 2 and 3). One additional patient (Group 1) required a subsequent lateral mass fusion for chronic pain and one (Group 3) incurred a deep infection.

Conclusion: Fusion in combination with decompression for the treatment of foraminal stenosis and single level degenerative disc disease offers no long term functional benefit over decompression in isolation.

Reference: 1Hallett A, Huntley JS, Gibson JNA. Foraminal stenosis and single level degenerative disc disease: A RCT comparing decompression with decompression and instrumented fusion. Spine 2007;32(13):1375-80.

P141

MODIC TYPE 1 CHANGE INFLUENCES SURGICAL OUTCOME IN SELECTED PATIENTS WITH DISKOGENIC LOW BACK PAIN.

Seiji Ohtori,Sumihisa Orita,Kazuyo Yamauchi, Yawara Eguchi,Yasuchika Aoki,Miyako Suzuki, Gou Kubota,Kazuhide Inage,Takeshi Sainoh,Jun

Sato, Kazuki Fujimoto,Yasuhiro Shiga,Koki Abe, Hirohito Kanamoto,Kazuhisa Takahashi
Chiba Univ. 260-8670, Japan

Introduction: Surgery for diskogenic low back pain (DLBP) is challenging. A systematic review found fusion surgery for DLBP based on magnetic resonance imaging (MRI) findings and diskography as a diagnostic test for spinal pain to be controversial.
Aim: To determine whether MRI findings predict surgical outcomes for selected patients with DLBP using diskography and diskoblock.
Materials and Methods: We investigated 57 patients with LBP and no dominant radicular pain. We used MRI to select patients with disk degeneration at 1 or 2 levels. If pain was provoked during diskography and pain relief was found after diskoblock using bupivacaine, we performed combined anterior interbody fusion with posterior pedicle screws (37 patients, average age 41.3 years). Visual analogue scale (VAS) score was assessed before and 2 years after surgery. Existence of a high intensity zone (HIZ), disk degeneration, morphology, level of degenerated disks, and vertebral bone marrow change were classified according to Pfirrmann or Modic grading, or Macnab classification respectively. We evaluated whether MRI findings predict surgical outcomes for selected patients with DLBP.
Results: We found 79% of patients with a good outcome showed postsurgical pain relief (≥60% pain relief), but 21% patients with a poor outcome did not (<60% pain relief). Between the good surgical and poor surgical result groups, there was no significant difference in level of the degenerated disk, disk degeneration based on Pfirrmann grade, morphology of the disk based on Macnab classification, existence of a high intensity zone (HIZ), or type 2 and 3 change on Modic grading. However, there was a significant difference in vertebral bone marrow change based on Modic classification (type 1) between the two groups ($P < 0.05$).
Conclusion: Modic type 1 change can influence surgical outcome in selected patients with diskogenic low back pain if DLBP was diagnosed by both diskography and diskoblock.

P142

MINI-OPEN ANTERIOR RETROPERITONEAL LUMBAR INTERBODY FUSION: OBLIQUE LATERAL INTERBODY FUSION FOR DEGENERATED LUMBAR SPINAL KYPHOSCOLIOSIS

Seiji Ohtori,Sumihisa Orita,Kazuyo Yamauchi, Yawara Eguchi,Yasuchika Aoki,Miyako Suzuki, Gou Kubota,Kazuhide Inage,Takeshi Sainoh,Jun Sato, Kazuki Fujimoto,Yasuhiro Shiga,Koki Abe,Hirohito Kanamoto,Kazuhisa Takahashi
Chiba Univ. 260-8670, Japan

Introduction: The existing surgical procedures for the treatment of spinal kyphotic deformity, including Smith–Petersen osteotomy, pedicle subtraction osteotomy, and vertebral column resection procedures, are invasive. Extreme lateral interbody fusion to provide less invasive treatment of the deformity has been reported, but complications including spinal nerve and psoas muscle injury have been noted. The efficacy of OLIF for degenerated lumbar spinal kyphoscoliosis has not been reported. In the current study, we examined the clinical efficacy and complications of OLIF for degenerated lumbar spinal kyphoscoliosis.
Aim: To examine the clinical efficacy of mini-open anterior retroperitoneal lumbar interbody fusion: oblique lateral interbody fusion (OLIF) for degenerated lumbar spinal kyphoscoliosis.
Materials and Methods: Twelve patients with degenerated lumbar spinal kyphoscoliosis were examined. All patients underwent OLIF surgery (using a cage and bone graft from the iliac crest) with open pedicle screws or percutaneous pedicle screws, without real-time monitoring by electromyography. Visual analog scale score and Oswestry disability index were evaluated before and 12 months after surgery, and fusion rate at the OLIF cage, correction of the deformity, total blood loss, and surgical complications were also evaluated.
Results: Pain scores significantly improved after surgery ($p < 0.05$). Fusion rate was 90%, balance parameters also improved after surgery ($p < 0.05$), and average total blood loss was less than 350 mL. There was no spinal nerve, major vessel, peritoneal, or urinary injury, or breakage of instrumentation.
Conclusions: OLIF surgery for degenerated lumbar spinal kyphoscoliosis is less invasive

than other procedures and good surgical results were produced without major complications.

P143

REOPERATION FOLLOWING LUMBAR MICROENDOSCOPIC DECOMPRESSION: MICROENDOSCOPIC DISCECTOMY AND MICROENDOSCOPIC LAMINOTOMY

Takato Aihara,Yoshikazu Ikeda,Kenji Hatakeyama, Makoto Urushibara,Juntaro Ouchi, Masatsune Yamagata

Funabashi Orthopedic Hospital 274-0822 Funabashi-city, Japan

Introduction: The purpose of this study was to investigate the reoperation cases following lumbar microendoscopic decompression (MED).
Methods: Between June 2005 and May 2014, the same surgeon had been using MED for all 471 patients with 1 or 2 levels of disc herniation (400 levels in 376 patients) and/or spinal stenosis (163 levels in 125 patients) and epidural cyst (9 patients) including degenerative spondylolisthesis (DS: 91 patients) and scoliosis (26 patients) with disc herniation and/or spinal stenosis. All 471 consecutive patients were followed and investigated the reoperation cases. Follow-up ranged from 3 to 111 months (median, 71 months). The main causes and rates of reoperations (ROR) at the same level as the initial MED were determined. We also investigated the interval between June 2005 and the initial MED (IJI: median, 40 months), and the interval between the initial MED and the reoperation (IIR).
Results: The main causes of the reoperations were recurrence of disc herniation (ROR, 5.85%=22/376; median IJI, 49 months; median IIR, 14 months) and increase of postoperative olisthesis and/or instability (ROR, 1.70%=8/471; median IJI, 16 months; median IIR, 32 months): two of the 8 cases were caused by excessive decompression and IJIs were 11, 16 months, and IIRs were 38, 46 months, respectively. The other main causes of the reoperations were postoperative epidural hematoma or dural tear (ROR, 1.49%=7/471; median IJI, 25 months; median IIR, 4 days), surgical site infection (ROR, 1.06%=5/471; median IJI, 36 months; median IIR, 21 days), and residual segmental scoliosis (ROR, 7.69%=2/26; IJIs, 48 and 63 months; IIRs, 4 and 2 months): two segmental scoliosis cases were not provided relief of sciatica, and the reoperations (transforaminal lumbar interbody fusion) were performed by the same surgeon. The other causes of the reoperations were new disc herniation at the level of laminotomy (ROR, 1.60%=2/125; IJIs, 40 and 63 months; IIRs, 11 and 35 months), insufficient decompression (ROR, 0.21%=1/471; IJI, 17 months; IIR, 7 months), and lateral foraminal stenosis at the level of discectomy (ROR, 0.21%=1/471; IJI, 14 months; IIR, 39 months): the reoperation (transforaminal lumbar interbody fusion) was performed by the other surgeons in another hospital.
Conclusion: Postoperative epidural hematoma or dural tear and excessive or insufficient decompression were often observed in the initial series of patients as the causes of reoperations (underlined). We think that it is important to know and prevent these problems in the initial series of patients. We reported that a large (over 20) percentage of DS could lead to inadequate improvement in 2-year and 5-year outcomes following MED (2011 and 2013, ISSLS). From the results of these and the present studies, we think that there are some surgical indication limitations to the use of MED for DS with over 20% slipping and segmental scoliosis because of the excessive traction or kinking of the nerve roots.

P144

SPINAL RESTABILIZATION OF LUMBAR DEGENERATIVE SPONDYLOLISTHESIS ASSOCIATED WITH SPINAL INSTABILITY FOLLOWING MINIMALLY INVASIVE SPINAL DECOMPRESSION SURGERY

Akihito Minamide, Munehito Yoshida, Hiroshi Yamada, Hiroshi Hashizume, Yukihiro Nakagawa, Hiroshi Iwasaki, Shunji Tsutsui, Masanari Takami, Motohiro Okada, Shin-ichi Nakao

Orthopaedic Surgery, Wakayama Medical University Wakayama 641-8510, Japan

Introduction: Minimally invasive spinal surgery has become increasingly popular for lumbar spinal disorders. However, the clinical outcomes of such surgery for lumbar degenerative spondylolisthesis (DS) remain unclear. The

purpose of this study was to investigate the clinical outcomes of microendoscopic laminotomy (MEL)1 in patients with DS, and to clarify the effect of preoperative spinal instability on such outcomes. We hypothesized that MEL would be an effective treatment without greatly affecting spinal instability. Disc degeneration is associated with DS to a varying degree. The DS with disc degeneration becomes the destabilized spine and returns to stabilized spine before long. In the report about the natural history of DS, no progression of slippage was noted in patients who showed narrowing of the intervertebral disc, spur formation and degeneration of the facet joint. 2 The restabilization of the spine occurs over the natural course of DS. We examined the spinal restabilization with the intervertebral disc narrowing on our hypothesis of the MEL surgery for DS.

Methods: This was a prospective cohort study. Consecutive patients with single-level DS at L3/4 or L4/5 who required surgical treatment were enrolled. All enrolled patients (n=304) underwent MEL. Based on the slippage rate and spinal instability, patients were assigned to either the advanced DS (n=101) or DS (n=203) group. The Japanese Orthopaedic Association (JOA) score, JOA score recovery rate, visual analog scale for low back pain, Roland-Morris Disability Questionnaire, and Short Form 36 were used to evaluate patients preoperatively and at >2 years postoperatively.

Results: Of the 304 patients, 242 (advanced DS group, n=86; DS group, n=156) were finally examined, with a mean follow-up of 3.6 years. No significant differences were found in the preoperative measurements between the groups. The mean slippage rate was 17.1% preoperatively and 17.7% at the final follow-up (P>0.05). The mean JOA score recovery rate was 64.8%. Progressive spinal instability was noted in 6 (7.0%) and 13 (8.2%) patients in the advanced DS and DS groups, respectively (P>0.05). Restabilization was achieved in approximately 35% of patients with preoperative spinal instability. The success rate of MEL was good/excellent in 70%, fair in 20%, and poor in 10% of patients in both groups.

Conclusions: MEL showed similar outcomes in patients with DS, regardless of the presence of advanced spinal instability. This minimally invasive spinal decompression technique should be considered as an alternative surgical procedure for the treatment of DS.

Reference(s):

1. Minamide A, Yoshida M, Yamada H, et al. Endoscope-assisted spinal decompression surgery for lumbar spinal stenosis. J Neurosurg Spine 2013;19:664–71.

2.Matsunaga S, Sakou T, Morizono Y, et al. Natural history of degenerative spondylolisthesis. Pathogenesis and natural course of the slippage. Spine 1990;15:1204–10.

P145

RISK FACTORS FOR REOPERATION AFTER LUMBAR RECAPPING LAMINOPLASTY

Naohiro Tachibana,Naohiro Kawamura,Shigeru Masuyama,Yujiro Hirao,Hiroshi Maruyama, Masaaki Iizuka,Takaki Shimizu,Yukimasa Yamato, Junichi Kunogi

Japanese Red Cross Medical Center Shibuya-ku 150-8935, Japan

Introduction: We have developed a posterior decompression procedure “recapping laminoplasty” in which temporarily detached lamina was restored after decompression of spinal canal. There are few reports about the outcome after recapping laminoplasty.

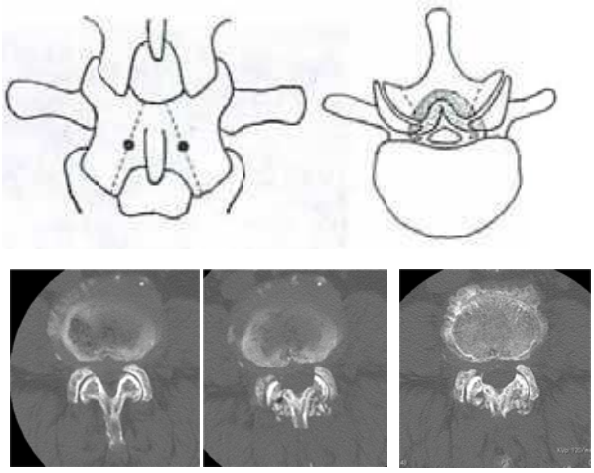
Aim: To investigate the risk factors for reoperation after lumbar recapping laminoplasty.

Materials and Methods: Of 389 patients with lumbar spinal stenosis who underwent lumbar recapping laminoplasty between January 2006 and May 2010, 313 patients with no previous lumbar surgery were included. We divided the patients into two groups. The patients who underwent reoperation were defined as group R. The other patients who did not undergo reoperation were defined as group C. We evaluated patient’s demographic data, preoperative facet morphology, Modic change, and Pfirrmann’s classification, and radiographical sagittal alignment parameters, and compared them between 2 groups. Results: The mean age was 65.6 years old (18-88), and the mean follow-up period was 1146 days (9-3348). Group R included 23 patients. There was no difference between 2 groups in patient’s demographic data, Modic change, Pfirrmann’s classification, and sagittal alignment para-

meters. Group R had significantly higher incidence of preoperative facet tropism (p=0.02) and more levels of decompression (p=0.029) in Cox regression analysis. The patho-logical causes for reoperation were foraminal stenosis (2 cases), lumbar disc hernia (7 cases), re-stenosis (2 cases), instability (8 cases), adjacent segment stenosis (3 cases), deep infection (1 case).

Discussion: The presence of preoperative facet tropism and multiple level decompression were suggested to be the risk factors for reoperation after recapping laminoplasty. Facet tropism may cause rotational instability which potentially lead to degeneration of disc and facet. In cases with preoperative facet tropism, a consideration on fusion or stabilization may be necessary.

Conclusion: The patients with preoperative facet tropism or multiple level stenosis need careful and long follow-up after lumbar recapping laminoplasty.



P146

SKIN DAMAGE PREVENTION WITH OLIVE OIL - VERIFICATION OF EFFICACY IN PRONE SPINAL SURGERY

Sakamoto Hiroko,Mikiko Ueda,Takahiro Iida, Junya Katayanagi,Ken Mine,Takashi Tomura, Satoru Ozeki

Dokkyo medical university Koshigaya hospital Koshigaya-shi 34300 Saitama-ken, Japan

Introduction: In prone spinal surgery skin damage tends to arise from friction, slippage and pressure at the Hall frame contact interface. Various prevention methods tried, include PERME-ROLL® film dressing (hereafter film dressing) but these dressings still result in skin damage such as traction water blisters, removal irritation, slippage and exfoliation. Following other facilities and existing research we adopted a lubrication approach using Yoshida® sterilized olive oil. This study examines the efficacy of this method. However, when using the olive oil method, SI AID® dressings were applied to the nipples.

Aim: In this study we aimed to clarify the comparative efficacy of the Olive oil method as used in our facility in the prevention of skin damage during prone spinal surgery.

Subjects: 220 patients (65 males, 155 females) of PLIF, PF or PLF, scoliosis surgery, or posterior-anterior fusion (posterior approach only) from September 2012 to December 2014.

Materials and Methods: In this retrospective cohort study data was collected from surgery records, surgical nursing records, nursing records and skin trouble assessment records in 49 dressing group cases and 171 olive oil group cases. Skin damage was defined as blisters and exfoliation related to contact with the Hall frame, excluding naturally resolving redness. Parameters were operative time, EBS, height, weight, BMI and age. Parameter distribution was charted at the median and quartile deviations after testing for normality. The Mann-Whitney test ($p<0.05$) was used to identify relationships to skin damage. Incidence of skin damage was compared between the two groups using chi-square ($p < 0.05$) with a 95% confidence interval.

Results: The Mann-Whitney test found no significant differences in parameters between groups (All parameters $p > 0.05$). Also the chi-square test found no slightly significant difference in the incidence of skin damage between groups (p=0.056). 95% Confidence Interval = 0.054,0.058, and the odds ratio was 2.84. The incidence of skin damage was 2.84 times higher in the film dressing group. 67% of skin damage cases in the olive oil group were tension blisters in males caused by dressings used to protect the nipples.

Conclusion: While not quite statistically significant, the incidence of skin damage was 2.84 times higher in the film dressing group, suggesting that the lubricating effect of olive oil

reduced the friction stimulus between the skin and the Hall frame. The olive oil may have had other skin protection effects as well. The higher incidence of skin damage around the nipples in males is thought to be attributable to the relative lack of fat in that area compared to females, resulting in increased friction stimulus. Olive oil was effective in skin damage prevention during prone spinal surgery and the use of film dressings appears inappropriate.

P147

MICRODISKECTOMY UNDER LOUPES MAGNIFICATION – A SAFE AND COST EFFECTIVE TREATMENT FOR HEALTH SYSTEMS WITH LIMITED RESOURCES

Odysseas Paxin
251 Hellenic Air Force Hospital 11525, Greece

Introduction. Microdiscectomy is normally done under magnification with a microscope. However a microscope is not always available - especially in financially challenged health care systems. The objective of this study was to investigate the safety and efficacy of microdiscectomy under loupes magnification.

Material and Methods. Case series study of a cohort of 198 patients (127 males, mean age 38 years – range 16-68) surgically treated for sciatica between the years 2003-2013 by the same surgeon. Mean time until surgery was 34 days (range 4-53 days). The operation was performed under general anesthesia in the kneeled position with loupes magnification (x5). Mean surgical time was 35 minutes (range: 20-60 minutes) and the final skin incision was 3 cm with negligible blood loss. Epidural steroid and collagen foam was used in all cases before wound closure with resorbable sutures. 189 patients were operated in one level and 11 in two levels. All patients without dura tear ambulated the evening of surgery but were discharged the next day due to local insurance policies. Patients were clinically evaluated at 10 days and 3 months postoperatively and were again interviewed by phone with an Oswestry Disability Index (ODI) questionnaire at a mean follow-up time of 6 years. Postoperative complications were also noted.

Results. Mean preoperative ODI was 67% and mean VAS score was 8,4. Postoperative mean VAS was 1,5. There were 9 dura tears repaired during surgery without further sequel. 11 patients had a recurrent disk herniation at the same level during the first 2 postoperative years and 5 of those underwent repeat discectomy and 2 one level fusion. The mean reported ODI during the last interview was 8%. All patients reported that they will chose to be operated in the same way and will recommend this procedure to a friend.

Conclusion. Microdiskectomy with loupes is a simple, cost effective and safe operation with clinical results similar to those reported in the literature with the use of surgical microscope and can be recommended as a safe alternative in financial constrained health systems

P148

LUMBO-PELVIC "NEGATIVE MISMATCH" CONTRIBUTES TO CERVICAL KYPHOSIS AFTER LAMINOPLASTY

Yuji Matsuoka, Hidekazu Suzuki, Kenji Endo, Hirosuke Nishimura, Hidetoshi Tanaka, Kengo Yamamoto
Tokyo Medical University Shinjukuku 160-0023 Tokyo, Japan

Introduction: Expansive laminoplasty (ELAP) is an effective procedure for decompressing multilevel spinal cord compression. It often induces postoperative complications such as cervical kyphosis, but there are only a few reports on the relationship between the total spine balance and postoperative cervical kyphosis.

Aim: This study was to analyze the effect of spinal sagittal balance on cervical kyphosis after ELAP in patients with cervical spondylotic myelopathy.

Materials and Methods: The study participants were 26 patients with preoperative C2-7 angle > 0 ° (13 males, 13 females, mean age 66 years) who underwent ELAP and had a follow-up at least one year. We evaluated their pre- and postoperative radiographs, and classified into two groups according to postoperative cervical sagittal alignment (Group K: C2-7 angle ≤ 0, Group NK: C2-7 angle > 0). Sagittal parameters were evaluated using pre- and postoperative values such as C-SVA、T1 slope, TK, LL, PI, PT, SVA, PI-LL and C2-7 angle.

Results: Five patients (19%) were classified into Group K. The mean age of Group K was higher than that of Group NK (74.4 vs 63.8). The measurements of spinal sagittal parameters were as follows: preoperative C2-7 angle (Group K, 15.2, Group NK, 15.5), T1 slope (25.8, 25.7), TK (34, 23.7), LL (53, 38.9), PI (37.8, 46.6), PT (13.2,16.1), SVA (12.4mm, 39.8mm), C-SVA (31.5mm, 23.3mm), postoperative C2-7 angle (Group K, -10.8, Group NK, 12.3), T1 slope (29.8, 22.1), TK (35.2, 21.6), LL (49, 40.7), PT (12.4, 15.4), SVA (4.8mm, 31.3mm) C-SVA (36.8mm , 25.2mm).The patients in Group K had smaller SVA and PI with larger LL and C-SVA preoperatively, then acquired large T1 slope and TK postoperatively

Conclusion: The K group showed large LL but small PI, and large C-SVA but small SVA before operation. In other words, postoperative cervical kyphotic patients had preoperative neck and trunk imbalance due to lumbo-pelvic “negative mismatch”. It suggests that kyphotic force occurs by cervical positive imbalance with lumbo-pelvic “negative mismatch” in addition to postoperative weakness of posterior neck muscle may cause cervical kyphosis after ELAP.

P149

THREE DIMENSIONAL ANATOMICAL STUDY ANALYSIS OF YELLOW LIGAMENTS IN HUMANS CADAVERIC LUMBAR SPINE

Javid Akhgar,Hidetomi Terai

Osaka City University 545-8585Osaka, Japan

Introduction: The ultimate aim of lumbar decompression surgery in a patient with hypertrophied yellow ligament is to release the compression, and prepare enough space for neural elements by removing yellow ligament (YL) simultaneously prevention of iatrogenic instability. However the overall shape of the YL cannot be seen from dorsal side of vertebra, therefore safe penetration and total resection of yellow ligaments required information about the relation of YL borders and dorsal spine bony landmarks.

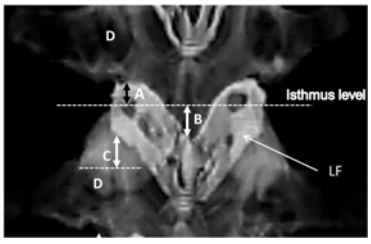
Aim: To describe the relations between attachments of YL and posterior lumbar spine bony landmarks (isthmus, lamina, and articular process) to design a safe and adequate lumbar spinal decompression surgery.

Materials and Methods: Whole spine (C1-coccyges) from 21 human embalmed cadavers was taken out en-bloc. Plain X-Ray and CT-scans of the whole spine were taken, then the spinal column was divided into two pieces by cutting at the base of pedicels with thread saw, neural element removed totally, and manual measurement of the deep layers of YL from L1 to S1 was done. Subsequently the YL was painted with a contrast dye and second X-Ray and CT-Scans were performed. All radiological data was analyzed by using three-dimensional analyzing software (Virtual Place, AZE Japan) to evaluate the relation of YL and posterior spinal bony landmarks.

Result: Cranio-lateral edge (A in Fig.1), of YL attached up to the isthmus level in upper lumbar level, (3.5mm in average), however, it located just at isthmus level or below (0.5mm in average) in lower lumbar level. Midline attachments (B in Fig.1), YL attached below isthmus level in upper lumbar level (4mm in average), however, it located just at isthmus level (1mm in average) in lower lumbar level. Empty zone between pedicle and YL (C in Fig.1) in upper lumbar levels were wider than those in lower levels (3.3mm vs 1.2mm, p=0.001).The distance between medial border of the pedicle and lateral border of YL gradually increased from upper lumbar levels toward lower lumbar levels; mean distance in L1-L2 was 21.3±1.7mm and L5-S1 was 33.1±3.73mm.

Conclusion: We found significantly different relation between dorsal spinal bony landmarks with YL borders in different level. Therefore, based on these findings the amount of bone resection for adequate decompression and starting point for safe bone piercing should be different according to the level of lumbar spine.

Distance between:
A-Isthmus &cranial edge of YL
B-Isthmus & craniomedial edge of YL
C-Caudal edge of YL& adjacent pedicle
D-Pedicle



P150

SURGICAL RESULTS FOR POSTERIOR LUMBAR INTERBODY FUSION WITH ADJACENT SEGMENT DECOMPRESSION

Hidekazu Tobimatsu,Hiroyuki Aono
Ikeda Municipal hospital Osaka JAPAN 5630025, Japan

Introduction There are several studies concerning about adjacent segment degeneration (ASD) after posterior lumbar interbody fusion (PLIF). In such studies, a degenerative change was accelerated at unfused adjacent segments especially in the cranial level by PLIF. In cases when decompression at the adjacent cranial segment is necessary for multiple spinal canal stenoses combined with PLIF, the strategy of surgery was still controversial. We investigated the results of PLIF and decompression for L4 degenerative spondylolisthesis and L3-L4 canal stenosis retrospectively.

Methods This study consists of consecutive 39 patients who underwent L4-5 PLIF with pedicle screw fixation and L3-4 decompression for L4 degenerative spondylolisthesis and L3-4 canal stenosis between 2007 and 2012. 8 patients were excluded who could not be followed for at least 24months. The remaining 31 patients (mean age at surgery was 71 years old) were the subject of this study and the mean follow-up period was 49 months (range 24-85months). Clinical outcomes were assessed using the scoring system proposed by the Japanese Orthopedic Association (JOA). ASD was defined as a radiologic change in which narrowing of disc height was greater than 3mm, posterior opening was greater than 5 degrees, and progress of slippage was greater than 3mm in comparison with preoperative flexion and extension lateral radiographs.

Results Bone union of PLIF was achieved in 30 patients(96.7%) and no one needed additional surgery for pseudarthrosis. The mean preoperative JOA score was 11.1 points, and it improved to 21.8 points. Although 3 were experienced ASD and 2 were experienced neurologic deterioration, in these patients neurological symptoms were not severe, and so no one needed additional surgery for L3/4 segments.

Discussion Although there are several reports about ASD after PLIF, no reports evaluated the relationship between ASD and additional decompression surgery at adjacent cranial segment combined with PLIF. Posterior decompression surgery sacrifices the posterior supporting elements, therefore it has been reported to accelerate a degenerative change in the segments. In this study, additional decompression above the level of PLIF resulted in ASD in 3 patients(9.6%) and symptomatic ASD in 2patients(6.4%).Despite of short follow-up period, this incidence of ASD was compatible with the incidence of ASD after PLIF in the past reports without decompression. Therefore the results of this procedure for L4 degenerative spondylolisthesis and L3-L4 canal stenosis were good enough.

P151

FACTORS INFLUENCING NEUROLOGICAL DEFICIT IN LUMBAR DISC PROLAPSE AND THEIR ROLE IN NEUROLOGICAL RECOVERY FOLLOWING SURGICAL DECOMPRESSION

Rishi Kanna,Vibhu Krishnan,Ajoy Shetty, S Rajasekaran
Ganga hospital, Coimbatore Chinnammal Street Extension Coimbatore, India

Introduction: Neurological deficit is a rare, but serious complication following lumbar disc herniation (LDH). The clinical and radiological factors causative for neurological deficit in LDH is not clear.

Aim: The current study is a prospective, large scale case control study on the role of various clinical and radiological parameters in the development of neurological deficit and post-operative recovery in patients with LDH.

Methods: Patients admitted for microdiscectomy following LDH were divided into two groups based on the presence of neurological deficit. Group 1 included 70 consecutive patients with neurological deficit and Group 2 (controls) included 70 patients with intact neurology. Multiple clinical and radiological parameters were studied between the two groups. All patients were followed up post-operatively for 6 months and assessed for neural recovery and predictive factors for recovery were analysed.

Results: The mean ages of patients were 43.37 years and 39.56 years in the neuro-deficit and non-deficit groups respectively (p 0.067). Patients with diabetes (p 0.004), those with acute onset symptoms (p 0.036), first episode of radiculopathy (p 0.001), L3-4 disc (p 0.001), sequestered discs (p 0.004), superiorly migrated discs (p 0.012), central disc prolapse (p 0.004) and primary canal stenosis (p 0.0001) had a positive correlation with neurological deficit. Patient's age (p 0.067), sex (p 0.999), previous precipitating events (p 0.379), severity of pain (p 0.605), smoking (p 0.309) and antero-posterior canal dimensions (p 0.985) did not have a significant correlation. 5 out of 70 patients were lost to follow-up. 41 out the 65 patients (63%) showed complete neurological recovery by 2 months. Of the remaining 24 patients, 4 patients had late recovery at 6 month follow-up. Patients with diabetes (p 0.025), longer duration since onset of symptoms (p 0.048), bladder involvement (p 0.265), complete neurological deficit (p 0.0001) and multi-level disc prolapse (p 0.006) showed poorer recovery (at the end of 2 months).
Conclusion: The major parameters associated with development of neurological deficit were diabetes, acute onset of symptoms, lesser number of previous episodes, high lumbar discs (L3-4), sequestrated, central and superiorly migrated discs, primary bony canal stenosis, greater canal compromise and larger disc dimensions. Understanding the factors related to development and recovery of neurological deficit in LDH could help in advising early surgery in at-risk patients and also help in prognosticating the chances of neural recovery.

