Eur Spine J (2019) 28:2805–2872
https://doi.org/10.1007/s00586-019-06103-0

ABSTRACTS

EUROSPINE 2019: Quick Fires

(Concurrent Short Communications)

BASIC SCIENCE

QF1

ENDPLATE AND INTERVERTEBRAL DISC CHANGES IN RAT LUMBAR SPINE INDUCED BY PROLONGED HINDLIMB TAIL SUSPENSION

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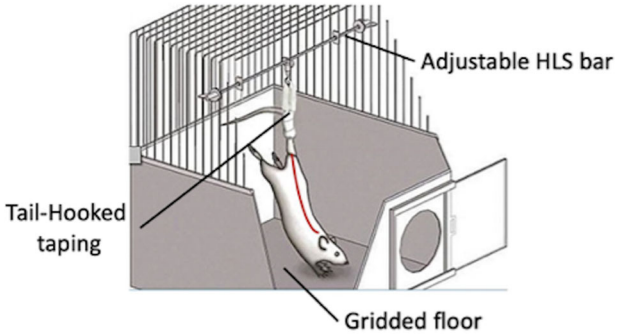
Prolonged exposure to microgravity has deleterious effects on the human spinal disc. However, the pathogenesis of disc degeneration under unloading conditions is poorly understood. The objective of this study was to evaluate disc degeneration and notochordal cell migration in the fiber layers under unloading conditions. We employed the hindlimb suspension rat model to investigate superior and inferior endplate changes associated with intervertebral disc volume, considering them as a functional unit. A total of 54 rats were studied for 2 or 6 weeks by micro-CT and histology. Aberrant mechanical unloading led to endplate and disc changes (43% bone density loss in the fifth lumbar vertebra and 23% decrease in disc height after 6 weeks of hindlimb suspension). Compared to controls, HLS induced a significant increase in the NP area after 2 weeks. However, a significant decrease was observed with HLS after 6 weeks compared to controls. Alcian Blue staining intensity was lower in the 2- and 6-week HLS groups than in the control groups, indicating that the proteoglycan content in the unloading condition is decreased once mechanically unloaded. We also observed rare notochordal cells in the disarrayed inner disc fiber layers after 6 weeks of hindlimb suspension, while notochordal cells were equally distributed in in the fiber layers of control animals. Intervertebral discs are avascular; cyclic compression from daily loading and induced dynamic fluid flow through collagen channels may be important for nutrition supply and waste removal. Aberrant spinal unloading changes endplate microstructure by interrupting the daily fluid inflow-outflow cycle in the discs. This interruption might misdirect notochordal cells from the inner to the outer fiber layers; inner layers may remain unrepaired, increasing the risk of disc degeneration. Although most intervertebral degeneration can result from repetitive or persistent spinal compressive forces, our study revealed the opposite: persistent spinal unloading, as with long-term bedrest or space flight might also accelerate disc degeneration.



Schematic diagram of the rat hindlimb suspension model.

Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none.

QF2

FACET JOINT CAPSULAR LAXITY IN DEGENERATIVE LUMBAR SPONDYLOLISTHESIS ASSOCIATED WITH THE INCREASED EXPRESSION OF FRACTALKINE CX3CL1/CX3CR1 CHEMOKINE

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Introduction: Involvement of CX3CL1 and its receptor CX3CR1 in leukocyte recruitment and adhesion in chronic inflammatory disease and their activity have been established in ligament flavum, synovial membrane, and intervertebral discs. The purpose of this study was to investigate the role of fractalkine CX3CL1/CX3CR1 chemokine on facet joint capsular laxity in degenerative lumbar spondylolisthesis (DLS) and the correlation between CX3CL1/CX3CR1 chemokine and degree of slippage in DLS.
Methods: The mRNA concentrations of CX3CL1/CX3CR1 chemokine were analyzed in facet joint capsule surgically obtained from grade 1 (n = 12), grade 2 (n = 12) and more than grade 3 (n = 11) DLS by real-time PCR. Grade 1 to 3 was decided upon degree of slippage which is, < 5 mm, 5–10 mm, and > 10 mm. The localization of CX3CL1/CX3CR1 chemokine within the facet capsule was determined using immunohistochemical study. Plasma level of soluble fractalkine (sFKN) was measured by enzyme-linked immunosorbent assay (ELISA).
Results: The ratio of CX3CL1/CX3CR1 positive cell in the facet joint capsule obtained in high grade DLS patients was significantly higher than in low grade DLS patients. Both of CX3CL1 and CX3CR1 were expressed on infiltrated mononuclear cells in the facet

joint capsule. In the quantitative RT-PCR, CX3CL1/CX3CR1 expression in the high grade DLS patients was higher compared to that in the low grade DLS patients. An amount of CX3CL1/CX3CR1 mRNA expression in the high grade DLS patients was relatively greater than in the low grade DLS patients (P = 0.000, 0.003). Serum CX3CL1 in high grade DLS patients was prominently elevated compared to that in low grade DLS patients. (P = 0.002). Degree of slippage in DLS patients was significantly correlated with both serum CX3CL1 level (R2 = 0.451, P = 0.000) and mRNA expression of CX3CL1/CX3CR1 (R2 = 0.360, P = 0.000) (R2 = 0.205, P = 0.006). **Conclusion:** It was assumed that CX3CL1/CX3CR1 would be very important in migration of inflammatory cells into diseased facet joint capsule. First, overexpressed sFKN promotes the recruitment of CX3CR1-expressed mononuclear cells into the diseased capsule. And then inflammation, vascular injury and angiogenesis occur. CX3CL1, expressed on the cell membrane of endothelium by stimulation of pro-inflammatory cytokines, mediates activation and adhesion of leucocytes to express CX3CR1. The recruitment of mononuclear cells induces the proliferation of fibroblast and inflammatory cell in the facet joint capsule of DLS. Second, the enhanced CX3CL1/CX3CR1 activity induces the degradation of the capsular matrix leading to facet joint capsular laxity. This study identified for the first time that increases in CX3CL1 and CX3CR1-expressing cells are significantly related to facet joint capsular laxity, which may provide new conceptual and therapeutic approaches for treating DLS.
Disclosures: author 1: none; author 2: none; author 3: none.

QF3

COMPARISON OF ANNULUS FIBROSUS CELL COLLAGEN REMODELING RATES IN A MICRO-TISSUE SYSTEM

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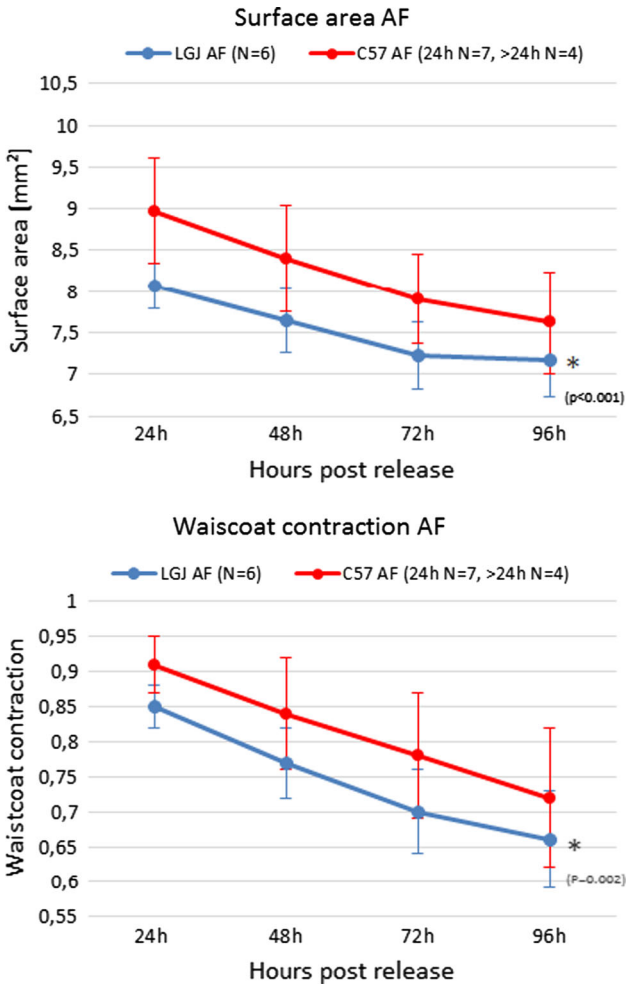
Introduction: In scoliosis, most of the early deformity is in the disc. We hypothesize that all spines experience asymmetric loading during rapid adolescent growth resulting in temporary bending of the disc. The difference between individuals who develop persistent and progressive disc deformation, and those who spontaneously correct the same initial deformation of the disc, could be dependent on the individual's ability or lack thereof to alter their collagen network, in a faster and more permanent manner.
Purpose of this study: We hypothesize that the collagen network remodeling response to asymmetrical loading of the disc determines whether a curvature becomes structural or not, and also whether an established curve progresses more or less rapidly. Recently, strains of mice (C57BL/6 J and LG/J mice) have been identified with differences in their connective tissue healing capacity and disc wedging as part of an experimental model of scoliosis. In this experiment, we determined whether an in vitro micro-tissue assay can distinguish the differences in collagen remodeling rates of annulus fibrosus (AF) cells between these strains.
Materials and Methods: AF cells, harvested from 8 to 10 week-old C57BL/6 J and LG/J mice were expanded in a hydrogel in a tissue remodeling platform, consisting of ten constraining posts in a hexagon shape and cultured for 48 h. Hereafter the micro-tissues were released from one opposing set of posts and cultured for an extra 96 h. With the alteration in support, the cells are stimulated to remodel the collagen in the micro-tissue from an isotropic to anisotropic organization. Micro-tissue surface area and waistcoat contraction were analysed by making digital top-down images of the micro-tissue assay system with a stereo microscope at different time points. Collagen orientation was analysed by staining tissues at 24 h and 96 h post-release with CNAmCherry for collagen and visualized using a confocal microscope.
Results: For LG/J N = 6 and for C57BL/6 J N = 7 (at 24 h) and N = 4 (after 24 h) micro-tissues were analyzed. 96 h post-release, LG/J cells contracted the tissue more than the C57cells as evidenced by a smaller micro-tissues surface area, 7.14 ± 0.44 vs. 7.62 ± 0.62 mm ($p < 0.001$) and more waist coat contraction, 0.66 ± 0.07 vs 0.72 ± 0.1 mm (p = 0.002) (Figure 1). Although no significant difference in collagen orientation between the groups was seen at 24 h, at 96 h, LG/J AF cells oriented the collagen more than C57 cells ($p < 0.001$).
Conclusion: The micro-tissue remodeling assay system shows promising results in terms of distinguishing between the collagen network remodeling capability of AF cells of these different mice. The next step is to determine whether these differences are reproducible with skin fibroblasts which are more clinically accessible. This could pave the way towards a bioassay for the prediction of curve progression in human AIS patients.



Disclosures: author 1: grants/research support: Fondation Yves Cotrel/AO Foundation; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: grants/research support: K2M, Eurospine, Fondation Cotrel, AO; author 8: grants/research support: DSM.

QF4

AN INVESTIGATIONAL STUDY OF A DUAL-LAYER, CHORION-FREE AMNION PATCH AS A PROTECTIVE BARRIER FOLLOWING LUMBAR LAMINECTOMY IN A SHEEP MODEL

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Background context: A decompressive laminectomy is the most common surgery performed to relieve symptoms of lumbar spinal stenosis. While this surgery has been shown to be successful in relieving patient symptoms, partially removing the lamina exposes the dura to elements, and potential damage, from the surrounding environment. While a number of different biomaterials have been investigated for use as a protective barrier in spine surgery, the inherent properties of the human amniotic membrane (HAM) may make it favorable to protect neural elements and anterior vessels from the surrounding environment. The effect of a dual-layer HAM patch used as a physical barrier following a laminectomy in an animal model has yet to be investigated.

Purpose: The objective of this study was to evaluate the effect of a dual-layer, chorion-free amnion patch (DLAM) processed from HAM as a protective barrier following lumbar laminectomy in a sheep model.

Methods: Twelve adult sheep each underwent a laminectomy at L3 and L5, and one surgical site randomly received DLAM treatment. A multiplex immunoassay was performed to quantify the inherent cytokines present in the amnion after processing. Epidural fibrosis and neurohistopathological responses were assessed based on epidural fibrosis-dura tenacity scores and decalcified histology, respectively, at 4 and 10 weeks post-operatively.

Results: Immunoassay results showed that inflammatory mediators and immunomodulatory cytokines were present in the amnion after processing, but no pro-angiogenic cytokines were detected. At 10 weeks, tissue tenacity was significantly less in the DLAM treatment group compared to the operative control (1.2 ± 0.4 vs 2.8 ± 0.4, $p < 0.05$), demonstrating the ability of DLAM to act as a barrier and cover the dura. At both 4 and 10 weeks, there were significantly more infiltrated fibroblasts at the operative control sites than in the DLAM treated sites (Fig 1), expressed as a percentage of the total number of fibroblasts present (4 weeks: $72.3 \pm 10.2\%$ vs $10.8 \pm 10.1\%$, $p < 0.05$; 10 weeks: $84.9 \pm 15.8\%$ vs $43.1 \pm 11.6\%$, $p < 0.05$). Additionally, fibroblasts traveled further into the dura in the operative control group compared to the DLAM treated group at both time points.

Conclusion: This study found that DLAM reduced fibroblast infiltration and tissue tenacity 10-weeks post-lumbar laminectomy in an animal model. DLAM reduced fibroblast infiltration and tissue tenacity post-surgically in an animal model, supporting its potential use as a protective barrier for neural elements and anterior vessels.

Disclosures: author 1: none; author 2: employee: Globus Medical; author 3: stock/shareholder: Globus Medical, employee: Globus Medical; author 4: grants/research support: Globus Medical, employee: Globus Medical; author 5: employee: Globus Medical.

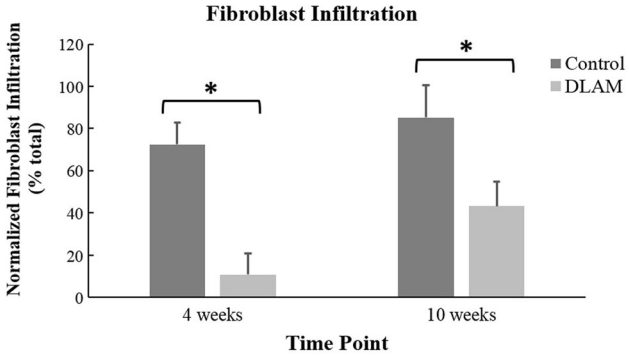

Figure 1. Fibroblast infiltration at 4 and 10 weeks. The number of fibroblasts that migrated into the dura were counted for each specimen and normalized to the total number of fibroblasts in the specimen's field of view. Significant differences in fibroblast infiltration ($p < 0.05$) were observed between the operative control and DLAM-treated groups at both 4 and 10 weeks.

QF5

THE MECHANISM OF DURAL ADHESION IN THE EXCESSIVE FIBROSIS CAUSING PAIN AFTER SPINE SURGERY; THE AFFINITY TO COLLAGEN THROUGH INTEGRIN AND MATRIX METALLOPROTEINASE

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Introduction: Dural traction by peridural adhesion and direct neural compression by excessive fibrosis might be one of major factors causing axial and radicular pain after spine surgery.

Purpose: This study was designed to explore the molecular mechanism of dural adhesion by using primary culture of human dura mater cells (hDMCs).

Materials and methods: hDMCs were cultured on the collagen I coated plate from human dura mater tissue (8 men and 2 women, mean age 55.4 ± 17.86) obtained during duroplasty following decompressive craniectomy. The comparison between naive hDMCs and co-culturing hDMC with macrophage like THP-1 cells (MΦ) is performed in various assays to reflect inflammatory circumstances of post-operation. Adhesion assay was performed for investigating major adhesive substrates to human dura matter cells (hDMCs). Flow cytometry about integrins and western blot about intracellular proteins related with adhesion (focal adhesion kinase (FAK), talin 1, and Factin) was performed for investigating the alteration on adhesion-related molecules in hDMCs. ELISA about secreted matrix metalloproteinases (MMPs) was performed for investigating ECM remodeling factors for adhesion).

Results: The human dura mater tissue was sufficiently well adhered to the collagen I coated-dishes and plates within 3 days of gentle compression. After 3 days, the hDMCs which had similar compatible morphology of fibroblasts were appeared from the edge of the explanted tissues. The cells had elongated or multiple protruding pseudopods in shape initially, and gradually migrated away from the tissue. The adhesion profiles of hDMCs with collagen I, IV, fibrinogen and fibronectin after co-culture was significantly increased 6.4, 5.0, 3.0 and 1.6 times comparing to those of control group respectively ($P < 0.001$). There were significant increase in expression of

the integrin subtype α2β1 about 6.3 times ($P < 0.001$) and αIIbβ3 about 2.0 times ($P < 0.001$). α1, which had highly expressed in naïve hDMCs, showed significant decrease after co-culture ($P < 0.001$). FAK showed significant increase 1.99-fold in co-culture ($P < 0.001$). There was no significant alteration between control and co-culture group in talin and F-actin. Co-culturing of the hDMCs with the MΦ induced significant increment of MMP-1, MMP-3, and VEGF concentrations compared to the sum of naive hDMCs and MΦ (MMP-1: $p < 0.01$, 13.9 fold change; MMP-3: $p < 0.01$, 7.6 fold change; VEGF: $p < 0.01$, 3.8 fold change). MMP-9 secretion at co-culture was significantly suppressed into 9.7% comparing to that of activated THP-1 cells only.

Conclusion: hDMCs could be successfully utilized for the study of dural adhesion. Collagen might be a critical substrate of hDMCs in terms of adhesion, mediated by integrin α2β1 rather than α1. The increase of MMP 1, 3 and suppression of MMP 9 from hDMCs after exposure to inflammation might have critical roles in adhesion of hDMCs through ECM remodeling after peridural tissue injury.

Disclosures: author 1: not indicated; author 2: not indicated; author 3: none; author 4: none.

QF6

SEQUENTIAL CHANGES IN LUMBAR LORDOSIS AND SEGMENTAL STABILITY FOLLOWING LATERAL INTERBODY CAGE PLACEMENT, SMITH-PETERSON OSTEOTOMY, AND ANTERIOR LONGITUDINAL LIGAMENT RELEASE

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Introduction: Interbody cage systems are used in isolation to achieve lumbar lordosis correction, but can also be deployed using techniques to shorten the posterior or lengthen the anterior spinal column to achieve even larger corrections. The Thomasen pedicle subtraction osteotomy (PSO) yields ~ 30° of correction, but with high degree of difficulty and surgical complication rates. A lateral lordotic cage with Smith-Petersen Osteotomy (SPO), a hyper-lordotic lateral cage with anterior longitudinal ligament (ALL) release, or a lateral cage with combined techniques show potential for substantial lordosis correction. The removal or release of local spinal anatomy, however, can increase segmental motion and may inhibit fusion. The objective of this biomechanical cadaver study was to identify the lordosis correction and resulting segmental stability achieved with implantation of lateral lordotic cages of increasing angle coupled with either or both minimally invasive surgical techniques of ALL-release and SPO. We hypothesize that a combination of lordotic cage placement, ALL-release and SPO yields more segmental lordosis than with these interventions in isolation and that the biomechanical stability of the construct will be sufficiently rigid to promote fusion.

Materials and methods: Cadaveric lumbar spines (n = 6) were divided into L1-L2 and L3-L4 segments, potted in plaster with pedicles exposed and randomly distributed (Figure 1A, n = 6 segments/group); Group 1: SPO followed by ALL-release, Group 2: ALL-release followed by SPO. Sagittal fluoroscopic images for lordosis angle measurement and range of motion (ROM) data were collected after each intervention. A spine simulator applied 7.5 Nm pure moments to segments in flexion-extension (FE), lateral bending (LB), and axial rotation (AR), while optical motion capture recorded ROM. Linear mixed models with repeated measures provided statistical comparisons at $\alpha = 0.05$ within each group for each metric (angle, FE-, LB-, AR-ROM); ROM data reported as percent of native.

Results: The combination of SPO with ALL-release yielded the largest lordotic angle regardless of procedure order (28.5° ± 7.3°), but also greatest ROM in all planes. A 30° cage provided no additional gain in lordotic angle and increased ROM in FE and AR with ALL-release and SPO. An 8° lordotic cage with SPO achieved the largest angle correction (10.1° ± 6.8°) while reducing ROM in all planes. The addition of a 2-hole plate does not decrease correction and tends to reduce ROM in all planes compared to the 1-hole plate.

Conclusion: We show that lordosis > 15° is possible through these minimally invasive techniques of SPO and ALL-release and that performing a SPO without ALL-release yielded substantial correction without compromising stability. Performing a SPO after ALL-release increases segment ROM in FE, LB, AR, thus a 2-hole plate is recommended to aid in stability with ALL-release.

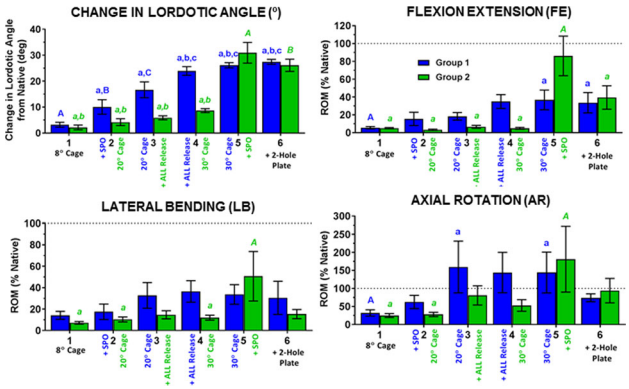

Figure 1. Change in lordotic angle (degrees) and range of motion in flexion-extension, lateral bending and axial rotation (% of native range of motion). Significance: p<0.05

Disclosures: author 1: consultant: Zimmer Biomet; author 2: none; author 3: employee: Zimmer Biomet; author 4: employee: Zimmer Biomet Spine; author 5: employee: Zimmer Biomet; author 6: employee: Zimmer Biomet Spine.

QF7

INFLUENCES OF CERVICAL STRUCTURES ON THE KINEMATIC BEHAVIOR OF THE CERVICAL SPINE

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Surgical treatment of the degenerated cervical spine (CS) often requires resections to a series of structures. Thereby, a broad range of treatment options aim to maintain physiological motion. However, it is not yet fully understood which influences each structure of the CS and its resection might have on its kinematic behavior. Knowledge of these influences could help to reduce or even prevent iatrogenic degeneration after surgical intervention. Therefore, we conducted an in vitro study in order to investigate the influences of different structures on the kinematic behavior of the CS using 3D helical axes (HA).

We extracted motion segment C4-C5 from six human cadaveric specimens with an average age of 48 years. For the in vitro experiments, 7 states were defined. The first state represented the intact state. The remaining 6 states correspond with the subsequent resection of the following structures in the given order: interspinous ligament

(IS), ligamentum flavum (FL), facet capsule (FC), vertebral arch (AV), posterior longitudinal ligament (PL) and anterior longitudinal ligament (AL). Each state was tested using a well-established spine tester. Each test sequence included 3.5 quasi-static motion cycles in all three bending directions using 1 Nm. We calculated the 3D-HA using Vicon motion recordings and matched them with x-ray images. Due to the small number of specimens quantitative data was analyzed using descriptive statistics.

The least change in the kinematic behavior of the CS was observed during flexion/extension. For lateral bending (LB) and axial rotation (AR) the greatest change in the pattern of the HA was observed during the resection of the vertebral arch. For LB, it could be observed that the deviation in the axes' orientation increased (Figure 1) whereas for AR it decreased. Furthermore, a great variety among the specimens was observed regarding the influences of each resection step on the mean HA' orientation and deviation.

To the knowledge of the authors, this is the first investigation of the influences of cervical structures on the kinematic behavior of the CS using 3D-HA. It is assumed that the angular orientation of the cervical facet cartilage has the greatest effect on cervical kinematics. However, the herein calculated HA indicate that other structure may also play a relevant role in the kinematic behavior of the CS depending on the pathology of the respective specimen. The data also indicate that the Uncinate processes and the overall shape of the vertebral body greatly influence cervical kinematics due to the kinematic behavior after the last step of resection. Regarding surgical treatment, the results of this study suggest that the resection of IS, FL and PL may cause less iatrogenic degeneration compared to the resection of FC, AV and AL.

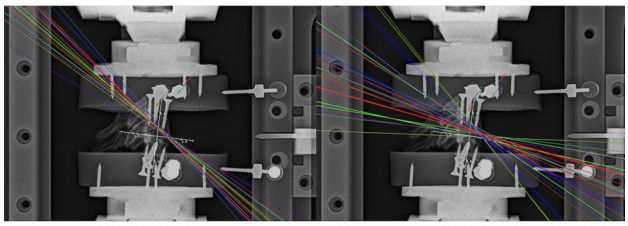

Figure 1: HA during LB, intact (left) and without AV (right)

Disclosures: author 1: none; author 2: none; author 3: grants/research support: Signus, Neos, ApiFix, Spinol, 3D Matrix.

QF8

GENDER SPECIFIC BIOMECHANICAL EVALUATION OF FORTY-FOUR HUMAN CADAVERIC LUMBOPELVIC SPINES - EMPHASIS ON THE KINEMATIC DIFFERENCES IN SACROILIAC JOINT RANGE OF MOTION

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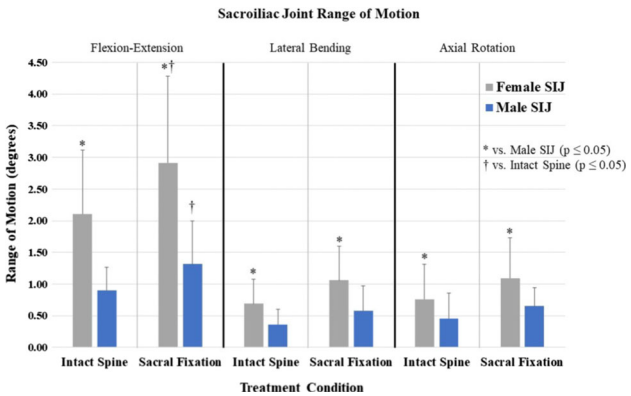
Introduction: Sacroiliac joint (SIJ) dysfunction reportedly accounts for 15–30% of patients presenting with low back pain. Alterations in SIJ biomechanics, due to prior instrumented lumbosacral arthrodesis, trauma, osteoarthritis or pregnancy can cause debilitating pain, leading to impaired mobility. To our knowledge, the current investigation is the largest compilation of biomechanical data quantifying the gender specific kinematic properties at the SIJ, with and without lumbosacral reconstruction.

Hypothesis: Motion at the SIJ during multidirectional flexibility testing is minimal and independent of gender or age.
Study design/setting: In-vitro human cadaveric model and multidirectional flexibility testing.
Methods: A total of 44 cadaveric lumbopelvic spines (mean age 68.2 years, 22-93) were utilized in the current investigation. Multidirectional flexibility testing was performed utilizing a pure moment of ± 12.5 Nm in flexion-extension, lateral bending and axial rotation from L2-pelvis. The SIJ range of motion (ROM), with and without sacral fixation, was compared between males and females. Linear regression and correlation analysis between SIJ ROM and age was also quantified.
Results: Females (n = 20) demonstrated significantly greater intact SIJ ROM compared to males (n = 24) during flexion-extension (2.1 ± 1.0° vs. 0.9 ± 0.4°), lateral bending (0.7 ± 0.4° vs. 0.4 ± 0.2°) and axial rotation (0.8 ± 0.5° vs. 0.5 ± 0.3°) ($p \leq 0.05$). Differences in SIJ ROM between males and females remained significant following sacral fixation in all three bending modes. Comparisons between treatment conditions revealed significant increases in SIJ motion in flexion-extension following sacral fixation (females: 2.9 ± 1.4°; males: 1.3 ± 0.7°) compared to the intact spine (females: 2.1 ± 1.0°; males: 0.9 ± 0.4°), regardless of gender. Linear regression and correlation analysis indicated significance between decreasing SIJ ROM and increasing age under flexion-extension ($r2 = 0.18$, $p \leq 0.05$), lateral bending ($r2 = 0.17$, $p \leq 0.05$) and axial rotation ($r2 = 0.25$, $p \leq 0.05$) for males but not females ($p > 0.05$).
Conclusion: This serves as a comprehensive biomechanical evaluation of SIJ ROM comparing males and females. The study highlights motion at the SIJ, which increases with fixation to the sacrum and is higher for females than males. Gender-specific clinical consideration is advised for patients presenting for index and revision lumbosacral surgical procedures.



Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: grants/research support: Spineology, K2M, consultant: Globus Medical, Innovasis, royalties: Globus Medical, other financial report: Innovasis.

QF9

RADIOGRAPHIC SPINOPELVIC PARAMETERS IN ASD: A DYNAMIC EVALUATION

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Summary: Conventional radiographic analysis in spinal deformity only quantifies the static skeletal body structure from which no conclusions can be drawn with respect to functional abilities. The aim of this work was to extend some of the currently used 2D, static, radiographic concepts to 3D, dynamic, equivalent parameters.
Hypothesis: Motion analysis enables the use of 3D, dynamic, equivalents of 2D, static, radiographic measurements.
Introduction: At present, assessment of spinal alignment in Adult Spinal Deformity (ASD) is mainly based on static standing 2D radiographic spinopelvic parameters. Radiographic images, however, are but instantaneous snapshots of a patient's spinal alignment, which don't provide objective information about the patient's spinopelvic anatomy in more dynamic activities of daily living.
Methods: Eight ASD patients were included in this study. All of them underwent a spinopelvic analysis using a biplanar imaging system followed by performance of a series of motion tasks in the 3D motion lab, including gait. Subsequently, multi-body analysis (MBA) of a subject-specific skeletal model, based on the radiographic images, was used to simulate the motion of each subject performed in the motion lab. 3D equivalent parameters for sagittal vertical axis (SVA, Figure A–C), pelvic tilt, sacral slope, lumbar lordosis, thoracic kyphosis and spino-pelvic inclinations were automatically calculated for each time frame based on the 3D trajectories of predefined anatomical landmarks (such as the C7 body center) on the skeletal model. This 3D, dynamic, equivalent parameter was defined ensuring that when the patient is perfectly aligned with the radiograph plane, the 2D projection of the 3D measurement in the image produces identical values.
Results: As shown in figure D it is now possible to use multi-body simulations to estimate dynamic equivalents of radiographic measurements. Furthermore, classic 2D radiographic analysis of the eight subjects provided an average (SD) SVA of 40.4 mm (38.4 mm) while the dynamic analysis calculated a time-averaged SVA of 69.2 mm (30.2 mm) with an average dynamic range of 20.4 mm (7.7 mm) during gait.
Conclusion: Load-bearing skeletal models of the spine, created based on biplanar images and driven by recorded motion capture data, can be used to calculate dynamic and 3D equivalent radiographic measures. Future research should further analyze the clinical added value over the current static 2D evaluation.
Take home message: 2D, static, radiographic measurements can be extended to their 3D equivalent and thereafter evaluated in dynamic conditions using MBA.

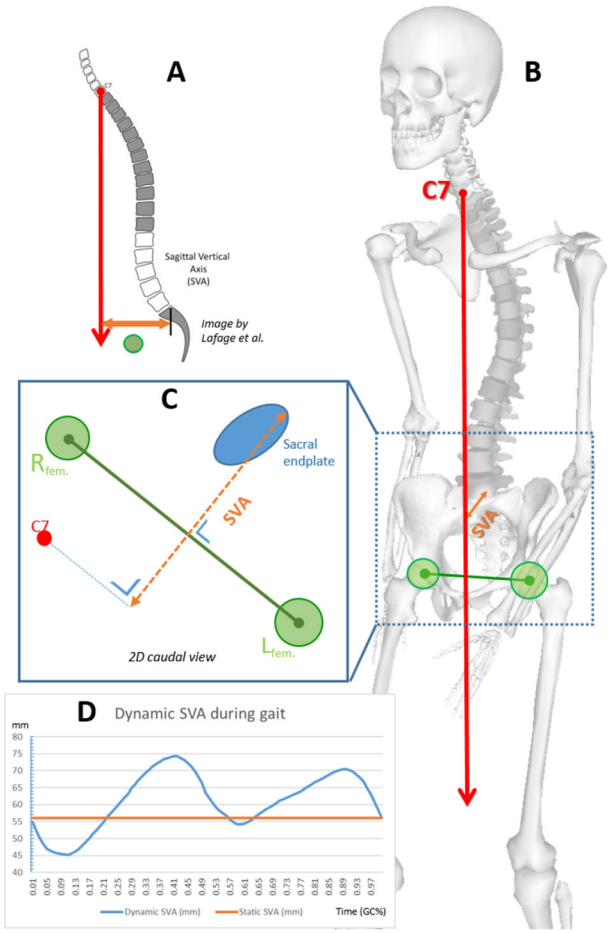

Illustration of the principle with the Sagittal Vertical Axis (SVA) measurement. **A**: Traditional 2D measurement of the SVA. **B**: Virtual augmentation of the SVA on a skeletal model during simulation of gait. **C**: Definition of the 3D equivalent SVA. **D**: Average absolute values of the SVA during a gait cycle (blue) with the classic static SVA (orange) measured from radiography.

Disclosures: author 1: grants/research support: Medtronic; author 2: grants/research support: Medtronic; Research Foundation Flanders (FWO); author 3: none; author 4: grants/research support: KU Leuven Medtronic educational chair for Spinal Deformity research 2013-2017, consultant: KU Leuven C2 grant Advanced Spinal Evaluation and Surgical Planning Platform (ASESP-P); author 5: grants/research support: Medtronic, Depuy-Synthes, Zimmer-Biomet, Smith&Nephew, Arthrex, V!GO.

QF10

DIFFERENCES IN VERTEBRAL MOTION BETWEEN AN ADULT SPINAL DEFORMITY PATIENT AND A HEALTHY SUBJECT: A CASE STUDY

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Summary: Conventional radiographic analysis in spinal deformity only quantifies the static skeletal body structure which inherently

impedes conclusions with respect to dynamic functional abilities. The aim of this case study was to investigate the kinematic strategies of an adult spinal deformity (ASD) patient compared to a healthy subject as an illustration of the possible added value of integrating motion analysis in clinical decision making in spinal deformity.
Hypothesis: The kinematic strategy to perform a well-defined spinal motion is related to the structural spinal deformity in an ASD patient.
Introduction: Radiographic measurements are the main parameters in the clinical decision making in spinal deformity. They, however, don't provide objective information about the patient's spinopelvic anatomy in more dynamic activities of daily living.
Methods: The spinopelvic anatomy of one healthy subject (61y) and one ASD patient (59y, lumbar scoliosis: Fig. 1) were reconstructed in 3D (Fig. 1) based on load-bearing biplanar radiographic images and CT data. Both subjects were asked to perform a maximal forward bending motion while seated, with an optical motion tracking system tracking retroreflective markers placed on the back of the subjects. An inverse kinematics simulation provided intervertebral joint (IVJ) motions from the lumbosacral joint up to the T3-T4 joint. The range of motion (ROM) at each IVJ was determined for every axis (i.e. lateroflexion, axial rotation and flexion).
Results: The ROM graphs (Fig. 1) show that the ASD subject used a clearly different kinematic strategy to reach the bent position, compared to the healthy subject. First, the ASD patient used a combined kinematic strategy involving all three degrees of freedom, which contrasts with the healthy subject almost solely relying on flexion to reach the forward bent posture. Secondly, the thoracic region is clearly more involved in the ASD-specific kinematic strategy compared to a primarily lumbar involvement in the healthy subject.
Conclusion: This case study illustrates the additional information that motion analysis may provide about vertebral kinematic strategies in the ASD population, possibly leading to more informed clinical decision making. The difference at lumbar level between ASD patient and control can be attributed to the spinal deformity realigning the directions of motion and thus forcing a portion of the global spine flexion to be realized through axial rotation and lateroflexion. The difference at the thoracic region may be a compensation mechanism for the lowered mobility in the lumbar region.
Take home message: Motion analysis may provide additional insights to the radiographic evaluation of spinal deformity patients.

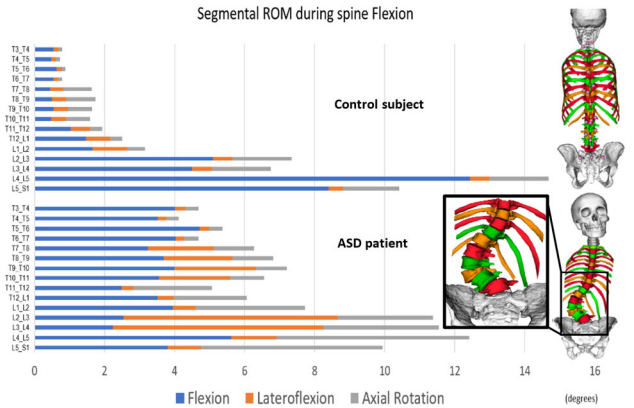

Figure 1: Segmental Range of Motion (ROM) during a spine flexion motion for the healthy control (top) and ASD subject (bottom), with their respective models (right).

Disclosures: author 1: grants/research support: Medtronic; author 2: grants/research support: Medtronic; Research Foundation Flanders (FWO); author 3: none; author 4: grants/research support: KU Leuven Medtronic educational chair for Spinal Deformity research 2013-2017, consultant: KU Leuven C2 grant Advanced Spinal Evaluation and surgical planning platform (ASESP-P); author 5: grants/research support: Medtronic, Depuy-Synthes, Zimmer-Biomet, Smith&Nephew, Arthrex, V!GO.

QF11

POC5 VARIANT LEADS TO CELLULAR ALTERATIONS AND RETINAL ANOMALIES IN ADOLESCENT IDIOPATHIC SCOLIOSIS

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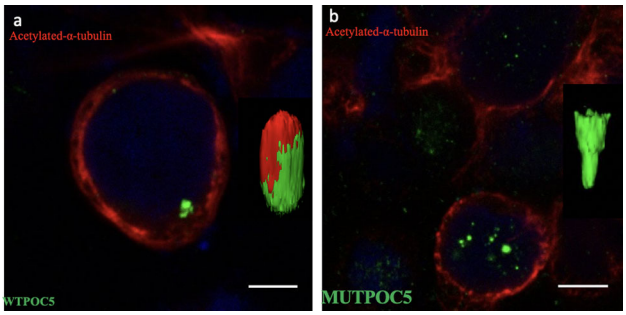
The etiology of adolescent idiopathic scoliosis (AIS) is largely unknown, but clinical observations revealed the role of hereditary and rapid growth in the development of this condition. More recently, several genes were suspected to cause or contribute to AIS. Our group identified gene variants of POC5 centriolar protein in a French and French-Canadian families with multiple members affected with AIS. In order to understand the role of POC5 in the pathogenesis of AIS, we investigated the subcellular localization of POC5 in cilia of cells over-expressing either the wild type (wt) or a POC5 variant (c.C1286T; p.A429V).
Study design: The potential pathogenic effect of mutated POC5 was investigated in vitro (cell culture) and in vivo in a zebrafish animal model.
Methods: To investigate the role of POC5 in AIS, we investigated subcellular localization of POC5 with respect to cilia in cells over-expressing wt or POC5 variants (C1286T, A429V) and in human osteoblasts from scoliotic patients carrying these POC5 variants and normal control cells (in vitro study). We also created a loss-of-function model in zebrafish (in vivo study). The role of POC5 was investigated by: (1) mass spectroscopy analysis and co-immunoprecipitation to identify differences in binding partners between the wild-type (wt POC5 and mut POC5 protein; (2) immunolocalization of POC5 wt and mut proteins at the cellular level; (3) histology and immunohistochemistry performed on tissues from wt (control) and scoliotic (poc5 mut) zebrafish.
Results: In human osteoblasts, POC5 protein was co-localised with acetylated-α-tubulin in the wt- as compared to the mut- POC5 cells. Mutation of POC5 induced ciliary retraction and loss of the connection of acetylated-α-tubulin to POC5 (Fig. 1), which impaired the progression of the cell-cycle as was noted by the accumulation of cells in the S-phase. Using immunoprecipitation coupled to mass spectrometry, we identified specific protein interaction partners of POC5, most of which were components of cilia, and cytoskeleton. We also immunolocalized POC5 with the acetylated-α-tubulin in the retina of zebrafish expressing wtpoc5 or mutpoc5, and we observed colocalization of both proteins in wt but not in mutpoc5. These results demonstrate the role of mutant POC5 in a ciliopathy underlying AIS pathogenesis.
Conclusion: This work identified specific protein interaction partners of POC5 and reveled that POC5 variant (c.C1286T; p.A429V) alters the interaction with several ciliary and cytoskeletal proteins. Improved interaction of mutPOC5 with ciliary proteins resulted in the loss of POC5 co-localization with acetylated-α-tubulin, impaired cell cycle progression, cilium retraction and retinal phenotypes. These findings open new avenues for the understanding the role of POC5 in AIS at the molecular and cellular levels.