P152

PREOPERATIVE MEASUREMENT OF BMD USING DXA AND QCT COULD BE USEFUL TO PREDICT THE STRENGTH OF PEDICLE SCREW FIXATION.

Koji Ishikawa,Takeshi Eguro,Tomoyuki Toyone, Toshiyuki Shirahata,Yoshifumi Kudo,Katsunori Inagaki, Tomoaki Toyone

1. Department of Orthopaedic Surgery, Showa University School of Medicine, Tokyo, Japan 142-8666, Japan

Introduction: Loosening of pedicle screws is a common complication and the frequency of screw loosening reported in the literature varies between 0.6% and 27%. In previous studies, a positive correlation was observed between the maximum insertion torque of pedicle screwing and bone mineral density (BMD). It has also been reported that 3D-quantitative computed tomography (QCT) could avoid the overestimation of BMD by DXA associated with spinal degeneration, abdominal aortic calcification, and other sclerotic lesions. In this study, we used QCT (Mindways, USA) to obtain more precise information on trabecular BMD.
Objective: The objective of this study was to demonstrate (1) how BMD assessed by DXA and QCT affected the insertional torque of pedicle screws, together with (2) factors contributing to the insertional torque of pedicle screws.
Materials and Methods: A clinical study of 10 patients who underwent pedicle screw fixation (ZODIAC: Alphatec Spine, USA) augmenting PLF was performed. There were 3 men and 7 women, with an average age of 75.4 years (range, 64-84). BMD was measured using DXA and QCT at baseline, and the insertional torque was measured during surgery. Of all, 47 screws (diameter: 7.5-8.5 mm, length: 40-45, inserted from L3 to L5) were eligible for this study and were analysed to identify the factors contributing to the insertional torque. The following factors were investigated; age, gender, screw diameter, screw length, DXA: spine and hip BMD, QCT: spine and hip trabecular BMD, and bone turnover markers.
Results: Insertional torque correlated significantly with age, DXA: spine BMD, and QCT: spine trabecular BMD (Spearman's rank correlation: r=-0.32, P=0.02; r = 0.44, P<0.01; r=0.39, P<0.01, respectively). In single regression analysis, results showed that age (standardized regression coefficient [β] = − 0.33, P = 0.02), screw diameter (β = 0.26, P = 0.08), DXA: spine BMD, (β = 0.45, P < 0.01), and QCT: Spine trabecular BMD (β = 0.38, P < 0.01) served as contributing factors. In addition, the following multiple regression equation was obtained: insertional torque (cN. m) = DXA: Spine BMD (g/cm2) × 177.6- age × 4.8 + screw diameter (mm) × 66.2 - 97.5, (R2 = 0.37, P < 0.001).
Conclusion: Although findings of this study showed that insertional torque was indepen-

dently affected by QCT: spine trabecular BMD, it was more strongly affected by DXA: spine BMD. Spine BMD values measured by DXA included not only trabecular BMD but also osteophytes and articular facet hypertrophy. Therefore, when pedicle screws are to be used, surgeons need to consider the effect of osteophytes and articular facet hypertrophy around the screw entry point. Measurement of BMD using DXA and QCT could be useful in clinical practice to predict screw fixation strength before surgery.

P153

ACCURACY OF PEDICLE SCREW PLACEMENT IN POSTERIOR LUMBOSACRAL INSTRUMENTATION UNDER CT EVALUATION—SAFETY IS NOT SAFE IN L5 AND S1

Fengdong Zhao,Tianming Yu,Chongyan Wang, Zhi Shan,Maiwulanjiang Mamuti,Xuyang Zhang
Department of Orthopaedics, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University Hangzhou, Zhejiang, China 310000, China, People's Republic of

Introduction: Pedicle screw misplacement rates vary substantially with conventional techniques, of which between 21.1% and 39.8% have been reported by postoperative CT assessment. However, breach rates in L5, S1 in conventional operations have not been specifically concerned yet.

Methods: 401 patients were evaluated under CT scan with reconstruction and conventional radiography in 3 hospitals by 2 professional observers after posterior lumbosacral instrumentation including 152 3rd lumbar spines(L3), 219 4th lumbar spines(L4), 270 5th lumbar spines(L5) and 95 1st sacral spines(S1) with screws placed. Patients were followed for potential clinical symptoms.

Aim: In clinical practice, surgeons usually belittle the pedicles of the 5th lumbar (L5) and the 1st sacral spine(S1) in posterior pedicle screw fixation because of their broad cross sections. However, imaginary safety is not really safe. This study aimed to evaluate the accuracy and safety of pedicle screw placement in posterior pedicle instrumentation, especially in L5 and S1.

Materials and Methods: 401 patients were evaluated under CT scan with reconstruction and conventional radiography in 3 hospitals by 2 professional observers after posterior lumbosacral instrumentation including 152 3rd lumbar spines(L3), 219 4th lumbar spines(L4), 270 5th lumbar spines(L5) and 95 1st sacral spines(S1) with screws placed. Patients were followed for potential clinical symptoms.

Results: The breach rates are different in different levels: L3: 91/301(30.2%), L4: 126/436 (29.0%), L5: 132/539(24.5%), S1: 22/191 (11.5%). In the perspective of breach sites, inferomedial breach L3: 43/91(47.3%), L4: 74/126(58.7%), L5: 99/132(75%), S1: 19/22 (86.4%). To evaluate grade III and IV breach at different levels, L3: 8/91(8.8%), L4: 8/126 (6.3%), L5: 19/132(14.4%), S1: 8/22(36.4%). And there were 9 cases of cerebrospinal fluid leakage and 3 cases of neurological deficit.

Conclusion: L3, L4 and L5 have no significant differences in pedicle breach rates, but higher than that in S1. The incidences of high risk pedicle breach(grade III, grade IV) of L5 and S1 are higher, and the breach sites are more common in the inferomedial wall of L5, S1 than that of L3 and L4. Although many surgeons regarded L5, S1 with safety when inserting pedicle screws, they are not safe as expected actually.

P154

IN-HOSPITAL REPEAT SPINE SURGERY FOLLOWING LUMBAR FUSION SURGERY FOR DEGENERATIVE CONDITIONS AND FRACTURES

Ian Engler,Brook Martin,Jon Lurie,Farrokh Farrokhi, James Weinstein
Geisel School of Medicine at Dartmouth 01776 Sudbury, United States

Introduction: Repeat spine surgery following a lumbar fusion operation is a commonly reported measure of quality. Long term repeat surgery tends to reflect disease progression, treatment failure, or choice of intervention, while short term and in-hospital repeat surgery may reflect more controllable technical problems of the initial operation or surgical complications. Previous studies have focused on the rates of repeat spine surgery following a hospital discharge. Trends in repeat lumbar

spine operations occurring during the same admission following an initial lumbar fusion operation (in-hospital repeat spine surgery) have not been reported.
Aim: Our aim was to examine the trends in the rate of in-hospital repeat spine surgery following an initial lumbar fusion between 2004 and 2012. We described these trends for patients undergoing lumbar fusion for either elective degenerative diagnoses or for spinal fracture – two distinct clinical populations that represent the breadth of the spectrum of patient complexity. We identified factors, such as operative features, that were associated with increased rates.
Materials and Methods: Our dataset was the National Inpatient Sample from 2004-2012. Spinal operations occurring on any day subsequent to an initial fusion operation, but during the same hospital admission, were used as a proxy for in-hospital repeat spine surgery. Survey-weighted multivariate logistic regression models were used to identify patient characteristics and operative features associated with in-hospital repeat spine surgery.
Results: Adjusted in-hospital repeat spine surgery rates following lumbar fusion increased significantly from 2004 to 2012 for both degenerative conditions (1.5% to 2.1%; p <0.001) and fracture (7.9% to 11.5%, p <0.001). Combined anterior-posterior surgical approach and multilevel fusion were associated with greater risk for in-hospital repeat spine surgery among the degenerative cohort.
Conclusion: Trends in in-hospital repeat spine surgery have increased among patients undergoing lumbar fusion operations for both degenerative indications and fractures. For patients with degenerative conditions, complex fusion procedures were associated with a greater likelihood of in-hospital repeat spine operations.

P155

CERVICAL ALIGNMENT AFTER SHORTENING VERTEBROPLASTY FOR VERTEBRAL FRACTURES IN THORACO-LUMBAR REGION

Kazuma Murata,Kenji Endo,Hidekazu Suzuki, Hirosuke Nishimura,Yuji Matsuoka,Hidetoshi Tanaka,Kengo Yamamoto

Tokyo Medical University 160-0023, Tokyo, Japan

Introduction: The cervical spine may increase lordosis in compensation for truncal kyphosis due to thoraco-lumbar vertebral fractures in order to maintain horizontal gaze. Therefore, cervical alignment is considered to improve after kyphoplastic surgery for the trunk, such as pedicle subtraction osteotomy. However, cervical and thoracic contours may differ among patient profiles. We hence hypothesized that the post-operative course of the cervical spine in adult spinal deformity patients differs among patients as reflected in the sagittal spinal traits.
Aim: The primary aim of this investigation was to assess the factors related to post-operative cervical malalignment after shortening vertebroplasty for vertebral fractures in thoraco-lumbar region.
Material and Methods: A consecutive series of 50 patients with vertebral fractures in thoraco-lumbar region, who received shortening vertebroplasty was retrospectively investigated by assessing pre-operative and post-operative spino-pelvic parameters in full-spine radiographs.
Results: There was a significant decrease in local kyphosis post-operatively. However, there were also some cohorts (6/50, 30%) that showed increased C2-C7 SVA more than 40 mm. For the strong correlation among C2-C7 SVA and focal correction angle which was represented by the difference between preoperative local kyphosis angle and postoperative local kyphosis angle (r= -0.71), both logistic and linear regression model was made. These analysis revealed that loss of balance of head probably occurred with shortage of correction volume of local kyphosis less than approximately 5□.
Conclusion: Shortening vertebroplasty decreased local kyphosis, but did not affected global balance. Therefore, shortening vertebroplasty may be one of optimal methods for corrective surgery in the case of vertebral fracture without severe global loss of balance. Shortage of correction angle lower than approximately 5□ may increase the risk of post-operative cervical malalignment.

P156

ESTABLISHMENT OF A NOVEL RADIOLUCENT SPINAL FUSION CHAMBER FOR STUDY OF THE LUMBAR INTERBODY SPINAL FUSION

Hu Tao,Zheng Yang,Wing Moon Raymond Lam, Felly Ng,Ramruttun Amit Kumarsing,Xia Fei Ren, Ming Wang,Kim Cheng Tan,Kai Thong Kwok, Stuart Goodman,Cho Hong, James Goh,Hee Kit Wong

National University of Singapore 117510, Singapore, Singapore

Introduction: The majority of lumbar interbody spinal fusion procedures are treated with autologous bone graft. However, limitations associated with autograft has warranted much research to focus on developing tissue engineered graft constructs with the aim of replacing autologous bone graft. In an attempt to set up a standardized platform, an interbody spinal fusion chamber was designed for the rabbit lumbar spine, to create a platform for the study of biological events during lumbar interbody spinal fusion.

Aim: An interbody spinal fusion chamber was designed, to create a platform for the study of the biological events during bone regeneration.

Materials and Methods: Poly-ether-ketone-ketone (PEKK), being radiolucent was used to fabricate the spinal fusion chamber as it permits subsequent micro-computed tomography (μCT). In vitro biomechanical testing was carried to evaluate the stability of the chamber. Subsequently, polyelectrolyte complex (PEC) and absorbable collagen sponge (ACS) - delivered bone morphogenetic protein-2 (BMP-2) were included in the chamber to facilitate bone formation in vivo. Stability of the spinal fusion was analysed by manual palpation, and bone formation in the chamber was assessed by histological analysis and quantitative microCT.

Results: The mechanical stability of the inserted chamber in a defected functional spinal unit (FSU) was established, in comparison to that of the intact FSU and FSU with surgical created disc defect. Histological examination and quantitative microCT analysis showed extensive bone formation achieving complete spinal fusion in PEC delivered 100 μg rhBMP-2, but no bony fusion, within the chamber in ACS delivered 100 μg rhBMP-2.

Conclusion: Mechanical evaluation of the operated spine and analysis of bone formation within the bone chamber indicate that PEC-slow release of growth factor is a superior delivery system than ACS. The spinal fusion chamber provides a platform to study and evaluate the biological events during bone regeneration.

P157

CLINICAL RESULTS ANALYSIS OF L4 ~ 5 STENOSIS WITH FIRST GRADE DEGENERATIVE SPONDYLOLISTHESIS WITH COFLEX

Meng Xianglong,Hai Yong

Chaoyang Hospital 100020, China, People's Republic of

Introduction: Lumbar decompression and fusion surgery has been the standard treatment of lumbar degenerative spondylolisthesis since Herkowitz reported that decompression and pedicle screw fixation is obviously better than decompression alone in degenerative lumbar spondylolisthesis in 1994. But lumbar spinal fusion often bring great surgical injury, more blood loss, and high possibility of pseudarthrosis, which can easily cause the degeneration of adjacent segments. In order to reduce the problems by the lumbar fusion, some interspinous dynamic devices, like Coflex, have been used to treat degenerative lumbar spinal stenosis combined with lumbar instability. But it is still controversial if the long-term surgical results could be maintained by application of Coflex in the treatment of lumbar spinal stenosis with lumbar instability.

Aim: To study surgical results of lumbar interspinous Coflex fixation for the treatment of L4 ~ 5 segment stenosis with first grade degenerative spondylolisthesis.

Materials and Methods: From Jan, 2007 to Mar, 2011, 17 patients of L4~ 5 degenerative spondylolisthesis treated with interlamina fenestration decompression and Coflex internal fixation in our hospital were reviewed. Patients were followed up for 36 ~ 64 months, anterior-posterior x-ray, the flexion and extension dynamic radiograph were taken. Intervertebral angle surgery and sagittal displacement were measured at L4 ~ 5, L3 ~ 4 and L5S1 on the x-ray. ODI and VAS were used to evaluate the surgical results.

Results: The average operation time was 93.4min, and average bleeding loss 127mL. Preoperative VAS, ODI scores are statistically significant different with postoperative results (P<0.05). Preoperative intervertebral angle has statistically significant difference with 1 year follow-up results at L4 ~ 5 segment (P<0.05), but no statistical difference between 1 year follow-up and final follow-up. Preoperative intervertebral angle at L3 ~ 4, L5S1 are not statistical different after surgery. The pre-operative slip distance were also measured and compared with postoperative measurement at L4 ~ 5, L5S1 and L3 ~ 4 level. No statistical differences were observed.

Conclusion: Coflex fixation for the treatment of L4 ~ 5 segment stenosis with first grade degenerative spondylolisthesis, has the characteristics of good efficacy, less surgical injury and less complications. No slippage progression at index level, and no obvious degeneration at the adjacent segments were observed at 3-5 years follow-up.

P158

THE OUTCOME OF THE CORRECTIVE LONG FUSION SURGERY FOR SAGITTAL IMBALANCE DUE TO MULTIPLE VERTEBRAL-BODY FRACTURES IN SEVERE OSTEOPOROSIS PATIENTS: A MINIMUM ONE-YEAR FOLLOWUP STUDY

Kotaro Nishida,Toru Takada,Kenichiro Kakutani, Koichiro Maeno,Takashi Yurube,Shingo Miyazaki, Yoshiki Terashima,Masaaki Itoh,Yuji Kakiuchi,Tetsuhiro Iguchi,Masahiro Kurosaka

Dept. of Orthop. Surg., Kobe Univ. Graduate School of Med 650-0017, Kobe, Japan

INTRODUCTION: Multiple vertebral-body fractures due to severe osteoporosis often cause for severe back pain and furthermore, could be a cause for paralysis of lower extremities or sagittal imbalance due to kyphotic deformity. The surgical treatments for this condition is extremely difficult mainly because of very poor bone quality and there are few reports regarding this condition.

AIM: The aim of this study was to evaluate clinical outcome of long spinal fusion for this condition, in which we used S2-alar iliac screw (S2AIS) for distal-end anchor.

Patients and Methods: 16 patients suffering from multiple vertebral fractures below Th11 due to severe osteoporosis, who underwent long spinal fusion with S2AIS, and minimum followup period over one year were enrolled. There are 3 males and 13 females and most of them could not stand because of severe back pain or paralysis of lower extremity. The average age was 76.3 years old (64~87) and follow-up periods were 20.3±5.8 month. For these patients, post-operative clinical outcome were evaluated.

RESULTS: The average blood loss during surgery was 950.3±558.9g and surgery time 406.9±70.6min. The anchor for distal-end of spinal fusion was S2AIS in all cases, in which 6 cases underwent spinal fusion to upper-thoracic spine and 10 cases middle to lower thoracic spine. For all cases, multilevel TLIF and Ponte osteotomy were applied to correct kyphotic deformity and hybrid fixation of sub-laminar polyester bands and pedicle screws were applied to proximal end of fixation. Teriparatide was administered to all patients after surgery. All S2AISs were appropriately inserted, and no clinical problem was identified. One infection and 6 proximal junctional failure cases (37.5%) were reported and salvage surgeries were required for 4 cases. The lumbar lordosis and thoracic kyphosis were difficult to estimate due to deformity of the vertebral bodies. The average sagittal vertical axis (SVA), pelvic incidence, and pelvic tilt at one year after surgery were 64.5±38.9mm, 52.6±11.5° and 25.6±10.6°, respectively. All patients obtained ability to stand or walk except for 1 case.

CONCLUSION:We obtained acceptable clinical results for this difficult condition. Our results indicated S2AIS could be a reliable distal anchor for corrective spinal long fusion even in severe osteoporosis patients. The combination of multilevel TLIF and Ponte osteotomy seems to be an appropriate method to correct sagittal imbalance due to osteoporotic multiple vertebral-body fractures. The proximal junctional failure and major surgical invasion for the patients still remain an unsolved problem.

P159

OVER THREE-YEAR POSTOPERATIVE OUTCOMES OF PROSPECTIVE CONTROLLED STUDY FOR DEGENERATIVE LUMBAR SPONDYLOLISTHESIS -COMPARISON BETWEEN THE DECOMPRESSION WITHOUT FUSION AND THE DECOMPRESSION WITH POSTEROLATERAL FUSION-

Akihiro Koh,Syuichi Kaneyama,Masatoshi Sumi
Kobe Rosai Hospital Kobe, 651-0053, Japan

Introduction: Although surgical treatment is known as effective for lumbar spinal stenosis (LSS) with degenerative lumbar spondylolisthesis (DLS), it still remains controversial whether the fusion is necessary for mild spondylolisthesis.

Aim: To compare clinical and radiologic outcomes of the treatment for LSS with Grade I Meyerding DLS between the decompression without fusion and the decompression with the posterolateral fusion after a minimum 3-year follow-up.

Materials and Methods: Between January 2005 and December 2007, the all patients < 76-year-old with neurogenic claudication that had not improved after conservative treatment as well as confirmatory imaging showing DLS with LSS were enrolled in the prospective controlled study. The patients are treated alternately with standard decompressive laminectomy (Group A) or fenestration with posterolateral fusion (Group B). The patients who have degenerative scoliosis with more than 20° of cobb angle, over grade II Meyerding spondylolisthesis, more than two levels of DLS, more than 5° of segmental posterior angulation on flexion view and more than 5mm of dynamic sagittal translation were excluded. The operation time and intraoperative blood loss were recorded. Clinical outcomes were assessed using Japanese Orthopaedic Association (JOA) score and visual analogue scale (VAS) of back pain. Radiological outcomes were analyzed by determining changes in slippage in Group A. The disc height in neutral view and the angular motion on dynamic views at the adjacent segment to proximal and distal end of decompression or fusion were also evaluated in the two groups respectively.

Results: A total of 23 patients (Group A: 12 patients ; mean age, 67.6 years, Group B: 11 patients ; mean age, 66 years) were accessed in September 2015. The average follow-up period was 54.5 months and 54.9 months respectively. The spondylolisthesis levels in Group A were located at L3-4 (2 patients); L4-5 (9); and L5-S1 (1), whereas all levels in Group B were located at L4-5. There was no significant difference in the preoperative clinical and radiological assessment. The patients in Group A had significantly shorter surgical time and less blood loss ($P < 0.05$). JOA and VAS scores were improved significantly in both groups at the one-year and last follow-up compared with the preoperative assessment ($P < 0.05$), but no difference was shown between the groups. The recovery rates of JOA score were 59.7% in Group A and 54.6% in Group B at the last follow-up. The slippage was significantly increased at the final follow-up compared with the preoperative assessment in Group A ($P < 0.05$). In Group B, the disc height at the adjacent segment to distal end of fusion was significantly decreased at the last follow-up compared with one-year follow-up ($P < 0.05$).

Conclusion: The two groups showed similar clinical outcomes overall, although the decompression without fusion was shown to be less invasive.

P160

CORRELATION BETWEEN POSTOPERATIVE VALUE OF PELVIC INCIDENCE MINUS LUMBAR LORDOSIS AND CLINICAL OUTCOMES AFTER ADULT SPINAL DEFORMITY SURGERY IN JAPANESE PATIENTS

Masayuki Ohashi,Toru Hirano,Kei Watanabe, Hirokazu Shoji,Naoto Endo
Department of Orthopedic Surgery, Niigata University School of Medical and Dental Sciences Chuo-ku Niigata City, 951-8510, Japan

Introduction: In SRS-Schwab Adult Spinal Deformity (ASD) classification, Schwab proposed threshold values of sagittal spinopelvic alignment [pelvic incidence minus lumbar lordosis (PI-LL) < 10°, sagittal vertical axis (SVA) < 4 cm, and pelvic tilt (PT) < 20°] to obtain satisfactory health-related quality of life (HRQOL) outcomes. Because the parameter that we can directly control during surgery is lumbar lordosis, PI-LL < 10° is the most useful parameter for surgical planning. However, these threshold values are

based on the data from ASD patients in Western countries, and thus it is not clear whether this criteria is applicable for Japanese patients.
Aim: To evaluate the influences of postoperative PI-LL value on clinical outcomes after ASD surgery in Japanese patients.
Materials and Methods: This study included 54 patients (44 women, mean age: 65.5 years, mean follow-up: 3.4 years) with minimum 4 segments fused (mean: 8 segments) including sacrum. Patients were divided into 4 groups based on the immediate postoperative values of PI-LL: group A, 12 patients with PI-LL < 10°; group B, 12 patients with 10°-20°; group C, 13 patients with 21°-30°; and group D, 17 patients with > 30°.
Results: In patients' demographics, surgical procedures, rate of revision surgery, follow-up period, and baseline values of sagittal parameters and HRQOL scores, there were no significant differences among the 4 groups, except for PT (group A: 31.1°, B: 28.9°, C: 35.9°, D: 39.1°, p = 0.03). There were no significant differences between pre- and postoperative SVA in groups A (preop/final: 8.2 cm/4.8 cm), B (8.2/6.9), and C (11.6/11.9). On the other hand, patients in group D demonstrated a significant deterioration at the final follow-up (11.1/14.1, p = 0.04). Pelvic tilt was significantly decreased after surgery in all groups except for group D (group A: 31°/24°, B: 29°/24°, C: 36°/30°, D: 39°/38°). Visual analogue scale for lower back pain significantly decreased only in group A (6.5 cm/3.3cm, p = 0.02). With regard to SRS-22 scores, all domains significantly improved at the final follow-up in group A. On the other hand, the scores for self-image and function significantly improved in group B, those for pain and self-image significantly improved in group C, and all domains failed to improve in group D.
Conclusion: The postoperative value of PI-LL within 10° may become one of the goals to achieve during surgery for ASD also in Japanese patients. Although postoperative PI-LL should be corrected to at least less than 30°, further study on the tolerance of PI-LL from 10° to 30° is needed.

P161

NOVEL ALIF CAGE WITH SELF-ADAPTING LORDOSIS PERFORMS WELL IN INITIAL CLINICAL USAGE

Jean Etienne Castelain,Julien Rigal,Arnaud Cogniet,Stephane Aunoble, JEAN CHARLES LE HUEC
University Bordeaux 33076 Bordeaux, France

Introduction: Spinal balance is a "buzzword" within spinal surgery. A loss of balance, through a loss of lumbar lordosis, has been associated with back pain (Jackson, 1994) as well as relatively poorer outcomes of fusion surgery (e.g. Videbæk, 2011). Similarly, it is accepted that approximately 40% of the total lumbar lordosis is found at the L5/S1 level and that its lordotic angle varies continuously from 12 to 36˚ (Jackson, 2000). Despite this normal variation, most ALIF cages are available in only two or three lordotic options. To cope with the individual physical and anatomic variations, a cage for the L5/S1 level providing a self-adapting lordodic angle seems like an attractive concept.
Aim: To prospectively evaluate the clinical performance associated with a novel self-adaptable ALIF cage, the Statur-L (FBC Device). The two-piece articulating cage adapts naturally in situ, permitting from 7-21˚ of lordosis. This is done without change of components, external adjustment of components or insertion of additional components. Following adaptation, the segment is fixed with an anterior lumbar plate, in the normal fashion.
Material and Methods: The first 18 ALIF patients with Statur-L are presented at one-year radiological and clinical follow-up. Mean age was 43 years. There were 11 women and 7 men, and 8 patients had previous disc surgery. All Statur-L surgeries occurred at L5/S1. After insertion of the ALIF, an anterior anatomic lumbar plate (Pyramid, Medtronic) was used to fix the segment. Standard radiographic imaging in standing position, MRI and functional follow-up was performed preoperatively and at regular intervals through one year (fusion, subsidence, implant failure, L5/S1 lordosis (SL), VAS back and leg, ODI, SF36). CT scan were performed to confirm the bone bridging.
Results: All 18 cases were classified as fused at one-year follow-up and no measurable subsi-

dence could be identified. There were no implant failures or reoperations. The pre-operative mean SL was 5.8˚ (SD 3.0, range 1-10) and at one year follow-up 14.9˚ (SD 2.8, range 10-20) ($p<0.000$). The pre-operative mean L5/S1 disc height was 5.0 (SD 1.3, range 3-8) and at one year follow-up 10.5 (SD 2.3, range 7-15) ($p<0.000$). The VAS back pain improved from median 6.0 to 2.0 ($p<0.000$) and VAS leg pain from median 4.7 to 0.2 ($p<0.001$). The ODI score improved from median 46 to 13 ($p<0.001$). The SF36 PCS improved from median 32.4 to 44.5 ($p<0.000$) and MCS improved 38.9 to 51.7 ($p<0.004$).

Conclusion: No complications during or post-surgery and no re-operations were identified. The average lordotic correction was 9 degrees and mean L5/S1 SL at one year was 15 degrees. All cases fused, and no measurable subsidence or implant failure was identified. The patients improved significantly in pain, functional outcome and life quality. At one year follow-up, the Statur-L performed well. This adjustable cage allowed to adapt the L5/S1 lordosis to each patient anatomy and balance parameters.

P162

NERVE RECONSTRUCTION WITH ORIENTED COLLAGEN TUBES COMBINED WITH BASIC FIBROBLAST GROWTH FACTOR.

Hisako Fujimaki,Gen Inoue,Kentaro Uchida, Masayuki Miyagi,Wataru Saito,Masashi Takaso
Dept. of Orthopaedic Surgery, Kitasato University School of Medicine 252-0375, Japan

Introduction Traumatic and iatrogenic nerve damage sometimes develops to a chronic neuropathic pain, which often severely debilitate patients psychologically, physically, and economically. In order to exploit the ability of peripheral nerve regeneration, several types of artificial substitutes have been developed. Although, these materials are sometimes insufficient for bridging long nerve defects, and ideal substitutes is still expected in the clinical situation.

Aim In this study, we developed a new material, oriented collagen tubes (OCT), and evaluated the treatment efficacy of OCT combined with basic fibroblast growth factor (bFGF) for the repair of 15-mm sciatic nerve defect in rats.

Materials and Methods OCT, which consists of longitudinally oriented type 1 collagen fibers, was prepared and immersed in 10ug/ml bFGF solution for 30 min. OCT with adsorbed bFGF (OCT/bFGF group), OCT with PBS (OCT/PBS group), or Defect only (Defect group) was used to bridge 15-mm left sciatic nerve defect in Sprague Dawley rats (n=8, each group). Functional evaluation was performed using the CatWalk system. Histological and electrophysiological analysis of the defect site was also performed. Results In rats treated with either OCT/bFGF or OCT/PBS, the walking function parameter of paw print area returned to normal levels 4 weeks after graft and the regeneration of myelinated fibers was detected after 8 weeks. However, more regenerated myelinated fibers were observed in the OCT/bFGF group compared with the OCT/PBS group at 4 weeks. In addition, the paw print area, and swing speed in the OCT/bFGF group were significantly recovered compared to the OCT/PBS and PBS groups at 8 weeks ($p<0.05$).

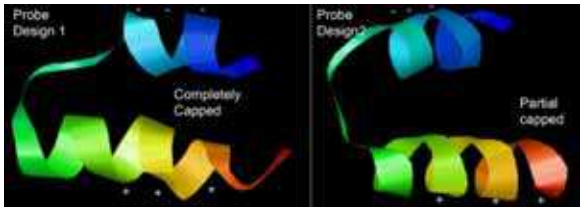
Conclusion The treatment of a 15mm sciatic nerve rat defect with OCT accelerated the formation of myelinated fibers and significantly improved walking function, even though previous paper showed that the graft of collagen tubes alone did not result in functional recovery. As cell orientation structure was previously reported to affect Schwann cell survival and directionality, OCT might accelerate nerve repair by promoting Schwann cell proliferation. In addition, the combination of bFGF and OCT was superior to OCT alone for nerve regeneration and functional recovery. bFGF might accelerate nerve regeneration, regulating Schwann cell proliferation and axonal regrowth, when administered in OCT. In conclusion, OCT and the OCT with adsorbed bFGF promoted nerve repair in a large nerve defect in rats. It might be one of applicable materials for the treatment of large peripheral nerve defects in the clinical setting.

P163

MATRIX METALLOPROTEINASE-12 (MMP-12) EXPRESSION IN AN NEUROPATHIC PAIN RODENT MODEL, FROM ACTIVITY TO PROBE PROTOTYPE DEVELOPMENT

Wing Moon Raymond Lam,Tao Hu,Shi Hui Priscilla Goh,Sanjay Khanna,Thiam Huat Andy Lee, Kishore Bhakoo,Yulin Lam,Ming Wah Richard Wong,Nurul Dinah Binte Kadir,Roger Chun Man Ho,Hee Kit Wong
National University of Singapore 117510, Singapore, Singapore

Introduction: Matrix Metalloproteinase (MMP-12) plays an important role in activating pro-inflammatory cytokine and facilitating macrophage infiltration in compressed nerve root. In our previous study, MMP-12 is upregulated on compressed nerve. We hypothesize that neuropathic pain associates with higher expression of MMP-12 may increase uptake of activatable cell penetrating peptide coupled iron oxide nanoparticle. This study aims to quantify MMP-12 level in neuropathic pain using the spinal nerve ligation (SNL) rodent model and develop a pain probe prototype for in vivo study.
Methods: Sixteen 8- week-old male Sprague Dawley rats were divided into two groups: spinal nerve ligation(SNL) and sham. In SNL group, left side lumbar level 5 spinal nerve was ligated by 3-0 suture while sham group spinal nerve was exposed. Pain behavior of rats were evaluated by thermal withdrawal latency and mechanical withdrawal threshold test. Rats were euthanized at 2 weeks. Active MMP-12 in rat DRG and spinal nerve was measured by Anaspec MMP-12 activity assay. MMP-12 activatable peptide probe was developed by combination of capping sequence, MMP-12 selective peptide sequence and cell penetrating sequence. Several design was screened by Amber modelling. Design 1:Succyl-eeeeeeeee-PLGLEEAgrkkrrqrrr-c and Design 2:Succyl-eeeeeeeee-RPKPVE-Nva-WR-rrrrrrrr-c were fabricated by solid state method and coupled on iron oxide nanoparticle surface. Surface charge and size were determined by zetasizer. Cytotoxicity was evaluated by MTT assay. Uptake selectivity of probes were evaluated by measuring difference of Prussian Blue labelled U87 glioma cell treated with Tenascin C (positive) against MMP-12 inhibitor(negative). Results: Ligated side of SNL rat showed lower withdrawal threshold and latency. MMP-12 activity of ligated side DRG(261.3±98.9ng, p=0.037) was higher than contralateral (88.6±57.2ng) and sham(127.7±14.7ng). Amber model shows positive charge part completely capped in design 1 and partially capped in design 2. Design 1 has lower zetapotential(2.41±4.21mV) than design 2(6.36±8.74mV). From MTT Assay, probes were not toxic at 20µg/ml. Design 2 probe showed higher uptake selectivity than design 1.
Discussion: Higher MMP-12 activity in ligated side DRG vs sham suggested that MMP-12 may be a potential target for probe detection. Suitable binding strength between capping sequence and cell penetrating peptide was essential, complete capped design 1 fail to release the cell penetrating sequence affecting uptake, while partially capped design 2 showed probe uptake enhancement. Zetapotential result matched with the uptake pattern.
Conclusion: This study demonstrated the potential of targeting MMP-12 to localize potential pain generating nerve. Probe design 2 showed uptake enhancement in glioma model, we will perform further study on rodent model.



P164

MAGNETIC RESONANCE IMAGE FINDINGS IN THE EARLY POST-OPERATIVE PERIOD AFTER MICROSCOPIC BILATERAL DECOMPRESSION VIA A UNILATERAL APPROACH

Ryosuke Iio,Teruo Kita,Kazushi Takayama,Hideki Sakanaka,Yoshiki Yamano,Hiroaki Nakamura
Seikeikai Hospital 590-0064, Osaka, Japan

Introduction: Computed tomography or magnetic resonance imaging (MRI) is frequently performed in the early postoperative period when a symptom is persistent or deteriorates after microscopic bilateral decompression via a unilateral approach. Especially MRI is useful for

the detection of spinal canal lesions such as insufficient decompression and epidural hematoma. MR images in the normal early postoperative phase can also show subclinical disc bulge and hematoma. However, the scope of acceptable postoperative changes in MRI findings in symptomatic patients has not yet been determined. We evaluated the characteristic findings from MRI obtained within 1 week after microscopic bilateral decompression via a unilateral approach.

Materials and methods: This study was conducted with 20 patients who underwent single-level microscopic bilateral decompression via a unilateral approach after January 2012. Lumbar MRI were obtained 5 to 7 days and 3 months or later after surgery. Of the patients, 10 were male and 10 were female. The mean age at the time of surgery was 71.6 years (range, 48-90 years). The mean postoperative follow-up duration was 8 months (range, 3-30 months). The Japan Orthopedic Association (JOA) score was evaluated before surgery, at 1 week after surgery, and at the latest follow-up. The dural sac area was measured on the T2-weighted axial MR images by using image measurement software (Image J).

Results: The mean JOA score of the subjects increased markedly from 13.3 before operation to 20.1 at 1 week after operation and to 24.4 at the latest follow-up. The mean dural sac area increased from 256% (114%–550%) at 1 week after surgery to 308% (146%–664%) at the latest follow-up.

Conclusion: On the MR images obtained at 1 week after surgery, no significant difference was observed in the improvement of the mean JOA score in the presence or absence of dural sac compression by epidural hematoma.

P165

OBLIQUE LATERAL INTERBODY FUSION VERSUS EXTREME LATERAL INTERBODY FUSION: COMPARATIVE STUDY OF DIFFERENCES IN CLINICAL/RADIOLOGIC OUTCOMES AND COMPLICATIONS

Masatoshi Hoshino,Hidetomi Terai,Hiromitsu Toyoda, Akinobu Suzuki,Shinji Takahashi, Kazunori Hayashi,Koji Tamai,Shoichiro Ohyama, Hiroaki Nakamura

Dept. of Orthopedic Surgery, Osaka City University Graduate School of Medicine 545-8585 Osaka, Japan

Introduction: Lateral lumbar interbody fusion (LLIF) is becoming popular because of its low levels of invasiveness. Oblique lateral interbody fusion (OLIF) and extreme lumbar interbody fusion (XLIF) are representative LLIF methods.

Aim: To undertake direct comparison of OLIF and XLIF in terms of clinical/radiologic outcomes and complications from a single institution.

Materials and Methods: Eleven and fourteen consecutive patients presenting within two-level degenerative conditions underwent OLIF and XLIF combined with percutaneous fixation of pedicle screws and without posterior decompression, respectively. Clinical outcomes were compared according to recovery of the Japanese Orthopaedic Association (JOA) score, operation time, blood loss per fused interbody, and blood-test data (creatine kinase, C-reactive protein, white blood cell count, red blood cell count, hemoglobin) preoperatively and on postoperative days 1, 4, and 7. Radiologic outcomes were compared in terms of changes in disk height (DH), disk angle (DA) and canal diameter (CD), as well as cage position. Transient and persistent postoperative complications were noted.

Results: Postoperative improvement in leg pain and pain in the lower back was obtained in all cases. The only intraoperative complication was peritoneal damage in one patient in the OLIF group. Postoperatively, anterior thigh pain was observed in three cases in the OLIF group (30%) and in nine cases in the XLIF group (64%) (P=0.09). Cage position was more anterior in the OLIF group (P=0.09). None of the other clinical or radiologic outcomes (postoperative transient weakness in muscles and sensory disturbance; persistent complications; operation time; blood loss; blood-test data, recovery of the JOA score; DH, DA and CD) were significant.

Conclusion: Clinical and radiologic outcomes demonstrated no significant differences between the two groups except transient pain in the anterior thigh and cage position. We obtained satisfactory results using OLIF and XLIF for degenerative lumbar disease. To verify

differences between these two types of LLIF, longer-term follow-up with larger patient cohorts is needed.

P166

THREE-COLUMN SPINAL OSTEOTOMY WITH SAGITTAL PLANE CORRECTION USING SUK VERTEBRAL DEROTATOR

Masahiro Kanayama,Akira Iwata,Fumihiro Oha, Yukitoshi Shimamura,Kei Kuroki,Yuichiro Hisada, Kahoru Tashiro,Tomoyuki Hashimoto
Spine Center, Hakodate Central General Hospital Hakodate, Japan

Introduction: SUK vertebral derotator was developed for vertebral derotation maneuver in scoliosis surgery. We applied this device for sagittal-plane correction in adult spinal deformity. The surgical procedure included (1) preparing proximal and distal multisegmental foundations for correction, (2) decancellating only posterior two-thirds of vertebral column, (3) providing supplemental interbody fusion above and below the osteotomy site, (4) closing the osteotomy by gradual approximation of SUK tubes secured to the proximal- and distal-endmost screw heads, and (5) connecting rods between the proximal and distal screw-rod constructs.

Aim: This study aims to report radiographic and clinical outcomes of this osteotomy/correction procedure.

Materials and Methods: We reviewed 17 consecutive patients who had undergone the aforementioned vertebral osteotomy procedure for sagittal imbalance. They were one male and 16 females with a mean age of 71 years. The osteotomy procedures were pedicle subtraction osteotomy (PSO) in 15 and vertebral column resection in two patients. Length of instrumentation was averaged to 5.5 motion segments; no patients underwent fixation to the sacrum and/or pelvis. Radiographic parameters included anterior deviation of sagittal vertical axis (SVA) and kyphosis correction. Clinical outcomes were evaluated by visual analog scale (VAS) of back pain and Roland-Morris Disability Questionnaire (RDQ). Mean follow-up period was 25.4 months.

Results: Kyphosis angle improved from +22 degrees to -23 degrees; mean correction was 45 degrees. Anterior deviation of SVA was 15.7 cm before surgery, 5.4 cm after surgery, and 10.4 cm at the final follow-up. Thoracic kyphosis (T5-12) changed from 12 degrees to 23 degrees. VAS of back pain improves from 72/100 to 30/100. RDQ were 16.8 before surgery, and improved to 8.6 at the final follow-up. Proximal junctional kyphosis/vertebral fractures occurred in two patients (12%). Fixation failure at distal foundation developed in three patients (18%); they all had severe osteoporosis.

Conclusion: Application of SUK vertebral derotator can provide and control sagittal correction force as intended. Also, multisegmental vertebral anchors can avoid stress concentration to a specific screw-bone interface, and provide secure foundations for correction. Even though the vertebral osteotomy is partial, the current procedure ensures successful sagittal-plane correction in adult kyphotic deformity or sagittal imbalance.

P167

IS SURGICAL SITE INFECTION FOLLOWING SPINAL SURGERY AFFECTED BY INFECTION-RELATED RISK FACTORS AND THE DURATION AND GENERATION OF PROPHYLACTIC ANTIBIOTICS REGIMEN?

Chang-Hoon Jeon,Nam-Su Chung,Han-Dong Lee
Department of orthopaedic surgery, Ajou university school of medicine Yeongtong-gu 443-380 Suwon, Korea, South

Introduction Preoperative prophylactic antibiotics are suggested to decrease infection rates in patients undergoing spine surgery. A recent prevalence study found that postoperative surgical site infection (SSI) was the most common healthcare-associated infection. The superiority of generation and the duration of prophylactic antibiotics for spinal surgery has not been clearly demonstrated.

Methods Six groups of patients who had undergone a thoracolumbar/lumbar surgery for degenerative or traumatic disease were included. Each group was composed of fifty consecutive patients depend on the regimen and duration of prophylactic antibiotics: 1st generation cephalosporins (1CP) for 1 day (group 1-1), 1CP for 3 days (group 1-3), 1CP for 5 days (group 1-5), 2nd generation cephalo-

sporins (2CP) for 1 day (group 2-1), 2CP for 3 days (group 2-3), and 2CP for 3 days (group 2-5). The occurrences of SSI were evaluated as either incisional or organ/space SSI. Serial changes of hematologic inflammatory markers (WBC, ESR, CRP) and disseminated intravascular coagulation (DIC) markers (fibrinogen, FDP, D-dimer) were compared until postoperative 2 weeks. Risk factors such as age, sex, body mass index, estimated blood loss, diabetes mellitus, smoking, nutritional status, baseline laboratory values, catheter indwelling, duration of drain, and type of surgery were analyzed.

Results The study groups were not significantly different regarding the demographic data and risk factors and the type of surgery, bacterial culture, hematologic inflammatory markers and DIC profiles. The occurrence rate of organ/space SSI was 2% in group 1-1, 1-5, 2-1, 2-3 and 4% in group 1-3 and 2-5. There was no difference in the occurrence of incisional and organ/space SSI among the 6 groups (all $P > 0.05$) until 1-year follow-up. Hematological analysis results revealed that postoperative changes of hematologic inflammatory markers and DIC markers were not influenced by prophylaxis antibiotics regimen and duration (all $P > 0.05$). Risk factors did not significantly influence the occurrence of SSI.

Discussion One-day 1st generation cephalosporin prevents the occurrence of SSI. The host immune responses and postoperative hematologic investigation were not influenced by postoperative antibiotics regimen and duration. The incidence of SSI is not affected by the complexity of the spine surgery. Risk factors were not influenced on postoperative SSI with shot-term 1st generation cephalosporins.

P168

OCCULT TETHERED CORD SYNDROME CAN CAUSE A LOW BACK PAIN.

Kazuyoshi Nakanishi,Nobuhiro Tanaka,Naosuke Kamei,Norihiko Sumiyoshi,Takanori Rikita,Shinji Kotaka,Mitsuo Ochi

Hiroshima University 734-8551, Hiroshima, Japan

Objectives: The pathophysiology of occult tethered cord syndrome (OTCS) with no anatomical evidence of a caudally shifted conus and a normal filum terminale is controversial. Urinary dysfunction is one of the predominant symptoms. However, the patients with OTCS frequently complain other symptoms. The aim of this study is to investigate the improvements of the symptoms after surgical release of the filum terminale.

Methods: Twenty one patients with OTCS (11 women and 10 men) were included in this study. The mean age of the patients was 14.1 ± 2.7 years (mean ± SD, range 10–18 years). Patients with complaints of incontinence, urgency, and/or frequency of urination beyond 5 years of age were included. In all patients, T2 weighted axial MRI findings with the subjects in a prone position were examined (Nakanishi K et al., J Neurosurg Spine 2013). Patients underwent sectioning of the filum terminale using a surgical microscope. The low-back pain Japanese Orthopaedic Association (JOA) score was obtained before surgery and at the final follow-up period.

Results: Patients had spinal stiffness (n=20, 95%), low back pain (n=18, 86%), leg sensory disturbance (n=9, 43%), and/or leg weakness (n=5, 24%). On prone position axial MRI findings, the filum terminale was separated from the cauda equina, and was shifted caudally to dorsal in the subarachnoid space in all of the OTCS patients. The locations of the caudal cauda equina shifted to ventral in the subarachnoid space. After surgery, improvements in urinary dysfunction were observed in all patients. Spinal stiffness improved in 18 patients (90%), low back pain improved in 16 patients (89%), sensory disturbance improved in 8 patients (89%), and muscle weakness improved in 1 patients (20%). The JOA score was 21.3 ± 3.2 (mean ± SD) before surgery and it significantly improved to 25.8 ± 3.0 after surgery.

Conclusions: The prone position MRI findings suggests a loss of elasticity in the filum terminale in all cases. Therefore, our results suggest that the tight filum terminale can cause spinal stiffness and low back pain, which may improved after a release of the filum terminale.

P169

NEW GROWING RODS INSTRUMENTATION FOR EARLY-ONSET SPINAL DEFORMITIES AT 3-YEAR FOLLOW-UP: A PRELIMINARY REPORT

Wang WJ, Yan YG, Wang C, Ouyang ZH

Spinal Dept. 1st Affiliated Hostpicat Of South China University 421001 Hengyang, China, People's Republic Of

Background: The growing rod (GR) technique is a viable alternative for current non-fusion operations of early-onset scoliosis. Conventional GR rods are lengthened to allow for spinal growth to occur, but rod lengthening requires multiple invasive operations performed under general anesthesia. Such operations are highly costly and associated with negative psychosocial outcomes. Growing rods with a sliding pedicle screw system (GRSPSS), a newly invented instrumentation, has been developed to treat spinal deformities without the need for repeated operative lengthening.

PURSPOSE: A retrospective review of patients treated by the GRSPSS for early-onset spinal deformity was performed at a >3-year follow-up to describe clinical outcomes caused by this instrumentation.

Methods: We implanted the GRSPSS in thirty-three early-onset scoliosis patients, eighteen of whom had reached a 3-year follow up at the time of the study. We used standard, clinical radiographic methods to measure the magnitude of spinal curvature and spinal length.

Results: Our sample comprised eighteen patients (10 girls, 8 boys) with a mean age of 8 years old. The mean preoperative curve, 66.8 degrees, was corrected to 28 degrees at 4 weeks follow-up. This magnitude of correction was maintained at the 3-year follow-up. T1–S1 spinal height gained an average of 35mm from postoperative measurements to those taken at 3-years follow-up. Complications in the sample population included transient neurological deficit (n=1) and mild, recoverable skin infection at one end of the rods (n=3) during the early-postoperative period. Two patients required minimally invasive revision surgery because of shoulder imbalance. There were no other neurological deficits or evidence of implant failure.

Conclusions: The GRSPSS procedure can effectively correct spinal deformity at a 3-year follow-up, with an acceptable incidence of complication. This new instrumentation may be a promising approach for facilitating spinal growth without repeated lengthening operations.

P170

TPA IS A USEFUL PARAMETER TO ASSESS THE OUTCOME OF ADULT SPINAL DEFORMITY SURGERY

Tomohiro Banno,Tomohiko Hasegawa,Yu Yamato, Sho Kobayashi,Daisuke Togawa,Shin Oe, Yuuki Mihara,Kenta Kurosu,Yukihiro Matsuyama

Hamamatsu University School of Medicine Higashi-ku 431-3192 Hamamatsu, Japan

Introduction: T1 pelvic angle (TPA) is a novel spinopelvic parameter that accounts for both pelvic retroversion and trunk anteversion. TPA which defined as angle is less affected by the posture and reported to have good correlation to HRQOL for adult spinal deformity patients. According to our cohort study for elderly volunteers, the threshold value of TPA for disability (ODI>20) was approximately 20 degree.

Aim: The purpose of this study was to investigate the availability of TPA as a post-operative assessment and target value for corrective surgery.

Materials and Methods: 70 adult scoliosis patients (5 male and 65 female; mean age 67.8 years) who underwent spinal deformity surgeries in our department with at least 2-year postoperative observation were studied. The following spinopelvic parameters based on the whole spine and pelvic X-ray were assessed: TPA, SVA, PT, PI-LL at pre-op, soon after operation and 2 years post-op. The ODI and SRS-22 were obtained for outcome measurement at pre-op and 2 years post-op. According to the value of postoperative TPA, the patients were divided into two groups; TPA≤20° (group G) and TPA>20° (group P) and the outcomes were compared.

Results: Mean values of each spinopelvic parameter at pre-op, soon after operation and 2 years post-op were following: TPA=34.4°,

SVA=94.6mm, PT=32.2° and PI-LL=31.9° at pre-op, TPA=21.4°, SVA=44.3mm, PT=23.6° and PI-LL=11.3° soon after operation, TPA=28.2°, SVA=73.6mm, PT=28.2° and PI-LL=16.1° at 2 years post-op, respectively. Correlation between preoperative parameters and HRQOL, TPA and SVA were correlated with the ODI. Concerning about the relationship between preoperative parameters and HRQOL obtained 2 years post-op, TPA was best correlated with ODI, SRS-22 though all parameters were correlated to ODI and SRS-22. Moreover, among the parameters measured soon after operation, TPA was best correlated with ODI at 2 years post-op. At 2 years post-op, each parameter and ODI of group G were better than those of group P.

Conclusion: Since TPA was stronger correlated with postoperative outcome than other parameters, TPA was the proper parameter for assessing the clinical outcome of spinal deformity surgery. Furthermore, TPA of soon after operation was correlated with the ODI at 2 years post-op, thus TPA was useful for predicting the prognosis. Since the patients corrected TPA≤20° postoperatively had better spinopelvic parameters and ODI at 2 years post-op, TPA≤20° was proper target value for corrective surgery.

Reference(s):

1. Protopsaltis T., Schwab F., Bronsard N., et al. The T1 pelvic angle, a novel radiographic measure of global sagittal deformity, accounts for both spinal inclination and pelvic tilt and correlates with health-related quality of life. *J Bone Joint Surg Am* 2014; 96;1631-1640.

P171

MODIC CHANGES ON MAGNETIC RESONANCE IMAGING AND ENDPLATE REMODELING ON COMPUTED TOMOGRAPHY AFTER POSTEROLATERAL FUSION SURGERY

Yasuhiro Shiga,Sunihisa Orita,Kazuyo Yamauchi, Kazuhide Inage,Jun Sato,Kazuki Fujimoto,Koki Abe, Hirohito Kanamoto,Masahiro Inoue, Hideyuki Kinoshita,Kazuhisa Takahashi,Seiji Ohtori *Department of Orthopaedic Surgery, Graduate school of Medicine, Chiba University, Chiba, Japan 260-8670, Japan*

Introduction: Modic changes in the vertebral endplates on magnetic resonance imaging (MRI) are reported to associate with the indices for symptom correlation and prognosis: Type 1 is associated with intervertebral instability and pain, type 2, restabilization, and type 3, bone scar. Among them type 1 change has been reported to include increased bone turn over in the marrow of Type 1 signals. However the rationale for changes in the bone marrow on MRI or computed tomography (CT) after a lumbar fusion surgery and its indications remains still unclear.

Aim To follow the prognosis of LSS patients at least five years after posterolateral fusion (PLF) surgery via radiological evaluations and symptoms, and to evaluate the relationship between the radiological findings and pain. Subjects and Methods We conducted a retrospective study on 112 individuals who underwent PLF surgery between January 2007 and October 2010. We used MRI to examine Modic changes and CT for endplate damage, by calculating a ratio of damaged endplates including adjacent bone marrow to the vertebral width, also to examine changes in the visual analogue scale (VAS) scores for lower back pain (LBP). Three experienced spine surgeons were involved in the judgment.

Results Preoperative distribution of Modic changes was: 28 Type-1, 14 Type-2, and 48 Type-3 cases, and 32 cases showed no Modic change. After the surgery, 11 cases (9.0%) cases showed subtype change as following: Type 1 to 2: 3 cases, Type 1 to normal : 3 cases, Type 2 to 3: 3 cases, and Type 3 to 2: 2cases. However, significant improvement was found in the endplate damage ratio from an average of 48.5% to 32.8% which indicates bone remodeling. The remodeling was observed in 69 of 112 (61.6%) cases after spinal fusion. The LBP VAS score (cm) improved from 7.8 to 3.2 a month after the surgery, and was 3.5 at the final examination. No correlation was observed between Modic changes and endplate damage ratios.

Discussion In the current study, Modic Type 1 signals changed to Type 2 or normal; however, Type 2 did not change to Type 1, suggesting that Type 2 signals indicate a stabilized stage. Type 2 and 3 signals showed reciprocal change, suggesting that these two were changeable each other. In contrast, endplate remodeling occurred more frequently than the Modic

change alteration. The finding indicates the Modic changes are lacking in prompt reaction, and should be assessed in the evaluation of postoperative morphological change in combination with end plate degeneration by using CT imaging. However, postoperative Modic change on MRI bone remodeling on CT had no significant correlation with the LBP VAS scores. This indicates that LBP does not emanate from degenerations of the intervertebral disks and vertebral endplates in postoperative LSS patients.

P172

FACTORS ASSOCIATED WITH HAVING AN INDICATION FOR SURGERY IN PATIENTS WITH ADULT SPINAL DEFORMITY

Sarah Wunderlin,Anne F Mannion,Ibrahim Obeid, Ferran Pellisé,Emre Acaroglu,Ahmet Alanay, FS Pérez-Grueso,Frank Kleinstück
Schulthess Clinic 8008 Zurich, Switzerland

Introduction Adult spinal deformity (ASD) represents a challenge to the surgeon as there is currently no established decision-making pathway for its optimal surgical or non-operative treatment. ASD patients constitute a heterogeneous patient population with varying clinical presentations, treatment indications and treatment outcomes. Consequently, indications for treatment are often inconsistent and indistinct1,2. Fu et al.3 investigated factors that differed between operative and nonoperative cohorts of patients with ASD, stratified by age. However, many of the identified factors were intercorrelated and no multivariable analyses were carried out.

Aim To use multivariable regression analyses to determine the variables that are most strongly associated with having an indication for surgery in patients with ASD.

Patients and Methods Baseline variables grouped into 6 blocks (demographics, medical history, questionnaires, coronal parameters, sagittal parameters and neurologic parameters) were evaluated in a multicentre, prospective cohort of patients with ASD. Surgeons documented whether the patient had an indication for surgery (regardless of whether surgery was ultimately carried out). Each block was analysed with binary logistic regression analysis using forward, backward and simultaneous variable entry to find the best predictive ability with the fewest independent variables. All significant parameters were added to the final model of prediction. The predicted probability of having an indication for surgery and hence the predicted group membership (indication for surgery vs no indication) was compared with the actual group membership. The accuracy of the model was measured by the area under the curve of the Receiver Operating Characteristics (ROC) analysis.

Results 740 cases (236 degenerative, 504 idiopathic) with complete data were included in the prognostic model. The final analysis revealed that the following factors were associated with having an indication for surgery: lower age ($p=0.001$), degenerative etiology ($p=0.025$), no prior fusion surgery ($p=0.014$), lower SRS self-image scores ($p<0.0001$), prior decompression surgery ($p=0.011$), the use of narcotics ($p=0.006$), higher ODI scores ($p<0.0001$), presence of sagittal subluxation ($p=0.003$), and a higher major cobb angle ($p=0.035$). 327 (78%) patients were correctly predicted through the model with ROC analysis showing a good accuracy, as measured by the area under the curve of 0.808.

Conclusion A number of key variables were associated with an indication for surgery. This may help in the development of decision aids in the treatment of ASD.

References

1.Glassman S.D. et al. (2007). Spine, 32(1), 93-97.
2.Bess S et al. (2009). Spine, 34(20), 2186-2190.
3.Fu KM et al. (2014). Spine, 39(17):1401-7.

P173

RADIOLOGICAL EVALUATION AFTER POSTERIOR FUSION COMBINED WITH VERTEBROPLASTY FOR NONUNION OF OSTEOPOROTIC VERTEBRAL FRACTURES

Katsumasa Tanimoto, Tsuneo Takebayashi, Mitsunori Yoshimoto, Yoshinori Terashima, Toshihiko Yamashita
Takikawa Municipal Hospital Omachi 073-0022, Takikawa, Japan

Introduction: In recent years, the number of patients with osteoporotic vertebral fracture (OVF) has been increasing. For some cases resulting in nonunion of OVF, which have per-

sistent back pain and/or delayed nerve paralysis, various surgical procedures including percutaneous vertebroplasty and multiple level spinal fusion with corrective osteotomy have been proposed. Since June 2009, we have performed posterior instrumentation combined with vertebroplasty with hydroxyapatite (HA) blocks for nonunion of OVF. Although the surgical procedure provided good clinical results, loosening of pedicle screw occasionally led to excessive correction loss.