Disclosures: author 1: grants/research support: Yves Cotrel Foundation, and SRS; author 2: none; author 3: grants/research support: DePuy Synthes Spine, Medtronic, EOS-Imaging, Spinologics, K2M, consultant: DePuy Synthes Spine, EOS-Imaging, stock/shareholder: Spinologics, royalties: EOS-Imaging.

QF12

MACROPHAGES CONTRIBUTE TO AGGRAVATE INTERVERTEBRAL DISC DEGENERATION UNDER A PRO-INFLAMMATORY/DEGENERATIVE MICROENVIRONMENT

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Introduction: Low back pain is a highly prevalent clinical problem and intervertebral disc (IVD) degeneration is now accepted as the major pathophysiological mechanism responsible for this condition. Inflammation plays a crucial role in the progression of human IVD degeneration [1], with macrophages being pointed as the key immune cell players in this process. Macrophages are highly plastic and may play different roles depending on the microenvironmental cues. The study of inflammation associated with IVD degeneration has been somehow neglected and one of the reasons is related with a lack of adequate models. To overcome this, we propose the establishment of a new model of degenerated IVD in 3D organ culture to further dissect the role of macrophages in IVD associated immune response.
Methods: For that, human monocyte-derived macrophages were co-cultured either with bovine caudal IVD punches in the presence of the pro-inflammatory cytokine IL-1β, as previously described [2], or IVD-conditioned medium (CM), to investigate how IVD-produced factors influence macrophage phenotype. After 72 h, metabolic activity, gene expression and cytokine profile of macrophages and IVD cells were measured. Statistical analysis was performed using non-parametric tests: paired Friedman test for macrophages and unpaired Kruskal–Wallis for IVDs.
Results: Macrophages remain metabolically active in the presence of IL-1β-stimulated IVDs, with significantly higher upregulation of CCR7 gene expression ($p < 0.001$) and increased production of IL-6 ($p < 0.05$). When treating macrophages with IL-1β-IVD-CM, CCR7 upregulation follows the same trend ($p = 0.06$), while for IL-6 an opposite effect was observed. On the other hand, macrophages interfere with IVD ECM remodeling, decreasing MMP3 expression and significantly downregulating aggrecan ($p = 0.09$) and collagen II ($p < 0.05$) gene expression in the presence of IL-1β.
Conclusions: Overall, the co-culture model established in this study can be considered a suitable approach to address the cellular and molecular pathways that regulate macrophage-IVD crosstalk, suggesting that degenerated IVD tissue tends to polarize human macrophages towards a more pro-inflammatory profile, which seems to aggravate IVD degeneration. This model could be used to improve the knowledge of the mechanisms that link IVD degeneration and the immune response.
Reference: [1]Molinos, J Royal Soc Interf, 2015; [2] Teixeira, Tissue Eng, Part C, 2016.

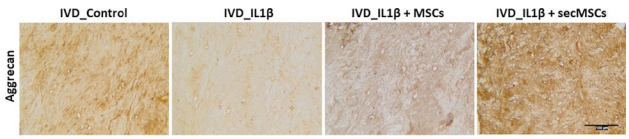

Figure 1. Degenerated IVDs ECM maintenance in response to MSCs and their secretome
IVD matrix contente after pro-inflammatory stimulus with puncture plus culture medium supplementation with IL-1β (10 ng/mL), and treatment with MSCs conditioned media (secMSCs) for 14 days.
Sagital sections of IVD punches stained for aggrecan (scalebar:100μm; n=4)

Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: none.

QF13

A ROLE FOR MSCS SECRETOME TO MODULATE THE INFLAMMATORY RESPONSE IN DISC DEGENERATION

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Introduction: Intervertebral Disc (IVD) degeneration, a major cause of spine disorders and disability worldwide, occurs naturally with age. It's associated with matrix degradation, inflammation and IVD vascularization and innervation (in a tissue physiologically avascular and non-innervated) which lead to the onset of low back pain (LBP). Current treatments can alleviate associated symptoms but don't solve the underlying cause.
Mesenchymal stem/stromal cells (MSCs) clinical potential has been widely demonstrated in a variety of disorders including LBP. Still, the MSCs paracrine competence is frequently pointed out as its main therapeutic factor, particularly considering the questionable MSCs survival upon transplantation to the harsh environment of the degenerated IVD.

Previous work has shown that in the pro-inflammatory/degenerative IVD environment MSCs assume an immunoregulatory role [1]. Here, we aimed to evaluate if we can replicate this effect using only the MSCs secretome.
Methods: Human bone marrow-derived MSCs were pre-conditioned for 48 h with IL-1β (10 ng/mL), in hypoxic (6%O2) conditions, the microenvironment used to culture bovine IVDs (bIVDs) [1]. MSCs secretome (secMSC) was collected and used to culture bIVD punches in pro-inflammatory/degenerative conditions (puncture + IL-1β) plus hypoxia (6%O2), using an ex vivo model previously established in the group [2]. Control groups of non-stimulated IVDs and IVDs co-cultured with MSCs were analysed in parallel.

Results: MSCs preconditioning with hypoxia and IL-1β shifted their secretome towards a pro-inflammatory profile with increased production of pro-inflammatory cytokines IL-6, IL-8, MCP-1, RANTES and PGE2. After 48 h, the levels of pro-inflammatory markers of degenerated IVDs were down-regulated (IL-6, IL-8) comparatively to non-degenerated discs, which was also observed with MSCs-treated IVDs. Regarding the matrix degenerative process, 48 h after the proinflammatory/degenerative stimulus, neither secMSCs nor MSCs seemed to be able to counteract the down-regulation of collagen type II and aggrecan expression induced by the model. Yet, treatment with secMSCs significantly altered the expression of matrix degrading enzymes MMP1 and MMP3, decreasing the first and increasing the last. Co-culture with MSCs didn't have a significant effect. Interestingly, only secMSC treatment was able to increase Aggrecan deposition relatively to the degenerated IVDs at a later timepoint (14 days) (Figure 1).
Conclusions: Overall, the results show it is possible to replicate the immunomodulatory effect observed with MSCs in a pro-inflammatory/degenerative IVD model using only their secretome. Additionally, secMSCs seems to have the ability to inhibit the loss of aggrecan from the IVD's ECM in response to the pro-inflammatory/degenerative stimulus applied.
References: [1] G.Q. Teixeira et al., Spine 43(12) E673-E682, (2018). [2] G.Q. Teixeira et al., Tissue Engineering Part C: Methods, 22(1):8-19, (2015).
Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none.

QF14

FROM STATIC TO DYNAMIC: SAGITTAL ALIGNMENT AND COMPENSATION STRATEGIES DURING WALKING IN ADULT SPINAL DEFORMITY

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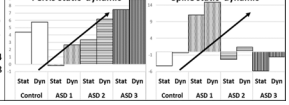
Hypothesis: Adult spinal deformity (ASD) patients are not able to preserve their static compensations during walking.
Introduction: Although static spinal alignment and compensation mechanisms in ASD are well documented, what happens to them during motion is less clear. The primary goal of this study was to compare the static and dynamic sagittal profile of these patients during standing and walking in the motion lab. Secondly, also spatiotemporal parameters and balance performance are compared between different deformity types to document their functionality.
Methods: 51 ASD patients and 20 controls were recruited. The ASD group was divided into three groups: a decompensated sagittal deformity group (ASD1: SVA $>$ 4 cm), a compensated sagittal deformity group (ASD2: SVA $<$ 4 cm), a primary coronal deformity group (ASD3: Cobb $>$ 30°, SVA $<$ 4 cm, PT $<$ 20°). All subjects performed 3D motion analysis and balance assessment using the Balance Evaluation Systems Test (BESTest). A static and walking trial were processed (full body Plug-In-Gait model, Vicon Nexus) for each subject resulting in sagittal kinematics of the spine and lower limbs. Between group differences were analyzed using the Kruskal–Wallis test.
Results: Decompensated ASD patients showed increased trunk flexion during stance compared to all groups (p = 0.002–0.014), for which they tried to compensate with increased knee (p = 0.007) and ankle (p = 0.008) (dorsi) flexion and non-significant pelvic retroversion. These findings are in accordance with the static alignment and compensations reported in the literature, measured on radiographic images. No static differences with controls could be found for compensated sagittal or primary coronal patients. During walking the static differences at the lower limb level disappeared, suggesting decompensated ASD patients adopt a normal walking pattern. Within group analysis of sagittal kinematics revealed that from stance to walk all groups performed similar spinal and pelvic strategies, namely trunk flexion and pelvic anteversion. Overall, ASD patients showed altered spatiotemporal parameters during walking and decreased balance control. However, between group analysis revealed that these functional differences were mainly due to sagittal deformity (BESTest: ASD1: p $<$ 0.001; ASD2: p = 0.002) since no differences were found for balance control between the primary coronal deformity group and controls. All results and p-values are displayed in Table.
Conclusion: ASD patients with sagittal malalignment seem to adopt the same strategies from stance to walking, measured with motion analysis, compared to controls, although their functionality, measured by spatiotemporal parameters and balance assessment, was clearly decreased. Therefor it can be assumed that these functional strategies are rather a loss of their static compensations, possibly compromising their functionality. Also, sagittal malalignment seems to be a better predictor of functionality than coronal malalignment.

	Control	ASD total	ASD 1	ASD 2	ASD 3	p-value						
	N=20	N=51	N=18	N=19	N=14	C vs ASD	C vs ASD 1	C vs ASD 2	C vs ASD 3	ASD 1 vs ASD 2	ASD 1 vs ASD 3	ASD 2 vs ASD 3
Static alignment (°)												
Spine	-4.3±5.5	1.5±14.1	11.1±12.1	-2.3±15.0	-5.8±7.4	0,09	**0,002**			**0,014**	**0,002**	
Pelvis	4.4±4.6	3.3±8.2	-0.2 ± 8.8	3.4±8.3	7.5±5.5	0,78					**0,021**	
Knee	0.3±4.6	4.0±7.9	8.5±7.6	1.4±8.4	1.7±5.1	0,08	**0,007**			**0,025**		
Ankle	4.8±3.8	7.3±4.1	9.3±3.7	5.9±4.5	6.5±3.2	**0,03**	**0,008**					
Dynamic alignment (°)												
Spine (mean)	4.4±1.3	3.8±1.4	3.3±1.2	4.1±1.2	4.3±1.8	0,11	**0,001**			**0,006**	**0,001**	
Pelvis (mean)	5.8±4.6	5.7±6.9	2.7±6.3	6.2±7.5	8.9±5.1	0,828					**0,022**	
Knee (midstance)	22.0±4.9	19.6±9.2	19.1±11.7	18.5±8.9	21.8±5.6	0,421						
Ankle (midstance)	13.6±3.4	14.0±9.5	12.5±15.4	14.1±3.8	15.9±3.3	0,064						
Spatiotemporal												
Cadence (steps/S)	2.0±0.1	1.9±0.2	1.9±0.2	1.8±0.1	1.9±0.1	**0,001**		**0,003**				
Step Length (m)	0.6±0.03	0.6±0.1	0.5±0.1	0.6±0.1	0.6±0.1	**<0.001**	**<0.001**	**0,005**			**0,032**	
Step Time (s)	0.5±0.03	0.5±0.04	0.5±0.04	0.6±0.1	0.5±0.04	**0,001**		**0,004**				
Velocity (m/s)	1.3±0.1	1.1±0.2	1.0±0.2	1.1±0.2	1.1±0.1	**<0.001**	**<0.001**	**<0.001**	**0,026**			
Stride Length (m)	1.3±0.1	1.1±0.1	1.1±0.1	1.2±0.1	1.2±0.1	**<0.001**	**<0.001**	**0,002**				
Stride Time (s)	1.0±0.1	1.1±0.1	1.1±0.1	1.1±0.1	1.1±0.1	**0,001**		**0,003**				
Double Support (s)	0.2±0.03	0.3±0.1	0.3±0.1	0.3±0.1	0.3±0.1	**<0.001**	**<0.001**	**0,002**	**0,033**			
Foot Off (%)	62.0±1.4	63.8±2.0	64.8±2.1	63.4±2.1	63.3±1.4	**<0.001**	**<0.001**					
Balance												
BESTest (%)	93.1±4.8	82.9±10.6	77.6±12.0	82.8±9.9	89.8±4.2	**<0.001**	**<0.001**	**0,002**			**0,013**	
From static to dynamic (°)						Pelvis static- dynamic				Spine static- dynamic		
Static Pelvis	4.4±4.6	3.3±8.2	-0.2±8.8	3.4±8.3	7.5±5.5							
Dynamic Pelvis	5.8±4.6	5.7±6.9	2.7±6.3	6.2±7.5	8.9±5.1							
p-value	***0,01***	***<0.001***	***0,02***	***0,003***	***0,12***							
Static Spine	-4.3 5.5	1.5±14.1	11.1±12.1	-2.3± 15.0	-5.8±7.4							
Dynamic Spine	-0.4±5.6	5.3±13.6	14.8±10.9	1.3±14.6	-1.6±7.8							
p-value	***<0.001***	***<0.001***	***0,022***	***0,001***	***0,016***							



Disclosures: author 1: grants/research support: MEdtronic; Research Foundation - Flanders (FWO); author 2: grants/research support: Medtronic; author 3: none; author 4: grants/research support: Medtronic, Depuy-Synthes, Zimmer-Biomet, Smith&Nephew, Arthrex, V!GO; author 5: grants/research support: KU Leuven Medtronic Educational Chair for Spinal Deformity Research 2013-2017, consultant: KU Leuven C2 grant Advanced Spinal Evaluation and Surgical Planning Platform (ASESP-P).

QF15

BIOMECHANICAL EFFECTS OF LATERAL BENDING POSITION ON PERFORMING CERVICAL SPINAL MANIPULATION FOR CERVICAL DISC HERNIATION: A THREE-DIMENSIONAL FINITE ELEMENT ANALYSIS

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Background: Most studies report that the common position of cervical spinal manipulation (CSM) for treating symptomatic cervical

disc herniation (CDH) is lateral bending to the herniated side. However, the rationality of lateral bending position on performing CSM for CDH is still unclear.
Objective: The purpose of this study is to investigate the biomechanical effects of lateral bending position on performing CSM for CDH.
Study design: A finite element analysis study.
Methods: A finite element (FE) model of CDH (herniated on the left side) was generated in C5-C6 segment based on the normal FE model. The FE model was performed CSM in left lateral bending position, neutral position and right lateral bending position, respectively. Cervical disc displacement, annulus fiber stress and facet joint stress were observed during the simulation of CSM.
Results: The cervical disc displacement on herniated side moved forward during CSM, and the maximum forward displacements were 0.23, 0.36 and 0.45 mm in left lateral bending position, neutral position and right lateral bending position, respectively. As the same trend of cervical disc displacement, the annulus fiber stress on herniated side from small to large were 7.40, 16.39 and 22.75 MPa in left lateral bending position, neutral position and right lateral bending position, respectively. However, the maximum facet stresses at left superior cartilage of C6 in left lateral bending position, neutral position and right lateral bending position were 6.88, 3.60 and 0.12 MPa, respectively.
Conclusion: Compared with neutral position and right lateral bending position, though the forward displacement of cervical disc on herniated side was smaller in left lateral bending position, the annulus fiber stress on herniated side was declined by sharing load on the left facet joint. The results suggested that lateral bending to the herniated side on performing CSM tend to protect the cervical disc on herniated side. Future clinical studies are in need to verify that.
Keywords: cervical spinal manipulation; cervical disc herniation; lateral bending position; finite element analysis.
Disclosures: author 1: none; author 2: not indicated; author 3: not indicated; author 4: none.
Degenerative (thoracolumbar)

QF16

WHERE DOES THE PAIN COME FROM? EXPLORING THE PATHOPHYSIOLOGY OF NEUROGENIC CLAUDICATION

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Introduction: The pathophysiology of neurogenic claudication due to lumbar spinal stenosis (LSS) is poorly understood. Several hypotheses such as impaired blood flow and nerve conduction or lower limb vascular impairment secondary to autonomic nerve fibre dysfunction have been advanced. We hypothesised that lower limb pain could be due to mechanical cyclical traction on the lumbar roots during walking while conduction or blood flow abnormalities could be mere secondary accompanying observations. Should this be the case, passive mobilisation of the legs simulating gait in an erect position should therefore reproduce lower leg symptoms.
Materials and methods: Patients suffering from neurogenic claudication symptoms with a myelographic bloc on MRI were included. Patients performed an active walking test using a treadmill as well as a separate passive walking test involving an external robotic rehabilitation device (Lokomat) whereby the lower limbs were being passively moved simulating walking while being suspended by the pelvis in a harness, thus replicating weight-bearing erect position. Strain gauges monitored the absence of voluntary muscle activity. Subjects were randomised to start either from the passive (n = 6) or the active part of the experiment (n = 9). Tests lasted for 20 mn and patients were instructed to report on their symptoms as soon as they appear. Primary outcome measure was pain reported by patients on a VAS scale while secondary outcomes included pain free distance walked, sensory symptoms reporting related to distance walked as well as Oswestry disability index (ODI) score and pre-test estimation of walking distance. Statistical analysis was performed using Fisher's exact test.
Results: Fifteen patients were enrolled in this pilot study with a male/female ratio of 1.6 and an average age of 70 years. They had an average of 1.6 stenotic levels on MRI. Average ODI score was of 33 with an average pre-test reported walking distance of under 545 m. During the experiment, an average walking speed of 2.3 km/h in both passive and active walking tests was recorded. Lower limb pain of an average of VAS 4/10 was reported by all patients on active walking after an average of 116 meters. By contrast passive walking reproduced no pain in 14 out of the 15 patients enrolled, while only a single patient experienced leg symptoms ($p < 0.001$). Sensory symptoms developed in 11 subjects on active walking after an average of 191 m and in 3 patients during passive walking after an average of 167 m ($p = 0.009$).
Discussion: This study suggests that neurogenic claudication is most likely unrelated to a mechanical cause such as traction of the severely compressed nerve roots during walking. A vascular origin is more likely although the exact mechanism is poorly understood. Further research is warranted in order to better understand the pathophysiology of claudication in LSS.
Disclosures: author 1: grants/research support: Profectus, non-profit research Foundation, consultant: Medtronic/Spineart; author 2: none.

QF17

IS THE SIZE OF LUMBAR DISC HERNIATION, A BIOMECHANICAL FOOTPRINT OF ABNORMAL BODY MASS INDEX?- RESULTS FROM AN AGE AND GENDER MATCHED CASE-CONTROL STUDY

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Study design: Retrospective, age-gender matched, case-control study.
Objective: Evaluate relationship between body mass index and size of lumbar disc herniations.
Summary of background data: Although deleterious biomechanical and metabolic effects of BMI on lumbar discs degeneration have been widely studied and satisfactorily established, the literature evaluating relationship between size of lumbar disc herniations and BMI is sparse.
Methods: The patients who underwent surgical treatment for symptomatic single level lumbar disc herniations between June 2009 to October 2010 at a spine surgery specialty hospital were categorized into cases (ones with massive disc herniation) and controls (ones with non-massive disc herniation. For each study subject following data was recorded: body weight, standing height, BMI, level/size of disc herniation, symptoms duration, motor involvement, pre-operative pain and quality of life scores (visual analogue score for back pain (VAS-B) and radiculopathic leg pain (VAS-L) and Oswestry Disability Index (ODI) score).

Results: Final analysis had 99 cases and matching 99 controls. Statistical analysis was significant for higher prevalence of abnormally high BMI, shorter symptom duration and increased incidence of motor weakness among cases.
Conclusions: Abnormally high BMI levels can significantly affect the size of symptomatic lumbar disc herniations predisposing one to greater spinal canal compromise. This can have critical clinical implications both for the patient and surgeon group.
Disclosures: author 1: none; author 2: none; author 3: none.

QF18

THE POTENTIAL ROLE OF BLADDER SCAN POST VOID RESIDUAL VOLUME MEASUREMENT IN IMPROVING DIAGNOSTIC ACCURACY OF CAUDA EQUINA SYNDROME

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Study design: Prospective, observational cohort study.
Objective: To identify the role of bladder scan in predicting Cauda Equina.
Syndrome (CES): CES is a changing diagnosis with both medical and financial implications that affect any spinal unit worldwide. Despite great efforts there are no agreed combination of clinical symptoms and/or signs that reliably predicts cauda equina compression nor single defining clinical criterion that has high enough predictive value to confirm or exclude CES with certainty.
Methods: Patients with suspected CES admitted over a period of 1 year at a single institution were prospectively assessed by physical examination (including digital rectal examination and pin prick perianal sensation) and bladder ultrasound scanning (recording pre- and post-void residual volume - PVR). Those clinical results were compared with the subsequent MRI scans and those patients that had emergent surgery for a positive diagnosis of CES.
Results: 215 patients were included in the study (65.6% females, 34.4% males) with mean age of 44.3 years old. An MRI scan demonstrating compression of the cauda equina was present in only 16.7% of the patients (36 cases). The sensitivity of anal tone to predict CES was 47.2%. Peri-anal numbness (either unilateral or bilateral) had sensitivity of 75% and negative predictive value of 91.2%.
Receiver operating characteristic (ROC) curve was constructed for pre-void and post void bladder volume to determine cut-off points to predict CES. Based on ROC, the optimal bladder volume cut-offs for predicting the CES were $\geq$ 400 ml for pre-void scan and $\geq$ 200 ml for post void scan. A PVR of $<$ 200 ml gave CES probability of 2.8%. If $>$ 200 ml then the probability of having CES was 97.2%. A PVR $<$ 200 ml had a negative predictive value of 99.2%.
Conclusions: According to our findings Bladder scanning has to potential to be a useful adjunct tool in the diagnosis process of CES. It was found to be superior and with better negative predictive value than physical examination. We suggest to add this a mandatory step in the diagnosis process of any suspected case of CES.
Disclosures: author 1: none; author 2: none; author 3: not indicated; author 4: consultant: Silony.

QF19

INDIRECT DECOMPRESSION WITH LATERAL INTERBODY FUSION FOR SEVERE DEGENERATIVE LUMBAR SPINAL STENOSIS: MINIMUM 1-YEAR MRI FOLLOW-UP

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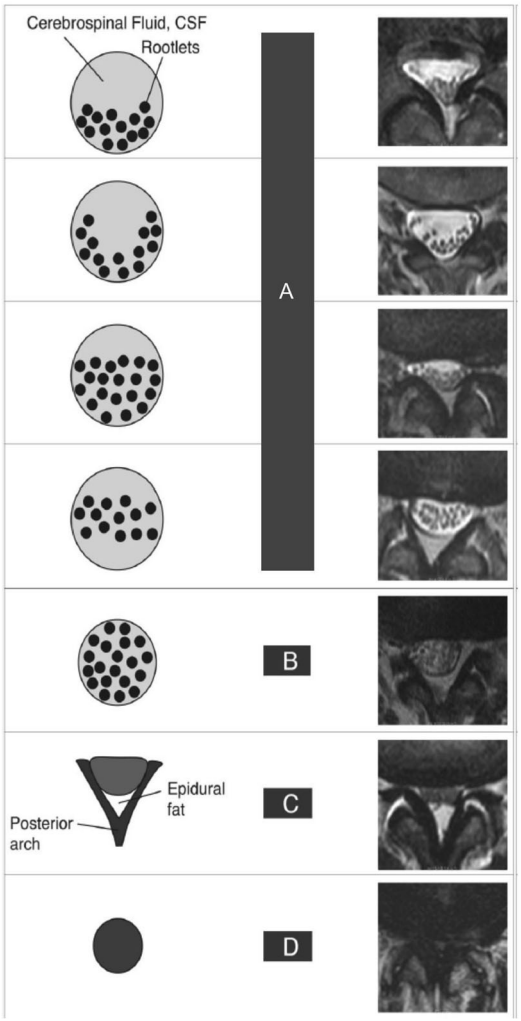
Introduction: Conventional surgical treatment for symptomatic degenerative lumbar spinal stenosis includes direct posterior decompression with or without fusion. Prior studies have shown that LIF without posterior decompression can improve neurological symptoms through indirect decompressioñ that results from restoration of intervertebral and foraminal heights. However, the indication for the use of indirect decompression surgery for severe canal stenosis is still controversial.
Methods: We included 35 patients (37 surgical levels) who were preoperatively diagnosed with severe degenerative lumbar stenosis using MRI results based on previously published criteria (Grade C or D, Fig 1) These patients underwent oblique LIF with supplemental percutaneous pedicle screws without posterior decompression. Surgical levels were limited to L3/4 or L4/5. All patients satisfied minimum 1-year MRI follow-up. We compared the cross-sectional area (CSA) of the thecal sac as well as clinical outcome scores (Japanese Orthopedic Association [JOA] Score) among preoperation, 3-week postoperation, and 1-year postoperation. Postoperative changes in severity of foraminal stenosis were also assessed using MRI. Fusion status and disc height were investigated based on computed tomography scans at 1-year follow-up.
Results: CSA improved over time, increasing from 54.9 mm2 preoperatively to 88.1 mm^2 at 3-week postop and 135.1 mm^2 at last follow-up (average 28.3 months) ($P < 0.001$). MR images indicated that foraminal stenosis also improved at 3-week postoperatively and this improvement was maintained at 1-year follow-up (Stenosis Score: 0.7 vs. 0.2 pre- and postoperatively, respectively). Clinical symptoms significantly improved (72.8% improvement of JOA Score at 1-year follow-up). Fusion rate at 1-year follow-up was 89.1%, and disc heights were significantly restored (preoperative 6.3 mm vs postoperative 9.8 mm, $p < 0.001$). Patients showing poor CSA expansion ($<$ 200% expansion rate) had a higher prevalence of pseudarthrosis than patients with significant CSA expansion ($>$ 200% expansion rate) (21.4 vs. 4.3% with pseudarthrosis). Perioperative complications observed included transient thigh pain (n = 2), incidental anterior longitudinal ligament rupture (n = 2), and retroperitoneal hematoma (n = 1).
Conclusions: LIF with indirect decompression provided successful surgical outcomes throughout the postoperative period, including restoration of disc height and indirect expansion of the thecal sac. LIF is a safe and effective surgical option for severe degenerative lumbar stenosis. Achieving solid fusion is critical to maintain the expansion of the dural sac through the postoperative period.
Disclosures: author 1: none; author 2: none; author 3: none; author 4: none.

Fig 1. Grading Criteria for Lumbar Spinal Stenosis on MRI



QF20

5-YEAR RESULTS OF A DOUBLE-BLIND RCT ON COMPARING INTERSPINOUS IMPLANT WITHOUT BONY DECOMPRESSION TO CONVENTIONAL DECOMPRESSION FOR LUMBAR SPINAL STENOSIS

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Introduction: Short-term results comparing interspinous process devices (IPD) to conventional decompression in patients with intermittent neurogenic claudication (INC) due to lumbar spinal stenosis provide evidence that clinical outcomes are comparable1. This study focuses on the long-term, 5-year results of this comparison.

Methods: Patients with neurogenic claudication due to lumbar spinal stenosis at one or two levels who had failed to respond to conservative treatment, were randomized to receive either standard bony decompression or stand alone implantation of an IPD (Coflex). A total of 159 patients were randomized at the five participating neurosurgical centers. Patients and research nurses remained blinded for the allocated treatment throughout the study period of 5 years. The primary outcome at long-term (5-year) follow-up was the score for the Zurich Claudication Questionnaire (ZCQ), secondary outcome measures included Visual Analogue Scores (VAS) for back pain and leg pain. Repeated-measurement analyses were applied to compare outcomes over time.

Results: 80 participants received an IPD and 79 participants underwent spinal bony decompression. At five years, the success rate according to the Zurich Claudication Questionnaire for the IPD group [68% (95% CI 56-78)] did not show a significant difference compared to standard bony decompression [56% (95% CI 44-68) *p* value 0.422]. Reoperations, because of absence of recovery, remained significantly higher in the IPD group compared to standard decompression with comparable reoperation rates at 2 and 5 years (p = 0.04). Long-term back pain was lower [26 mm on a 100 mm scale (95% CI 20–32)] in the IPD group compared to the bony decompression group [38 mm (95% CI 30–46) p-value 0.02]. This is in contrast to the 2-year results where the VAS back pain was higher in the IPD group compared to standard bony decompression (36 vs. 28 mm, p-value 0.04).

Discussion: Long-term results demonstrate that implanting a stand-alone interspinous device is equally successful compared to standard decompression in treating neurogenic claudication. The VAS back pain seems to improve over time in the IPD group. However, the difference in VAS back pain between both treatment group at 5-years might be statistically significant, but is clinically probably non-relevant. Reoperation rate in the IPD group remains significantly higher but does not increase after 2 years follow-up. Implanting an IPD appears to be an acceptable, though more expensive, alternative for decompressive surgery.

Disclosures: author 1: none; author 2: employee: Leiden University Medical Center; author 3: none; author 4: none; author 5: grants/research support: Medtronic; Paradigm Spine; Braun; author 6: grants/research support: Zimmer-Biomet, consultant: Intrinsics, Zimmer-Biomet, EIT, Silony, royalties: EIT; author 7: grants/research support: Covidien sponsors a trial on legpumps in neurosurgical surgery. Ynske Meyes Fund sponsors a trial on epidural injections in sciatica. These are all investigator initiated trials. The payment is not made to my own account but to our research department. Board of CSRS Europe, faculty for EANS, CSRS, Eurospine and webinar for AO spine.

QF21

DEVELOPMENT AND VALIDATION OF A PREDICTION MODEL FOR SUCCESS IN ADULT PATIENTS UNDERGOING ELECTIVE LUMBAR SPINAL FUSION: A DOUBLE COHORT STUDY

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Title: Development and validation of a prediction model for success in adult patients undergoing elective lumbar spinal fusion: a double cohort study.

Background: Patients with degenerative disorders of the lumbar spine not responding to conservative treatment may consider undergoing lumbar spinal fusion (LSF). However, on average 56% of patients report a clinically important pain reduction. Consequently, preoperatively identifying which patient will benefit from LSF is paramount to improve clinical decision making and tailor care to the specific needs of the individual; improving treatment choices and outcomes of patients.

Purpose of the study: To develop and validate a clinical prediction model predicting clinically important reduction of pain (success) one to two years after LSF in adults with degenerative spinal disorders.

Materials and methods: The primary outcome variable of the prediction model was defined as the change in the predominant pain in the back and/or leg as measured with the Visual Analogue Scale (VAS). Patient reported outcome measures and patient characteristics were collected preoperatively from 202 consecutive patients undergoing one to three level elective LSF in one hospital. These data were used to construct and internally validate a clinical prediction model using multivariable logistic regression. Next, external validation was performed on a dataset of 251 patients from another hospital.

Results: Patients who do not smoke (odds ratio (OR) = 0.41 [95% confidence interval (CI) = 0.19–0.87]), with lower Body Mass Index (BMI) (OR = 0.93, [0.85–1.01]), shorter pain duration (OR = 0.49 [0.20–1.19]), lower educational level (OR = 0.46 [0.19–1.12]), lower American Society of Anaesthesiologists (ASA) score (OR = 4.82 [1.35–17.25]), higher VAS score for predominant (back or leg) pain (OR = 1.05 [1.02–1.08]), lower Oswestry Disability Index (ODI) (OR = 0.96 [0.93–1.00]) and higher RAND-36 mental component score (MCS) (OR = 1.03 [0.10–1.06]) preoperatively had a higher chance of success. The overall model fit of the prediction model after internal validation was 0.22 (Nagelkerke's r-squared) and had an area under the receiver operator curve (AUC) of 0.74. In the external dataset the AUC of model yielded 0.70.

Conclusions: Our preoperative clinical prediction model can estimate one to two year postoperative success chance in patients eligible for LSF. Information on modifiable risk factors like smoking, BMI and perceived physical functioning can be used to improve postoperative success, by preoperatively addressing these risk factors. This prediction model can be implemented in clinical practice to give patients and care professionals insight in the postoperative success chance.

Disclosures: author 1: employee: Maastricht University; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none.

QF22

A COMPARATIVE STUDY OF EARLY FUSION STATUS AFTER PLIF WITH CORTICAL BONE TRAJECTORY SCREW FIXATION USING CARBON PEEK CAGES OR TITANIUM-COATED PEEK CAGES

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Objective: We recently reported that posterior lumbar interbody fusion with cortical bone trajectory screw fixation (CBT-PLIF) provided significantly favorable postoperative improvement of clinical symptoms and significantly reduced the incidence of symptomatic adjacent segment disease compared with PLIF using traditional pedicle screw fixation (PS-PLIF). However, the fusion rate was relatively lower after CBT-PLIF than after PS-PLIF, although no significant difference was found. Since the titanium-coated PEEK (TP) cage could improve and accelerate fusion status after CBT-PLIF, we changed from carbon PEEK (CP) cages to TP cages in January 2016. We thus compared early fusion status, including the incidence of vertebral endplate cysts (cyst signs), between CBT-PLIF using TP cages and that using CP cages.

Methods: The subjects were 36 consecutive patients who underwent single-level CBT-PLIF using TP cages for degenerative lumbar spondylolisthesis (TP group). As a historical control group, 92 consecutive patients who underwent single-level CBT-PLIF using CP cages for the same pathological condition were enrolled (CP group). Clinical symptoms were assessed using the Japanese Orthopaedic Association (JOA) score before surgery and at 1-year postoperatively. None of age at the time of surgery, gender, fusion area and preoperative JOA score showed significant differences between the 2 groups. On MPR-CT at 6 months after surgery, cyst signs were evaluated and classified into diffuse or local cysts. Early fusion status was assessed by dynamic plain radiographs and MPR-CT at 1-year postoperatively.

Results: The mean JOA score improved significantly from 13.0 points before surgery to 22.8 points at 1-year after surgery (Mean recovery rate, 62.8%) in the TP group, and from 13.9 points preoperatively to 23.7 points at 1-year follow-up (Mean recovery rate, 65.6%) in the CP group ($P > 0.05$). The incidence of cyst signs was 38.9% in the TP group and 66.3% in the CP group ($P < 0.01$). The incidence of diffuse cysts was 16.7% in the TP group and 32.6% in the CP group ($P = 0.07$). The early fusion rate was 83.3% in the TP group and 79.3% in the CP group ($P > 0.05$). Combining the 2 groups, 22 of the 36 patients (61.1%) with diffuse cysts had non-union at 1-year after surgery, whereas non-union at 1-year after surgery was found in only 2 of the 39 patients (5.1%) with local cysts and in only 1 of the 53 patients (1.9%) without cyst signs ($P < 0.01$).

Conclusions: The early fusion rate at 1-year after surgery was not significantly different between the 2 groups. TP cages did not accelerate fusion process after CBT-PLIF. However, in the TP group, the incidence of a diffuse cyst (a known predictor of non-union) decreased to about half that of the CP group. These results indicate that TP cages, which provide greater early postoperative fixation strength than CP cages and have osteoconductive activity, may improve the fusion rate at follow-up longer than 1-year after surgery.

Disclosures: author 1: none; author 2: none; author 3: none; author 4: none.

QF23

LONG TERM OUTCOME AFTER LUMBAR MICRODISCECTOMY IN YOUNG ADULTS

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Low back problems are a significant cause of disability and incapacity for employment. Lumbar disc herniation is a common reason for sciatica and can be treated surgically in cases of acute severe or persisting symptoms. After microdiscectomy the long term cumulating of low back problems and need for new surgeries is of particular interest in the cohort of young adults, who have a long expected life and working age.

We conducted a retrospective study on long-term outcome of 18-40 year old patients treated operatively for lumbar disc herniation in Helsinki University Hospital Department of Neurosurgery between 1990 and 2005. Main outcomes were reoperations during follow-up

and current condition as assessed by EQ-5D and Oswestry disability index (ODI) - questionnaires and satisfaction to the results of surgery.

Number of patients included in the study was 616. The median follow-up time was 18.5 years (12–27 years). Median age of the patients was 33 years and there were 61% male and 39% females. Average body mass index (BMI) was 24.6. 33% of the patients were smokers at the time of the surgery. Of 616 patients, 14% had had a lumbar spine surgery already previously.

Reoperation rate during entire follow-up period was 32%. 24 (12%) reoperations were conducted in the acute within 28 days and 171 (88%) later. Interestingly overweight patients (BMI > 25) had significantly more reoperations in the acute period (< 28 days after index surgery, 6% vs. 0.3%, p = 0.028). For later reoperations, there was a trend of more reoperations for males, patients with elevated BMI (over 25) and smokers (p = n.s.). Patients who already had had lumbar spine surgery before this index surgery had higher reoperation rate (51% vs 29%, p = <0.000). In the Kaplan-Maier analysis for time to reoperation, risk factors for earlier need reoperation were elevated BMI (p = 0.027) and prior lumbar spine surgery (p = <0.000). Factors found out to be not significant were smoking (p = 0.505), gender (p = 0.347), age over 30 years (p = 0.968).

Questionnaires were answered by 367 patients (60%). 90% of patients were still satisfied with the results of the surgery and 94% would chose the same treatment again. The average ODI score now at median 18.5 years of follow-up was 8.9, which is similar to that of normal population (reports ranging from 8.17 to 10.19). Patients who had reoperation had worse scores than those who did not have (11.8 vs 7.6, p = 0.007). Females had worse scores than men (10.7 vs 7.3, p = 0.01). Overweight patients had slightly higher scores (9.5 vs 8.7, p = 0.579).

The mean EQ-VAS score was 81.0, which is in the range of population norms. Patients who had had previous lumbar spine operation prior to the index surgery had lower scores than those who had not (81.8 vs 75.7, p = 0.07). Patient who had been in a reoperation afterwards had slightly but insignificantly lower scores (79.3 vs 81.7, p = 0.192). Sex, smoking status or obesity did not affect EQ-VAS scores.

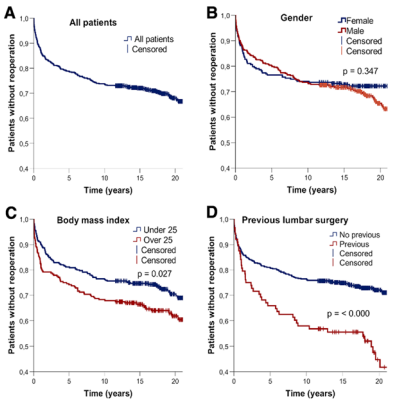

Figure 1. Reoperation times. Kaplan-Meier plots for proportion of patients without need of reoperation as a function of time as years from the index surgery. The groups were compared to each other with the log-rank test. A) Includes all patients. B) Female patients (blue, n=243) and male patients (red, n=373). C) Patients who had BMI had under 25 (blue, n=345) and over 25 (red n=241). D) Patients who had not had previous lumbar spine surgeries (blue, n=527) and patients who had had previous surgery (red, n=89).

Disclosures: author 1: none; author 2: none; author 3: stock/shareholder: Helsinki Hospital, employee: Helsinki University Hospital; author 4: none.

QF24

PREOPERATIVE ESTIMATION OF DISC HERNIATION RECURRENCE AFTER MICRODISCECTOMY: PREDICTIVE VALUE OF A MULTIVARIATE MODEL BASED ON RADIOGRAPHIC PARAMETERS

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Background: Recurrence of lumbar disc herniation (rLDH) is one of the unfavorable outcomes after microdiscectomy. Prediction of the patient population with increased risk of rLDH is important because patients may benefit from preventive measures or other surgical options.

Purpose: The study assessed preoperative factors associated with rLDH after microdiscectomy and created a mathematical model for estimation of chances for rLDH.

Methods: This is a retrospective case-control study. The study included 350 patients with LDH and a minimum of 3 years of follow-up. Patients underwent microdiscectomy for LDH at the L4-L5 and L5-S1 levels from 2008 to 2012. Patients were divided into two groups to identify predictors of recurrence: those who developed rLDH (n = 50) within 3 years and those who did not develop rLDH (n = 300) within the same follow-up period. Multivariate analysis was performed using patient baseline clinical and radiography data. Non-linear, multivariate, logistic regression analysis was used to build a predictive model.