Aim: To detect the limitations of our surgical procedure using radiological evaluation

Materials and Methods: This study included 28 consecutive patients with nonunion of single OVF who were followed for more than six months after surgery. There were 9 males and 19 females with a mean age of 75.3 years at the time of the surgery and a mean follow-up period of 18.1 months. All patients basically underwent posterior instrumentation three levels above and two levels below the fractured vertebra, using hooks in the upper end and pedicle screws in the other levels. Vertebroplasty was performed with HA block under C-arm fluoroscopy and no bone graft was performed posteriorly. The wedge ratio of vertebral body, local kyphosis angle, and existence of pedicle screw loosening were examined using lateral X-ray in sitting or standing position before and after surgery and at the final follow-up. We defined patients with more than 10% decrease in the wedge ratio of vertebral body and more than 5° increase in local kyphosis angle as correction loss group. HA leakage from vertebral body, insertion of pedicle screw in the fractured vertebra, bony bridging at anterior of vertebral body and the number of fixed levels were analyzed as risk factors for correction loss.

Results: The most frequent fractured vertebra was L1 in 10 patients, followed by T12 in 9, T10 in 4, L2 in 4, and T11 in 3. The wedge ratio of vertebral body and local kyphosis angle significantly improved from 33.2% and 30.4° before the surgery to 66.9% and 16.8° after the surgery, respectively (paired t-test; $p<0.001$ and $p<0.001$). However, at the final follow-up a deterioration of 10.2% and 4.7° was recognized, respectively. Pedicle screw loosening was confirmed in 16 patients (57%), in which 7 patients (25%) belonged to correction loss group. HA leakage from vertebral body was significantly associated with correction loss (Fisher's exist test; $p=0.021$).

Conclusion: This study showed that excessive correction loss occurred in patients with the breakdown of cortical bone at anterior of vertebral body and a high possibility of HA leakage. For these patients, we should undertake other measures including additional posterior bone graft, the extension of fixed levels and the change of surgical procedure.

P174

THE CLINICAL RESULTS OF THE PERCUTANEOUS ENDOSCOPIC LUMBAR DISCECTOMY WITH ELECTROMYOGRAM UNDER GENERAL ANESTHESIA

Yoshihiro Kitahama

Spine Center, Omaezaki Municipal Hospital 4371696 Omaezaki, Shizuoka, Japan

Background: The percutaneous endoscopic spine surgery (PESS) is one of many newly developed minimally invasive spine surgery (MISS) technique. This techniques require only a small skin incision, present less approach site tissue trauma, and allow an early recovery after the procedure. Transforaminal percutaneous endoscopic discectomy (TFPED) is commonly able to perform under local anesthesia, but patients and surgeons feel the large mental stress for the intraoperative uncontrolled pain.

Purpose: We evaluated the safety of the TFPED under general anesthesia by using free running Electromyogram (EMG).

Patients and Methods: A total of 101 patients with Lumbar degenerative diseases who underwent percutaneous endoscopic surgery under our institution between June 2012 and May 2015, and then mean follow up period was 12.4 (range 1-30) months at our institution, were investigated for their clinical outcomes. With the EMG monitoring TFPED under general anesthesia performed our institution. 40 cases' (4 local anesthesia, 36 general anesthsia) outcomes of the single level TFPED examined. There were 21 male and 19 female patients with mean age of 51.0(range 17-88) years. 1 patient underwent TFPED at L1-2 level, 2 at L2-3 level, 7 at L3-4 level , 23 at L4-5 level and 7 at L5-6 or L5-S level. The clinical outcomes were

evaluated by two methods: the numeric rating scale (NRS) for affected leg pain and day1 wound pain. MacNab's criteria were measured on the first examination and final follow-up. Other operation and social parameters such as return to walk and work were also assessed.
Results: The preoperative NRS score for the affected leg improved significantly from 6.5 to 0.6, and the mean NRS score of day 1 morning wound pain was 0.7. Excellent or good results stated by 87.5% of the patients and Fair was rated by 12.5% of the MacNab's criteria. The mean operation time were 66.7(range 38-152) minutes and bleeding of all cases were uncountable little. The mean days spent till return to walk were 0.4(range 2-20 hours) days, the average hospital stay was 3.5(range 1-24) days and the mean days spent till return to original work 16.0(range 5-56) days. No serious complication occurred, three patients(7.5%) having a transient paresis that had disappeared after 3 months. Recurrence rate was 0.0%.
Discussion: The foraminal stenosis and high grade compromised or migrated type had to be relative contraindications of TFPED. Minimum cutting of annulus, annuloplasty and coagulation of nucleus pulposus help relapse prevention.
Conclusion: With the EMG monitoring TFPED under general anesthesia of our institute were good clinical outcomes and low risk procedure.

P175

A COMPARISON OF BALLOON KYPHOPLASTY AND CALCIUM PHOSPHATE CEMENT-ASSISTED VERTEBROPLASTY FOR OSTEOPOROTIC VERTEBRAL FRACTURES

Tadao Tadao, Masatoshi Hoshino, Hiroaki Nakamura
Shiraniwa Hospital 630-0136 Nara, Japan

Introduction: Vertebral body compression fractures are common in osteoporotic patients, and require stabilization if accompanied by significant pain or neurologic deficit. Balloon kyphoplasty (BKP) has been proposed as an effective alternative to vertebroplasty (VP) with calcium phosphate cement (CPC). However, few prior studies have compared these techniques directly.
Objective: To assess the clinical and radiographic outcomes following BKP and CPC-VP in patients being managed for osteoporotic vertebral fractures (OVF).
Patients and Methods: OVF were treated with CPC-VP from August 2000, and BKP from October 2012. CPC-VP was performed on 12 patients, while BKP was performed on 20 patients. Clinical factors assessed included operative time, blood loss, back pain as measured by the visual analogue scale (VAS), the incidence of adjacent vertebral fractures, and cement leakage as noted during or after the procedure. Radiographs were assessed for changes in kyphotic angle.
Results: The median ages of patients who underwent CPC-VP and BKP were 77.3 years (range 71–85) and 78.6 years (range 64–88) respectively. Differences in age and gender between groups were not significant. The majority of OVF were at the thoracolumbar junction, predominantly at T12. The mean operative time was 79.5 minutes in CPC-VP and 55.1 minutes in BKP, which was significant. There was minimal blood loss in all BKP and half of CPC-VP cases. Where blood loss was appreciable in CPC-VP cases, the mean blood loss was 56.5 ml . VAS scores improved from 6.2 to 2.1 following CPC-VP, and from 7.4 to 2.5 following BKP. The mean kyphotic angle in patients who underwent CPC-VP was 24.3° preoperatively, 8.1° postoperatively, and 10.5° at the final follow-up, compared to 25.3° preoperatively, 8.1° postoperatively, and 9.1° at the final follow-up in patients who underwent BKP. Post-operative progression of more than 5° of kyphotic angle was observed in 2 patients following CPC-VP and 4 patients following BKP. Cement leakage was observed in 7 patients (58%) following CPC-VP and 6 patients (30%) following BKP. Adjacent vertebral fractures were observed in 3 patients (25%) following CPC-VP and 8 patients (40%) following BKP.
Conclusion: In our comparison of BKP and CPC-VP following OVF, we found that BKP requires a significantly shorter operative time and reduced blood loss compared to CPC-VP. These observations were likely due to the minimally invasive technique required for BKP. The radiographic and clinical outcomes of these procedures, including kyphotic angle, pain relief, and cement leakage, were equivocal. The

latter findings were surprising. PMMA has a stronger compressive strength compared to CPC, although adjacent segment fractures were equivalent. Prior work has reported the collapse of CPC blocks postoperatively, leading to recurrent kyphosis. In our study the long term correction was equivalent between the groups.

P176

EFFICACY OF THE INTRAOPERATIVE ANALGESIC INJECTION INCLUDING DORSAL RAMI AND CUTANEOUS NERVE CONDUCTION BLOCK WITH ROPIVACAINE IN POSTOPERATIVE PAIN MANAGEMENT AFTER LUMBAR DECOMPRESSION SURGERY

Kazunori Hayashi,Masatoshi Hoshino,Hiromitsu Toyoda,Shinji Takahashi,Hidetomi Terai, Akinobu Suzuki,Koji Tamai,Shoichiro Ohyama, Hiroaki Nakamura

Dept. Orthopaedic surgery Osaka City University of Medicine Abeno-ku 545-8585 Osaka, Japan

Introduction: Pain relief after lumbar decompression surgery is an unresolved problem. Non-steroidal anti-inflammatory drug (NSAIDs) or weak opioids are typically used for pain relief in these patients. However, these drugs have limited efficacy and may result in complications such as peptic ulcers or drug abuse. We introduce a novel approach for intraoperative local anesthesia to diminish postoperative wound pain, i.e., dorsal rami and cutaneous nerve conduction block with ropivacaine (DRCCR).

Aim: To evaluate the efficacy and safety of DRCCR in postoperative pain management after lumbar decompression surgery.

Material and Methods: A total of 50 participants enrolled in this study. Twenty-five patients received injections of 0.75% ropivacaine into the intra-paraspinal muscles just lateral to the isthmus and the subcutaneous layer before repair of the latissimus fascia to block the dorsal rami and cutaneous nerves after lumbar decompression surgery in 2015 at our institution (DRCCR group). The control group contained 25 patients whose age, sex, and operated levels matched those in the DRCCR group and had received surgery in 2014 by the same operators but did not receive DRCCR. All patients concomitantly received daily oral NSAIDs or acetaminophen. The visual analog scale (VAS) score for wound pain at 4, 12, 24, 36, and 48 h, and 3, 7, and 14 days after surgery were obtained by blinded trained nurses and compared between the two groups. The dosage of intraoperative fentanyl use, additional painkillers after surgery, amount of drainage, complications, and Japanese orthopaedic association (JOA) score at 3 months were also investigated.

Results: There were 12 male and 13 female patients in each group. Mean operated levels were 1.44. The VAS scores for wound pain at 4, 12, and 24 h were significantly lower in the block group than in the control group (21:42, 27:41, 27:40, respectively, $p<0.05$). Intraoperative fentanyl use, VAS scores for wound pain after 36 h, dosage of additional painkillers, total amount of drainage, and postoperative JOA score were not significantly different between the two groups. No serious complications were observed in either group.

Conclusion: DRCCR was effective in pain management after lumbar decompression surgery. DRCCR was also easy and safe. However, the intervention did not affect the short-term clinical outcome. Long-term follow-up will be needed to enhance the evidence.

P177

A VALIDATION OF EFFICACY OF POVIDONE-IODINE SOLUTION FOR THE SPINAL SURGERY

Yukimasa Yamato,Naohiro Kawamura,Shigeyuki Muraki,Shigeru Masuyama,Yujiro Hirao,Hiroshi Maruyama,Naohiro Tachibana,Takaki Shimizu, Junichi Kunogi

Dept. of Spine and Orthopedic Surgery, Japanese Red Cross Medical Center Shibuyaku 1508935,Tokyo, Japan

Introduction: Some studies have reported the efficacy of povidone-iodine solution (PIS) irrigation in the wound during spinal operation. However, relations between risk factors of surgical site infection (SSI) in spinal surgery and PIS irrigation are unclear. Aim: To investigate the efficacy of irrigation in the surgical wound using PIS for the spinal surgery, and relations between risk factors and PIS irrigation.

Materials and Methods: Between July 2010 and June 2013, 1504 cases without infection under-

went spinal surgery in our hospital. From July 2010 to December 2011, simple saline solution was used for all intraoperative irrigation of surgical site. (group A). On the other hand, from January 2012 to June 2013, PIS was used for all cases (group B). We compared the SSI rates of each group. Recorded data include classification of disease, ASA-PS, past medical history, smoking history, history of steroid use, method of surgery, surgical site, time, blood loss, a kind of antibiotics for precaution, a period of antibiotics, method of skin suture. To evaluate the influence of PIS in irrigation of local bone graft, the union rate of single level poterior lumbar interbody fusion (PLIF), were evaluated. The diagnosis of SSI was based on CDC guideline.

Results: This study included 642 cases in group A, and 862 cases in group B. Group A included 6 SSI cases and group B, 8 cases. There was no statistically significant difference in the incidence of SSI between two groups. Logistic regression analysis of the whole cases identified "reoperation" as a risk factor for SSI. The rate of SSI in reoperation cases was 4/103 (3.9%) in group A, and 1/109 (0.9%) in group B, which had no significant difference (P=0.13). Moreover, ASA-PS≧3, hemodialysis and using interbody spacer were identified as risk factors for SSI in the whole reoperation cases. Focusing on the reoperation cases with use of interbody spacers, the SSI rate was 4/48 (8.3%) in group A had 4 cases, but 0/24 (0%) in group B. The union rate of single level PLIF was 96/103 (93.2%) in group A, and 98/107 (91.6%) in group B, which had no significant difference(P=0.80).

Conclusion: Intraoperative irrigation of surgical site with PIS may be effective to prevent SSI in reoperation and using interbody spacer cases without adverse influence on bone union.

P178

AGE IS NOT A CONTRIBUTORY FACTOR TO POOR CLINICAL OUTCOME WHEN PERFORMING SINGLE LEVEL MINIMALLY INVASIVE TRANSFORAMINAL LUMBAR INTERBODY FUSION (MIS-TLIF) AT 5 YEARS

MUN CHUN Lai,Mashfiqul Arafin Siddiqui, William Yeo,Chusheng Seng,Poh Ling Fong, Chang Ming Guo,Seang Beng Tan,Wai Mun Yue
Singapore general hospital
cmunchun2001@gmail.com 542272, Singapore

INTRODUCTION: MIS-TLIF has gained popularity due to perioperative benefits of decreased blood loss, postoperative pain and faster recovery with shorter hospitalization. These benefits are important in the perioperative period especially in the elderly population. However, the long term outcome is not as well documented in the elderly population with osteoporotic bone who may be more prone to cage migrations, fractures at instrumented or adjacent levels.

AIM: The aim of this study is to compare the 5-year clinical outcome of single level MIS TLIF between patients who are old-old (≥75 years of age), young-old (65-74 years) and middle-aged (45-64 years).

MATERIALS AND METHODS:Between 2006-2010, all patients who underwent a single level MIS-TLIF for degenerative conditions with neurological symptoms refractory to conservative measures were considered for the study. Our study comprised 270 patients who were subsequently followed-up. Data was prospectively collected and retrospectively analysed. Outcome measures collected include Numeric Pain Rating Scale (NPRS) for back and leg pain, Oswestry Disability Index (ODI), Neurogenic Symptom Score (NSS) and 36-Item Short Form Health Survey (SF-36) collected pre-operatively, at 1,3,6 months, 2 and 5 years postoperatively.

RESULTS: Patients in the old-old group had a significantly longer (Mean 6.63 SD 8.58 days; $p<0.01$) hospitalization stay compared to the young-old (Mean 3.68 SD 1.99 days) and middle-age (Mean 3.35 SD 1.5 days). There was no significant difference in the operative time between the 3 groups ($p=0.167$). Pre-operative parameters were similar between the 3 groups except for the SF-36 physical functioning subscale which was significantly lower for the old-old (Mean 31.9 SD 22.5; $p=0.017$) as compared to the young-old (Mean 40.8 SD 28.7) and middle-age (mean 48 SD 26.4) group. All 3 groups showed significant improvement post-operatively compared to their pre-operative scores. The SF-36 physical functioning subscale for the old-old group remained significantly lower compared to the young-old and middle-age throughout the study period

(p<0.01). The remaining SF-36 subscales were similar between the 3 groups at 5 years.
CONCLUSION: Our study shows that age is not a contributory factor for most clinical outcomes at 5 years. Patients who are 75 years or older tend to have a lower SF-36 physical functioning subscale pre-operatively and this difference remains at 5 years post-operatively.

P179

DECOMPRESSION FOR SPINAL STENOSIS IS NOT ADEQUATELY REPRESENTED ON POST-OPERATIVE MRI

Catharina Schenck,Job Van Susante,Maarten Van Gorp,Ruben Belder,Carmen Vleggeert-Lankamp
Leiden University Medical Center 2333 ZA Leiden, Netherlands

Introduction: Lumbar spinal stenosis (LSS) is common in the elderly, presenting with leg pain exacerbated by prolonged walking or standing. In some cases of LSS treated with surgical decompression, the postoperative results are not satisfactory with respect to the symptoms. In these cases, a postoperative MRI is sometimes performed in search of an explanation. In the experience of the investigators of this study, the obtained decompression observed on early postoperative MRI tends to be disappointing compared to the decompression achieved intraoperatively. This raises the question whether the early postoperative MRI, performed after lumbar decompression, is a fair representation of the 'real' decompression.
Aim: This study investigated the correlation between intraoperative and postoperative dimensions of the decompressed lumbar spinal canal.
Materials and Methods: 20 patients with LSS underwent surgical decompression on a single level. The orthopaedic surgeon performed direct intraoperative measurements of height, width, and length using a caliper after surgically decompressing the affected level. Height was defined as the distance of the dural sac in AP direction, width was defined as the distance of the dural sac from pedicle to pedicle and length was defined as the distance from inferior border of superior lamina to superior border of inferior lamina. Preoperative supine MRI and postoperative prone and supine MRI were acquired. Two radiologists measured width, length and height of the spinal canal on the pre- and postoperative MRI. Pre- and postoperative Visual Analogue Scores (VAS), Roland Disability Questionnaire Scores (RDQS) and Likert scores were recorded. Intraoperative measurements were compared to measurements on post-operative MRI in prone position (thus reproducing the intraoperative situation) to avoid positioning bias. Preoperative and postoperative measurements on MRI were also compared. In addition to this, postoperative measurements on supine and prone MRI were also compared.
Results: Interobserver reliability for MRI measurements by both radiologists was generally excellent (intraclass correlation coefficients ≥0.73). The postoperative spinal canal dimensions improved on both prone and supine MRI compared to the preoperative situation. Intraoperatively measured height and width were significantly greater than height and width on postoperative MRI in prone position (P<0.05). Postoperative dural sac height was greater on the supine MRI compared to the prone MRI (P<0.05). Clinical parameters improved significantly, but no correlation between increase in dimensions of the canal and improvement in clinical outcome scores was established.
Conclusion: Surgical decompression of the spinal canal effectively decreases the compression of the dural sac. However, early postoperative MRI after lumbar decompression does not adequately represent the decompression achieved intraoperatively. Moreover, positioning of the patient in prone or supine position affects the dimensions of the spinal canal.

P180

VERTICAL INSTABILITY OF TRANSLATION SEGMENT AND DECOMPRESSION SURGERY OUTCOMES IN DEGENERATIVE LUMBAR SPONDYLOLISTHESIS

Takuya Nikaido,Koji Otani,Kazuyuki Watanabe,Kinshi Kato,Hiroshi Kobayashi,Shoji Yabuki,Shin-ichi Kikuchi,Shin-ichi Konno
Department of Orthopaedic Surgery, Fukushima Medical University School of Medicine 960-1295, Japan

Introduction: We have performed decompression alone as the primary operation regardless of the degree of translation and the disc angle for degenerative lumbar spondylolisthesis (DS). We have reported that vertical instability of the translation segment might be associated with low back pain (LBP) and buttock pain (BP) in DS. The present study aimed to clarify the relationship between vertical instability and decompression surgical outcomes.
Materials and Methods: This was a prospective cohort study involving 104 patients with L4-L5 DS who complained of LBP with radicular intermittent claudication. All cases underwent single-level decompression alone for L4-L5 and were observed for a postoperative period of ≥1 year. Exclusion criteria included multilevel decompression, pathological spondylolisthesis, and degenerative scoliosis (≥10 degrees). These cases were classified into two groups based on the presence of vertical instability. Vertical instability was evaluated by the difference in intervertebral disc height on radiographs in the neutral standing position and CT sagittal section images in the supine position; a decrease of more than 10% in the standing position of the intervertebral disc height was considered vertical instability. Between these two groups, the intensity of LBP and BP, lower extremity symptoms, the Roland-Morris Disability Questionnaire (RDQ), and the radiographic parameters were compared pre- and postoperatively. Results: 1. LBP, BP, lower extremity symptoms: The intensity of LBP, BP, and lower extremity symptoms was significantly higher in the group with vertical instability than in the group without vertical instability pre- and postoperatively. 2. RDQ score: The RDQ score was significantly higher in the group with vertical instability than in the group without vertical instability pre- and postoperatively. 3. Radiographic parameters: There were no significant differences in the other radiographic parameters (translation and disc angle on lumbar flexion and extension in the standing position) between the two groups.
Conclusion: Vertical instability of the translation segment is associated with LBP and BP in DS. In patients with DS with vertical instability of the translation segment, improvements of LBP, BP, lower extremity symptoms, and LBP-related quality of life may be less with decompression surgery alone.

Reference(s): 1. Simmonds AM., Rampersaud YR., Dvorak MF., et al: Defining the inherent stability of degenerative spondylolisthesis: a systematic review. J Neurosurg Spine. 2015; 23; 178-89.

P181

DOES PERCUTANEOUS VERTEBROPLASTY FOR VERTEBRAL COMPRESSION FRACTURE WITH INTRA-VERTEBRAL CLEFT RESTORE THE COLLAPSED VERTEBRAL BODY?

Bong-Soon Chang,Hui Jong Lee,Sang-Min Park, Jae-Woo Park,Guang Bin Zheng,Hyoungmin Kim, Choon-Ki Lee
Seoul National University College of Medicine Jongno-gu Seoul, 03080, Korea, South

Introduction: Intra-vertebral cleft (IVC) is a fluid or air filled cavity inside the vertebral body and represent dynamic mobility of vertebral body in these patients. In patients with IVC of vertebral body, to relieve pain that occurred from intravertebral mobility, it is necessary to fill the ICV with cement for the stabilization of vertebral body. However, the radiographic and clinical outcomes of vertebroplasty in the patients with IVC of vertebral body were still undetermined.
Aim: The purpose of this study was 1) to assess the vertebral height restoration and recollapse after single level vertebroplasty in the patients of compression fracture with IVC during follow-up period, and 2) to compare the radiographic and clinical results with the patients without IVC treated by vertebroplasty.
Patients and Methods: From March 2001 to February 2014, 108 patients with IVC (Group I) and 233 patients without IVC (Group II) were enrolled. The heights of the anterior (A), middle (M) and posterior (P) columns of the fractured vertebral body were measured. Mean of each vertebral column height of superior (R1) and inferior (R2) vertebral body, which served as the reference (R=[R1+R2]/2) was also measured. Initial, postoperative and final compression rates (CR, [1-(A or M or P/R)]x100) at each column were calculated. Restoration rates (RsR = Initial CR - Post CR) and recollapse rates (RcR = Final CR – Post CR) were calculated. The wedge angle (WA) of fractured vertebral body is the angle between two lines on superior and inferior endplates of fractured vertebral body.

Subjective back pain at preoperative and final follow-up was measured with a numeric rating scale (NRS) pain score.
Results: Group I showed significantly more CR over entire follow-up period than group II except CR of anterior column at final follow-up and posterior column. The mean RsR immediately after vertebroplasty at anterior and middle column in the group I showed significantly larger than that in group II. The mean RsR of posterior column had no difference between two groups. Both groups showed recollapse in all three columns, but they showed no significant difference. The mean WA in the group I showed significantly larger than that in group II over entire follow-up periods including before treatment. Groups I showed significantly larger than group II in NRS pain score for back pain before treatment. Group I and group II did not significantly differ in NRS pain score at final follow-up.
Conclusion: Treatment of compression fracture with IVC by vertebroplasty restores vertebral body heights and wedge angle more effectively and provides satisfactory radiographic and clinical outcomes comparable with compression fracture without IVC, although vertebral body recollapse can be occurred in both groups.

P182

NEUROLOGICAL COMPLICATIONS AFTER POSTERIOR SPINAL SURGERIES

Dong Ki Ahn, Jung Soo Lee, Minsu Kang, Seongmin Yi
Seoul Sacred Heart General Hospital 130-867 Seoul, Korea, South

Introduction: Previous studies have investigated postoperative neurological complications only in a specific disease entity and did not present specific clinical features. Aim: To propose data to that are necessary for the prevention and early diagnosis of neurological complications
Materials and Methods: We had a retrospective observational study based on the single hospital experiences in which those who received posterior thoracolumbar spinal surgeries in orthopedic department were reviewed. Incidence, causes, onset time and risk factors were investigated. Neurological deterioration was graded with 5 numeric scales, G1 increased leg pain or sensory loss, G2 hemiparesis, G3 paraparesis, G4 cauda equine syndrome and G5 complete paraplegia.
Results: Sixty-five cases out of 6,574 (0.989%) developed neurological complications. The order of incidence according to the cause were as follows; epidural hematoma 0.380%, instrumentation with insufficient decompression 0.213%, mechanical injury 0.167%, insufficient discectomy 0.061% and unknown 0.167% (P=0.000). The grade of neurological deterioration was G1 0.167%, G2 0.517%, G3 0.228%, G4 0.046% and G5 0.030%. It was most severe in epidural hematoma and followed by instrumentation with insufficient decompression, unknown, mechanical injury and insufficient discectomy in order (P=0.009). Revision surgery was a significant risk factor (P=0.000, OR=2.741). The order of elapsed time of symptom development was as follows; unknown 0.6hours, epidural hematoma 5.4 hours, mechanical injury 6.6hours, insufficient discectomy 18.0hours and instrumentation with insufficient decompression 36hours (P=0.001).
Conclusions: The incidence was about 1%. Revision surgery increased the risk 3 times. Severe cases more than cauda equina syndrome rarely developed as 0.08%. The major causes were epidural hematoma and instrumentation with insufficient decompression. Close observation in early period was important for a diagnosis because most cases developed symptoms within 12hours. Delayed diagnosis was most common in instrumentation with insufficient decompression.
Key words: Spinal surgery, neurological complication, incidence, risk factors

P183

PARTICULAR FEATURES OF SURGICAL SITE INFECTION IN POSTERIOR LUMBAR INTERBODY FUSION

Dong Ki Ahn,Jin Woo Kim,Go We kim
Seoul Sacred Heart General Hospital 130-867 Seoul, Korea, South

Introduction: Previous reports notices only difference of infection rate between Posterolateral fusion (PLF) and Posterior lumbar interbody fusion (PLIF). However, there has

been no report which describes the particular features of surgical site infection (SSI) in PLIF.
Aim: We would like to identify the distinguishing characteristics and risk factors of SS Iin PLIF.
Materials and Methods: It was a case series study of an institute. Those who had undergone PLIF consecutively in author's hospital were reviewed. Two proactive procedures were added during the study period. One was irrigation of auto-local bone and the other was intra-discal space irrigation with a nozzle. Infection rate and risk factors were analyzed. As a subgroup analysis, the elapsed time to a diagnosis (ETD), clinical manifestations, hematologic findings and causative bacteria were examined in SSIs.
Results: There were 30 cases of SSI out of 1,831 (1.6%). Long operation time was an independent risk factor (P=0.008) and local bone irrigation was an independent protective factor (P=0.001). Two cases of referred SSI were included in subgroup analysis. There were 6/32(19%) superficial incisional infections (SII), 6/32(19%) deep incisional infections (DII) and 20/32(62%) organ/space infections (O/SI). The difference was significant (p=0.002). Most common bacteria were MRSE followed by MRSA in incisional infections, and no growth followed by S epidermidis in O/SI. ETD was 8.5+/-2.3 days in SII, 8.7+/-2.3 days in DII and 164.5+/-131.1 days in O/SI (p=0.013)
Conclusions: The rate of SSI in PLIF was 1.6% and most common type was O/SI. The causative bacteria of O/SI were lower virulence than wound infection and diagnosis was much delayed due to its latent and insidious feature. Contamination of auto-local bone was presumed attributable to develop SSI. Irrigation of auto-local bone could reduce SSI. Key words: Surgical site infection, Posterior lumbar interbody fusion, Organ/space infection, Delayed diagnosis.

P184

SELECTIVE LUMBAR FUSION IN PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS OF LENKE TYPE 6C: CAN IT BE AN EFFECTIVE TREATMENT OPTION JUST AS IN LENKE TYPE 5C?