Results: Recurrence of LDH occurred within 1 to 48 months after microdiscectomy. Preoperatively, patients who developed rLDH were smokers (70% vs. 27%, $p < 0.01$; odds ratio [OR] = 6.31, 95% confidence interval [CI]: 3.27–12.16) and had higher body mass index (29.0 ± 6.1 vs. 27.0 ± 4.3, $p = 0.03$; OR = 1.09 per 0.01 unit change). Radiological parameters that were associated with rLDH were higher disc height index (0.35 ± 0.007 vs. 0.26 ± 0.002, $p < 0.001$), higher segmental range of motion ($9.8 \pm 0.28°$ vs. $7.6 \pm 0.11°$, $p < 0.001$; OR = 0.53 per 0.01 unit change), and lower central angle of lumbar lordosis ($33.4 \pm 0.81°$ vs. $47.1 \pm 0.47°$, $p < 0.001$; OR = 0.53 per 0.01 unit change). Additionally, Pfirrmann grade 3 (OR = 16.62, 95% CI: 8.10–34.11), protrusion type of LDH (OR = 5.90, 95% CI: 3.06–11.36), and Grogan sclerosis grades 3 and 4 (OR = 4.81, 95% CI: 2.50–9.22) were also associated with rLDH. Multivariate non-linear modeling allowed for more accurate prediction of rLDH (90% correct prediction of rLDH; 99% correct prediction of no rLDH) than other univariate logit models.

Conclusions: Preoperative radiographic parameters in patients with LDH can be used to assess the risk of recurrence after microdiscectomy. The multifactorial non-linear model provided more accurate rLDH probability estimation than the univariate analyses. The software developed from this model may be implemented during patient counseling or decision making when choosing the type of primary surgery for LDH.

Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: none.

QF25

PREDICTING INPATIENT FUNCTIONAL RECOVERY IN PATIENTS UNDERGOING LUMBAR SPINAL FUSION: THE IMPORTANCE OF OBJECTIVE PHYSICAL PERFORMANCE MEASURES

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Title: Predicting inpatient functional recovery in patients undergoing lumbar spinal fusion: the importance of objective physical performance measures.

Background: Lumbar spinal fusion (LSF) is considered to be a major life event, involving significant health risks and causing temporary deconditioning. In order to identify patients at increased risk for negative postoperative outcomes, prediction models have been developed. Such preoperative risk prediction can aid patients and surgeons to choose the right care pathway per individual patient. However, current models, using only patient characteristics and patient reported outcome measures (PROMs), often lack predictive power. Therefore new relevant predictors need to be identified. Objective physical performance is a predictor of postoperative outcomes in several surgical populations (e.g., cardiac, abdominal, and total knee and hip replacement surgery).This might also hold true for patients undergoing LSF, as factors like cardiorespiratory capacity and muscle strength, are evidently affected in patients eligible for LSF.

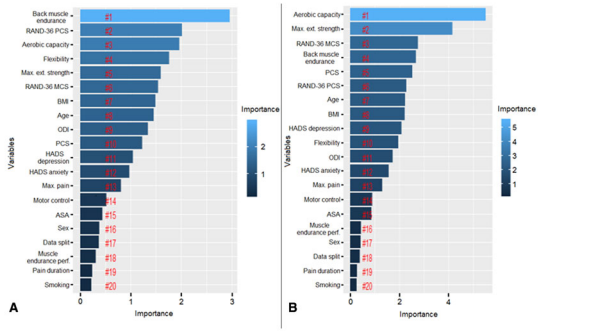
Purpose of the study: To identify relevant objective physical performance measures that contribute to inpatient functional recovery in adult patients opting for elective LSF.

Materials and methods: 120 adult patients with degenerative diseases of the lumbar spine scheduled for elective 1 to 3 level LSF underwent a preoperative screening. Data was collected on patient characteristics, PROMs, and objective physical performance: aerobic capacity, motor control, muscle strength and flexibility. Postoperative inpatient functional recovery was achieved if the patient had a score of 0 on the modified Iowa Level of Assistance Scale (mILAS). A patient was considered low risk if he or she achieved functional recovery within 3 days after surgery, a patient was classified as high risk when functional recovery took more than 4 days. Importance of objective physical performance measures as a predictor for functional recovery was established using random forest, a method with excellent performance in small sample sizes and many variables.

Results: When identifying a low risk patient, muscle endurance strength (1st rank), aerobic capacity (3rd rank), flexibility (4th rank) and maximal back extensor strength (5th rank) have a high rank, meaning they are important predictors for functional recovery (figure 1A). For high risk patients, aerobic capacity (1st rank), maximal back extensor strength (2nd rank) and back muscle endurance strength (4th rank) were identified as important preoperative predictors for functional recovery (figure 1B).

Conclusion: Objective physical performance measures are highly important individual predictors of inpatient postoperative functional recovery besides patient characteristics and PROMs in patients undergoing elective LSF. Future studies should consider objective physical performance measures to improve the prediction of postoperative outcomes.

Figure 1. Random forest plot ranking the importance of variables for predicting functional recovery in A. low risk patients and B. high risk patients



Abbreviations: RAND-36 PCS; RAND-36 physical component score, Max. Ext strength; maximum back extensor strength measured with isometric lumbar extension strength test, RAND-36 MCS; RAND-36 mental component scale, BMI; body mass index, ODI; Oswestry disability index, PCS; pain catastrophizing scale, HADS; hospital anxiety and depression scale, max. pain; predominant leg and or back pain measured with the VAS, ASA; American Society of Anesthesiologists classification, Data split; variable dividing dataset in before and after new care protocol was introduced in hospital, Muscle endurance perf.; patient was able to perform back muscle endurance test yes/no.

Disclosures: author 1: grants/research support: EUROSPINE, employee: Maastricht University; author 2: not indicated; author 3: stock/shareholder: Medical Data Works B.V., employee: Medical Data Works B.V.; author 4: grants/research support: Varian Medical Systems, consultant: Medical Data Works, stock/shareholder: Medical Data Works, royalties: Varian Medical Systems, employee: Maastricht University Medical Center; author 5: none; author 6: none; author 7: grants/research support: Eurospine.

QF26

DISC INFLAMMATION AND MODIC CHANGES SHOW AN INTERACTION EFFECT ON RECOVERY AFTER SURGERY FOR LUMBAR DISC HERNIATION

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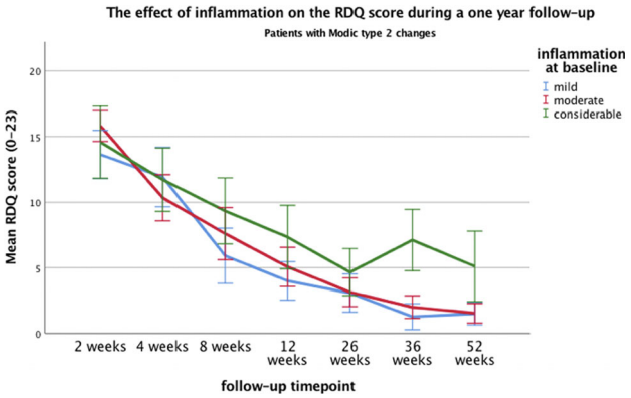
Purpose: To study the interaction between Modic Changes (MC) and inflammation by macrophages in the disc, in relation to clinical symptoms before and after discectomy for lumbar disc herniation.

Methods: Disc tissue was retrieved from patients in the Sciatica trial. Disc tissue was embedded in paraffin and stained with hematoxylin and CD68. Subsequently tissue samples were categorized for degree of inflammation. Type of MC was scored on MRI at baseline. The Roland Disability Questionnaire (RDQ) score, and visual analogue scale (VAS) for back pain and leg pain separately were considered sequentially at baseline, and one-year follow-up post-surgery. Main and interaction effects of MC and inflammation were tested against clinical outcome questionnaires.

Results: Disc material and MRI's of 119 patients were retrieved and analyzed. 48 patients demonstrated mild-, 45 patients moderate- and 26 patients considerable inflammation. 49/119 patients demonstrated MC. Grade of disc inflammation did not associate with presence of MC. At baseline, no main or interaction effects of MC and inflammation were found on the clinical scores. However, during follow-up after discectomy, significant interaction effects were found for the RDQ score: Only in patients with MC at baseline, patients remained significantly more disabled (3.2 points $p = 0.006$) if they showed considerable disc inflammation compared to patients with mild inflammation.

Conclusions: An interaction effect of MC and disc inflammation by macrophages is present. Only in patients with MC, those with

considerable inflammation recover less satisfactory during follow-up after surgery.



Disclosures: author 1: none; author 2: none; author 3: grants/research support: NWO, ZonMW, WCF; author 4: none; author 5: none, author 6: not indicated; author 7: grants/research support: Medtronic, Paradigm Spine, Braun; author 8: grants/research support: Covidien sponsors a trial on legpumps in neurosurgical surgery. Ynske Meyes Fund sponsors a trial on epidural injections in sciatica. These are all investigator initiated trials. The payment is not made to my own account but to our research department. Board of CSRS Europe, faculty for EANS, CSRS, Eurospine and webinar for AO spine.

QF27

EVALUATION OF GLOBAL ALIGNMENT AND PROPORTION SCORE IN AN INDEPENDENT ADULT SPINAL DEFORMITY DATABASE

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Background/introduction: Sagittal spinopelvic alignment has been associated with patient-reported outcome measures and mechanical complication rates. Linear numerical values of pelvic tilt and lumbar lordosis measurements with different pelvic incidences may be misleading. The use of relativë measurements embedded in a weighted scoring of Global Alignment and Proportion (GAP) has been described.
Purpose of the study: The purpose of our study was to evaluate the validity of the GAP score in an independent database.
Materials and methods: This study was a retrospective review of an independent adult spinal deformity data base from a single center. Patients who underwent $\geq$ 5 levels fusion to the pelvis between 2004 and 2014 were included. Demographic, clinical, surgical and radiographic patient characteristics were recorded. Cochran-Armitage tests were used to determine mechanical complication trends across GAP categories. Uni/multi-variable logistic regression analyses were used to obtain crude and adjusted Odds Ratios of predictor (GAP categories) and the outcome (mechanical complication). The diagnostic performance of the GAP score was tested using the area under the receiver operating characteristic curve, sensitivity, specificity, positive predictive value, negative predictive value and accuracy in predicting mechanical complications.
Results: 338 out of 657 patients (295 female, 43 male) with a mean age of 58 $\pm$ 9.6 met the inclusion criteria. Mean follow-up was 55 months (24–138). Every mechanical complication was included from minor proximal compression fracture and iliac screw disengagement. The most common complications were rod failure in 25.4% (86/338) patients, 23 patients (6.8%) with implant complication at the lumbar-sacral junction, proximal junctional failure in 45 patients (13.3%) and proximal junctional kyphosis in 20 patients (5.9%). Mechanical complication in proportioned (GAP-P), moderately (GAP-MD) and severely dis-proportioned (GAP-SD) patients were 23.8%, 55.7% and 66.1%, respectively. AUC for the GAP score was 0.653 (95% CI, 0.59 to 0.71, $p < 0.001$). GAP Score demonstrated 60.5% sensitivity, 76.2% specificity, 89.1% positive predictive value, 37.4% negative predictive value, and 64.2% accuracy in predicting mechanical complications. Post-op alignment of GAP-MD and GAP-SD resulted in 3.6 and 4.6 folds of more odds in incurring a mechanical complication compared to proportioned GAP.
Conclusion: This study validates the efficacy of GAP Score in predicting mechanical complications in an independent database. A trend was observed in which lower GAP scores were associated with lower rates of mechanical complications. Both the crude and adjusted odds ratios were high, showing the extent of effectiveness of this predictive tool.
Disclosures: author 1: grants/research support: AOSpine & OMeGA grants for fellowship paid directly to institution, consultant: Medtronic, DePuy, stock/shareholder: J&J, P&G, perForm Biologics, royalties: Innomed, DePuy; author 2: none; author 3: none; author 4: none; author 5: grants/research support: Depuy, consultant: Globus; author 6: grants/research support: Depuy Synthes Spine; author 7: grants/research support: Scoliosis Research Society, EOS, AOSpine, consultant: Medtronic, royalties: Medtronic, Quality Medical Publishing, other financial report: Evans Family Donation-1) philanthropic research funding from grateful patient/family, Fox Family Foundation-1) philanthropic research funding from grateful patient, AOSpine-1) reimbursement for airfare/hotel; 2) grant support - monies to institution; 3) fellowship support to institution, Broadwater- 1) reimbursement for airfare/hotel; author 8: grants/research support: Scoliosis Research Society - Multicenter Study of Adult Symptomatic Lumbar Scoliosis.

QF28

RISKS OF PULMONARY CEMENT EMBOLISM RELATED TO CEMENT AUGMENTED PEDICLE SCREW FIXATION OF THE OSTEOPOROTIC SPINES

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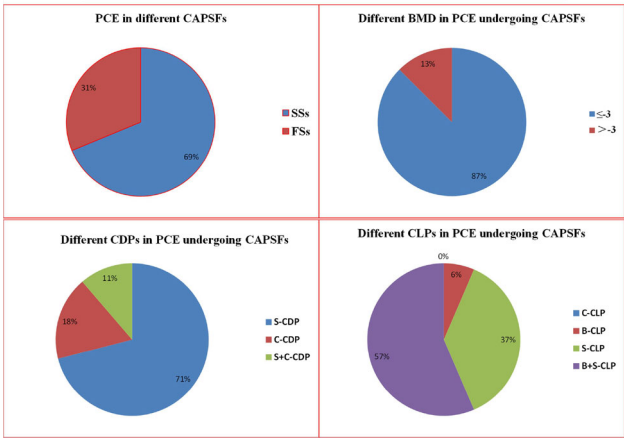
Background: Cement augmented pedicle screw fixation (CAPSF) appears to be an effective method for enhancing pedicle screw fixation in osteoporotic spine. However, only few studies focus on the incidence and risks of pulmonary cement embolism (PCE) associated with CAPSF.
Objective: To investigate the incidence and risk factors of PCE in patients undergoing CAPSF.
Methods: All the patients treated with CAPSF were evaluated from 2012 to 2015. 1 cc and 1.5 cc polymethylmethacrylate (PMMA) per pedicle were used in thoracic and lumbar levels, respectively. Inclusion criteria: degenerative spinal disease; patients with a bone mineral

density (BMD) < -2.5; patients with complete data of imaging; Exclusion criteria were: trauma, tumor, and infection cases.
Results: A total of 69 patients with 485 CAPSs in 253 vertebrae were included. Overall, the incidence of PCE and mortality were 23.2% (16/69) and 0 (0/69).In the group of pre-filling PMMA with solid screws (SSs): There were 36 patients with 245 SSs in 129 vertebrae. The overall incidence of cement leakage (CL) in vertebrae and PCE in cases of SSs group were 51.9% (67/129) and 30.5% (11/36). No patients presented with symptomatic PCE. In PCE patients, 34(72.3%), 8(17.0%) and 5(10.7%) SSs had scattered type of cement distribution patterns (S-CDP), concentrate CDP (C-CDP) and S + C-CDP, respectively. Of them, 47 vertebrae detected with CL [type basivertebral vein-B: 3 (6%), type segmental vein -S: 15 (31.9%) and type B + S: 29 (62%)]. In the group of fenestrated screws (FSs): There were 33 patients with 240 FSs in 124 vertebrae. The overall incidence of CL in vertebrae and PCE in cases of FSs group were 29.8% (37/124) and 15.1% (5/33). No patients presented with symptomatic PCE. In PCE patients, 10(66.7%), 3(20.0%) and 2(13.3%) FSs had S-CDP, C-CDP, S + C-CDP, respectively. Of them, 15 vertebrae detected with CL (type B: 3, S: 13 and type B + S: 21). There was statistically significant among detection of PCE (n = 16) and SSs, BMD ≤ -3, S-CDP, S-CLP ($p < 0.01$).
Conclusion: Although a higher incidence of PCE (23.2%) was detected in osteoporotic spine undergoing CAPSF, most of them were clinically asymptomatic. Patients with BMD < -3, who were treated with SSs and presented with S-CDP and S-CLP, had a higher risk of PCE.
Keywords: Osteoporosis; pulmonary cement embolism; spine surgery; pedicle screw.

Figure 1.Risk factors of PCE in osteoporotic spine undergoing CAPSF



Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: none; author 9: none.

QF29

ELECTIVE LUMBAR SPINE SURGERY IN DEPRESSED PATIENTS. DOES IT WORTH IT?

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Introduction and Objective: Depressive symptomatology has been associated with worse surgical results after elective lumbar spine surgery.
The objective of the present study is to compare surgical results (pain, function and satisfaction) between a group of depressed patients and a non-depressed group who had been operated on for a degenerative lumbar condition.
Materials and methods: Prospective observational study. Preoperative pain (lumbar and radicular VAS), function (ODI) and depression (Zung depression scale) were collected in patients listed to be operated for a lumbar degenerative condition. One year posteroperatively ODI and VAS were collected again and also two satisfaction questions (are you satisfied with the surgical results? Yes/no, would you repeat the same procedure?yes/no).
Results: 97 patients were included in the study, 78 non-depressed (80,4%) and 19 depressed (19,6%).Preoperatively, depressed patients had significant more lumbar pain (p 0,006) and more functional limitation (p 0,017) than non-depressed. One year postoperatively, depressed patients had significant more radicular pain (p 0,029) and more functional limitation (p 0,030). But, the overall improvement was similar between both groups. Depressed patients improved 3,34 points in lumbar VAS (compared to 4,23 points in non-depressed, p 0,310). Depressed patients improved radicular VAS in 5,76 points (5,02 non-depressed, p 0,307) and depressed patients improved ODI in 21,5% (17,2% non-depressed, p 0,293). 70% of depressed patients and 80% of non-depressed patients were satisfied with the surgical outcome (p 0,527)one year postoperatively.
Conclusion: Depressed patients experience the same overall level of improvement than non-depressed despite having more pain and functional limitation preoperatively and one year after elective lumbar spine surgery than non-depressed.The level of satisfaction is similar in both groups.
Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: none; author 9: none.

QF30

DO PSYCHOLOGICAL FACTORS IMPACT THE OUTCOME OF SURGERY DIFFERENTLY IN NECK VERSUS BACK PATIENTS?

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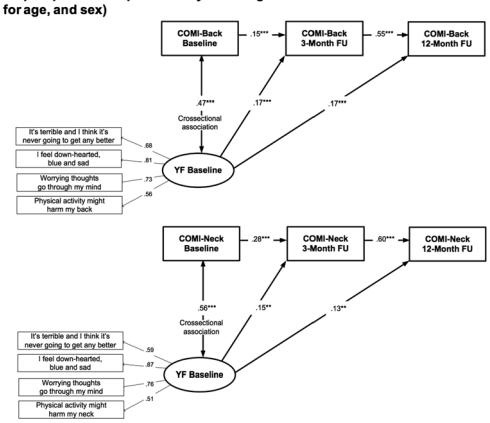
Introduction: It is generally accepted that psychological factors are significant predictors of treatment outcome in patients with back pain and/or undergoing lumbar spine surgery. However, the role that these factors play in predicting the outcome of cervical spine surgery is equivocal. Depression, anxiety, catastrophizing thoughts, and fear-avoidance beliefs are considered to be the key psychological "yellow flags". The recent development of a brief "yellow flag" tool allows for the efficient evaluation of these four dimensions (with one item for each) on a systematic basis within the routine preoperative assessment. We sought to compare its ability to predict outcome in patients undergoing either lumbar or cervical spine surgery.
Methods: The 4-item yellow flag instrument was answered preoperatively by 2'094 patients with degenerative spinal disorders operated between May 2015 and Jan 2018 (N = 1763 back pain and N = 331 neck pain patients; mean age 66 ± 14 y; 53% female).

Patients also completed the Core Outcome Measures Index (COMI) for either the back or neck at baseline and at 3 and 12 mo follow-up (FU). We used cross-lagged structural equation modelling (using AMOS 18.0) to test whether the cross-sectional association at baseline and the prospective risk path from yellow flag scores at baseline to COMI at 3 and 12mo FU differed for "back" and "neck" patients. **Results:** The back and neck patients did not differ significantly in their baseline yellow flag scores, except for a slightly higher anxiety in the neck patients than the back patients ($p = 0.02$). The yellow flag scores and COMI were significantly correlated at baseline, to a similar extent for both the back and neck groups (see Figure). The yellow flags at baseline predicted a significant proportion of the variance in COMI scores at 3 mo FU with a small to moderate effect size (standardised regression coefficient, $\beta = 0.17$ (back) and 0.15 (neck)). The stability between the COMI at 3 and 12 mo FU was high ($\beta = 0.55$ (back) and 0.60 (neck)). Nonetheless, the yellow flags still added significantly to the prediction of COMI at 12 mo FU ($\beta = 0.17$ (back) and 0.13 (neck)), explaining variation that was not explained by individual differences in COMI already existing at 3 mo. The prospective risk paths did not differ in strength between back and neck groups ($p > 0.818$) and model-fit was good (RMSEA = 0.05). **Discussion:** The yellow flag instrument provides a simple, practicable, reliable and valid tool for assessing key psychological attributes in patients undergoing spine surgery. The flags appear to be equally important determinants of the outcome of spine surgery in neck and back patients. Inclusion of the simple assessment of yellow flags at baseline may assist in improving the accuracy of our surgical outcome predictor models and may highlight individual need for cognitive-behavioural interventions prior to surgery, in an attempt to improve outcomes in both neck and back patient populations.

Structural equation models for back patients (top figure) and neck patients (bottom figure), showing the significant prospective risk paths from yellow flag scores at baseline to COMI at follow-up (controlled for age, and sex)



Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: grants/research support: DepuySynthes; author 7: none; author 8: not indicated; author 9: none.
Infection, Diagnostics, Imaging, Epidemiology

QF31

ROLE OF LOCAL STREPTOMYCIN IN PREVENTION OF SURGICAL SITE INFECTION IN TB SPINE

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Surgical site infection (SSI) continues to be one of the most common post-operative complication in most spine surgeries. Patients with tuberculosis (TB) of spine are more at risk of developing this dreaded complication due to a number of reasons. This adds to significant morbidity and economic burden on patients adversely affecting the mental status and quality of life of patients. The aim of this study was to investigate the role of local streptomycin in preventing SSI in patients undergoing surgical management of spinal TB. 56 patients who underwent surgical management for radiologically proven TB spine divided in two groups were included in the study. Group A included 30 patients with no local streptomycin administered intra-operatively while Group B included 26 patients operated in the later part of study with the use of local streptomycin intraoperatively. The two groups were compared with each other and the outcome criteria analysed were SSI rate, length of hospital stay, duration of post-operative antibiotics and need for debridement. Length of hospital stay and duration of post-operative antibiotics was significantly higher in group A when compared with group B. SSI rate and need for debridement were higher in group A but the difference was not statistically significant. Poor nutritional status, low immunity, poor patient compliance to anti-tubercular therapy and intraoperative spillage of tubercular debris, pus and necrotic material make these patients prone to secondary infections and SSIs. Intra-operative administration of local streptomycin powder may play an important role in reducing secondary infections and SSI's.

	GROUP A	GROUP B	
Age	35.8±18.7 (17-56)	28.7±11.7(18-66)	
Sex	M : 11 F : 19	M : 8 F : 18	
Level of spine involved	Cervicodorsal : 2 Dorsal : 12 Dorsolumbar : 8 Lumbar : 8	Cervicodorsal : 2 Dorsal : 9 Dorsolumbar : 8 Lumbar : 7	
Mean fusion levels	4.11±1.6	3.97±0.98	
SSI incidence	13.34%	3.84%	0.3
Duration of hospital stay	37.4±1.9	28.1±2.2	*<0.0001*
Length of post-op antibiotic	8.1±1.6	6.2±2.1	*0.0003*
Need for debridement	10%	3.84%	0.6

Disclosures: author 1: none; author 2: none; author 3: none.

QF32

THE EPIDEMIOLOGY OF VERTEBRAL OSTEOMYELITIS REQUIRING SURGICAL INTERVENTION IN THE UNITED STATES FROM 1998 TO 2013

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Introduction: Cases of vertebral osteomyelitis (VO) that are refractory to conservative treatment are treated surgically to debride infected segments, decompress and ultimately stabilize affected vertebral segments. There is limited data on the epidemiology of surgical management in VO in the US, and no study to date has evaluated the impact of patient characteristics on surgical outcomes on a large scale.
Purpose: To assess the characteristics of patients with VO who underwent surgical intervention.
Methods: From the Nationwide Inpatient Sample (NIS) database an estimated 228,044 patients were admitted for VO in the US between 1998 and 2013. Of these, 44,401 underwent surgical intervention.

Data were extracted on patient demographics, comorbidities, inpatient mortality, length-of-stay (LOS), and inflation-adjusted hospitalization charges. Sub-analysis included comparisons of LOS, hospital charges, & mortality rate between operative & non-operative VO cases.
Results: Incidence of surgical intervention for VO patients increased from 0.6 per 100,000 admission in 1998 to 1.1 in 2013, and is estimated to reach to 1.4 in 2020 (R = 0.9). Majority of patients were white, male, had a mean age of 56 years, and 38% carried Medicare insurance. 22.6% of patients has at least 1 complication during the immediate perioperative time. The comorbidities that significantly increased inpatient mortality were congestive heart failure (CHF) (OR: 6.1), liver disease (OR: 2.9), & renal disease (OR: 1.9). The most common postoperative complications were anemia (6.7%), sepsis (5.6%), superficial infections (4.1%), instrumentation complications (2.8%), pulmonary insufficiency (1.6%), deep venous thrombosis (1.2%), & hematoma (1.1%). The most commonly performed procedures were 2-3 level fusion/instrumentation of lumbar spine, cervical spine, and 4–8 level fusion of thoracic spine. Factors that significantly increased LOS were thoracolumbar fusion (OR: 19.9), combined anterior/posterior fusions (OR: 7.5), vertebral resection (OR: 4.4), and fusion of > 9 levels (OR: 3.7). Comorbidities that significantly increased LOS were CHF (OR: 8.3), renal disease (OR 8.3), hepatitis C (OR: 6.1), & history of drug abuse (OR: 3.2). Most common comorbidities that significantly increased total hospital costs were renal disease (OR: 7.4), liver disease (OR:2.2), CHF (OR: 2.1), psychological illness (OR: 1.6). Mean inflation adjusted total hospital costs increased from $20,355 per patient in 2001 to $39,991 in 2013.
Conclusion: VO is an understudied condition with a steady increase in its incidence in the US. It appears that the rate and the need for invasive procedures to salvage this condition is also increasing. We identified certain patient demographics and comorbidities to be associated with higher complications, mortality rate and overall costs. VO is associated with lengthy and expensive hospital stays resulting in a significant burden to patients and the healthcare system.
Disclosures: author 1: grants/research support: K2M; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: none; author 8: none

QF33

INSTRUMENTED VS NON INSTRUMENTED ANTERIOR DECOMPRESSION IN TB SPINE: LONG TERM OUTCOME ANALYSIS

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Introduction: Treatment of tuberculosis of spine has modalities ranging from medical to surgical in form of pus drainage to decompression with instrumentation. Goals of surgery include radical debridement of the infective focus. When surgery causes spinal instability, the question arises whether the risk of recurrent infection outweighs the benefits of spinal instrumentation and stabilization. Instrumentation helps in preventing progression of kyphosis and helps in maintaining the achieved correction. With the time treatment of tuberculosis of spine changed from preventing mortality to preventing and treating morbidity and deformity.
Method: Retrospective study,93 patients,divided in two groups Group1: decompression without instrumentation 50patients, Group2 decompression with instrumentation43 patients. Average age was 40.80 years ranging from 14 to 72. Groups were age matched (mean 39.48 vs. 42.34), average number of vertebrae involved (2.6 vs. 2.13)), severity of deformity (26.080 vs. 27.230) and type of auto grafts used. Most common region of spinal vertebrae involved was thoracic (D7-D8) in all the groups. Student T test is used. Average follow up was 30 months [18 to 42].
Result: In group 1, Postoperative local kyphosis correction was 9.80 [mean] and late loss of correction at last follow up was 9.10 [mean]. Local kyphosis correction at immediate postoperative period in group 2 was 18.120 [mean] and late loss of correction at last follow up has been 1.210. Late loss of correction in instrumented group was lesser [p value: < 0.05] which is statistically significant. Correction of kyphosis at latest follow up is significantly more in group 2 as compare to group 1 ($p < 0.05$). There is significant correction of kyphosis in group 2 as compare to group 1 ($p < 0.05$). In group 1 we achieved 2.6% correction of kyphosis as compared to preoperative angle. In group 2 this correction was 62.76%. Concern to neurological recovery there is no significant difference between group 1 and group 2. There were no episodes of wound infection, development of new discharging sinuses and recurrence of the disease at the same or any other level in the spine in either of the 2 groups. Conclusion Progressive kyphotic deformity can lead to late onset of paraplegia and cardiopulmonary compromised state. Instrumentation will prevent kyphosis progression and its adverse effect.
Disclosures: author 1: not indicated; author 2: none; author 3: none; author 4: none.

QF34

DEVELOPMENT OF AN EPIGENETIC IVD TEST FOR THE DIAGNOSIS AND PROGNOSIS OF ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS)

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Introduction: Adolescent idiopathic scoliosis (AIS) is a three-dimensional deformity of the spine in which the etiology is yet unknown. There is no clear explanation on how the disease will progress; and X-rays, considered as the gold standard for disease monitoring, has not prognostic value. The role of genetic factors involved in AIS is widely accepted but epigenetics may also contribute to AIS progression. In this context, miRNAs, epigenetic signaling molecules that contribute to bone morphogenesis and osteoclastogenesis can become new and useful biomarkers for the AIS diagnosis and prognosis.
Purpose of the study: We propose the development of an In vitro Diagnostic (IVD) test based on the detection of miRNAs signature as diagnostic/prognostic biomarkers of AIS.
Materials and methods: The original project granted by EuroSpine was performed in the Hospital Universitario y Politécnico La Fë (Valencia, Spain). Using NGS technology, we analyzed miRNAs isolated both from the plasma of AIS patients (aged 12 to 18 years) with a Cobb angle $> 10°$ (n = 17) and age matched healthy subjects (n = 10). To validate the miRNAs signature, we conducted RT-qPCR assays in 30 patients and 13 healthy adolescent subjects (validation cohort).
To develop the ScoliPro® prototype, we designed specific primers and Taqman probes for AIS-associated miRNAs measurement by RT-

qPCR. Analytical sensitivity and specificity have been evaluated using synthetic miRNAs.

ScoliPro® IVD test is currently being evaluated in 50 AIS patients (kit validation cohort) recruited at Hospital La Fe (Valencia). Anthropometric variables, Cobb angle, Risser and miRNAs expression levels are being measured over 18 months in order to evaluate the ScoliPro® diagnostic/prognostic ability.

Results: Circulating miRNAs from AIS patients showed differential expression patterns compared to controls. A specific biomarker signature composed by 4 miRNAS (miR-122, miR-27a, miR-223, and miR-1306) was identified. Moreover, a bioinformatics algorithm for early diagnosis and disease stratification was developed.

miRNA signature was protected by European Patent and EpiDisease S.L. obtained the technology license the development and commercialization of the test.

ScoliPro® kit has been manufactured with good analytical sensitivity and specificity. The technical file and the Clinical Evaluation Report to obtain the CE Mark are currently being prepared.

Conclusion: The involvement of miR-27a, miR-122, miR-223, and miR-1306 in the modulation of the genetic background of AIS patients provide a new tool to evaluate the progression and the phenotypic variability of AIS. Based on this miRNA signature we developed ScoliPro® test.

We are interested in performing a large-scale clinical trial in several hospitals across Europe to validate the potential prognostic value of our test in other countries.

Disclosures: author 1: grants/research support: Industrial PhD student, employee: EpiDisease S.L.; author 2: grants/research support: PhD Torres Quevedo, employee: EpiDisease S.L.; author 3: employee: Epidisease S.L, none, author 4: consultant: EpiDisease, stock/shareholder: EpiDisease; author 5: none; author 6: none; author 7: not indicated; author 8: grants/research support: EUROSPINE Funded Grant Application no. 20130125, consultant: EpiDisease S.L., stock/shareholder: EpiDisease S.L.; author 9: grants/research support: Eurospine.

QF35

CORRELATIONS OF PELVIC INCIDENCE-BASED RELATIVE RADIOGRAPHIC PARAMETERS TO LOWER EXTREMITY COMPENSATIONS

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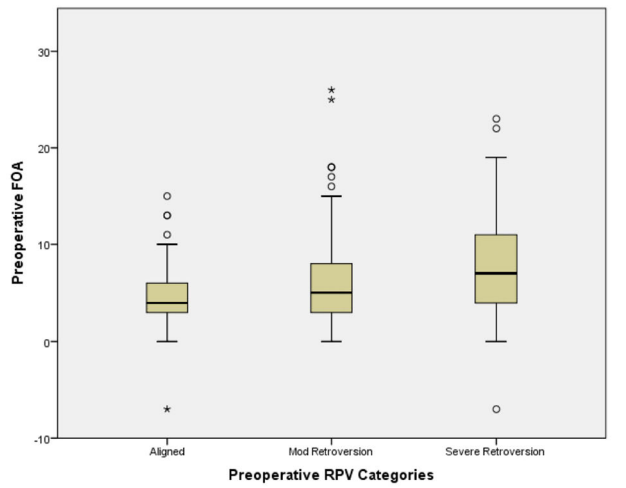
Background: As a response to positive sagittal malalignment, the human body progressively recruits compensatory mechanisms in the spine and/or non-spinal segments (i.e. lower extremities) in an effort to maintain the gravity line and a horizontal gaze. Whole-body radiographic assessment is hence suggested for quantifying lower extremity compensation. Yet, such imaging modalities are not widely available. Relation of Relative Pelvic Version (RPV), Relative Lumbar Lordosis (RLL) and Relative Spinopelvic Alignment (RSA) to previously defined lower extremity compensation angles were investigated.

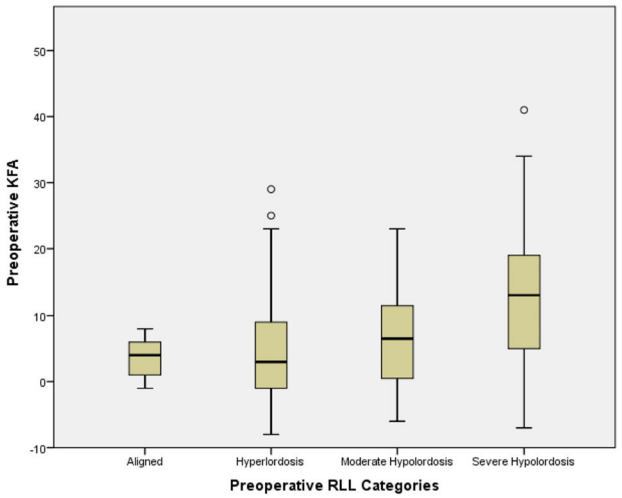
Purpose: The aim of the study was to assess the correlation between relative radiographic parameters of the GAP Score with the lower extremity compensation angles.

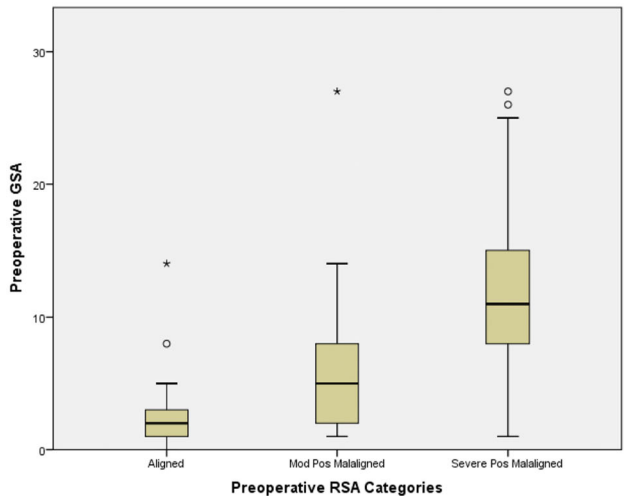
Material and methods: Inclusion: Having radiographs that include at least mid-femur or mid-tibia; $\geq$ 4-level fusion. Pre and postoperative RPV (measured minus ideal sacral slope), RLL (measured minus ideal lumbar lordosis), RSA (measured minus ideal global tilt), femoral obliquity angle (FOA), knee flexion angle (KFA) and global sagittal angle (GSA) were measured. Preoperatively, relation of relative radiographic parameters to lower extremity compensation angles was assessed by Kruskal–Wallis tests. Correlations of changes in RPV, RLL and RSA, from preoperative to postoperative radiographs, to changes in FOA, KFA and GSA were assessed by Spearman's correlations.

Results: 193 patients (knee available in 144) (156F, 37 M, 58 $\pm$ 17 years) with a mean f-up of 36 (24-67) months were included. Preoperatively, FOA, KFA and GSA were significantly different in categories of RPV, RLL and RSA (for all comparisons, $p < 0.01$). Changes in RPV, RLL and RSA were significantly correlated to changes in FOA, KFA and GSA (rho range, 0.351-0.767) (for all comparisons, $p < 0.001$).

Conclusions: PI-Based relative radiographic parameters significantly correlate to measurements reflecting lower extremity compensation. Preoperative to postoperative changes in PI-Based relative radiographic parameters of RPV, RLL and RSA, reflect into changes in measurements quantifying lower extremity compensations such as FOA, KFA and GSA. This information may be useful when whole-body imaging is not available. Setting surgical goals in the sagittal plane on the basis of the parameters reflected by the GAP score may result in spontaneous resolution of lower extremity compensations.







Disclosures: author 1: none; author 2: none; author 3: none; author 4: none; author 5: none; author 6: none; author 7: consultant: Medtronic; author 8: grants/research support: depuy synthes, consultant: depuy synthes, Medtronic, royalties: Clariance, alphatecspine, Spineart; author 9: grants/research support: DepuySynthes; author 10: grants/research support: DEPUY, consultant: Globus; author 11: grants/research support: Depuy Synthes, Medtronic, royalties: AOSpine; author 12: grants/research support; DePuySpine, Medtronic; author 13: grants/research support: Depuy; consultant: Globus; author 14: DePuy Synthes and Medtronic. Additional support was provided.

QF36

RELIABILITY AND VALIDITY OF SELF-REPORTED DISABILITY QUESTIONNAIRES IN LOW BACK PAIN POPULATION: A SYSTEMATIC REVIEW

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Background: Low back pain is a common health problem in the general population. It is the leading cause of disability in the world. Self-reported questionnaires are reported by the patient and do not require a physical examination by the practitioner. Pain and disability are the most commonly measured domains of these questionnaires. Systematic reviews looking at the reliability and validity of self-reported pain questionnaires in LBP patients are limited despite their widespread use in clinical practice.
Objective: The purpose of this systematic review was to determine both the reliability and validity of self-reported questionnaires used in the assessment of disability in adults with LBP aged 18 years or older. Method: We systematically searched five databases from 2000 to 2018. We screened and critically appraised eligible studies using QAREL and QUADAS-2 instruments for reliability and validity studies, and AMSTAR-2 for systematic reviews. Low risk of bias articles were included.
Results: 10,917 articles were captured and four were low risk of bias. Four questionnaires were studied: Functional Rating Index (FRI), Oswestry Disability Index (ODI), StrarT Back Screening Tool (SBT), and Absenteeism Screening Questionnaire (ASQ). The test re-test reliability is ICC = 0.63 for FRI and 0.78 for ODI. Validity was reported in four phase II studies according to Sackett and Haynes. FRI is correlated with ODI and has the area under the curve as 0.93 using 8.4 as cut-off in measuring four-week changes. There is statistically significant difference in ODI scores between patients with or without sick-leave or treatment. SBT is associated with ODI and numerical pain scale. ASQ has sensitivity 92% and specificity 89% using 40% and 70% of total score as a cut-off, respectively.
Conclusions: There is limited evidence to support the clinical utility of disability questionnaires. More high quality studies (phase III validity studies) are needed.
Disclosures: author 1: none, author 2: none, author 3: not indicated; author 4: none; author 5: author 6: employee: UOIT-CMCC Centre for Disability Prevention and Rehabilitation, Faculty of Health Sciences | University of Ontario Institute of Technology (UOIT), Canadian Memorial Chiropractic College; author 7: employee: IFEC.