Choon-Ki Lee,Hyoungmin Kim,Guang Bin Zheng, Sang-Min Park,Jae-Woo Park,Hui Jong Lee, Bong-Soon Chang
Seoul National University College of Medicine Jongno-gu Seoul, 03080, Korea, South

Introduction: The thoracic curve in patients with AIS of Lenke type 6C is considered to be a structural curve, which will not be spontaneously corrected just as a compensatory curve does after surgical correction of major curve. Thus, currently the thoracic curve in Lenke 6C AIS is recommended to be included in fusion level for the surgical treatment of the deformity. However, this presumption was not proved in any published study.
Aim: The purpose of this study was to compare radiographic and clinical parameters between Lenke 5C and 6C patients who received selective lumbar fusion only, and to evaluate the feasibility and effectiveness of selective lumbar fusion in Lenke 6C AIS patients.
Patients and Methods: For the radiographic assessment, the Cobb's angle of thoracic and lumbar curve, tilt angle of uppermost instrumented vertebra (UIV) and lowermost instrumented vertebra (LIV), wedging angle of intervertebral disc just distal to LIV, global coronal and sagittal balance, apical vertebral translation (AVT) of thoracic and lumbar curve, and shoulder height differences were measured before / after surgery and at the latest follow up visit. The SRS-22 questionnaire was acquired at the latest follow-up.
Results: The mean age at surgery was 13.1 years and 14.7 years respectively in each group of patients with AIS of Lenke 5C and 6C type and the mean of follow-up period was 5.5 years and 4.2 years respectively. The mean preoperative Cobb's angle of lumbar curve (53.0° and 60.4° in each group) was reduced after surgery (14.4°and 19.6°), which did not change significantly until the last follow-up. The Cobb's angle of thoracic curve was 26.4° in Lenke 5C group and 47.1° in Lenke 6C group preoperatively, it reduced to 12.3° and 29.9° after surgery, and in the final, it increased slightly to 14.4° and 34.7° in each group, however, without statistical significance during the follow up. The UIV tilt was significantly higher in Lenke 6C group in every time point, but the angle reduced significantly after surgery and main-

tained well until last follow-up in each group. Although the AVT in thoracic curve was statistically higher in Lenke type 6C pre- and postoperatively, the global coronal balance was well maintained in both group at every time point. Global sagittal balance, LIV tilt angle, disc angle just distal to the LIV, and shoulder height difference were equivalent between two groups in every time point. The SRS-22 score at the final follow-up was not different between the groups of patients.
Conclusion: In adolescent idiopathic scoliosis (AIS) patients of Lenke 6C, the unfused thoracic curve significantly improved after selective lumbar fusion with comparable clinical and radiographic results to Lenke 5C.

P185

MUSCLE MASS MEASUREMENT USING BIOELECTRICAL IMPEDANCE ANALYSIS MAY BE A USEFUL INDICATOR OF SURGICAL OUTCOME AFTER LUMBAR SURGERY

Kazuki Fujimoto, Kazuhide Inage, Kazuyo Yamauchi, Sumihisa Orita, Miyako Suzuki, Go Kubota, Takeshi Sainoh, Jun Sato, Yasuhiro Shiga, Koki Abe, Hirohito Kanamoto, Masahiro Inoue, Hideyuki Kinoshita, Kazuhisa Takahashi, Seiji Ohtori
Department Orthopedic Surgery, Graduate School of Medicine, Chiba University Chuo-ku, Chiba 260-8670, Japan

Introduction: We often find that patients can walk well after surgery of the lumbar spine. However, it is difficult to assess their degree of improvement. Upon diagnosis of sarcopenia, dual energy X-ray absorptiometry (DXA) is the most trusted index. However, it has disadvantages in that it requires radiation exposure, whereas bioelectrical impedance analysis (BIA) has the advantages of avoiding radiation exposure, and we can measure whole body muscle mass repeatedly in a relatively simple manner. There are few reports regarding the BIA measurement of muscle mass changes after surgery of the lumbar spine. We used BIA to measure muscle mass repeatedly in three regions (upper and lower limbs, and trunk) after lumbar surgery.
Methods: We examined 26 patients who underwent surgical treatment for leg pain caused by lumbar spinal canal stenosis (15 men, 11 women, average 62.2 years). We used BIA (Tanita MC-780A) to measure muscle mass in three regions (upper and lower limb, and trunk) before and 3 months after surgery. We used a t test to compare the regions before and 3 months after surgery. Results: Lower limb muscle mass increased significantly by 3 months after surgery (preoperatively 15.1 ± 4.64 kg and postoperatively 15.8 ± 4.55 kg ($p < 0.01$)). While the upper limb muscle mass and trunk muscle mass were not significantly different after surgery (upper limb; preoperatively 4.3 ± 1.39 kg, postoperatively 4.3 ± 1.88 kg, trunk; preoperatively 23.3 ± 5.34 kg, postoperatively 23.1 ± 5.32 ($p > 0.05$)).
Discussion: Denaturation of muscle fibers is generally considered irreversible. In patients with lumbar spinal canal stenosis, decrease of lower limb muscle mass might arise from immobility because of pain. When pain is reduced after surgical treatment, lower limb muscle mass probably increased because exercise of these muscles was increased.
Conclusion: Muscle mass measurement using BIA may be a useful indicator of surgical outcome after lumbar surgery.

P186

RETROSPECTIVE INVESTIGATION OF PERIOPERATIVE COMPLICATIONS IN 155 PATIENTS WHO UNDERWENT OBLIQUE LATERAL INTERBODY FUSION SURGERY: PERSPECTIVES AND INDICATIONS FROM A MULTICENTER SURVEY

koki Abe,Sumihisa Orita,Seiji Ohtori,Kazuhisa Takahashi, Chikato Mannoji,Masaaki Aramomi, Tetsuhiro Ishikawa,Toshiaki Kotani,Tsutomu Akazawa, Tatsuo Morinaga,Takayuki Fujiyoshi, Masatsune Yamagata,Tomoki Yamauchi,Yawara Eguchi,Eiji hanaoka
Dept. of Orthopaedic Surgery, Graduate School of Medicine, Chiba University 260-8670 Chiba, Japan

Introduction: Recently, minimally invasive lumbar lateral interbody fusion (LLIF) has been widely performed. LLIF is divided into two techniques according to the approach used as follows: oblique lateral interbody fusion (OLIF) and transpsoas LLIF (direct/extreme LIF: D/XLIF). Perioperative complications associated

with D/XLIF has been previously reported, such as transient thigh pain and muscle weakness. Regarding the OLIF procedure, few reports on perioperative complications have been well established.

Aim: To investigate and report the perioperative complications of OLIF surgery by performing a retrospective multicenter survey.

Patients and Methods: The present study was a retrospective review of operative data collected from 24 spine surgeons at our 11 affiliated medical institutions, performed under the approval of the institutional ethics committee in Chiba Prefecture, Japan. The study subjects were patients with low back pain (LBP) underwent surgery under the diagnosis of degenerative lumbar diseases such as spondylolisthesis and degenerative lumbar kyphoscoliosis from April 2013 to May 2015. Each institution had ≥5 OLIF cases. The collected data were analyzed and arranged according to the following major categories: intraoperative and early-stage postoperative (<1 month) complications. The intraoperative complications were then subcategorized into organ damage (neural, vertebral, vascular, and others) and other complications, mainly related to instrumental failure. The incidents were indicated in percentage (%). The collected data were also divided and analyzed based on (i) whether the surgeon was certified to perform the surgery and (ii) incidence of complications in the early (April 2013–March 2014) and late stages (April 2014–May 2015) of the introduction of OLIF.

Results: In total, 155 patients were evaluated (male/female, 69/86; age: mean, 63.5 years; range, 14–87 years). The most frequent diagnosis was spondylolisthesis (100 cases, 65.0%), followed by kyphoscoliosis with multilevel fusion (28 cases, 18.1%) and discogenic LBP with intervertebral disk degeneration (16 cases, 10.3%). Overall, 75 complications were reported (incidence rate, 48.3%). The highest complication was endplate fracture (18.7%), followed by transient psoas weakness and thigh numbness (13.5%), segmental artery injury (2.6%), and skin infection (1.9%). Almost all of these cases were transient, whereas three cases had permanent damage due to ureteral injury in one case and neurological injury such as spinal nerve and cauda equina in two cases, respectively. Whether the primary operator was a certified spine surgeon or not (resident) affected the incidence of complications, indicating that the trainee under the supervision of a certified trainer can perform OLIF surgery without increasing the risk of complications. Regarding the introductory stage, the incidence was 50% at the early stage and 38% in the late stage.

Conclusion: The overall incidence of perioperative complications of OLIF surgery reached 48.3%, of which only 1.9% resulted in permanent damage. Our analysis based on surgeon experience showed no significant difference between experienced and inexperienced surgeons, indicating that the OLIF procedure can be safely performed under experienced supervisors.

P187

INTERVERTEBRAL OVERCORRECTION USING OBLIQUE LATERAL INTERBODY FUSION MAY BE A RISK FACTOR FOR ADJACENT SEGMENT DEGENERATION

Kazuki Fujimoto,Seiji Ohtori,Kazuyo Yamauchi, Sumihisa Orita,Kazuhide Inage,Jun Sato, Yasuhiro Shiga,Koki Abe,Hirohito Kanamoto, Masahiro Inoue,Hideyuki Kinoshita,Kazuhisa Takahashi

Department Orthopedic Surgery, Graduate School of Medicine, Chiba University Chuo-ku, Chiba 260-8670, Japan

Purpose: Lateral lumbar interbody fusion (LLIF) surgery (oblique LIF (OLIF) and extreme LIF (XLIF)) has frequently been used to treat chronic lumbar spinal disease because it allows good correction using a large cage. However, there are few reports of the effects of overcorrection on adjacent segments. We began using OLIF surgery in our hospital in 2012. Subsequently we have examined the impact of single segment OLIF on adjacent segments. We sought to examine the effect of OLIF on the degeneration of adjacent segments (ASD). Methods: We retrospectively examined the cases of 35 patients (19 men, 16 women) who underwent single level OLIF with pedicle screw fixation for degenerative lumbar disease between September 2012 and May 2014 with at least a 2-year follow-up. All of the patients had undergone preoperative radiological

assessment at regular intervals. We evaluated the onset and progression of ASD. The patients were divided into two groups: patients with radiographic evidence of ASD (Group 1) and patients without ASD changes (Group 2). We examined the frequency and the period of occurrence of ASD in the affected group and the difference between the two groups. At fixed segments, corrected disc height and intervertebral angle were measured using CT. The degree of disc degeneration at adjacent segments was classified using Pfirrmann criteria on MRI, and disc height measured using CT. Results: ASD was identified radiographically in 23% (8/35) of patients. Five of these 8 patients developed ASD within a year. There was no significant difference in corrected disc height or intervertebral angle between the two groups at any fixed segment (Group 1, 4.18 ± 1.93 mm; Group 2, 4.05 ± 1.85 mm ($p > 0.05$); Group 1, 2.86 ± 1.68°; Group 2, 2.59 ± 1.82° ($p > 0.05$)). At adjacent segments, there was no significant difference in preoperative disc height between the two groups (Group 1, 9.38 ± 2.77 mm; Group 2, 9.74 ± 2.96 mm). However, there were more segments with Pfirrmann grade 3 degeneration in Group 1 ($p < 0.01$). Conclusion: Corrected disc height and intervertebral angle at the fixed segment, and preoperative disc height of the adjacent segment were not obvious risk factors for ASD after OLIF. However, compared with conventional posterior LIF, overcorrection after OLIF may be a risk factor for ASD. Pfirrmann grade 3 degeneration at adjacent segments may pose a greater risk than grades 4 or 5.

P188

IS THE DURATION OF PRE-OPERATIVE CONSERVATIVE TREATMENT ASSOCIATED WITH THE CLINICAL OUTCOME FOLLOWING SURGICAL DECOMPRESSION FOR LUMBAR SPINAL STENOSIS? AN ANALYSIS FROM AN INTERNATIONAL SPINE REGISTRY

Thomas Zweig,Anne Mannion,Markus Melloh, Rolf Sobottke,Brian Freeman,Emin Aghayev
theSpinecenter Bern, Switzerland

Background: The timing of surgery for lumbar spinal stenosis (LSS) varies from shortly after the onset of symptoms to several years of conservative treatment. The study investigated association between the duration of pre-operative conservative treatment and the ultimate outcome following LSS surgery.
Methods: The study was based on an international spine registry. LSS patients without spondylolisthesis, previous surgical treatment and additional spinal pathologies who were treated using spinal decompression and had a preoperative and at least one post-operative patient assessment between 3–30 months were analysed in the study. The query resulted in 3'478 patients who were stratified in four groups: 1) no pre-operative treatment (14.3%), 2) conservative treatment 12 months (36.1%). The inverse probability of treatment weighting using the propensity score was applied to balance the groups for their characteristics. Outcome measures included the minimum clinically important change (MCIC) of 2 points for back pain, leg pain, Core Outcome Measures Index (COMI) score, surgical complications, general complications, and operation time >2 hours.
Results: Patient group was not associated with MCIC in leg pain, COMI score, or with surgical or general complications ($p > 0.08$). Patient group (1 vs. 2 odds ratio [OR] 0.77, 95% confidence interval [95%CI] 0.62-0.96; 3 vs. 2 OR 0.77, 95%CI 0.63-0.93; p=0.021) was associated with MCIC in back pain. Patient group (3 vs. 2 OR 1.39, 95%CI 1.11-1.74; p=0.038) was associated with longer operation time.
Conclusions: A longer conservative treatment is not detrimental to the ultimate surgical outcome of lumbar spinal decompression.

P189

POTENTIAL INVOLVEMENT OF INFLAMMATORY CYTOKINES IN THE ETIOLOGY OF IDIOPATHIC SPINAL EPIDURAL LIPOMATOSIS

Nobuyuki Fujita,Naobumi Hosogane,Tomohiro Hikata,Akio Iwanami,Kota Watanabe,Yuta Shiono, Eijiro Okada,Masayuki Ishikawa,Keisuke Horiuchi,Masaya Nakamura,Morio Matsumoto, Ken Ishii
Keio University School of Medicine 181-0002 Tokyo, Japan

Introduction: Spinal epidural lipomatosis (SEL) is a rare disorder characterized by an abnormal

accumulation of non-encapsulated adipose tissue in the epidural space. Patients with SEL are usually presented with a variety of neurologic symptoms, including back pain, radiculopathy, claudication, myelopathy, and cauda equina syndrome. SEL is often associated with history of steroid use; on the other hand, the etiology of idiopathic SEL remains poorly understood.
Aim: To elucidate the molecular basis of idiopathic SEL.
Materials and Methods: Clinical data were collected from patients who underwent decompression surgery in 4 different hospitals from June 2013 to June 2015. Patients with relatively severe SEL (epidural fat / spinal anteroposterior diameter ratio > 60% at the level responsible for the clinical symptoms) were included in the study (SEL group, 16 patients). Age- and sex-matching patients without SEL who underwent decompression surgery for lumbar canal stenosis were selected as controls (Ctrl group, 15 patients). The following parameters were analyzed in these two groups; BMI, medical history, histology and the size of adipocytes of the epidural fat tissues, and the expression levels of the transcripts for adiponectin, leptin, TNF-α, IL-1β, IL-6, and IL-8.
Results: SEL group included 15 men and 1 woman with a mean age of 71.5 years and Ctrl group 14 men and 1 woman with 70.3 years. Consistent with past studies, SEL group had a significantly higher mean BMI than Ctrl group (29.1 kg/m2 vs 25.2 kg/m2, P=0.006). The average adipocyte size in the epidural fat was significantly larger in SEL group than in Ctrl group (2846.8 μm2 vs 1699.0 μm2, P=0.017). There was a significant increase in the expression levels of the transcripts for TNF-α and IL-1β in SEL group compared to Ctrl group (2.59 fold increase (P=0.023) and 2.60 fold increase (P=0.015), respectively). Whereas, there was no significant difference in the expression levels for the transcripts for adiponectin, leptin, IL-6, or IL-8.
Discussion: Our data suggest that idiopathic SEL is associated with higher BMI and larger adipocytes in the epidural fat. Of note, we found a marked increase in the expression of two major inflammatory cytokines (TNF-α and IL-1β). These observations indicate that these cytokines are casually related to the etiology or the neurological symptoms in SEL and may serve as molecular targets to treat patients with this disorder.

P190

CAUSE AND RATE OF REVISION SURGERY FOR THE PATIENTS WITH ADULT SPINAL DEFORMITY

Daisuke Togawa,Tomohiko Hasegawa,Yu Yamato, Sho Kobayashi,Tatsuya Yasuda,Shin Oe, Tomohiro Banno,Hideyuki Arima,Yuuki Mihara, Kenta Kurosu,Yukihiro Matsuyama
Hamamatsu University School of Medicine Hamamatsu 4313192 Shizuoka, Japan

Introduction: Corrective surgery for adult spinal deformity (ASD) requires adequate decompression, correction, and often long fusion by highly invasive procedure. This procedure is a high risk of postoperative complications, especially for high age patients.
Aim: The purpose of this study was to investigate the cause and rate of revision surgery for the patients with adult spinal deformity.
Materials and Methods: From October 2010 to August 2015, 282 consecutive patients with adult spinal deformity underwent corrective long fusion surgery from thoracic to lumbar or pelvis. There were 56 males and 226 females with average age of 63 years old. The pathologies of these patients included kyphoscoliosis (KS), kyphosis with vertebral fractures (VF), Kyphosis (K), adult idiopathic scoliosis (AIS), Deformity with Parkinson disease (PD), iatrogenic flatback (IF), and congenital or syndromic scoliosis (CD). The patients underwent revision surgery were investigated; 1) gender and age in decade at the primary surgery, 2) frequency of revision surgery by ages, 3) rate of revision surgery per pathology, 4) cause of revision surgery, 5) number of revision surgery per case, 6) final clinical outcome (Oswestry Disability Index (ODI)) comparing revision group with non-revision group.
Results: Seventy-seven revision surgeries were performed in 55 patients with ASD required revision surgery (20%, Male 11, Female 46, average age at primary surgery: 69, age 30s: 1, 40s: 3, 50s: 4, 60s: 19, 70s: 25, 80s: 5). Pathologies of these patients were KS 19 (22%),

VF 11 (25%), K 8 (53%), PD 6 (21%), AS 3 (7%), and CD 2 (18%). Causes of revision surgery were progression of deformity 24 cases (proximal 13, distal 10, coronal 1), rod fracture 19 cases, infection 12 cases, postoperative hematoma 11 cases, skin trouble due to instrumentation 5 cases, screw malposition 4 cases, and neural compression: 2 cases. All rod fractures were occurred either at 3-column osteotomy sites or L5/S disc level. Numbers of revision surgery were 1 time: 39 cases, 2 times: 11 cases, and 3 times: 4 cases, and 4times: 3 cases. Average scores of Oswestry Disability Index at final follow-up were 33.4 in non-revision group and 37.5 in revision group (P=0.23). Conclusions: Revision rate of our ASD series was 20%. Adjacent segment diseases and rod fractures were most frequently observed in this series. Although there was no significant difference in final clinical outcome between revision group and non-revision group, further research is necessary to closely look at the cause of revision surgery, and to establish the better surgical planning to reduce the rate of the revision surgery. Three or 4 rod placement covering for the 3-column osteotomy site and/or L5/S1 disc level is one of the option to prevent rod fractures, and using intrawound vancomycin power might be able to achieve to reduce the infection rate.

P191

COMPARISON OF MINIMALLY INVASIVE V.S. TRADITIONAL OPEN POSTERIOR PROCEDURE COMBINED WITH XLIF IN THE TREATMENT OF LOW BACK PAIN DUE TO ADULT SPINAL DEFORMITY IN THE ELDERLY

Hiroshi Yamada, Munehito Yoshida, Hiroshi Hashizume, Akihito Minamide, Yukihiro Nakagawa, Hiroshi Iwasaki, Shunji Tsutsui, Masanari Takami, Shinichi Nakao, Ryohei Kagotani

Wakayama medical university 641-8509 + Wakayama city, Japan

Introduction: The surgical treatment of low back pain (LBP) due to adult spinal deformity (ASD) has long been challenging, especially in the elderly patient population because of a high risk of complication. To date, minimally invasive surgeries (MIS) have been popularized and applied to the treatment of ASD. However, there has been little published data evaluating the effectiveness and feasibility of these treatments for LBP in the elderly.

Aim: We performed comparative radiological and clinical effectiveness analysis for minimally invasive versus open posterior procedures combined with the extreme lateral interbody fusion (XLIF) for the treatment of LBP due to ASD in the elderly.

Materials and Methods: Patients were eligible for study enrollment if they were at least 65 years of age, diagnosed of scoliosis with Cobb angle of at least 20° and/or kyphosis with lumbar lordosis of less than 20°. All patients underwent an XLIF procedure with posterior percutaneous pedicle screw fixations (PPS) or traditional open pedicle screw fixations (OPS). Clinical outcomes included operative time, estimated blood loss, VAS (100mm method), ODI (%), SF-36, patient satisfaction and complications were recorded. X-ray was used to evaluate coronal Cobb angle, PI-LL, PT & SVA pre and postoperatively.

Results: 15 PPS with an average age of 71.9 years and 9 OPS with an average age of 73.1 years were enrolled. Radiological improvements of PI-LL($p=0.0598$) and SVA($p=0.012$) of open procedure were significantly superior to those of MIS, while estimated blood loss was greater ($p < 0.0001$) and operative time was longer($p < 0.0001$). PPS versus OPS demonstrated similar improvement in patient-reported outcomes assessed. PPS had fewer major complications in the perioperative period than those undergoing open procedure (6.4% vs. 44.4%).

Conclusion: This study demonstrated the clinical usefulness of PPS combined with XLIF in the treatment of ASD in the elderly. PPS procedure is associate with similar clinical results after OPS, while having a substantially less blood loss, operative time and lower major complication rate. The combination of XLIF and PPS may become the gold standard for the treatment of LBP due to ASD in the elderly.

P192

DEVELOPMENT AND VALIDATION OF THE IDI. A SHORT SELF-RATING DISABILITY INSTRUMENT FOR LOW-BACK DISORDERS

Norbert Boos, Cornelia Rolli-Salathé, Michael Mayer, Michael Ogon,A lex Tuschel, Achim Elfering

Prodorso Centre for Spinal Medicine 8006 Zürich, Switzerland

Introduction: The prerequisite for a widespread use of quality management in daily clinical practice relies not only on data validity and reliability but also on the simplicity of data collecting and handling.

Aim: We therefore developed and validated a short, reliable and valid questionnaire for the assessment of LBP related disability in a cross-sectional and longitudinal validation study.

Materials and Methods: The so-called iDI was created in a step-wise procedure: 1) The development was based on the literature and theoretical consideration. 2) Outcome data was collected and evaluated in a pilot study. 3) Final validations were performed based on an international multicenter spine surgery outcome study including 514 patients. 4) The iDI was programmed for a tablet computer (iPad) and tested for its clinical practicability. The iDI was compared to the Oswestry Disability Index (ODI), Roland and Morris Disability questionnaire and the EQ-5D.

Results: The final version of the iDI comprises of 8 simple questions related to different aspects of disability with a five-point Likert answer scale. Overall, 514 patients have been included in all three studies. 118 participated in the pilot study, 306 in the multicentre outcome study (follow-up >6 months) and 90 in the electronically iDI assessment. Cronbach's alpha revealed that the strength of the relationship between the items within the test instrument are comparable for both questionnaires (iDI: .92, ODI: .93). The extent to which the same results are obtained on repeated measures when no changes are expected have been analysed with a test re-test analysis: ICCagreement demonstrated comparable values for both questionnaires (iDI: .97, ODI: .98). Explained variance is slightly higher for the iDI (.68) compared to the ODI (.63). The hypothesis regarding convergent validity (i.e. all questionnaires are expected to positively correlate moderate to high to the RMDQ (r=.80) was confirmed. Similarly, the hypothesis regar-ding divergent validity (i.e. all questionnaires are expected to negatively correlate to the EQ-5D was confirmed (r=-.76). With regard to completion time in the electronically assessment, a sample of n=63 filled out the ODI in 137.0s (mean), while they answered to the iDI in 70.8s (p<.001). Only 3 patients could not handle the electronic device due to peripheral neuropathies and needed full assistance by our staff.

Conclusion: Although the iDI has less items than the ODI, reliability and validity measures are comparable. Factor analysis revealed higher item loadings and higher percentages of explained variance for iDI. The simple application and programming of the iDI on a tablet computer (iPad) was demonstrated. Missing data are omitted improving overall data quality. The iDI exhibits advantageous features and can therefore be seen as an alternative for the assessment of self-reported disability.

P193

SURGICAL TREATMENT OF LOW LUMBAR OSTEOPOROTIC VERTEBRAL COLLAPSE

Nakajima H, Honjoh K, Sakamoto T, Kitade M, Izubuchi , Yamamoto Y

Department of Orthopaedics and Rehabilitation Medicine, Faculty of Medical Sciences University of Fukui 910-1193, Japan

Introduction: Low lumbar osteoporotic vertebral collapse (OVC) has not been well documented compared OVC of the thoracolumbar spine. The differences between low lumbar and thoracolumbar lesions should be studied to provide better treatment.

Aim: The primary purpose of this study was to discuss the appropriate choice of surgical treatment and outcome for low lumbar OVC. For this purpose, we examined the differences in clinical and imaging features and associated neurological symptoms of low lumbar OVC compared those of thoracolumbar lesions.

Materials and Methods: Thirty patients (men, 10; women, 20, age 79.3 years) with low lumbar OVC affecting levels below L3 underwent

surgical treatment. The surgeries for patients with cleft formation at affected vertebra (n=14) were vertebroplasty (VP) in 2 patients, and the combination of decompression, VP, pedicle screw fixation (PS), and postero-lateral fusion (PLF) in 12 patients. For patients without cleft formation (n=16), we performed decompression, PS, and PLF in 10 patients, and posterior lumbar interbody fusion (PLIF) in 4 patients. In 2 cases, correction osteotomy was performed. The clinical symptoms, morphological features of affected vertebra, sagittal spino-pelvic alignment, neurological status before and after surgery, and surgical procedures were reviewed at a mean follow-up period of 2.4 years.

Results: The mean age of the patients is considerably older than that of patients with thoracolumbar vertebral collapse (70.3 years) described in our previous study. The main clinical symptom was radicular leg pain. The average lumbar spine BMD of these patients was 0.64 g/cm2 indicating poor bone quality. Most patients had old compression fractures at thoracolumbar level. The affected vertebra was flat-type and concave or H-shaped type, not wedge type as often found in thoracolumbar OVC. There were mismatches between pelvic incidence (PI) and lumbar lordosis (LL) on the plain radiographs. On CT and MR images, foraminal stenosis was seen in 18 patients (60%) and canal stenosis in 24 patients (80%). Decompression with short fusion from posterior approach was performed. Augmentations of VP, PLF, and PLIF were performed based on the presence/absence of local kyphosis of lumbar spine, cleft formation, and/or intervertebral instability. Although the neurological and VAS scores improved postoperatively, 8 patients developed postoperative complications (26.7%) mainly related to instrumentation failure. In patients with postoperative complications, lumbar spine bone mineral density was significantly low; but the spino-pelvic alignment showed no correlation when compared with those without complications.

Conclusion: The main types of low lumbar OVC were flat-type and concave type that resulted in neurological symptoms by retropulsed bony fragments generating foraminal stenosis and/or canal stenosis. For patients with low lumbar OVC, decompression of the foraminal and canal stenosis with short fusion surgery from posterior approach can improve neurological symptoms. Since these patients are elderly with poor bone quality and other complications, treatments for both OVC and osteoporosis should be provided to achieve good clinical outcome.

P194

EFFECT OF BOOMERANG-SHAPED CAGE VERSUS BOX-SHAPED CAGE ON THE LOCAL ALIGNMENT AFTER POSTERIOR LUMBAR INTERBODY FUSION WITH BILATERAL FACETECTOMY

Kei Kuroki,Masahiro Kanayama,Fumihiro Oha, Yukitoshi Shimamura,Yuichiro Hisada,Kahoru Tashiro, Yuki Suzuki,Tomoyuki Hashimoto, Norimasa Iwasaki

Spine Center, Hakodate Central Hospital 0408585 Hakodate, Japan

Introduction: Sagittal alignment in spinal instrumentation surgery has been widely reported in recent years. Lumbar lordosis is one of the important factors in making optimal sagittal alignment of the whole spine. Posterior interbody fusion (PLIF) and transforaminal interbody fusion (TLIF) are common surgical techniques for degenerative spinal diseases. Several designs of the cage shapes are now widely used, and these designs might make differences in postoperative lordosis. Aim: In this study, we compared the effects of two types of cage designs (boomerang-shaped versus box-shaped) on the local alignment after PLIF/TLIF.

Materials and Methods: 168 patients who had undergone PLIF or TLIF from August 2014 to September 2015 in our institution were reviewed retrospectively. We compared 103 levels in 85 patients who had undergone a PLIF with bilateral placement of box-shaped cages (box group) versus 126 levels in 83 patients who had undergone a TLIF with single boomerang-shaped cage (boomerang group). The same decompression procedure was employed in both groups using bilateral facetectomy. Radiographic assessment was performed before surgery and 3 weeks after surgery using upright whole spine radiographs. The parameters included segmental lordosis, and anterior/posterior disc heights.

Results: Postoperative segmental lordosis had no statistical difference between the two groups (13.4° in the box group vs 14.2° in the boomerang group, P=0.43). However, lordosis gained by surgery was significantly higher in the boomerang group (2.8° vs 5.1°, P=0.01). Anterior disc height had no difference between the groups (11.4 mm in box vs 11.8 mm in boomerang, P=0.31), but posterior disc height was significantly lower in the boomerang group (7.1 mm vs 5.9 mm, P<0.001). Regarding the amount of correction depending on the fusion level, the increase in lordosis was relatively smaller in L5/S1 when compared with the other levels (2.5° vs 4.4°, P=0.12). The preoperative lordosis was significantly larger in L5/S1 than in other levels (14.6° vs 8.9°, P<0.001).
Conclusion: Use of boomerang-shaped cage was more beneficial to gain segmental lordosis at the fusion site than box-shaped cage, especially at the levels except L5/S1. Although cage design did not affect the anterior disc height, boomerang-shaped cage might be favourable to allow greater compression force to pedicle screws because of avoiding impingement between cage and posterior endplates. Since L5/S1 had larger lordosis preoperatively, the amount of correction might be limited in L5/S1 level. Use of boomerang-shaped cage in PLIF/TLIF should be effective procedure to restore optimal local alignment.

P195

RADIATION EXPOSURE TO THE SURGEON AND PATIENT DURING A FLUOROSCOPIC PROCEDURE

Kazuta Yamashita,Kosaku Higashino,Toshinori Sakai,Yoichiro Takata,Mitsunobu Abe,Masatoshi Morimoto,Yoshihiro Fukui,Koichi Sairyo
Department of Orthopedics, Institute of Biomedical Sciences, Tokushima 770-8503, Japan

Introduction: Awareness of the harmful effects of long-term low-dose radiation is rising. There are no all-inclusive reports evaluating the radiation exposure dose to medical staff associated with fluoroscopic procedures which can accurately simulate the real clinical situation.
Aim: To evaluate the radiation exposure dose from C-arm fluoroscopy, which is used to generate real-time images of the lumbar vertebral body, under a variety of conditions and in different areas.
Materials and Methods: Seven fresh cadavers were irradiated for 1, 3, and 5 min with C-arm fluoroscopy. The X-ray source was positioned under the table, over the table, and laterally. Radiation exposure doses were measured at different simulated areas such as the center area, and the surgeon's hand or thyroid gland.
Results: There were significant differences in the radiation exposure dose under different conditions and for different irradiated areas. The risk of direct and scatter radiation exposure was the greatest with the lateral position, which increased by more than 200 times and more than 30 times, respectively, compared with that from a position under the table. Direct radiation was attenuated to less than one-hundredth after passing through the body of the cadaver. All radiation exposure doses were positively correlated with total exposure time.
Conclusion: Our study revealed the direct and scatter radiation exposure dose from C-arm fluoroscopy to different areas under a variety of conditions when fluoroscopy is used to generate real-time images of the lumbar vertebral body. Our results serve as a guide for medical staff to understand the risk of radiation exposure during each fluoroscopic procedure. Medical staff, especially surgeons, should consider how to protect themselves and reduce radiation exposure by using appropriate shielding.

P196

MODIC CHANGE TYPE III MAY BE A RISK FACTOR FOR LOW BACK PAIN IN PATIENTS WITH LUMBAR SPINAL STENOSIS

Kazuki Fujimoto,Seiji Ohtori,Kazuyo Yamauchi, Sumihisa Orita,Kazuhide Inage,Jun Sato, Yasuhiro Shiga,Koki Abe,Hirohito Kanamoto, Masahiro Inoue,Hideyuki Kinoshita,Kazuhisa Takahashi
Department Orthopedic Surgery, Graduate School of Medicine, Chiba University Chuo-ku, Chiba 260-8670, Japan

Purpose: Modic changes (MCs) are a common phenomenon on magnetic resonance imaging (MRI) of patients with spinal degenerative diseases and thought to be tightly linked to low back pain (LBP). The appearance of LBP and the occurrence of MC are not synchronized, thus the relationship between the type of MC and the degree of LBP should be elucidated. The purpose of the current study was to determine the prevalence of MC in patients with single-level lumbar spinal stenosis (LSS), especially at L4/5, and to define the relationship between the type of MC and the degree of LBP in these patients.
Methods: We retrospectively examined 119 patients (mean age = 69.5 ± 13.0 years) who complained of LBP and radicular pain for single-level LSS at L4/5 and underwent lumbar surgery between 2008 and 2012. All of the patients had undergone a physical examination and MRI scan before surgery, and the physical findings and image findings were consistent. At the same time, the type of MC at L4/5 and the degree of LBP were noted. MC was divided into 3 types (I – III) using the Modic classification system. LBP was assessed using a visual analog scale (VAS) pain score (cm).
Results: The prevalence of MC was 60.5% (72/119: type I, 15 [12.6%]; type II, 16 [13.4%]; type III, 41 [34.5%]). The average VAS score before surgery was significantly increased in parallel with the increase in MC type (type I, 6.5 ± 1.8; type II, 7.25 ± 1.5; type III, 7.9 ± 1.7; $p < 0.05$). Conclusion: In previous reports, MC type I was most common and most strongly associated with LBP than the other MC types. In the current study, however, MC type III was most common in L4/5 single-level LLS patients and the pre-operative VAS score of MC type III was the highest. Based on these results, LBP in LSS patients may arise from the radiculopathy due to intervertebral foraminal stenosis caused by intervertebral disc height narrowing of MC type III.

P197

WRONG SITE SURGERY IN SPINE

Nobuhiro Hara, Takashi Yamazaki, Satoru Matsutani
Musashino Red Cross Hospital 1800023 Tokyo, Japan

Introduction: The report of wrong site surgery is a few though it is one of the important accidents in spine surgery.
Materials and Methods: We picked wrong site surgery out from incident report in our hospital since 1996. Definition of wrong site surgery in spine was to be found after scheduled operation, for example in posterior decompression, to be found after laminectomy. Marking methods in our institution is following: in lumbar surgery, 18G needle is inserted into spinous process before operation in the op room, and antero-posterior and lateral X-ray are taken. In cervical surgery, if the operation is including C3 level, touch the C2 spinous process in the operation. If the operation level is not including C3, bite the spinous process with forceps and lateral X-ray is taken.
Results: The number of incident reports by orthopaedic surgeon in our hospital was 769 from 1996 to 2014. The frequency of occurrence of wrong site surgery in spine was 0.30% (12/3977), 0.10% (1/1003) in cervical spine, 0.48% (2/411) in thoracic, and 0.34% (9/2625) in lumbar surgery. Eleven cases were decompression surgery and one case was used instrumentation. The mean BMI of the patients was 24.4 (16.9-32.5). The average years of experience of the surgeon was 11.2 (4-20). Ten cases were pointed out just after operation, and re-operations were carried out on the same day. The surgeons found it wrong site by X-ray in nine of these ten cases. One case was found because of absence of expected herniation of the lumbar disc. Two cases were found the following days by examining CT. Most frequent reason of wrong site surgery was misunderstanding of the marker level (10/12). In most cases, the surgeons had lack of understanding relationship between spinous process and laminae. It was difficult to identify the marker level in 2 cases of thoracic, ossification of ligaments and obesity patients.
Conclusion: We found twelve wrong site spine surgery from 3,977 cases since 1996. To remove the authority gradient is important to avoid misunderstanding the marker level.

P198

PREDICTION OF TREATMENT OUTCOMES FOR PATIENTS WITH CHRONIC LOW BACK PAIN: THE DEVELOPMENT OF A CLINICAL DECISION GUIDELINE FOR SPINE SURGEONS

Miranda van Hooff,Hanneke van Dongen, Maarten Spruit,Veerle Coupé,Raymond Ostelo, Marinus de Kleuver

Sint Maartenskliniek 6522 JV Ubbergen, Netherlands

Introduction. Chronic Low Back Pain (CLBP) is among the most common reasons why patients visit a spine surgeon. As the CLBP population is heterogeneous, it remains a challenge to address etiology and to suggest treatment options. Evidence in literature recommends developing a decision tool to triage towards either surgical or nonsurgical interventions. The Nijmegen decision tool, consisting of a web-based questionnaire and a systematic follow up of outcomes, is built in a patient-based online system. It is developed to support patient-triage and is based on current evidence and professional (Delphi) consensus. Since April 2012 all new patients complete the questionnaire, consisting of 47 indicators potentially predicting successful treatment outcome or persistence of pain complaints, and are systematically followed over time.

Aim: To determine pre-intervention patient profiles and to develop a decision algorithm, based on indicators predicting successful one-year follow-up outcome of spine surgery and of a non-surgical, multidisciplinary Combined Physical and Psychological (CPP) program.

Materials & Methods. A consecutive cohort study was performed. Diagnostics and decision-making were performed 'as usual'. Data of patients were included who completed the one-year follow-up assessment: 219 had surgery and 171 followed a multidisciplinary CPP-program. The outcome was functional status (Oswestry Disability Index v2.1a [ODI]) and being successful was defined as one-year improvement to an absolute ('normal'/healthy) ODI-threshold (value≤22). The 47 potential predictive indicators included indicators in the sociodemographic, pain-related, somatic, psychological, functional and quality of life domains. After data cleaning and having fulfilled all assumptions for analyses, for each cohort a separate multiple logistic regression analysis was performed.

Results. Probability of successful surgical outcome: the prediction model (R2=31%) included pre-treatment previous surgery (OR 0.390 [95%CI 0.201-0.757]), expectations of recovery (OR 2.830 [95%CI 1.391-5.756]), expectation of work return (OR 0.824 [95%CI 0.706-0.960]), pre-treatment functioning (OR 0.961 [95%CI 0.939-0.984]), and 'red flag' for age (pain started age 50 years; OR 2.321 [95%CI 1.214-4.435]). Probability of successful CPP-program outcome: the prediction model (R2=26%) included pre-treatment functioning (OR 0.963 [95%CI 0.937-0.990]), somatization (OR 0.199 [95%CI 0.065-0.610]), and depressed mood (OR 0.205 [95%CI 0.063-0.665]).

Conclusion. Different patient profiles predicting either a successful outcome for spine surgery or for CPP program are determined. The presented profiles are based on first analyses. After final analyses the prediction models, for treatment success, will be converted to probability formulae and built in the online tool. For every new patient the probabilities for treatment success will be available in the electronic patient file. We expect that this relatively simple decision tool will considerably help daily spine practice to guide and triage the right patients to the right practitioners and to enhance personalized care. We will present the final prediction models at the conference.

P199

IMPACTS OF PERCUTANEOUS POSTERIOR FIXATION SURGERY ON THE PERFORMANCE STATUS, ACTIVITIES OF DAILY LIVING, AND QUALITY OF LIFE IN PATIENTS WITH SPINAL METASTASIS

Takashi Yurube,Kenichiro Kakutani,Koichiro Maeno, Toru Takada,Shingo Miyazaki,Yoshiki Terashima, Masaaki Ito,Yuji Kakiuchi,Yoshitada Sakai, Masahiro Kurosaka,Kotaro Nishida

Kobe University Graduate School of Medicine Chuo-ku Kobe 650-0017, Japan

Introduction: Spinal metastasis can cause severe neurological deficit and/or pain, resul-

ting in a drastic loss of the patients' performance status (PS) and activities of daily living (ADL). We performed open surgery of internal fixation and/or decompression or only posterior fixation surgery using percutaneous pedicle screws (PPS) based on the severity of symptoms. However, compared to open surgery, little evidence exists regarding clinical impacts of PPS on spinal metastasis.

Aim: To clarify effects of PPS surgery on the PS and ADL in patients with spinal metastasis.

Materials and Methods: Between 2013 and 2015, 60 patients who had thoracic or lumbar spinal metastasis with neurological complications and/or pain were prospectively enrolled and underwent spinal surgery with optimal treatments including radiation, chemotherapy, cancer rehabilitation, and palliative care services. They consisted of 18 who took PPS and 42 who received open surgery. Evaluation was performed at postoperative 0, 1, 3, and 6 months by the Eastern Cooperative Oncology Group PS, Barthel index (BI) for ADL, EQ-5D for the quality of life (QOL), and Frankel classification for neurological status. The $\chi 2$ or Student t-test was used with significance of $P<0.05$.

Results: No obvious differences in the patient age, sex, number of metastatic and operated vertebrae, and preoperative Tokuhashi and Katagiri classification scores were detected between patients with PPS and those with open surgery. 96.7%, 85.0%, 91.7%, and 91.7% of patients took radiation, chemotherapy, rehabilitation, and palliative cares, respectively. Operation time was shorter and perioperative bleeding volume was smaller in patients with PPS ($P<0.01$ and $P=0.01$, respectively), indicating less invasion of PPS surgery. Then, 94.4% of patients with PPS showed preoperative Frankel grades DE paralysis while 57.1% of those with open surgery demonstrated Frankel grades ABC ($P<0.01$); so, we performed PPS, targeting patients with useful motor function. Consequently, 83.3% (PPS) and 81.6% (open) surgery improved Frankel grade ≥1 throughout 6 months. In the PS, no remarkable difference was observed preoperatively. However, patients with PPS had the tendency toward the improvement of PS maintained throughout 6 months (94.4% vs. 73.8%, $P=0.07$). Further, patients with PPS showed higher preoperative BI for ADL ($P=0.049$) and a higher improvement rate of the BI throughout 6 months (100.0% vs. 61.9%, $P<0.01$). Finally, although there was no significant difference in the EQ-5D for QOL, a higher EQ-5D improvement rate throughout 6 months was found in patients with PPS (83.3% vs. 65.7%, $P=0.02$).

Conclusion: PPS surgery can improve and maintain ADL and QOL for minimum 6 months in spinal metastatic patients with preserved motor function, indicating PPS as a less invasive, effective palliative therapy.

P200

MRI-BASED SCORING OF MULTIFIDUS INADEQUATELY CHARACTERIZES MUSCLE TISSUE QUANTITY AND QUALITY IN PATIENTS WITH CHRONIC LUMBAR SPINE DISEASE

Bahar Shahidi,James Hubbard,Michael Gibbons, Vinko Zlomislic,Steven Garfin,Richard Allen, Samuel Ward

University of California San Diego MC0863 San Diego 92093, United States

Introduction: Low back pain (LBP) is a complex condition and the leading contributor to disability in the United States. Individuals with LBP demonstrate deficits in functional capacity of the lumbar musculature. Current literature demonstrates muscle-specific changes in individuals with LBP including; decreased muscle volume, increased fatty infiltration and fibrosis, and changes in fiber area. Muscle quality is measured using imaging-based grading schemes (e.g. Kjaer grade), which are thought to be crude estimates of fatty degeneration. However, there are no comparisons of imaging estimations with direct histological measures of tissue composition and biology.

Aim: To compare MRI-based estimations of muscle quality with quantitative histological measurements of tissue composition and degeneration in individuals with chronic low back pain.

Patients and Methods: Eleven individuals (8 males, 3 females, mean(SD) age of 63(13) years) with chronic LBP undergoing a lumbar spinal surgery were recruited for this study. Intraoperative biopsies (150mg) of the lumbar multifidus muscle were obtained along spino-

laminar region on the ipsilateral side at the level of primary surgical intervention. Tissue was flash-frozen in liquid nitrogen and sectioned for histological analysis of fiber area and centralized nuclei (laminin/DAPI), collagen content (trichrome), and fat content (Oil Red O). Axial MRI images at the level of biopsy were also obtained pre-operatively using a 3T scanner and graded based on Kjaer grades. Histological outcomes of average fiber area, percent centralized nuclei, and percent composition of muscle, collagen, and fat were compared across Kjaer grades corresponding to greater than (Grade 2) or less than (Grades 0 and 1) 50% fatty infiltration.

Results: Of the 11 participants, 1 individual demonstrated a Kjaer grade of 0 (50% fatty infiltrate). Individuals with Kjaer grades of 0 and 1 were pooled due to low sample size in the grade 0 category. Mean (SD) fiber areas for individuals with low (50%) Kjaer grades were 4607.0 (1196.7) and 5738.3 (2289.2) μm2, respectively. Percent of fibers with centralized nuclei in each category were 22.1(8.4), and 24.5(14.4)%, respectively, which is clinically significant (~3% normal). Histological sections were composed of 53.7(20.3)% and 35.0(19.0)% muscle; 21.5(9.4)% and 31.7(12.2)% collagen; and 9.1(5.2)% and 16.9(7.6)% fat in low and high Kjaer grade groups respectively. At this preliminary stage, there were no significant differences in tissue composition measures between Kjaer grade groups ($p>0.16$).

Conclusion: Kjaer grades overestimate total muscle quantity in all patients. Clinically significant signs of prior muscle degeneration were present in all patients, regardless of Kjaer grade. Imaging-based categorization of muscle quantity and quality do not reflect the underlying histological composition of muscle.

P201

TRANSPEDICULAR FORAMINAL DECOMPRESSION: A NEW TECHNIQUE FOR THE MANAGEMENT OF RADICULAR PAIN FROM FORAMINAL STENOSIS

Francis Brooks,Robert Fraser
Royal Adelaide Hospital Adelaide, Australia

Introduction The surgical management of radicular pain from foraminal stenosis is a technical challenge, particularly in the setting of degenerative spondylolisthesis (DS) and degenerative scoliosis. Unilateral disc space narrowing often produces vertical compression of the dorsal root ganglion (DRG) within the foramen that is not amenable to standard medial or lateral foraminal decompressive techniques as they only increase AP but not vertical dimensions of the foramen. This has led to widespread use of TLIF for decompressing the foramen in DS and extensive instrumentation with curve correction for decompressing the foramen in degenerative scoliosis; and both are associated with significant morbidity including adjacent level disease. We present early results of a new and simpler method for decompressing the nerve root/DRG within the intervertebral foramen that obviates the need for extensive surgery and expensive implants. Technique The technique involves transpedicular decompression of the affected nerve root/DRG either on its own or in combination with the standard technique for lateral foraminal decompression. Through a midline skin incision the superior pedicle on the affected side is located via a Wiltse approach and the level is confirmed radiologically. A pedicle seeker is used to define the pedicle, preserving as much as possible of the overlying facet joint. With care and use of magnified vision a high speed burr (with, if necessary, a small curette and 2mm laminectomy punch) is used to remove the inferior and lateral cortical wall of the pedicle to expose the nerve root and DRG. Once complete this allows the DRG to move superiorly into the space created.

Results This procedure has been performed on 21 patients in a single surgeon's spinal practice since January 2014. The average age of the population was 68.4 years (31-84). Average follow up is 7.3 months (2-22 months). There were 12 males and 9 females. The reason for decompression in all groups was significant leg pain. Previous interventions had been performed in all patients with 57% having had previous surgery and 47% had previous surgery at the same level that included foraminal decompression. Pre-op mean VAS for leg pain was 8.5 compared with a post op VAS of 0.9. Post op all patients reported an improvement in leg pain and no patient has required further surgery. There have been no cases of pars or

pedicle fractures recorded and no other complications reported in this group.
Conclusions Transpedicular decompression of the intervertebral foramen appears to reliably improve pain and does not limit future surgical options, other than avoidance of screw insertion within the partly excised pedicle. With an ageing population and increasing pressures on the cost of health care this less destructive technique offers major advantages over procedures currently offered to patients with symptoms from foraminal stenosis associated with DS or degenerative scoliosis. Long term and larger studies are required to determine the precise efficacy of this procedure.

P202

STAND-ALONE MINIMALLY INVASIVE ANTERIOR LUMBAR INTERBODY FUSION FOR THE TREATMENT OF ADJACENT SEGMENT DISEASE: A CASE SERIES

Deeptee Jain,Kushagra Verma,Jun Mizutani, Shane Burch,Bobby Tay,Vedat Deviren
University of California San Francisco San Francisco 94117, United States

Introduction: Adjacent segment disease is a common following lumbar fusion surgery. Surgical treatment typically requires a posterior approach with decompression, fusion and extension of instrumentation to the affected level. Minimally invasive lateral interbody approach avoids the risks of revision surgery.
Aim: To comprehensively review the clinical outcomes, the radiologic outcomes, and the complications of a series with patients with adjacent segment disease treated with single level minimally invasive lateral interbody fusion.
Material and Methods: A retrospective chart review was conducted on all patients over a five year period who underwent minimally invasive anterior lumbar interbody fusion at our institution. Patients who underwent single level surgery for adjacent segment disease were included. Patients who had an additional posterior approach as a planned staged approach were excluded. Patient demographics collected were age, BMI, ASA score, and smoking status. Surgical data included blood loss, levels fused, and hospital length of stay. Radiographic outcomes included pre-op, immediate post-op, and final, sagittal vertical axis, lumbar lordosis, intervertebral lordosis, and segmental height. Clinical outcomes included VAS back pain, leg pain, ODI, and EQ5D. Finally, complications and reoperations were diligently followed. All radiographic measurements were made by the first author. Clinical and radiographic data was compared using a Wilcoxon sign rank test.
Results: Twenty-two patients (10 male, 12 female, age 62.9 ± 11.7, ASA 2.0 ± 0.4, 2 smoker, 20 non-smoker) underwent stand-alone single level minimally invasive lateral interbody fusion. Average follow up was 11.4 months. The levels performed were as follows: 1 at L1/L2, 5 at L2/L3, and 16 at L3/L4. Blood loss was 35 ± 15.5 mL. Hospital stay was 2.6 ± 2.5 days. VAS leg pain (6.4 ± 3.0 to 2.8 ± 3.3, $p = 0.01$), EQ-5D (0.49 ± 0.21 to 0.66 ± 0.15, $p = 0.019$), and ODI (52.9 ± 17.3 to 43.8 ± 18.7, $p = 0.007$) all significantly improved. VAS back pain trended toward improvement (5.2 ± 3.8 to 3.6 ± 3.1, $p = 0.17$). Intervertebral height significantly improved (6.5 ± 2.8 to 12.2 ± 2.6 mm, $p < 0.001$) and segmental lordosis trended toward improvement (12.6 ± 7.8 to 16.7 ± 8.3, $p = 0.09$). Five patients underwent revision operations with posterior instrumentation and extension of fusion: two for persistent radiculopathy, one for pseudarthrosis, one for cage subsidence and rotatory subluxation, and one for a fracture.
Conclusion: Minimally invasive lateral interbody fusion is an operation with minimal blood loss and short hospital stays. It is a good option for the treatment of adjacent segment disease, resulting in improved clinical outcomes and radiographic parameters.

P203

THE SHORTCOMINGS OF THE THORACOLUMBAR INJURY CLASSIFICATION AND SEVERITY SCALE AND THE LOAD-SHARING CLASSIFICATION IN THE EVALUATION OF THORACOLUMBAR BURST FRACTURES

Hiroyuki Katoh,Masahiko Watanabe,Akihiko Hiyama,Daisuke Sakai,Masato Sato,Joji Mochida
Dept of Orthopaedic Surgery, Surgical Science 143 Shimokasuya, Isehara Kanagawa 259-1193, Japan

Introduction: In the evaluation of thoracolumbar burst fractures, the thoracolumbar injury classification and severity scale (TLICS) grades the morphology of the spinal injury, the integrity of the posterior ligamentous complex, and the patient's neurological status to provide a final score and recommended treatment (5 surgical intervention). The load-sharing classification (LSC) system grades vertebral body comminution, fragment displacement, and kyphosis; a total score of 7 or above indicates a high probability of failure with posterior short segment fixation. Although these classifications provide guidance in the treatment of burst fractures, we occasionally encounter cases where we disagree with their recommendations.

Aim: The aim of this retrospective study is to examine the surgeries performed on thoracolumbar burst fractures, focusing on the discrepancies between the proposed surgical indications based on the TLICS and LSC systems and the actual surgeries performed.

Materials and Methods: Forty-eight cases of thoracolumbar burst fractures were surgically treated during January 2012 to July 2015. The TLICS and LSC scores, surgical methods, and radiological parameters were examined.

Results: The TLICS and LSC scores were generally in agreement, with a significant positive correlation ($r=0.374$, $p<0.01$). However, there were cases with apparent discrepancies between the TLICS and LSC scores. Three cases with LSC scores of 6 or below had TLICS scores of 5, due to the presence of neurological symptoms or posterior ligament damage. Nineteen cases received surgery with TLICS scores of 3 or less, for which conservative treatment is recommended. Surgery was deemed necessary due to the high kyphotic angulation (average 31.4 degrees), high canal encroachment ratio (average 42.8%), or the presence of vertebral split fractures (8 cases). Examination of the 29 cases with LSC scores of 7 or greater (short segment posterior fixation insufficient), revealed cases with significantly higher canal compromise and neurological symptoms, requiring significantly more neural decompression procedures and bone grafts, as well as more aggressive vertebrectomy procedures either through anterior approaches or through posterior vertebral column resection procedures ($p<0.05$), verifying the significance of the LSC system. However, short segment posterior fixation was performed in 11 cases in contrary to the recommendation of the LSC. In 8 of these cases, vertebroplasty procedures were performed in order to fortify the load-bearing capacity of the fractured vertebra.

Conclusion: By incorporating assessment of neurological symptoms and posterior ligamentous complex conditions, the TLICS simplifies the decision-making process of surgical intervention. However, we believe that the weight of morphological status is undervalued, since burst fractures with intact morphology and fractures with severe comminution and kyphosis are uniformly assigned 2 points. The LSC can aid in making comprehensive decisions of surgical intervention. However, we fell that a modification of the TLICS to incorporate adequately weighted points for morphological characteristics is desired.

P204

BILATERAL DECOMPRESSIONS VIA UNILATERAL APPROACH FOR LUMBAR SPINAL STENOSIS HAVE ADVANTAGE? ~FOLLOW-UP STUDY~

Kenji Hatakeyama, Takato Aihara, Makoto Urushibara

Funabashi Orthopedic Hospital 274-0822 Funabashi city, Japan

INTRODUCTION: There was little advantage in preserving spinous processes in two-year follow-up for bilateral decompression via unilateral approach (BDU) when compared to laminotomy with cutting the basal part of those (ML). The purpose of this study was to evaluate the role of spinal processes by analyzing clinical results of BDU at minimum three-year follow-up after surgery.

METHODS: From 2010 to 2012, 50 consecutive patients with lumbar spinal stenosis, who underwent decompression surgery, were included. These surgeries were performed by one surgeon (H.K) and ML was done mainly in former period, on the contrary, BDU in later period. The number of patients was 24 in ML and 22 in BDU. (Four patients died this year). We compared the clinical outcome of these two groups. As clinical index, we used Japanese Orthopaedic Association Back Pain Question-

naire (JOABPEQ) score and VAS score of low back pain (LBP), leg pain and leg numbness. We evaluated them at before-surgery, 1, 3, 6, 12,24,36 months after surgery.
RESULTS: There was no difference between two groups about age, the number of levels decompressed, all five factors of JOABPEQ score and VAS scores before surgery ($p > 0.2$). Improvement rate of JOABPEQ score of BDU group was not significantly different. Regarding VAS scores of low back pain, BDU seemed to have advantage to ML at all times to three years, but not significant. In both groups, JOABPEQ scores were better at 3 or 6 months after surgery.
DISCUSSION: We make an effort to preserve spinous processes, because we believe those are important for spinal stability and those has a function of posterior loading. However, within three-year follow up, no statistical superiority was seen on this study for preserving spinous process. Conversely, ML operation has advantage with comparatively easy procedure and good results. We think further follow up and more cases are needed to prove the advantages of BDU.

P205

PATIENTS WITH AN ELEVATED SVA AND A LOW PT (LACK OF PELVIC COMPENSATION FOR A HIGH SVA) INDICATES A GREATER RISK OF DETERIORATION OF THORACIC KYPHOSIS FOLLOWING PEDICLE SUBTRACTION OSTEOTOMY FOR RIGID DEGENERATIVE LUMBAR KYPHOSIS.

Tomoaki Toyone,Tomoyuki Ozawa,Tishiyuki Shirahata,Yoshifumi Kudo,Akira Matsuoka
Showa University Shinagawa-ku 142-8666 Tokyo, Japan

Introduction: Pedicle subtraction osteotomy (PSO) provides good correction of lumbar kyphosis. Rose et al. reported that PI and TK can predict the lumbar lordosis, and that the formula PI + LL + TK < 45° showed 91% sensitivity for predicting ideal sagittal balance at 24 months after PSO. On the other hand, Lafage et al. reported that changes in thoracic kyphosis negatively Impact sagittal alignment following lumbar PSO, and concluded that risk factors for unfavorable thoracic reciprocal changes include larger pre-op PI and PT.
Aim: To evaluate the risk factors for deterioration of the thoracic kyphosis after PSO.
Materials and Methods: A total of 40 patients who had undergone corrective pedicle subtraction osteotomy were enrolled. Instrumentation was performed from middle or lower thoracic spine to L5 (L5 group: 18 cases) and S1 (S1 group: 22 cases). The average age at PSO surgery was 68 years (range, 45–77). Follow-up period was from 2 to 7 years. Clinical and radiological results were analyzed.
Results: Mean preoperative lumbar lordosis improved from -1° to 42°. All of the radiological parameters improved significantly. In 8 patients in whom LL>PI-10 was not obtained after surgery, PJK occurred in 3, adjacent level vertebral fracture occurred in 2, and loosening of S1 screw was observed in 1 patient. Although one patient in S1 group needed the revision surgery using iliac screws, no patient in the L5 group needed further fixation to the sacrum. In patients with an elevated SVA and a low PT (lack of pelvic compensation for a high SVA), thoracic kyphosis deteriorated up to 73 degrees, from -27 to 46 degrees.
Conclusion: Significant postoperative alignment changes resulting in SVA>100mm can occur through unfused thoracic spinal segments following lumbar PSO. Postoperative progression of thoracic kyphosis occur in patients with an elevated SVA and a low PT, representing lack of pelvic compensation for a high SVA.