QF37

GREATER DISABILITY ASSOCIATED WITH PATIENTS' UNREALISTIC EXPECTATIONS OF LUMBAR SURGERY COMPARED TO SURGEONS' EXPECTATIONS

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Background: Agreement between patients and surgeons regarding expectations of lumbar surgery is a preop goal. Knowing what characteristics contribute to differences in expectations, particularly unrealistically high expectations, would help direct preop communication.
Purpose: To compare agreement within the patient-surgeon pair regarding expectations of surgery.
Sample: 402 lumbar surgery patient-surgeon pairs.
Outcome: HSS Lumbar Spine Surgery Expectations Survey.
Methods: Patients of 5 spine surgeons completed the ODI and the valid 20-item Expectations Survey preop. The Survey asks how much improvement is expected for each item with response options of complete to no improvement; a total and four domain scores (personal activities, daily function, psychological well-being, and skeletal function) are generated (range 0–100, higher is greater expectations). Surgeons independently completed an identical Survey preop rating expected improvement for each item for each patient, yielding similar 0–100 total and domain scores. Agreement within the patient-surgeon pair was measured with the intraclass correlation coefficient (ICC) (range 0 (agreement no better than chance) to 1 (perfect agreement)). Differences between patients' and surgeons' scores were then assessed in multivariable models.
Results: Mean age was 55, 55% were men, and mean ODI was 53 (range 4–84). The mean total Survey score was 73 $\pm$ 19 for patients, 57 $\pm$ 16 for surgeons ($p < 0.0001$), and the ICC was 0.32 (i.e. fair agreement). 86% of patients had higher scores (i.e. greater expectations) than their surgeons. Greater expectations were not due to expecting more items, but rather to patients more often expecting complete improvement (e.g. for $\geq$ 15 items 34% vs 2%, $p < 0.0001$) whereas surgeons more often expected a lot/moderate improvement. The mean difference between patients' and surgeons' scores was 16.5. In multivariable analysis with this difference as the dependent variable, worse ODI score was the variable most closely associated with patients' greater expectations (OR 2.5, CI 1.7–3.7, $p < 0.0001$). For domains scores, although ICC values varied (0.67 personal activities, 0.09 daily function, 0.49 psychosocial well-being, 0.55 skeletal function), in multivariable analyses worse ODI score consistently was the variable most associated with patients' greater expectations ($p < 0.005$ for each model).
Conclusions: There was fair agreement between patients and surgeons regarding expectations with patients having greater expectations, especially if they were more disabled. Although it seems logical that patients with the most disability would have the most to expect, the essential issue is whether such high expectations (i.e. complete improvement) are realistic; according to surgeons, a lot/moderate improvement is more appropriate. Thus preoperative discussions should not be centered on what items to expect, but instead should emphasize how much improvement to expect for each item.
Disclosures: author 1: grants/research support: US Agency for Healthcare Research and Quality; author 2: none; author 3: grants/research support: Spinal Kinetics, Inc.; Ivy Healthcare Capital Partners, LLC; ISPH II, LLC; NuVasive, Inc.; Mallinckrodt Pharmaceuticals; Centinel Spine, Inc. (fka Raymedica, LLC); Beatrice & Samuel A. Seaver Foundation; 4WEB Medical; Woven Orthopedic Technologies; Depuy Synthes; Orthobond Corporation; Pfizer, Inc.; Paradigm Spine, LLC; 7D Surgical, Inc., consultant: Vertical Spine, LLC; 4WEB Medical, stock/shareholder: VBVP VI, LLC, royalties: NuVasive, Inc., other financial report: Spinal Kinetics, Inc.; Vertical Spine, LLC; Bonovo Orthopedics, Inc.; Viscogliosi Brothers, LLC; Liventa Bioscience (fka AF Cell Medical) Woven Orthopedic Technologies; Healthpoint Capital Partners, LP; Paradigm Spine, LLC; Tissue Differentiation Intelligence, LLC; author 4: grants/research support: AO Spine North America, Spinal Kinetics, MiMedx Group Inc (all paid to institution)AO Spine North America, Spinal Kinetics, MiMedx Group Inc (all paid to institution), consultant: DePuy Orthopaedics Inc, Ortho Development, Clariance Inc, 4WEB Inc, Kuros Biosciences AG, Sentio LLC, stock/shareholder: Paradigm Spine LLC, royalties: Ortho Development Corp, other financial report: Scientific Advisory Board – Clariance Inc, Strategic Advisory Board – Kuros Biosciences AG; author 5: grants/research support: 4WEB Medical; NuVasive, Inc.; Mallinckrodt Pharmaceuticals; Pfizer, Inc.; author 6: none, author 7: grants/research support: Aesculap (Paid to Institution); MiMedx Group Inc (Paid to Institution); Nuvasive, Inc. (Paid to Institution), consultant: Ortho Development Corp; SPINEART USA; Nuvasive, Inc; DePuy Synthes Spine; Lanx, Inc; EIT Emerging Implant Technologies, stock/shareholder: Healthpoint Capital Partners; Paradigm Spine, LLC; Centinel Spine, Inc.; Spinal Kinetics, Inc.; Liventa Bioscience, royalties: Lanx, Inc; DePuy Synthes Spine; Nuvasive, Inc; Ortho Development Corp.

QF38

DISSATISFACTION AFTER LUMBAR SURGERY ASSOCIATED WITH CLINICAL VARIABLES AND NOT PATIENTS' AND SURGEONS' EXPECTATIONS

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Background: Results of lumbar surgery often are described with patient-reported global assessments (e.g. satisfaction) which are associated with expectations of surgery. Knowing what clinical variables are related to dissatisfaction could impact preop discussions with patients and decisions to operate.
Purpose: To determine which patient and surgeon variables were related to dissatisfaction 2 years postop.
Sample: 401 lumbar surgery patient-surgeon pairs.
Outcome: Global satisfaction.
Methods: Preop patients completed valid clinical/psychosocial measures including the Expectations Survey rating amount of improvement expected for symptoms, function, and mental well-being (score 0–100, higher is greater expectations). Surgeons completed an identical Survey rating expected improvement for each item for each patient. A Surgical Invasiveness Index (SII) value was calculated from OR records (max 10 points/vertebral level); higher is greater complexity. Two years postop patients rated global outcome including satisfaction (very satisfied, satisfied, neither, dissatisfied, very dissatisfied) and how would they feel if their current symptoms were permanent (delighted, pleased, mostly satisfied, mixed, mostly dissatisfied, unhappy, terrible). At follow-up patients also reported any subsequent spine-related re-hospitalization. A patient-reported poor outcome was defined as any response of terrible, unhappy, or dissatisfied, and was the dependent variable in multivariable analyses with clinical variables/Expectations scores as independent variables.
Results: Mean age was 55, 55% were men, median SII value was 5 (range 1–50); mean follow-up was 2.1 years. 55 patients (14%) reported a poor outcome, 346 (86%) did not report a poor outcome. There were no differences between groups for most demographic/clinical variables or for Expectations scores (73 vs 73 by patient-report; 54 vs 57 by surgeon-report). Patients with poor outcome more often had prior spine surgery ($p = 0.004$), more depressive symptoms ($p = 0.07$), worse ODI ($p = 0.09$), more complex surgery ($p = 0.06$), and subsequent re-hospitalization (27% vs 9%,

$p < 0.0001$). In multivariable analysis including only variables known preop, poor outcome was associated with more depressive symptoms (OR 1.1, CI 1.0–1.1, p = 0.02), prior surgery (OR 2.7, CI 1.4–5.0, p = 0.002), and more complex surgery (OR 1.1, CI 1.0–1.1, p = 0.02). When re-hospitalization was added to the model, all variables remained associated and re-hospitalization became the most impactful (OR 3.3, CI 1.6–6.8, p = 0.002).

Conclusions: It was fitting that patients' and surgeons' expectations did not predict poor outcomes otherwise surgery would not have occurred. Prior surgery, depressive symptoms and complex surgery affected patients' assessment of outcome. Patient-reported poor outcome, however, was most strongly associated with spine-related re-hospitalization, emphasizing that averting or predicting additional spine care is a compelling challenge.

Disclosures: author 1: grants/research support: US Agency for Healthcare Research and Quality; author 2: none; author 3: grants/research support: Spinal Kinetics, Inc.; Ivy Healthcare Capital Partners, LLC; ISPH II, LLC; NuVasive, Inc.; Mallinckrodt Pharmaceuticals; Centinel Spine, Inc. (fka Raymedica, LLC); Beatrice & Samuel A. Seaver Foundation; 4WEB Medical; Woven Orthopedic Technologies; Depuy Synthes; Orthobond Corporation; Pfizer, Inc.; Paradigm Spine, LLC; 7D Surgical, Inc., consultant: Vertical Spine, LLC; 4WEB Medical, stock/shareholder: VBVP VI, LLC, royalties: NuVasive, Inc., other financial report: Spinal Kinetics, Inc.; Vertical Spine, LLC; Bonovo Orthopedics, Inc.; Viscogliosi Brothers, LLC; Liventa Bioscience (fka AF Cell Medical) Woven Orthopedic Technologies; Healthpoint Capital Partners, LP; Paradigm Spine, LLC; Tissue Differentiation Intelligence, LLC; author 4: grants/research support: AO Spine North America, Spinal Kinetics, MiMedx Group Inc (all paid to institution)AO Spine North America, Spinal Kinetics, MiMedx Group Inc (all paid to institution), consultant: DePuy Orthopaedics Inc, Ortho Development, Clariance Inc, 4WEB Inc, Kuros Biosciences AG, Sentio LLC, stock/shareholder: Paradigm Spine LLC, royalties: Ortho Development Corp, other financial report: Scientific Advisory Board – Clariance Inc, Strategic Advisory Board – Kuros Biosciences AG; author 5: grants/research support: 4WEB Medical; NuVasive, Inc.; Mallinckrodt Pharmaceuticals; Pfizer, Inc.; author 6: none; author 7: grants/research support: Aesculap (Paid to Institution); MiMedx Group Inc (Paid to Institution); Nuvasive, Inc. (Paid to Institution), consultant: Ortho Development Corp; SPINEART USA; Nuvasive, Inc; DePuy Synthes Spine; Lanx, Inc; EIT Emerging Implant Technologies, stock/shareholder: Healthpoint Capital Partners; Paradigm Spine, LLC; Centinel Spine, Inc.; Spinal Kinetics, Inc.; Liventa Bioscience, royalties: Lanx, Inc; DePuy Synthes Spine; Nuvasive, Inc; Ortho Development Corp.

QF39

DIFFERENCES BETWEEN POSTOPERATIVE NARCOTIC PRESCRIPTIONS IN OUTPATIENT LUMBAR SPINE SURGERY BETWEEN THE UNITED STATES AND FRANCE

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Introduction: The United States is currently undergoing a major opioid crisis that has recently started to decrease its population's life expectancy due to over-mortality of its young citizens by drug overdose. Among the listed causes, physician narcotic prescriptions for both acute and chronic medical conditions are often pointed out as the main culprit for this crisis.

Purpose: We investigated the differences between discharge prescriptions following outpatient lumbar spine surgery between a French and a U.S spine surgery department.

Patient sample: 100 age and sex-matched patients: 50 patients in the American center, 50 in the French center.

Outcome measures: Amount of narcotics in MED (Morphine Equivalent Dose) in the discharge prescription. Number of postoperative visits to the emergency room for inadequate pain control.

Methods: Demographics, comorbidities, operative data, current prescriptions and discharge prescriptions were compared between the two groups. Narcotic consumption was converted in milligrams of morphine equivalent dose (mg MED).

Results: 25 American patients (50%) consumed narcotics preoperatively versus 4 French patients (8%). Only 22% of Americans were opioid naïve. Postoperatively, all French patients had a narcotic-free prescription while all American patients were prescribed a significant amount of narcotics (617.04 mg $\pm$ 345.16 mg MED). One American patient returned to the emergency department for inadequate pain control while none of the French did. French patients were never prescribed steroids but had systematic non-steroid inflammatory drugs while 41.4% of American patients were prescribed postoperative steroid tapers following a postoperative telephone call.

Conclusions: For identical surgeries, All American patients were prescribed postoperative narcotics while none of the French were. Cultural beliefs from both patients, physicians and the industry probably represent the most significant barrier against the implementation of a narcotic-free culture in our practice. Reducing narcotic prescriptions in our practice is not only feasible but also highly desirable.

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: not indicated; author 8: royalties: Spineway; cousin biotech; author 9: none.

QF40

CERVICAL BONE MINERAL DENSITY MEASURED BY QCT IN PATIENTS UNDERGOING ANTERIOR CERVICAL SPINE SURGERY

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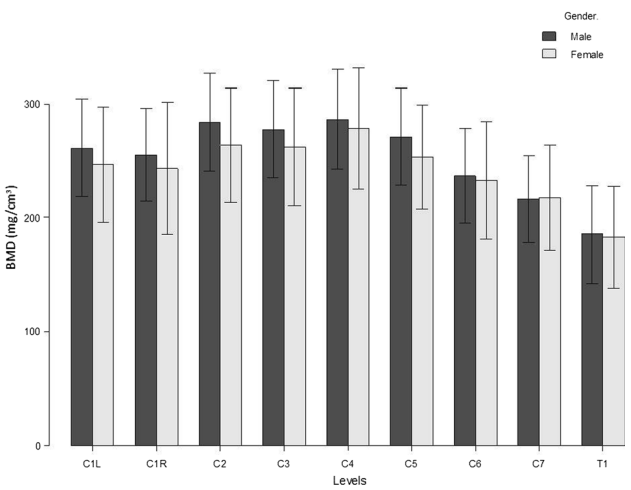
Background/introduction: Surgery to the anterior column of the cervical spine is commonly performed for a variety of spinal pathologies. Clinically, the association between bone mineral density (BMD) and surgical instrumentation performance is well recognized. Although several studies quantified the BMD of the human lumbar spine, comprehensive BMD data for the cervical spine is limited. The few available studies mainly included young and healthy patient samples, which are contrary to the typical cervical fusion patient. Currently no large scale study provides detailed BMD information of the cervical and first thoracic vertebrae in patients undergoing anterior cervical spine surgery.

Purpose of the study: The objective of this study was to determine the BMD of the cervical and the first thoracic vertebrae in patients undergoing anterior cervical discectomy and fusion (ACDF).
Materials and methods: Patients that underwent ACDF from 2015 to 2018 at a single, academic institution were included in this study. Subjects with previous cervical instrumentation or missing/incomplete preoperative cervical spine CT imaging were excluded. Asynchronous quantitative computed tomography (QCT) measurements of the lateral masses of C1 and the C2-T1 vertebral bodies were performed. For this purpose, an elliptical region of interest (ROI) that consisted exclusively of trabecular bone was selected. Any apparent sclerotic levels that might affect trabecular QCT measurements were excluded from the final analysis. Pairwise comparison of BMD was performed and correlations between the various cervical levels were evaluated. The statistical significance level was set at $p < 0.05$.
Results: 194 patients (men, 62.9%) met inclusion criteria. The patient population was 91.2% Caucasian with a mean age of 55.9 years and mean BMI of 28.2 kg/m^2. The trabecular BMD was highest in the mid-cervical spine (C4) and decreased in the caudal direction (C1 = 253.3 mg/cm^3, C2 = 276.6 mg/cm^3, C3 = 272.2 mg/cm^3, C4 = 283.5 mg/cm^3, C5 = 265.1 mg/cm^3, C6 = 235.3 mg/cm^3, C7 = 216.8 mg/cm^3, T1 = 184.4 mg/cm^3) (Figure 1). The BMD of C7 and T1 was significantly less than those of all other levels. Nonetheless, significant correlations in BMD among all measured levels were observed, with a Pearson's correlation coefficient ranging from 0.507 to 0.885.
Conclusions: To the authors' knowledge this is currently the largest study assessing cervical BMD by QCT. The patient sample consisted of patients undergoing ACDF, which clearly adds to the clinical relevance of the findings. Knowledge of BMD variation in the cervical spine might be useful to surgeons utilizing anterior cervical spine plate and screw systems. Due to the significant variation in cervical BMD, procedures involving instrumentation at caudal levels might possibly benefit from a modification in instrumentation or surgical technique to achieve results similar to more cephalad levels.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: consultant: Pfizer, Spreemo, other financial report: Image Analysis Group, Carestream; author 7: grants/research support: AO Spine North America, Spinal Kinetics, MiMedx Group Inc (all paid to institution)AO Spine North America, Spinal Kinetics, MiMedx Group Inc (all paid to institution), consultant: DePuy Orthopaedics Inc, Ortho Development, Clariance Inc, 4WEB Inc, Kuros Biosciences AG, Sentio LLC, stock/shareholder: Paradigm Spine LLC, royalties: Ortho Development Corp, other financial report: Scientific Advisory Board – Clariance Inc, Strategic Advisory Board – Kuros Biosciences AG; author 8: grants/research support: Spinal Kinetics, Inc.; Ivy Healthcare Capital Partners, LLC; ISPH II, LLC; NuVasive, Inc.; Mallinckrodt Pharmaceuticals; Centinel Spine, Inc. (fka Raymedica, LLC); Beatrice & Samuel A. Seaver Foundation; 4WEB Medical; Woven Orthopedic Technologies; Depuy Synthes; Orthobond Corporation; Pfizer, Inc.; Paradigm Spine, LLC; 7D Surgical, Inc., consultant: Vertical Spine, LLC; 4WEB Medical, stock/shareholder: VBVP VI, LLC, royalties: NuVasive, Inc., other financial report: Spinal Kinetics, Inc.; Vertical Spine, LLC; Bonovo Orthopedics, Inc.; Viscogliosi Brothers, LLC; Liventa Bioscience (fka AF Cell Medical) Woven Orthopedic Technologies; Healthpoint Capital Partners, LP; Paradigm Spine, LLC; Tissue Differentiation Intelligence, LLC; author 9: grants/research support: Aesculap (Paid to Institution); MiMedx Group Inc (Paid to Institution); Nuvasive, Inc. (Paid to Institution), consultant: Ortho Development Corp; SPINEART USA; Nuvasive, Inc; DePuy Synthes Spine; Lanx, Inc; EIT Emerging Implant Technologies, stock/shareholder: Healthpoint Capital Partners; Paradigm Spine, LLC; Centinel Spine, Inc.; Spinal Kinetics, Inc.; Liventa Bioscience, royalties: Lanx, Inc; DePuy Synthes Spine; Nuvasive, Inc; Ortho Development Corp.; author 10: grants/research support: 4WEB Medical; NuVasive, Inc.; Pfizer, Inc.

QF41

USE OF HOUNSFIELD UNITS OF S1 BODY TO DIAGNOSE OSTEOPOROSIS IN PATIENTS WITH LUMBAR DEGENERATIVE DISEASES

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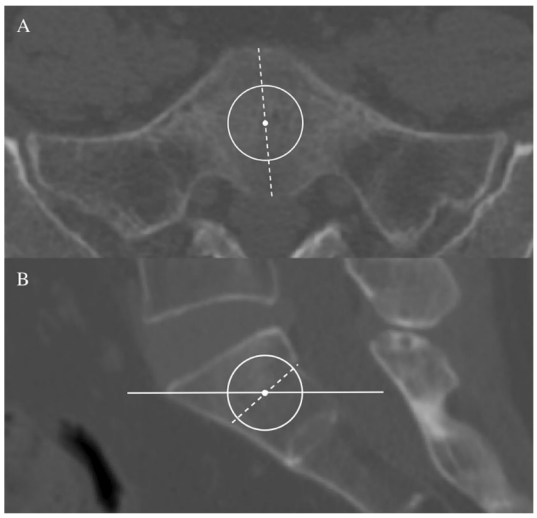
Object: To evaluate the performance of using Hounsfield unit (HU) of S1 body to diagnose osteoporosis in patients with lumbar degenerative diseases.
Methods: A total of 316 patients aged $\geq$ 50 years requiring surgery for lumbar degenerative diseases were reviewed. The bone mineral density (BMD) of S1 body and L1 was measured in HU with preoperative lumbar computed tomography(CT). Circular regions of interest (ROI) were placed on middle-axial and middle-sagittal images of S1 body. Dual energy x-ray absorptiometry(DXA) and the criterion of L1 $\leq$ 110HU were used to diagnose osteoporosis. The area under the receiver operator characteristic curve (AUC) was calculated to assess the performance of using HU of S1 body to diagnose osteoporosis.
Results: The inter-observer and intra-observer reliability of measuring HU of S1 body was excellent with ICCs over 0.8 ($p < 0.001$). The correlation between HU of S1 body and average T-score of L1-4 was significant with Pearson correlation coefficients $\geq$ 0.60 ($p < 0.001$). The AUCs of using HU of S1 body to diagnose osteoporosis were 0.86 and 0.88 for axial HU and sagittal HU, respectively ($p < 0.001$). The HU thresholds with balanced sensitivity and specificity for diagnosing osteoporosis were $\leq$ 202HU for axial HU (sensitivity:76%; specificity: 76%) and $\leq$ 185HU for sagittal HU (sensitivity:80%; specificity: 80%).
Conclusions: Both sagittal and axial HU of S1 body are useful tools for assessing BMD and diagnosing osteoporosis. Measuring HU of S1 body preoperatively from routine lumbar CT may help with surgical planning for patients with lumbar degenerative diseases.