P206

Comparative analysis of three different surgical strategies for adult spinal deformity

Junseok Bae,Alexander A. Theologis,Russell Strom, Bobby Tay,Shane Burch,Sigurd Berven, Praveen Mummaneni,Dean Chou,Christopher P. Ames,Vedat Deviren
Wooridul Spine Hospital Gangnam-gu Seoul, Korea, South

Introduction: Surgical treatment of adult spinal deformity (ASD) is a cost effective endeavor that may be accomplished using a variety of surgical strategies. Thus, we assess and compare radiographic data, complications, and health-related quality of life outcome (HRQoL) scores between ASD patients who underwent operation using a posterior-only approach (PSF

only), posterior approach combined with lateral lumbar interbody fusion (LLIF), and a posterior approach combined with anterior lumbar interbody fusion (ALIF).
Aim: Compare radiographic and clinical outcomes of ASD patients with three different surgical strategies.
Materials and Methods: Consecutive adults who underwent thoracolumbar fusions for ASD (2003-2013) were reviewed. Inclusion criteria: instrumentation from pelvis to L1 or above and minimum 2 years follow-up. Three column osteotomies were excluded. Three groups were compared: PSF only, LLIF, and ALIF. Peri-op spinal deformity parameters, complications, and HRQoLs (SRS-22, SF-36, VAS back and leg pain) were assessed for each group and compared to each other using ANOVA tests.
Results: Three hundred twenty one patients (PSF only: 116; LLIF: 68, ALIF: 137) met inclusion criteria. ALIF patients were on average younger and had lower BMIs than LLIF and Post. Average deformities consisted of SVA>5cm, PI-LL mismatch>170, PT>200, lumbar Cobb>200, and thoracic Cobb>150. Posterior-only patients had significantly lower preoperative lumbar Cobb angles, while ALIF patients had significantly lower preoperative TK. LLIF patients had significantly smaller preoperative SVAs, LL, and more commonly had a UIV at the thoracolumbar junction (T8-L1). Follow-up for LLIF was significantly less. At final follow-up, all radiographic parameters were similar between groups, except SVA, which was significantly lower for LLIF. Average number of complications was similar among groups. LLIF patients had significantly fewer PJKs and fewer UIV fractures. Posterior-only patients had significantly more pseudarthrosis and revision surgery for PJK. All preoperative HRQoL scores were similar between groups. After surgery, LLIF patients had significantly lower VAS back pain and ODI, and higher SRS self-image/satisfaction/ subtotal/total scores.
Conclusion: Satisfactory radiographic outcomes can be achieved similarly and adequately with different surgical approaches for ASD. Patients treated with LLIFs in this single institution, multi-surgeon cohort had lower rates of revision operations for pseudarthrosis and PJK as well as less back pain, less disability, and better SRS scores than patients treated with ALIFs and PSF or a posterior-only surgical strategy.

P207

TUBULAR SURGERY WITH THE ASSISTANCE OF ENDOSCOPIC SURGERY VIA PARAMEDIAN OR MIDLINE APPROACH FOR LUMBAR SPINAL CANAL STENOSIS OF SINGLE L4/5 LEVEL.

Jun komatsu, Masumi Iwabuchi, Hironari Fukuda, Takehiro Watanabe, Osamu Shirado
Aizu Medical Center Kawahigashi, 969-3492 Aizuwakamatsu, Japan

OBJECT: We undertook this study to document the clinical outcomes of two different method Microendoscopic laminotomy (MEL) and Microendoscopic muscle preservitng interlaminar decompression (ME-MILD), a minimally invasive decompressive surgical technique using spinal endoscopy for lumbar decompression, in patients with lumbar spinal stenosis(LSS). MEL was that tubular retractor and endoscopic system were used for posterior decompression with unilateral paramedian approach. Microendoscopy provided wide visualization through oblique lenses and allowed bilateral decompression via a unilateral approach, through partial resection of the base of the spinous process, thereby preserving the supraspinous and interspinous ligaments and contralateral musculature. On the other hand, ME-MILD approach was that tubular surgery with the assistance of endoscopic surgery via a midline approach is a minimally invasive surgical procedure with favorable results that enables preservation of paravertebral muscles and bilateral facet joints.
METHODS: A total of 274 patients were enrolled in the study and underwent microendoscopic decompression between 2000 and 2013. This study was a retrospective review of prospectively collected surgical data. The study comprised 76 patients (MEL 39 persons and ME-MILD 37 persons) with LSS who ranged in age mean age 68.7 years. The indications of surgery were moderate to severe stenosis, persistent neurological symptoms, and failure of conservative treatment over 3 months and the Japanese Orthopedic Association (JOA) score was under 15 points or Intermittent Claudication was 100m. Moreover, this study

investigated to patients with single L4/5 vertebrae level LSS. The patients with mechanical back pain, more than grade 2 spondylolisthesis, or radiographic signs of instability were not included. Clinical symptoms and signs of low-back pain were evaluated prior to and following surgical intervention by applying the Japanese Orthopaedic Association (JOA) scoring system, Japanese Orthopaedic Association Back Pain Evaluation Questionnaire (JOABPEQ). These items were evaluated preoperatively and 3 years postoperatively. RESULTS: The 3-year follow-up evaluation was completed for 76 patients. The average recovery rate based on the JOA score was 76.4% and 83.2% (MEL, ME-MILD, respectively). In all categories of JOA scores at 3 years' follow-up of both MEL and ME-MILD were significantly higher than those obtained before surgery ($p < 0.001$). All patients recovered, and there were no serious post-operative complications. The JOA score improved from 13.9 to 25.5 and 15.5 to 26.4 (MEL, ME-MILD, respectively). A dural tear in each one patient and infection in 4 patients of ME-MILD were the observed complication. There was no post-operative instability at the operated segment as evaluated with dynamic radiographs at final follow-up.

CONCLUSIONS: The aim of this study was to investigate the effectiveness of different methods of MEL and ME-MILD by evaluating the clinical outcomes with patient-oriented scoring systems. Collectively, these data suggest that the MEL and ME-MILD approach for lumbar decompression is less destructive to the paraspinous muscles and may facilitate better clinical outcomes. We concluded that ME-MILD is a safe and very effective minimally invasive technique for degenerative LSS as well as MEL. With an appropriate patient selection, the risk of post-operative instability is minimal.

P208

RELIABILITY OF EVALUATION FOR LUMBAR INTERBODY FUSION BY MULTI PLANER RECONSTRUCTION CT

Tomohiko Hasegawa,Hirotaka Haro,Jun Tkahashi, Shigehito Ebata,Yu Yamato,Sho Kobayashi,Daisuke Togawa,Yukihiro Matsuyama

Department of Orthopaedics, Hamamatsu University School of Medicine 431-3192 Hamamatsu, Japan

Introduction: High fusion rates were often reported evaluation by thin-sliced CT in PLIF. However, it is worthwhile to evaluate the process of fusion in lumbar interbody fusion until achieving the solid fusion. Fusion rate is sometimes changed by the fusion criteria.

Aim: The purpose of this study was to investigate the reliability of PLIF graft bone evaluation by using multi planer reconstruction CT (CT-MPR) in early periods and to identify what factor affects reliability of the fusion criteria.

Materials and Methods: This was a prospective, multicenter, randomized, controlled and blinded study. This study was performed as sub-analysis of the other study to investigate the effect of parathyroid hormone (PTH) therapy for the spinal fusion. Seventy female patients with osteoporosis were investigated. They underwent single level PLIF (L4/5 or L5/S) using local autograft and PEEK cage without PLF for lumbar degenerative disease. At 2, 4 and 6months after the surgery, CT-MPR was examined. Furthermore, they were examined blood test, DEXA before surgery and 6months after surgery. They were randomized to PTH group or non-PTH group just after surgery. CT-MPR images were evaluated in 3 sagittal and 3 coronal views within the cage were evaluated using the following grade (Grade 1: No lucency present at upper and lower side of graft, Grade 2U: No lucency present at upper side (cranial to the cage), Grade 2L: No lucency at lower side (caudal side of the cage) and Grade 3: lucency at both sides of graft). Evaluations were done by 4 board certified spine surgeons under blinded fashion. The grades with agreement of 4/4 and 3/4 were determined as final grade. When the grades were not determined under 2/4, final grade was made by discussion with the 4 experts. We investigated the reliability of fusion evaluation method by CT-MPR comparing with first and final grades in all CT-MPR data and analyzed by logistic regression test between the case of grades with 4/4 agreement and the others at 6M after surgery.

Results: The concordance rate in each grade between first and final evaluation were grade1:

92%, grade 2U: 63%, grade 2L: 57%, grade 3: 54%, and total concordance rate was 81%. Logistic regression test showed that hip BMD at 6M after surgery ($p<0.01$) and PTH therapy after surgery ($p<0.05$) had significantly associated with high concordance rate in CT-MPR evaluation.

Conclusion: Reliability of interbody fusion evaluation by CT-MPR was 81%. The evaluation was unstable especially in the cases with any lucent areas or in low BMD cases. Higher concordance rate of evaluation was observed in the cases underwent postoperative PTH therapy.

P209

RADIOGRAHICAL RESULTS OF A PROSPECTVE, MULTICENTER, OBSERVATIONAL STUDY OF TOTAL LUMBAR DIS REPLACEMENT, 24 MONTHS FOLLOW UP

Jean charles Le Huec,Richard Assaker

Hopital Pellegrin Tripode CHU Bordeaux 33000 Bordeaux, France

Introduction: Prospective, multicenter, observational study of total lumbar disc replacement.

Objectives: To report the radiographical results of a TLDR clinical study at 24 months follow up (NCT01338493).

Methods and Results: 11 international centers implanted 134 patients (pts) with a TLDR to treat back pain with or without radiculopathy linked to a degenerative disc disease (DDD). Available for follow up: 132 pts at 6 mo, 113 at 12 mo and 104 at 24 mo. Surgical parameters, Oswestry Disability Index (ODI), Visual Analog Scale (VAS) scores for back and leg pain, range of motion (ROM), implant position and adverse events (AEs) were assessed according to center's routine practice, follow up done 6, 12 and 24 mo. Extension-flexion measurements were used for range of motion. For ROM: ptss were subdivided into: Preserved ROM:>5° Limited ROM: 3-5° lost ROM:30%, >15% and >10%. Mean age 43 years, 52% female, mean BMI 25. The majority of the TDLR were one level (91.8%), 7.5% were two level and 0.7% three level. All single and multiple levels surgeries combined, most TDLR were done in L5-S1 (48.6%), while 45.2% were in L4-L5 and 6.2% in L3-L4. Subgroups: see Figure.

	Follow up		
	6mo	12mo	24mo
ODI score mean difference from BL (p<0.0001)			
ODI score	25.4	-29.2	-30.3
ROM increased at 6, 12 and 24mo (p=0.0055)			
ROM	1.3 (n=37)	0.9 (n=34)	2.8 (n=37)
Patients' range of motion (ROM) (%)			
Preserved ROM:>5°	70.0 % pts	70.0 % pts	69.0% pts
Limited ROM: 3-5°	14.0 % pts	17.0% pts	16.0% pts
Lost ROM:<3°	16.0 % pts	13.0% pts	15.0 % pts
Patient satisfaction 6, 12, 24mo			
Completely recovered/improved	96.0%	90.0%	80.0%
No change	3.0%	9.0%	10.0%
Slightly worse/worse	1.0%	1.0%	9.0%

	Levels			
	L3/L4	L4/L5	L5/S1	2+3 levels
Correlation of implant position and ODI at 6 months FU*				
ODI >30% (p=0.0509)	3.8	12.7	9.6	10.8
ODI >15% (p=0.1316)	3.8	12.0	9.8	10.8
ODI >10% (p=0.0397)	3.8	12.7	9.4	10.8

*Correlations at 12 and 24 mo performed but were not significant

	ODI improvement		
	ODI >30%	ODI >15%	ODI >10%:
Number of Adverse events x ODI improvement			
At 6 months	25 (n=23pts),	24 (n=22pts)	27 (n=25pts)
At 24 months	19 (n=17pts)	18 (n=16pts)	23 (n=21pts)

Conclusion: This study shows a significant improvement in ODI, VAS back and VAS leg pain at 6 months which was maintained at 12 and 24 months follow up. Patients improved range of motion, had similar distribution of AEs per subgroup, in addition to reported patient satisfaction above 80%. The subgroup results suggest that implant position can be used as a predictor of improved ODI (>10%) at 6 months follow up.

P210

EFFECT OF BMI AND AGE ON MINIMALLY INVASIVE FUSION (MILIF): ONE YEAR FOLLOW UP

Joerg Franke,Neil Manson,Wolfgang Senker

Otto von Guericke University of Magderburg 39120 Magdeburg, Germany

Introduction: The major public health issues are obesity and aging, many patients with degenerative lumbar disorders (DLD) being treated by minimally invasive lumbar interbody fusion (MILIF) are either obese and/or aging.

Aim: to investigate whether outcomes of MILIF for DLD were different between patients from different age groups and weight classes using the data from a multicenter 1-year prospective observational study (NCT01143324).

Material and methods: 252 patients underwent 1- (83.3%) or 2-level (16.7%) MILIF (TLIF: 95.0%; PLIF: 5.0%) for treatment of leg pain (52.0%), back pain (38.9%) or claudication (9.1%) due to DLD, including spondylolisthesis (52.8%), steno-

sis (71.4%), and/or disc pathology (93.7%). Time (days) to first ambulation (TFA) and postsurgical recovery (TPSR), VAS back/leg pain, ODI and EQ5D pre-/post-surgery (baseline, 4 weeks, 6 months, 12 months) [all variables: medians and interquartile ranges (IQR), kruskal-Wallis test] were compared between patients form different age groups (≤50yrs: N=102; 51-64yrs: N=102; ≥65yrs: N=48) and weight classes (min BMI – 25.0: N=79; 25.1 – 29.9: N=104; 30.0 – max: N=69). Baseline to 12 months was compared for all clinical outcome variables within age group/weight class (Mann-Whitney U-test). Linear regression analyses were performed to better understand the relationship between TFA/TPSR and age or BMI.

Results: All groups had significantly improved clinical outcome measures at 12m compared to baseline ($p<0.0001$). TFA was similar for all subgroups [age groups: 1.0 (1.0)/1.0 (1.0)/1.0 (0.5) $p=0.8707$; weight classes: 1.0 (1.0)/1.0 (1.0)/1.0 (0.0) $p=0.1013$)]. TPSR was higher for older and heavier patients [age groups: 2.0 (1.0)/2.0 (2.0)/3.0 (3.0) $p=0.0662$; weight classes: 2.0 (1.0)/3.0 (2.0)/3.0 (3.0) $p=0.1591$)] with a significant linear relationship between TPSR and age ($p=0.0028$) and TPSR and weight ($p=0.0024$). Clinical outcome measures ODI, VAS back and leg pain and EQ5D were similar in all subgroups at every time point.

Conclusion: Older, heavier and older heavier patients need more time to recover from MILIF MAST surgery, however the additional time needed on average remains acceptably below 24hrs. The MILIF approach for spine surgery gives good results for subjects of all age groups and weight classes with no significant differences in clinical endpoints between subgroups.

P211

DISCREPANCIES BETWEEN PLANNED POST-OPERATIVE ALIGNMENT AND AGE-ADJUSTED IDEALS: WHAT ARE THE IMPLICATIONS OF PLANNING TO OVER- OR UNDER-CORRECT?

Jensen Henry,Matt Spiegel,Jonathan Oren, Renaud Lafage,Bassel Diebo,Nancy Worley, Cyrus Jalai,Themistocles Protopsaltis,Thomas Errico,Virginie Lafage,Frank Schwab

Hospital for Special Surgery New York, NY 10021, United States

Introduction: Recent studies expanded SRS-Schwab classification for defining sagittal deformity by including age-adjusted ideals for post-operative alignment. However, the discrepancies between age-adjusted ideals (IA) and actual planned alignment (PA) have not been evaluated.

Aim: Evaluate the discrepancies between age-adjusted alignment ideals and actual surgical plans.

Material and Methods: ASD patients were selected from a prospective single-center database. Adults ≥18 years with severe sagittal alignment (SVA>50mm, PT>20°, or PI-LL>10°) undergoing corrective surgery were consecutively enrolled. For each patient, the baseline (BL) x-ray (XR) was measured, the operative plan was simulated using a validated software and the PA was recorded. Thresholds for significant differences between PA and IA were SVA±20mm, PT±10°, PI-LL±10°.

Results: 71 patients (63±11y; 80% revisions) were included. PA matched IA in 76%, 65% and 49% of the cases in terms of PT, PI-LL and SVA. The SVA and PI-LL were respectively planned for overcorrection in 30% and 17% of the cases, and for undercorrection in 21% and 18%. As age increased, the PA was more likely to call for overcorrection ($P<0.003$), but discrepancies between PA and IA were not affected by other demographics or HRQOL. Patients with more severe deformity and/or higher PI were more likely to be planned for under-correction. Preoperative PI-LL planning significantly impacted post-op alignment: when the PI-LL planning called for over- or ideal correction, post-op PI-LL was within 2° of ideal alignment. When PI-LL planning called for under-correction, post-op PI-LL was 13° greater than ideal alignment ($P<0.001$).

Conclusions: Preoperative plans for sagittal alignment overcorrected in comparison to age-adjusted ideals, especially in elderly patients. Favorable postoperative alignment occurred when the plan integrated age-adjusted ideals, emphasizing the need for patient-specific plans in achieving ideal outcomes. Favorable postoperative outcomes were most likely to occur when the planned alignments matched age-adjusted ideals.

P212

IMPORTANCE OF PREOPERATIVE PLANNING FOR ADULT SPINAL DEFORMITY CORRECTION

Jensen Henry,Matt Spiegel,Isaac Gammal, Renaud Lafage,Elizabeth Tanzi,Bassel Diebo, Jonathan Oren,Themistocles Protopsaltis, Thomas Errico,Virginie Lafage,Frank Schwab
Hospital for Special Surgery New York, NY 10021, United States

Introduction Preoperative planning for ASD surgery is an established method to improve surgical outcomes. However, it is common for surgeons to deviate from the preoperative plan secondary to medical or mechanical circumstances arising intraoperatively. Understanding the relative importance of the surgical plan and departures from the plan is critical to maximizing success in ASD realigment surgery.
Aim Investigate if preoperative planning for adult spinal deformity cases leads to better outcomes irrespective of intraoperative deviations from plan
Materials and MethodsThis study is a prospective analysis of consecutively enrolled adult patients (age>18) with severe sagittal ASD: pelvic incidence minus lumbar lordosis (PI-LL)≥10°, pelvic tilt (PT)≥20°, or sagittal vertical axis (SVA)≥50mm. Demographics and baseline (BL) radiographs (XR) were obtained. BL XR were used for surgical planning with validated software. Intra-op complications and changes in surgical strategy were recorded. XR and complication/revision data were obtained at each follow-up visit for 2 years. Planned and post-op alignments were compared to SRS-Schwab criteria and age-adjusted alignment ideals for PI-LL, PT, and SVA. Post-op outcomes were categorized as under-corrected, within ideal range, or over-corrected.
Results 71 patients were included (63yo, 35% male, 80% revisions). Post-op alignment was under-corrected when compared to planning: PI-LL mean difference (MD) 4.8°, p=0.006, and PT MD 7.2°, p<0.001. Post-op age-adjusted ideals were reached in 50% for PI-LL, 74% for PT, and 32% for SVA. Acceptable execution of plan was observed in 61% for PI-LL, 59% for PT, and 36% for SVA. Pre-op planning was the main determinant of favorable outcomes, regardless of intraoperative strategy changes. Of patients with pre-op plans that matched age-adjusted ideals, 63% resulted in ideal range PI-LL. Of patients with pre-op plans that did not match age-adjusted ideals, favorable outcomes were only achieved in 16% of cases.
Conclusions Initial pre-op planning is most important for successful post-op alignment outcomes. Intra-op deviation from plan has less of a role in achieving desirable outcomes.

P213

SAGITTAL PLANE CORRECTION USING LATERAL TRANSPSOAS APPROACH: EFFECT OF CAGE ANGULATION AND SURGICAL TECHNIQUE ON SEGMENTAL LORDOSIS

S. Tim Yoon,Rojeh Melikian,Jin Young Kim,Kun Young Park,Caroline Yoon,William Hutton
Emory University STE 3000 Atlanta, United States

Introduction:Lordotic cage insertion through lateral transpsoas approach is being used increasingly for restoration of sagittal alignment. However, the degree of correction achieved by varying cage angle as well as anterior longitudinal ligament (ALL) release and posterior element resection is not well defined.
Aim: The objective of this study is to determine the degree of segmental correction which could be achieved through lateral transpsoas approach by varying cage angle as well as adding ALL release and posterior element resection.
Materials and Methods: Thirteen human cadaveric lumbar motion segments between L1 and L5 were dissected into single motion segments. Segmental angles and disk heights were measured under both 50N and 500N loads under the following conditions: Intact specimen, discectomy (collapsed disk simulation), insertion of parallel cage, 10° cage, 30° cage with ALL release, 30° cage with ALL release and spinous process (SP) resection, 30° cage with ALL release, SP resection, facetectomy and compression with pedicle screws.
Results: Segmental lordosis was not increased by with either parallel or 10° cages as compared to intact disks, and contributed small amounts of lordosis when compared to the collapsed disk condition. Placement of 30° cages with ALL release increased segmental lordosis by 10.5°. Adding SP resection increased lordosis to

12.39°. Facetectomy and compression with pedicle screws further increased gains in lordosis to 26.4° in the 50N group and 25.8° in the 500 N group. Neither group experienced a decrease in either anterior or posterior disk height.

Conclusion: Insertion of parallel or 10° cage has little effect on lordosis. Despite the usage of a hyperlordotic cage (30° cage) and release of the ALL there was only 10.5° gain in segmental lordosis. However, the addition of SP resection and facetectomy allowed increases in correction of up to 26.4°. This suggests that when large degrees of segmental lordosis is desired, hyperlordotic cage, ALL release, facetectomy, and posterior copmression is necessary to achieve greater lordosis. No interventions resulted in decrease in either anterior or posterior disk height suggesting gains were achieved without causing foraminal stenosis.

P214

LONG TERM PAIN RECURRENCE RATES FOLLOWING LUMBAR DISCECTOMY OR EPIDURAL INJECTION

Kennedy D.J.[1], Schneider B.J.[1], Huynh L.[1], McCormick Z.[2], Levin J.[1], Smuck M.[1]

Stanford University 94063 Redwood City, United States

Introduction: Long term data regarding the outcomes and recurrence of pain in subjects undergoing a micro-discectomy or a epidural injection for acute radicular pain due to a single level unilateral herniated nucleus pulposus.

Aim: To determine long-term outcomes for lumbar radicular pain due to an acute herniated nucleus pulposus following an epidural corticosteroid injection or spine surgery.

Patients and methods: Long term phone follow-up of subjects previously enrolled in a prospective, randomized, double-blind trial multicenter trial. Independent phone interviews were conducted to assess: presence of pain within last 7 days, current use of opioid medications, utilization of additional epidural steroid after completion of study, surgical rates, and current unemployment due to pain.

Results: Phone follow-up with mean duration of 5 years. There continued to be no significant difference between the two steroid groups as shown in the original study. Collectively 76%, (+/- 15%*) experienced a recurrence of pain, however only (20% +/- 14%*) had experienced pain within the last week. Even less (10% +/- 11%*) were currently on opioids, and similar numbers (17% +/- 13%*) had received additional injections. (43% +/-18%*) had undergone surgery, and (7% +/- 9%*) were currently unemployed due to pain. Comparisons were also made between those who required and who did not require surgery. Of those who required surgery (31% +/- 25%*) reported pain within the last week and (15% +/- 20%*) were currently on opioids compared to (12% +/- 15%*) reporting pain within the last week and (6% +/- 11%*) on opioids in those who did not require surgery. * represents 95% confidence interval, all are non over lapping.

Conclusions: Despite a high success rate at 6 months, a majority of subjects with lumbar radicular pain due to herniated intervertebral disc herniation experience a recurrence of their pain after initial presentation. However, only a minority of these subjects needed additional injections or chronic opioid pain medication management. All subjects were initially deemed surgically appropriate and several did undergo surgery after an initial transforaminal epidural steroid injection. There was no significant differences in outcomes between those that underwent surgery or did not. Lumbar disc herniation is a disease that results in a high recurrence rate, even despite surgical fixation.

P215

OUTCOMES IN ADULT DEFORMITY SURGERY: WHAT HAPPENS TO THOSE PATIENTS WHO ARE LOST TO FOLLOW UP.

Daniel Beckerman,Tamara Sharf,Shane Burch, Jean Jacques Ntshaykolo,Sigurd Berven,Linda Racine

UC San Francisco San Francisco, CA 94143, United States

Introduction: Measuring outcomes after spine surgery is important to guide an evidence-based approach to care. Loss of patients to follow-up is a significant limitation of many clinical outcome papers. Several barriers may prevent patients from following up after

surgery including distance, finance, changes in insurance, or satisfaction with care.
Aim: The purpose of this paper is to report the reasons that patients lost to follow-up did not follow-up, and the outcomes of care in these patients.
Materials and Methods: Retrospective study of a randomized sample of patients status-post fusion surgery for adult spinal pathologies that did not return to clinic for follow-up beyond 1 year post-op. Patients were excluded if they had a future appointment. Patients identified for the study were contacted by phone and interviewed using a survey to evaluate health status, complications, revision surgery rates, and the reason they did not return to follow up.
Results: Forty-two patients completed the phone survey. The reasons that patients did not return included: Doing well and did not feel the need to return (26%), not offered an appointment (19%), burden of travel (17%), surgeon left the institution (9.5%), and disappointing result (7%). Other reasons reported by 9 patients included: did not want to take the time to come in (3), planned on booking a follow up appointment but hadn't (2), financial burden (1), other health issues that prevented their return (1), forgot about their appointment (1), and deceased (1). Changes in health status were consistent amongst those who followed up (81% positive change) and those who were contacted after being lost to follow (79% percent positive change). 34 patients (81%) said they would make the same decision to have surgery again, while 4 patients (9.5%) of patients reported "unsure" and "no" respectively. 43% percent of patients no longer take any medication for their back pain, while 33% use narcotics daily and 12% use non-narcotics daily. 7% and 5% of patients use narcotics and non-narcotics less than once a day, as necessary. 28 patients (67%) responded that they were completely satisfied and 6 patients (14%) reported being somewhat satisfied with their results. 4 patients (10%) were neither satisfied nor dissatisfied 1 and patient was somewhat dissatisfied. Three patients (7%) were completely dissatisfied with the results of surgery. Only 2 patients (5%) of patients had revision surgery at another institution.
Conclusion: Accurate collection of patient reported outcomes after surgery is important to guide an evidence-based approach to care. Patients who did not return to clinic primarily had positive outcomes. Changes in health status for those lost to follow up were consistent with changes in outcomes in patients who did follow up. Reducing barriers to follow-up and improving collection rates will improve quality of care and increase the accuracy of clinical outcomes studies.

P216

APPROPRIATE SURGICAL PROCEDURES IN OLDER PATIENTS WITH SPINAL DEFORMITY: A COMPARISON OF SURGICAL APPROACHES

Nicole Hohenstein,Kushagra Verma,Vedat Deviren, Shane Burch,Sigurd Berven,Daniel Beckerman
UC San Francisco San Francisco, CA 94143, United States

Introduction: Surgical approaches for older patients with spinal deformity are characterized by significant variability. In choosing an informed approach to care, surgeons and patients must consider risks, costs, and alternative approaches to care. Minimizing the risks and costs of surgery while optimizing outcomes and durability of surgery remains the goal of a value-based approach to care.
Aim: The purpose of this study is to present the clinical outcomes, and complications of older patients treated with surgery for spinal deformity, and to compare outcomes and complications in patients treated with a limited fusion (1-3 levels), an intermediate fusion (4-7 levels), or a large fusion (8 or more levels).
Materials and Methods: Retrospective study design of older patients (>age 60) treated operatively for the diagnosis of adult spinal deformity. Patientes over 60 with a diagnosis of spinal deformity and clinical outcomes at baseline and a minimum of 2 years after surgery met inclusion criteria. Patients were stratified according to the length of the fusion construct: limited (1-3 levels), intermediate (4-7 levels), or large fusion (8 or more levels). Predictor variables included surgical invasiveness, pre-operative health status, and preoperative radiographic measures. Outcome variables included perioperative and post-operative complications, revision surgery rates, and

change in health status. Chi Squared analysis to test for differences in dichotomous variables, and ANOVA analysis to compare continuous variables was used.
Results: 72 patients (average age 75) with minimum 2 year follow up met inclusion criteria. Of the 72, 31 patients had a short fusion, 15 had an intermediate fusion, and 26 had a long fusion. The groups were similar based upon age and comorbidities. Patients with long fusion had more severe deformity as measured by Cobb angle ($p<0.0001$). Pre-operative self-assessment of pain and function was similar between the groups, but patients with long fusions had more severe compromise of pre-operative self assessment of appearance. The surgical invasiveness index of the groups was significantly different ($p<0.0001$): Short (9.4), Intermediate (20.6) and Long (33.7). Perioperative and post-operative complications were similar ($p=0.57$). 25 patients required revision surgery (35%) at an average follow-up of 2 years. There was no difference in the rate of revision surgery between the groups ($p=0.88$). Self-reported improvements in disease specific outcomes (SRS-22, ODI) were not different between the groups. Patients with short fusions had a trend toward greater improvement of general health status compared with patients treated with long fusions (EQ-5D $p=0.075$, SF-36 $p=0.067$).
Conclusion: Based on appropriate surgical strategy, older adults with more severe deformity require more invasive surgical approaches and longer fusions. This study demonstrates that surgical complications, revisions, and outcomes are similar across the spectrum of surgical approaches to deformity. Therefore, the surgical strategy should be defined by the specific goals of surgery (decompression, stabilization, realignment) rather than expected differences in complications or outcomes.

P217

IS THERE AN OPTIMAL UPPER THORACIC UPPER-INSTRUMENTED VERTEBRAL ENDPOINT IN ADULT SPINAL DEFORMITY SURGERY?

Alexander Theologis,Junseok Bae,Shane Burch, Bobby Tay,Dean Chou,Praveen Mummaneni, Sigurd Berven,Christopher Ames,Vedat Deviren
UCSF 94143, United States

Introduction: Adult spinal deformity (ASD) is treated with long thoracolumbar fusions that stop at the thoracolumbar junction (TLjxn) or upper thoracic spine (UT). While the TLjxn's upper-instrumented vertebral level (UIV) has been shown not to affect outcomes in ASD, the ideal UIV endpoint in UT fusions has not been evaluated.
Aim: Compare radiographic and clinical outcomes of ASD patients with different UT-UIV levels.
Patients and Methods: Consecutive adults who underwent thoracolumbar fusions for ASD (2003-2013) at a single institution were retrospectively reviewed. Inclusion criteria: instrumentation from pelvis to UT (T1-T6). Three groups were compared based on the UIV level: T1/2, T3/4, and T5/6. Patient demographics, operative details, type of UIV fixation, perioperative spinal deformity parameters, including proximal junctional angle (PJA; angle between endplates of UIV and UIV+2), complications, and health-related quality of life scores (HRQoLs) (SRS-22, SF-36, VAS back) were assessed for each group and compared using ANOVA tests.
Results: Included were 123 patients (T1/2: 22; T3/4: 84; T5/6: 17; average age 62±11 years, SVA 8.5±7.4cm; PJA 7.5±7.90, TK 36±200; PI-LL 20±220, PT 36±200, thoracic Cobb 22±180, Lumbar Cobb 30±200, CSVL 0.8±4.2cm). Average follow-up was 36±24 months. The three groups were similar in regards to average follow-up, BMI (28±6), number of comorbidities (2.8±1.8), three-column osteotomies (28%), pre-operative spinal deformity parameters, and HRQoL scores [save SRS Self-Image (T1/2: 2.3±0.4 vs. T3/4: 2.6±0.6 vs. T5/6: 2.1±0.3) ($p=0.04$) and ODI (T1/2: 58.0±14.1 vs. T3/4: 45.2±16.8 vs. T5/6: 45.1±10.9) ($p=0.08$)]. UIV screws were more common at T1/2 (95.5%) and T5/6 (82.4%), while UIV hooks were more common at T3/4 (28.6%) ($p=0.04$). Post-operatively, percent changes in all spinal deformities parameters and HRQoL scores were similar between groups, save SRS Self-Image that improved significantly more for T5/6 ($p=0.03$). Average total complications were similar between groups (1.6±1.3; $p=0.58$). Rates of PJK (27.3% vs. 33.3% vs. 17.6%; $p=0.42$), UIV fractures (22.7% vs. 23.8% vs. 5.9%; $p=0.25$),

and PJK revisions (13.6% vs. 13.1% vs. 5.9%; p=0.42) were similar between groups, but tended to be lower for T5/6. Screw prominence was more common in T5/6 (17.6% vs. T1/2: 9.1%; T3/4: 9.5%; p=0.59) while screw pull-out was more common in T1/2 (18.2% vs. T3/4: 9.5% vs. T5/6: 11.8%; p=0.52). Sub-analysis of patients who had only screws at UIV demonstrated similar results.

Conclusion: In ASD operations from the pelvis to the upper thoracic spine, T1/2 constructs had higher rates of screw pull-out, while T5/6 constructs had more symptomatic hardware prominence and lower rates of PJK, UIV fractures, and PJK revisions. However, short-term radiographic and HRQoL outcomes were not significantly different between three UT-UIV levels.

P218

DOES SAGITTAL ALIGNMENT INDICATE RESPONSE AFTER LUMBAR SURGERY AUGMENTED WITH DIAM INTERSPINOUS IMPLANT?

Rebecca Crawford,Quentin Malone,Roger Price
Zurich University of Applied Sciences Winterthur, Switzerland

Introduction: Interspinous (ISP) implants like the Device for Intervertebral Assisted Motion (DIAM) are controversially yet commonly used in the surgical treatment of lumbar degenerative pathologies. Ill-defined indications, lack of superiority over decompression, and a poorly

Introduction: Interspinous (ISP) implants like the Device for Intervertebral Assisted Motion (DIAM) are controversially yet commonly used in the surgical treatment of lumbar degenerative pathologies. Ill-defined indications, lack of superiority over decompression, and a poorly understood mechanical effect have resulted in criticism. Yet, meaningful outcomes continue to be reported after surgeries involving ISP devices. Understanding features of responders would be beneficial to identifying appropriate patients in whom clinical effect might be optimised.

Aim: Examine radiographic spinal alignment, pain, and function after DIAM-augmented surgery to identify whether pre- and post-operative skeletal features indicate response.

Subjects and Methods: Single-surgeon study with serial follow-up of 40 patients [20F, 20M] for 12 months for spinal alignment (lumbar lordosis (LL), sacral inclination (SI), primary (PDA) and supradjacent (SDA) disc angles, and regional sagittal balance (RSB)) derived from standing lateral radiography, and 24 months for pain (VAS) and function (ODI) after DIAM-augmented lumbar surgery. Responder analysis examined meaningful serial change and relationships ($p<0.05$).

Results: Sagittal alignment was unchanged at 12m. Reduced PDA occurred at 6w [2.2˚ (4.0˚); $p<0.01$], more in back pain non-responders [3.8˚ (3.2˚); $p<0.05$] than responders [0.7˚ (4.4˚)]. The positive preoperative RSB [26.7Rmm (42.3Rmm)] seen in responders decreased at 6w [3.1Rmm (9.1Rmm)] whereas non-responders were negative preoperatively [-1.0Rmm (32.0Rmm)] and increased early [11.2Rmm (15.5Rmm); $p<0.05$]. Improved back pain [25.0% (28.0); $p<0.0001$] and function [15.4% (17.6); $p<0.0001$] were shown at all time-points to 24m.

Conclusions: Unaltered sagittal alignment at 12m was not related to symptoms. Subtle early flattening at the index disc angle was not maintained. Preoperative and early post-operative sagittal alignment may indicate response after DIAM-augmented surgery for mixed lumbar pathologies, and should be examined further. Pre-operative sagittal balance and early change to sagittal alignment may reflect longer term outcome.

P219

COMPLICATIONS OF CORTICAL SCREW FIXATION IN THE LUMBAR SPINE. A 3-YEAR LEARNING CURVE

Tharsa Thillainadesan,David Edis
Tasman Spine East Launceston, 7250, Australia

Introduction: Cortical screw (CS) fixation has been introduced in recent years as another alternative to traditional posterior pedicle screw (PS) lumbar spine fixation for interbody lumbar fusion. A number of biomechanical studies in cadaver bone comparing the CS with traditional PS have shown it to display equivalent or better pull-out strength. More recent studies comparing PS with CS suggest similar fusion rates and patient reported

outcomes for fixation during transforaminal lumbar interbody fusion (TLIF). There were no complications reported for the placement of the CS. Few other publications describe real-world clinical experience using the CS.

Aim: To describe our experience with CS fixation with regards to complications and revisions during the learning curve of adopting this new version of spinal fixation.

Materials and Methods: We conducted a single-centre retrospective review of complications for the first 101 consecutive cases from June 2012 to June 2015 in which the CS technique was utilized for lumbar spine fixation. CS screws were SoleraTM dual thread multiaxial screws coupled to 4.5mm cobalt chrome rods (Medtronic Spine). CS screws above S1 were inserted using the technique described by Santoni et al1. At S1 the screw trajectory was more typical of a bicortical pedicle screw. Minimum follow up of patients was 6 months.

Results: There were a total of 99 patients of which 58 (58.6%) were female. The mean age was 66.8 years. There were 518 cortical screws placed in 101 cases of which 54 (53%) were multi level. There were 90 primary cases and 11 revision cases. Median follow up time was 18.6 months (range 6 – 42). Overall 16 out of 518 screws (3.1%) required repositioning or salvage to PS intraoperatively. 9(1.7%) CS screws were assessed as malpositioned and revised intraopera-tively by redirecting the CS trajec-tory and 7(1.4%) CS screws required salvage to PS. In 3 (3%) cases, 3 CS screws could not be placed safely in the pedicle due to anatomical variations. In 6 (6%) cases a pedicle wall breach was noted intraoperatively but judged to be minor and not revised. In 8 (8%) of cases screw malposition was noted on postoperative CT and required early revision or late removal of hard-ware for symptoms. Incidental durotomy was noted in 12(12%) cases without sequelae. There were no recorded infections for the index wound. There was one death at day 7 postop-eratively from an acute myocardial infarct.

Conclusion: We report a number of intraopera-tive and postoperative complications during a 3-year learning curve for placement of CS fixation in the lumbar spine. CS fixation is a novel technique requiring specific insertion. Surgeons need to be vigilant of the expected complications, especially screw malposition during the learning curve.

Reference: 1. Santoni BG, Hynes R a., McGilvray KC, et al. Cortical bone trajectory for lumbar pedicle screws. Spine J. 2009;9(5):366-373.doi:10.1016/j.spinee.2008.07.008.

P220

COMPARISON OF POSTOPERATIVE OUTCOMES FOR DEGENERATIVE DISC DISEASE PATIENTS IN COMPARISON WITH POSTERIOR VS. ANTERO-POSTERIOR INTERBODY FUSION SURGERY.

Sumihisa Orita,Kazuhide Inage,Jun Sato,Kazuki Fujimoto,Yasuhiro Shiga,Hirohito Kanamoto, Koki Abe,Masahiro Inoue,Hideyuki Kinoshita, Kazuyo Yamauchi, Kazuhisa Takahashi, Seiji Ohtori

Dept. of Orthopaedic surgery, Graduate school of Medicine, Chiba University Chiba, 260-8670, Japan

Introduction: Lumbar degenerative disc disease (DDD) is thought to be one of the common causes of lower back pain (LBP) and it is a major target of diagnostic and surgical intervention. Surgical options for lumbar DDD include posterior interbody fusion (PIF) procedures and anteroposterior lumbar interbody fusion (APLIF). Among them less-invasive APLIF has been recently attracting attention.

Aim: To compare the postoperative outcomes of DDD patients who underwent traditional posterior surgery or APLIF fusion surgery.

Materials and Methods: DDD patients with refractory LBP (≥3 mon) who have undergone lumbar spinal surgery were involved. The inclusion criteria was defined as following: (1) Axial LBP (visual analogue scale≥4) with no radiating leg pain which exacerbates in flexion (2) Single disc degeneration in MR imaging (Pfirrmann classification ≥ grade 3) with no canal stenosis, intensity change nor deformity in adjacent vertebrae and facet joints (3) Posterior wedging in lateral flexion image of plain X-ray with no translation. (4) LBP provo-cation by discography and pain relief after discoblock with LBP VAS≤3. (5) Cases with no lateral recess stenosis, defined as height ≤ 2 mm and/or depth ≤3, mm at the DDD level. These painful DDD patients underwent PIF surgery, or APLIF via open extraperitoneal approach. Patients since 2012 underwent newly

introduced less-invasive APLIF known as oblique lateral interbody fusion (OLIF). To investigate the surgical invasiveness and outcome among PIF and APLIF, intraoperative parameters such as average operative duration and bleeding were evaluated. Radiological evaluation included intervertebral sagittal angle at the DDD level to evaluate instability using neutral / flexion X-ray images. VAS scale for LBP was also scored at just before the surgery as baseline and at the final timepoint. Furthermore these outcomes were also compared between the traditional open APLIF and minimally invasive OLIF cases.

Results: Twenty-three painful DDD patients out of 701 of lumbar spinal surgery patients (3.0%) were involved in the present study. Regarding operative duraition, there were no significance between PIF and APLIF groups, while only OLIF group showed significant shorter operative duration when in apart from the APLIF cohort ($P<.05$). In regard to intraoperative bleeding, APLIF method showed considerably significant decrease, and OLIF provided more significantly dominant decreased bleeding ($P<.01$). None of the VAS scores among the three groups showed significant pain. All of the VAS scores significantly decreased after the surgery, with the dominant improvement in the OLIF group.

Conclusion: The current study indicated the effectiveness of spinal fusion surgery in DDD patients. APLIF can achieve less invasiveness with significantly less bleeding than PIF, and especially OLIF can achieve more minimal invasiveness with more LBP relief and much less bleeding rather than PF and open APLIF.

P221

AMBULATORY SURGERY FOR LUMBAR DISC HERNIATION: PIONEER EXPERIENCE IN A FRENCH TEACHING HOSPITAL

Mayalen Lamerain,Perrine Jubert,Clémence Heyberger,Marc-Antoine Rousseau

Assistance Publique - Hopitaux de Paris 125 rue de Stalingrad 93000 Bobigny, Finland

Introduction: Due to sociological and economic reasons, outpatient surgery is increasing in general all over the world. Compared to US, France is quite late in the field of ambulatory practice in the context of spine surgery.Aim: Based on other countries' example, feasibility and safety of ambulatory surgery for lumbar disc herniation are investigated for the first time in our institution.

Materials and Methods: Twelve selected volunteer patients with sciatica due to lumbar dis herniation were enrolled and prospectively assessed for ambulatory surgical treatment since june 2013. They were 31 to 50 years old, no morbidity except the lumbar condition. The disc herniation was L4L5 or L5S1. The surgical treatment was a classical open procedure for discectomy. Any adverse event during the post-operative period was registered. The Oswestry score was recorded preop, at 3 weeks, 6 weeks, and 3 months. A satisfaction questionnaire regarding the ambulatory aspect of the procedure was administered at follow-up.

Results: All patients included actually left the hospital the same day of the surgical procedure. One patient developed a meningeal hernia due to an occult leak of cerebrospinal liquid. One infection was noted. One patient had recurrent disc herniation. The average Oswestry score passed from 41 to 27 at follow up. The satisfaction rate regarding the ambulatory stay was "excellent".

Discussion: Outpatient surgery for lumbar disc henriation at our teaching hospital was feasable had safe regarding the procedure itself. The adverse events recorded shall not be related to the ambulatroy stay. The satisafaction rate was excellent but the patients were well informed and had enthusiastically accepted the ambulatory project. The lack of developpement of the ambulatory spinal surgery in France seems more related to the absence of education and wishes of the population than to the surgical environnement that appears to reach a sufficient level of technicity and organization.

P222

PRE-VERTEBROPLASTY TRANSPEDICULAR "VERTEBROGRAPHY" ASSESSMENT IN DELAYED-UNION/PSEUDARTHROSIS ASSOCIATED WITH OSTEOPOROTIC VERTEBRAL FRACTURE

Tsuyoshi Kato,Toshitaka Yoshii,Hiroyuki Inose, Takashi Hirai,Tsuyoshi Yamada,Atsushi Okawa

Tokyo Medical and Dental University Bunkyo-ku, 113-8519, Tokyo, Japan

Introduction: Osteoporotic vertebral fracture (OVF) has become one of the most common types of fractures in the elderly worldwide. The invasiveness of surgery is a serious concern when treating fractures in such patients. Vertebroplasty (VP), and recently, balloon kyphoplasty (BKP) has become a particularly favored minimally invasive procedure. BKP is contraindicated for patients with fractures of the pedicle and posterior wall, and vertebral body defects. Assessment of the posterior wall of the vertebral body is critical in selecting the surgical procedure. Thus, we have been performing contrast imaging of the vertebral body (hereinafter referred to as vertebrography) as a part of preoperative examination in OVF patients.

Aim: We will suggest how to assess the selection of VP procedure with vertebrography for OVF.

Materials and Methods: Subjects were patients with OVF who received enough conservative therapy for the back pain (VAS ≥ 40 mm) between July 2008 and November 2013. A needle was inserted with radiographic guidance into the cleft. A contrast agent was injected and leaks were confirmed in the surrounding areas, and then, a CT scan was performed. Subjects were divided into four groups depending on the condition of the posterior wall of the vertebral body: normal (Group A); fractures protruded towards the spinal canal, without non-uniformity (Group B); no protrusion towards the spinal canal, with non-uniformity (poor trabecular continuity) (Group C); clear protrusion of a bone piece (Group D).

Results: Forty-nine vertebral bodies of 48 patients (11 men and 37 women, mean age: 75.8) were examined. Affected vertebrae were almost between T10 and L2. The time between symptom onset and examination ranged from 9 weeks to 4 years. The number of subjects in Groups A, B, C and D were 13, 17, 10 and 9, respectively. Leaks in the spinal canal were found in 5 subjects (10.2%, C: 2, D: 3). In these 3 subjects in Group D, a leak was seen around the posterior wall fracture and around the pedicle fracture. Leaks in Group C were intravenous. The leak through the fracture to the anterior area was found in 1 (Group D), and intravenous leaks to the anterior area were found in 3 (B: 1, C: 2). Leaks into the top and bottom of discs were seen in 5 (B: 1, C: 2, D: 2).

Conclusion: The incidence of OVF has further increased in recent years, so, indications for surgical treatment need to be assessed suffici--ently. The contrast agent did not leak when images showed good trabecular continuity. Even with poor trabecular continuity, leaks were intravenous. VP is associated with a high risk in patients with fractures protruding towards the vertebral canal in the posterior wall and the pedicle areas. Leaks in the anterior area and upper and lower slipper disc were also found (18.4%), suggesting that careful consideration is essential. Pre-VP vertebrography will provide sufficient data for selection of the surgical procedure, and thus, it is extremely effective in preoperative examination.

P223

DOES STOPPING OF TERIPARATIDE TREATMENT CHANGE THE VOLUME OF BONE FUSION MASS AFTER LUMBAR POSTEROLATERAL FUSION IN WOMEN WITH POSTMENOPAUSAL OSTEOPOROSIS?

Seiji Ohtori,Sumihisa Orita,Kazuyo Yamauchi, Yawara Eguchi,Yasuchika Aoki,Miyako Suzuki, Gou Kubota,Kazuhide Inage,Takeshi Sainoh,Jun Sato, Kazuki Fujimoto,Yasuhiro Shiga,Koki Abe, Hirohito Kanamoto,Kazuhisa Takahashi

Chiba Univ. 260-8670, Japan

Introduction: Intermittent parathyroid hormone (PTH) treatment increases bone mass and reduces the risk of osteoporotic vertebral fractures. Recombinant human PTH (1–34) has been approved as a treatment for severe osteoporosis. Clinical data support the efficacy of PTH for lumbar posterolateral fusion (PLF). However, the use of PTH is limited to within 2 years.

Aim: The purpose of the current study was to determine whether stopping teriparatide treatment changes bone volume of fusion mass after PLF in women with postmenopausal osteoporosis.

Methods: We treated 29 women with osteoporosis diagnosed with degenerative spondylolisthesis with teriparatide (daily subcutaneous injection of 20 μg of teriparatide). All patients underwent decompression and 1- or 2-level

instrumented posterolateral fusion with a local bone graft. Teriparatide was used for 3 months before and more than 3 months after surgery. After stopping teriparatide treatment, all patients used bisphosphonate (weekly oral administration of 17.5 mg risedronate). Volume of fusion mass across the transverse processes at one segment on an anteroposterior X-ray view was determined using a computer-linked digitizer at 1, 2, and 3 years after surgery.
Results: We followed up 19 patients for 3 years. Average period of use of teriparatide was 9.5 months. Bone union rate was 85% and average bone union duration was 8 months. Average volume of bone fusion mass was not significantly different at 1, 2, or 3 years after surgery ($P > 0.05$). (1 year: 765.1 ± 70.8 mm2, 2 years: 865.1 ± 80.4 mm2, 3 years: 787.2 ± 69.8 mm2) (mean ± SEM).
Conclusion: Daily subcutaneous injection of teriparatide for bone union using local bone grafting after instrumented PLF has been reported to be more effective than untreated control. The current study showed that stopping teriparatide treatment did not change the volume of bone fusion mass after PLF in women with postmenopausal osteoporosis

P224

CHARACTERISTICS OF PATIENTS WITH LUMBAR SPINAL STENOSIS WHO HAD MAINTAINED DISC HEIGHT

Tomonori Yano,Tetsuhiro Iguchi,Junya Yamamoto, Kenichiro Kakutani,Kotaro Nishida
Hyogo Rehabilitation Center Hospital 651-2181, Japan

Introduction: Main radiographic changes of lumbar spinal stenosis (LSS) are narrowed spinal canal with decreased disc heights. In spite of apparent stenosis, some patients had maintained disc height similar to normal disc. Difference of these two findings is not clear.
Aim: To identify clinical characteristics of LSS patients with maintained disc height.
Materials and Method: Seventy-two LSS patients underwent posterior decompressive surgery without fusion during 2010-2014 were elected in this study except for 16 patients who had previous lumbar surgery which could modify the clinical characteristics. The remaining 56 patients (35 men and 21 women) were included. The average age was 72.0 (range, 53-87) years at surgery. The disc height at the levels of stenosis was obtained by measure the relative height ratio (disc height at the middle / AP diameter of the upper vertebral body) in the plain X-ray upright lateral view. When the ratio was >20%, it was defined as the maintained (M) group, and <20% as the decreased (D) group. The variables; age, sex, symptoms, JOA score, number of the narrowed disc level, sagittal angulation between flexion and extension views, facet OA change in CT, disc degeneration (Pfirrmann) in MRI were compared and investigated statistically in both groups.
Results: There were 7 patients (12.5%) with 10 decompressed disc levels in M group and 49 patients (87.5%) with 106 decompressed disc levels in D group. Mean age was 66.4 and 73.3 years in M and D group respectively and showed statistical difference ($p=0.045$). The patients in M group exhibited more single-level lesion than D group (M: 5/7 cases, D: 12/49 cases, $p=0.037$). Angulation angle in M group was larger than D group with statistical difference (M: 10.6, D: 5.4 degrees, $p=0.029$). In the MRI analysis, less degeneration of the disc (Pfirrmann classification: grade 1 to 3) observed more frequently in M group (M: 7/10 discs, D: 8/106 discs, $p<0.01$). There was no significant difference in sex, JOA score, and the disc height ratio between the groups. All facet joint at the surgical disc level showed arthroritic changes in CT examination.
Conclusion: Even though no difference of clinical symptoms examined by JOA score, M group patient was characterized as younger, hypermobile segment and less disc degeneration at the surgical disc level, and more single-level lesion. These findings suggest that M group is a group in the early stage of disc degeneration. Arthroritic changes of facet joint were observed in all cases, therefore the authors thought that hypermobility of the disc segment might promote the degenerative change of the posterior elements. Because of small number of patient in M group, the patients of M group might be an initial stage of disc degeneration and they might develop to D group and apparent multi-level spinal stenosis.

P225

COMPARATIVE ANALYSIS OF SAGITTAL BALANCE AND PELVIC PARAMETERS BETWEEN LOW-GRADE LUMBAR SPONDYLOLISTHESIS (ISTHMIC AND DEGENERATIVE) AND SPINAL STENOSIS

Chang-Hoon Jeon,Nam-Su Chung,Han-Dong Lee
Department of orthopaedic surgery, Ajou university school of medicine Yeongtong-gu 443-380 Suwon, Korea, South

Introduction: Sagittal balance and spinopelvic parameters are important biomechanical factors for the pathogenesis of lumbar degenerative diseases. Several studies reported the relationship between pelvic incidence (PI), sacral slope (SS) and spondylolisthesis (SPL). The comparative correlation of sagittal balance and of pelvic parameters between SPL and lumbar spinal stenosis (LSS) has not been fully investigated.

Methods: This study involved 70 patients with SPL (isthmic SPL 30 + degenerative SPL 40) and 70 patients with LSS who were treated with back pain and claudication. In this study, developmental SPL is excluded. The radiological factors in this study included (1) C7 plumb line (C7PL), (2) pelvic parameters including pelvic incidence (PI), sacral slope (SS), pelvic tilt (PT), (3) spinal parameters including lumbar lordosis (LL) and thoracic kyphosis (TK).

Results: The demographics parameters were not significantly different between the two groups. The mean extent of slip in SPL group was 4.1±1.7 mm (81.4% in grade I and 18.6% in grade II). The mean C7PL of the SPL and LSS groups were 1.9±1.5 cm and 2.1±2.3 cm, respectively (P = 0.455). The mean PI of the SPL and LSS groups were 53.2°±11.2° and 51.5°±11.2°, respectively (P = 0.741). The mean SS of the SPL and LSS groups were 30.8°±9.2° and 33.1°±12.4°, respectively (P = 0.352). The mean PT of the SPL and LSS groups were 21.7°±7.9° and 19.2°±9.4°, respectively (P = 0.221). There was no difference in the LL and TK between the two groups (P = 0.425, 0.106, respectively). There was no difference in C7PL, PI, SS, PT, LL, and TK between the isthmic and degenerative SPL (all P > 0.05).

Conclusions: This study showed that the pelvic parameters between low-grade SPL (isthmic and degenerative) and LSS are not significantly different. The sagittal balances of the both groups are in normal range. And the results means that low-grade SPL is not influenced on the sagittal balance.

P226

THE EFFECT OF CAPACITIVELY COUPLED (CC) ELECTRICAL STIMULATION ON HUMAN INTERVERTEBRAL DISC CELLS AND THE RELATIONSHIP BETWEEN CC AND BMP

S.T. Yoon,Z. Wang,W.C. Hutton
Emory University STE 3000 Atlanta, United States

Introduction: Most biological treatment of disc degeneration involves injecting a therapeutic agent into the disc. While this has been effective in proof of concept experiments, a much better strategy would be to develop a non-invasive method of stimulating disc cells. Capacitively coupled (CC) electricity stimulates biological tissues in a non-invasive treatment method. CC is approved by the FDA for the use as an adjunct to spine fusion and therefore has an extensive safety evaluation and experience in the clinical setting. However, any effect that CC stimulation may have on intervertebral disc cells has not been established.

Aims: 1) to determine if CC can stimulate the synthesis of the matrix macromolecules aggrecan, collagen II, and sGAG; 2) to determine the relationship, if any, between CC stimulation and the BMPs in the synthesis of the matrix macromolecules aggrecan, collagen II, and sGAG; 3) to determine if BMP-7 (applied exogenously) and CC can act in synergy to upregulate the matrix macromolecules aggrecan and collagen II.

Methods: Human intervertebral disc nucleus pulposus (NP) tissues were collected from twelve patients that had undergone spinal fusion surgeries. Nucleus pulposus cells were extracted from the tissues cultured in alginate beads. The cells were treated with CC stimulation. The mRNA levels of the disc extracellular matrix genes (collagen I, II, aggrecan) and BMPs were measured by real-time PCR. The protein levels of aggrecan, collagen II, and BMPs were determined by ELISAs and Western blots. Sulfated glyco-

saminoglycan (sGAG) content was assayed using the DMMB method. The effect of BMP on CC stimulation of the cells was evaluated by applying a BMP blocker or by applying additional BMP-7 to the culture. A 2-tailed T-test was used to compare between the groups. $P < 0.01$ was considered significant.

Results: Aim 1 CC effects on disc matrix macromolecules: CC stimulation upregulate the mRNA levels of aggrecan (61%) and collagen II (50%) and protein levels of aggrecan (90%) and collagen II (80%). The sGAG level were upregulated (45%). All values $p < 0.01$. Aim 2 CC and BMPs: CC stimulation upregulated BMP-4 and BMP-7 at the mRNA and protein levels as measured by western blots. However, BMP-2 and BMP-6 were not significantly changed by CC. The addition of a BMP competitive antagonist, Noggin, into the media completely blocked the effect of CC on disc matrix upregulation at the mRNA and protein levels. Aim 3 CC and BMP-7 together: BMP-7 was added to media at 0, 10, 20, 50, and 100 ng/ml and results with and without CC stimulation was tested. This showed that at lower concentrations of BMP-7 (< 100 ng/ml), CC and BMP-7 had additive increase in aggrecan and collagen II proteins levels. However the effect of CC in at 100 ng/ml of BMP-7 was not significant.

Conclusion: CC stimulation upregulates the production of the intervertebral disc-matrix macromolecules aggrecan, collagen II, and sGAG by a mechanism involving BMPs and has additive effect on low concentrations of BMP-7. CC stimulation could be a non-invasive way of stimulating disc cells to treat disc degeneration and warrants further study.