Disclosures: author 1: none, author 2: none.

QF42

EOS, O-ARM AND STANDARD SPINE RADIOGRAPHS; WHAT IS THE CUMULATIVE RADIATION EXPOSURE DURING CURRENT SCOLIOSIS MANAGEMENT?

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Background/introduction: During the course of assessment and treatment for AIS, patients are subjected to repeated radiological exposure. Only a few studies have evaluated the total absorbed radiation dose from standard radiography and EOS during follow-up for scoliosis. To the best of our knowledge, this is the first study to evaluate and compare total radiation dose exposure from all modalities for a cohort of AIS patients.
Purpose of the study: The primary aim of this study was to determine the radiation exposure of AIS patients during scoliosis management. Moreover, this study aimed to compare follow-up algorithms among international spine centers.
Materials and methods: A retrospective review on radiation exposure of patients treated for AIS. Inclusions: patients followed for AIS from 2013 to 2016 without neuromuscular diseases. The O-arm cone-beam CT scanner was used for 3D navigation in all surgically managed patients, low dose protocols were used (70 kVp, 80 mAs). A survey asking for information on radiological algorithms and imaging frequencies was sent to a number of international spine centers for comparison with in-house algorithm.
Results: 61 patients were included, 19 were treated conservatively (M/F: 6/13) and 42 surgically (M/F: 11/31). Median follow up time for the conservative group was 8 (range 0–51) months and 37 (range 13–163) months for the surgical group. Median number of X-rays/EOS were; 2 (range 0–20)/2 (range 0–17) for the conservative group and 15 (range 2–57)/11(range 0–26) for the surgery group. Patients undergoing surgery received a median cumulative radiation dose of 10.31 mSv (range 3.79–20.43) vs. a median dose of 1.09 mSv (range 0.22–7.17) for those treated conservatively. Approximately 25% (39.04/161.82 mSv) of total intraoperative radiation dose for all patients was a result of O-arm 2D fluoroscopy. A mean of 11 levels of the spine were fused during correction surgeries. Median Cobb angle at the beginning/end of follow up were 19°(range 10°–50°)/23° (range 12°–65°) for the conservative group and 44° (range 10°–80°)/15° (range 4°–30°) for the surgery group. Median Cobb angle before the surgery was 52° (range 36°–82°). The results of the questionnaire showed great variety of radiological follow-up algorithms among 8 spine centers without adherence to any of the published consensus statements.
Conclusion: Surgically treated patients were, as anticipated, exposed to more, radiation dose than those treated conservatively, almost 10-fold more, owing mainly to intraoperative 3D scans and a larger numbers of radiological follow-up examinations. The use of cone-beam CT-based 3D navigation elevates patient safety during deformity surgery. However, patients are potentially exposed to a significant amount of radiation depending on protocol and use of 2D fluoroscopy. Further awareness of ways to reduce radiation dose and optimize radiological protocols is warranted in order to decrease radiation-induced malignancy.
Disclosures: author 1: none, author 2: none, author 3: none.

QF43

A NOVEL AND REPRODUCIBLE CLASSIFICATION OF THE VERTEBRAL ARTERY IN THE SUBAXIAL CERVICAL SPINE

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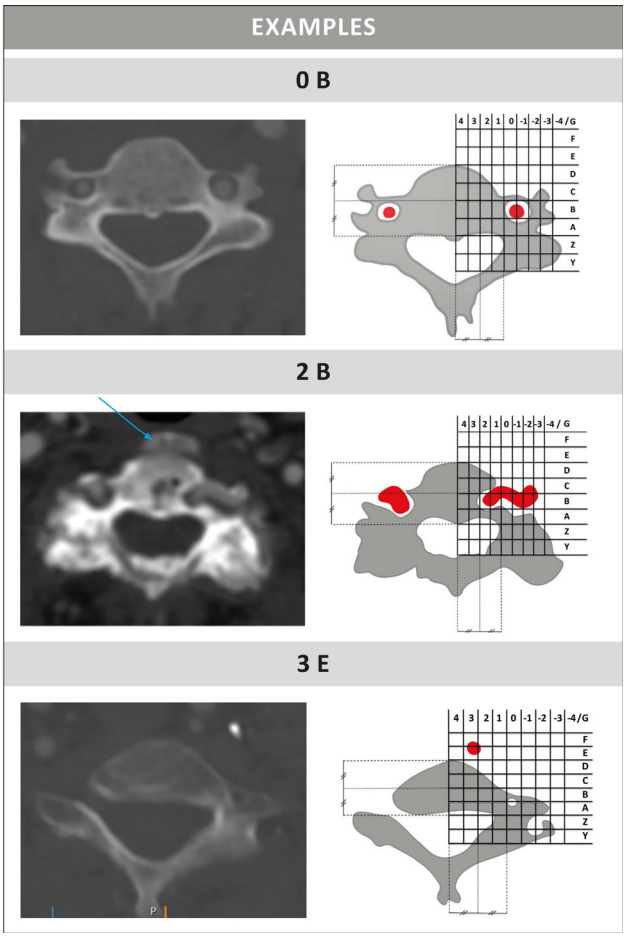
Background: An injury of the vertebral artery (VA) is one of the most catastrophic complications in the setting of cervical spine surgery. Anatomic variations of the VA can increase the risk of iatrogenic lacerations.
Objective: To propose a novel and reproducible classification system that describes the position of the VA based on a two-dimensional map on computed tomography angiographs (CTA).
Methods: This cross-sectional retrospective study reviewed 248 consecutive CTAs of the cervical spine at a single academic institution between 2007 and 2018. The classification consists of a number that characterizes the location of the VA from the medio-lateral (ML) aspect of the vertebral body and a letter that describes the VA location from the anterior–posterior (AP) aspect. The reliability and reproducibility was assessed by two independent raters on 200 vertebral arteries.
Results: The inter- and intra-rater reliability values showed the classification's reproducibility. The inter-rater reliability weighted κ-value for the ML aspect was 0.93 (95% CI: 0.93–0.93). The unweighted κ-value was 0.93 (95% CI: 0.86–1.00) for at-risk positions (ML grade $\geq$ 1), and 0.87 (95% CI: 0.75–1.00) for high-risk positions (ML grade $\geq$ 2). The weighted κ-value for the intra-rater reliability was 0.94 (95% CI: 0.95–0.95). The unweighted κ-values for the intra-rater reliability were 0.95 (95% CI: 0.91–0.99) for at-risk positions, and 0.87 (95% CI: 0.78–0.96) for high-risk positions.
Conclusion: The proposed classification is reliable, reproducible, and independent of individual anatomic size variations. The use of this novel grading system could improve the understanding and interdisciplinary communication about vertebral artery anomalies.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: grants/research support: AO Spine North America, Spinal Kinetics, MiMedx Group Inc (all paid to institution)AO Spine North America, Spinal Kinetics, MiMedx Group Inc (all paid to institution), consultant: DePuy Orthopaedics Inc, Ortho Development, Clariance Inc, 4WEB Inc, Kuros Biosciences AG, Sentio LLC, stock/shareholder: Paradigm Spine LLC, royalties: Ortho Development Corp, other financial report: Scientific Advisory Board – Clariance Inc, Strategic Advisory Board – Kuros Biosciences AG; author 7: grants/research support: Aesculap (Paid to Institution); MiMedx Group Inc (Paid to Institution); Nuvasive, Inc. (Paid to Institution), consultant: Ortho Development Corp; SPINEART USA; Nuvasive, Inc; DePuy Synthes Spine; Lanx, Inc; EIT Emerging Implant Technologies, stock/shareholder: Healthpoint Capital Partners; Paradigm Spine, LLC; Centinel Spine, Inc.; Spinal Kinetics, Inc.; Liventa Bioscience, royalties: Lanx, Inc; DePuy Synthes Spine; Nuvasive, Inc; Ortho Development Corp.; author 8: grants/research support: Spinal Kinetics, Inc.; Ivy Healthcare Capital Partners, LLC; ISPH II, LLC; NuVasive, Inc.; Mallinckrodt Pharmaceuticals; Centinel Spine, Inc. (fka Raymedica, LLC); Beatrice & Samuel A. Seaver Foundation; 4WEB Medical; Woven Orthopedic Technologies; Depuy Synthes; Orthobond Corporation; Pfizer, Inc.; Paradigm Spine, LLC; 7D Surgical, Inc., consultant: Vertical Spine, LLC; 4WEB Medical, stock/shareholder: VBVP VI, LLC, royalties: NuVasive, Inc., other financial report: Spinal Kinetics, Inc.; Vertical Spine, LLC; Bonovo Orthopedics, Inc.; Viscogliosi Brothers, LLC; Liventa Bioscience (fka AF Cell Medical) Woven Orthopedic Technologies; Healthpoint Capital Partners, LP; Paradigm Spine, LLC; Tissue Differentiation Intelligence, LLC; author 9: grants/research support: 4WEB Medical; NuVasive, Inc.; Pfizer, Inc.

QF44

A NOVEL PREOPERATIVE TRAJECTORY EVALUATION METHOD FOR L5-S1 TRANSFORAMINAL PERCUTANEOUS ENDOSCOPIC LUMBAR DISCECTOMY BY MRI OR CT

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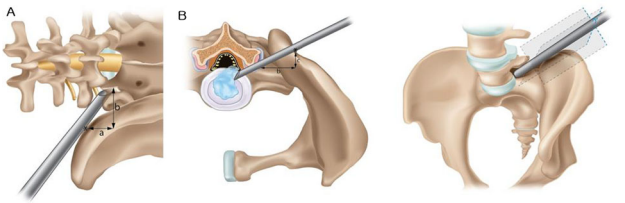
Introduction: L5-S1 transforaminal PELD is a demanding procedure due to structures like iliac crest, L5 transverse process, hypertrophic L5-S1 facet joint, and sacral ala. There has been no definite preoperative evaluation method to evaluate the surgical validity of L5-S1 transforaminal PELD. Authors report a new preoperative trajectory evaluation method for L5-S1 transforaminal PELD using magnetic resonance imaging (MRI) or computed tomography (CT) examinations.
Methods: Twelve patients who were diagnosed L5-S1 disc herniation were preoperatively evaluated with this new method. Skin marker is attached to patient's back as a tentative skin entry point which was determined by usual preoperative MRI or CT. A new tilted axial and coronal MRI or CT scan is performed according to axis of L5S1 transforaminal working channel. These images will show good relationship between working channel and iliac crest. With this tilted MRI/CT, surgeon can decide exact skin entry point.
Results: Six patients were decided to undergo a transforaminal PELD and results were successful. The other six patients were considered to be unsuitablë for transforaminal PELD because of the probable blockade by iliac crest.
Conclusion: A new preoperative trajectory evaluation method for L5S1 transforaminal PELD is simple technique to determine whether iliac crest blocks working channel pathway. The tilted MRI or CT can provide precise evaluation for L5S1 transforaminal PELD trajectory and may achieve good outcome.



MRI taken coronal and axial axis of PELD working channel

Disclosures: author 1: none, author 2: not indicated.

QF45

EXAMINING HOW SELF- PERCEIVED PARTICIPATION TO SOCIETY AND AUTONOMY DIFFERS AMONG ADULTS WITH SPINAL DEFORMITY RECEIVING SURGICAL OR NON-SURGICAL MANAGEMENT

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Background/introduction: Clinical decision making in ASD care is complex. The World Health Organization (WHO) calls for an assessment of patients with chronic disorders as ASD using the International Classification of Function, Disability and Health (ICF). Therefore this study introduces Self-perceived participation to society and autonomy (SSP) as a tool to quantify disability to support clinical decision-making in ASD care.

SPP can be quantified using the Impact on Participation and Autonomy Questionnaire (IPA); constituting 5 domains: autonomy indoors, family role, autonomy outdoors, social relations, work and education.

ASD patients with more SPP limitations are more likely receiving surgery as a result of decision-making based on radiographic parameters and Health-related Quality of Life measures, compared to ASD patients with less limitations. IPA might be a supporting tool during the ASD clinical decision-making process.

Purpose of the study: Adult Patients with Spinal Deformity experiencing more limitations in their self-perceived participation to society and autonomy are more likely receiving surgery compared to ASD patients with less limitations.

Materials and methods: Following informed consent, 56 ASD patients were recruited at the outpatient clinic and grouped depending on the type of ASD care required (group 1-non-surgical care; group 2-planned for surgery) in this cross-sectional cohort study. Demographics, Scoliosis Research Society-22r score (SRS-22r) and IPA were recorded for every patient (Table 1).

Non-parametric tests were used to statistically compare both groups. Area Under the Receiver Operating Characteristic (AUC-ROC)-analysis was used to determine the discriminative power of IPA to detect ASD patients that are more likely to receive surgical ASD care. Cutoff values for IPA were chosen by selecting the score which maximizes sensitivity and specificity. Using this cutoff value the total IPA scores were dichotomized in a positive (above cut-off value = worse SPP) and negative way (below cutoff value = less limited SPP), to allow calculating the odds ratio (OR) to be offered surgical care within the same patient cohort in case of IPA scores below the defined cutoff.

Results: The SPP, quantified by IPA and the SRS-22r is worse in ASD patients scheduled for surgical ASD care compared to non-surgical patients ($p < 0.001$). IPA has moderate power to discriminate between both groups (AUC-IPA = 0.81) with a cut off value for the total score of IPA equal to 38. Patients with a total IPA > 38 are more likely (OR = 7.5 ± 2.14) receiving surgical ASD care than ASD patients with a total IPA ≤ 38.

Conclusion: ASD patients with limited SPP (IPA score > 38), are more often scheduled for ASD surgery.

Quantitative assessment of the level of participation to society and autonomy in ASD patients can enhance clinical decision making in future ASD care, in line with the WHO's ICF model.

	Group 1 (n=36)		Group 2 (n=20)		p-value
Gender (F/M)	30/6		16/4		0.76
	Mean	SD	Mean	SD	
Age	60.91	10.82	57.24	15.19	0.64
BMI	24.47	4.24	25.58	5.12	0.55
SRS-22r	3.38	0.63	2.49	0.61	**<0.001**
Total IPA	27.94	20.39	54.80	24.78	**<0.001**
5 domains IPA					
Autonomy indoors	0.46	0.56	1.19	0.85	**0.001**
Family role	1.18	0.86	2.23	0.85	**<0.001**
Autonomy outdoors	1.25	1.07	2.32	0.99	**0.001**
Social relationships	0.74	0.63	1.44	0.96	**0.008**
Work and education	1.42	0.91	2.88	0.94	**0.001**

Table 1. Demographics, SRS-22r and IPA scores (significance level p<0.005)

Disclosures: author 1: grants/research support: KU Leuven Medtronic Educational Chair for spinal deformity research; KU Leuven SpineVision Educational Chair for Clinical and Translational Research in the Field of Pediatric Spinal Deformity Treatment;This research is part of a clinical PhD fellowship of Lieven Moke funded by the Research Foundation-Flanders;This research is part of a doctoral grant strategic basic research of Pieter Severijns funded by the Research Foundation-Flanders; Additional sources of support: this research is additionally funded by Klinische Onderzoeks- en Opleidingsraad (KOOR) UZ Leuven and KU Leuven GRANT for Advanced Spinal Evaluation and Surgical Planning Platform (ASESP-P); Research Foundation-Flanders (FWO); author 2: grants/research support: Medtronic; author 3: grants/research support: KU Leuven Medtronic Educational Chair for spinal deformity research; KU Leuven SpineVision Educational Chair for Clinical and Translational Research in the Field of Pediatric Spinal Deformity Treatment;This research is part of a clinical PhD fellowship of Lieven Moke funded by the Research Foundation-Flanders;This research is part of a doctoral grant strategic basic research of Pieter Severijns funded by the Research Foundation-Flanders; Additional sources of support: this research is additionally funded by Klinische Onderzoeks- en Opleidingsraad (KOOR) UZ Leuven and KU Leuven GRANT for Advanced Spinal Evaluation and Surgical Planning Platform (ASESP-P); Research Foundation-Flanders (FWO); author 4: grants/research support: Medtronic, Depuy-Synthes, Zimmer-Biomet, Smith&Nephew, Arthrex, V!GO; author 5: grants/research support: KU Leuven Medtronic Educational Chair for Spinal Deformity Research 2013-2017, consultant: KU Leuven C2 grant Advanced Spinal Evaluation and Surgical Planning Platform (ASESP-P).

Minimal Invasive Spine Surgery (MISS), New Techniques

QF46

BIOMECHANICAL EFFECTS OF THE LUMBAR SPINE AFTER DIFFERENT FORAMINOPLASTY SCHEME OF PTED: A FINITE ELEMENT ANALYSIS

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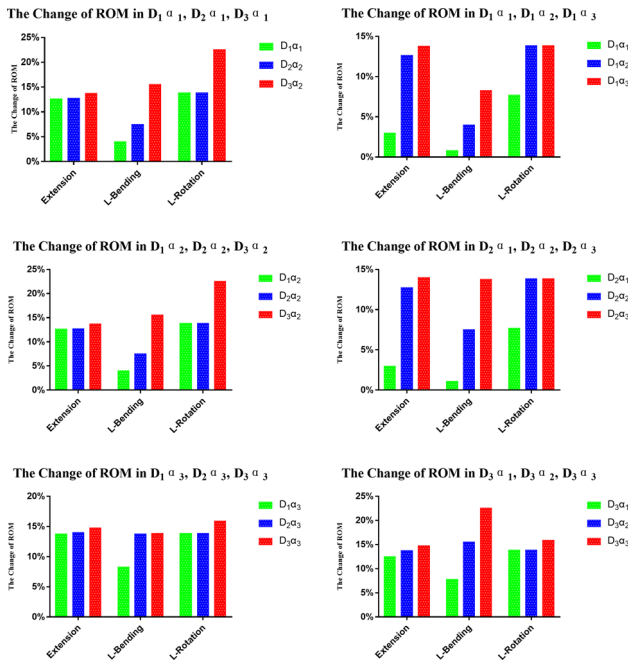
Study design: Finite element analysis.

Objective: To investigate the biomechanical effect of the lumbar spine after different foraminoplasty method of percutaneous transforaminal endoscopic discectomy (PTED).

Summary of background data: With the widely utilized of percutaneous transforaminal endoscopic discectomy (PTED), foraminoplasty is commonly used in patients with lumbar disc herniation. However, there is no standard for the foraminoplasty method. The biomechanical effects of different foraminoplasty methods on the lumbar spine are remains unclear.
Methods: A nonlinear intact three-dimensional L4-5 finite element model (Mod) was developed and validated from computed tomography images. Design three kinds of trephine with diameters of 7.5 mm, 8.5 mm and 9.5 mm (7.5, 8.5, 9.5). All three trephines are foraminoplasty at an angle of 10°, 30° and 50° (Lower, Medium, Upper) with the coronal plane. The range of motion (ROM) and maximum von Misses stresses of the intervertebral disc for the nine models (7.5L, 7.5M, 7.5U, 8.5L, 8.5M, 8.5U, 9.5L, 9.5M, 9.5U) were compared with Mod in flexion, extension, left and right lateral bending and left and right axial rotation.
Results: 7.5M, 7.5U, 8.5M, 8.5U, 9.5L, 9.5M, 9.5U showed the greatest increase in ROM with extension, L-bending, and L-rotation, and the extension state is the most obvious. 7.5U, 8.5U, 9.5L, 9.5M, 9.5U showed the increase significantly in von Misses stresses of intervertebral disc with extension, L-bending, and L-rotation. Interestingly, the von Misses stresses of intervertebral disc as increasing as the diameter of the trephine and the coronal angles. For 7.5L, 7.5M, 8.5L, 8.5M, Furthermore, the von Misses stress was magnified in the L5 superior articular process with L-bending and it's no significant changed for 7.5U, 8.5U, 9.5L, 9.5M, 9.5U.
Conclusion: For L4-5 foraminoplasty, using the trephine with a diameter of 7.5 mm or 8.5 mm can be done without sacrificing lumbar stability. Using 9.5 mm diameter trephine increases ROM and reduces the biomechanical stability of the lumbar spine. Compared to upper coronal angle, the lower coronal angle can maintain the biomechanical stability of the lumbar spine better, but it will increase the risk of tip fracture of the superior articular process.



Disclosures: author 1: none.

QF47

EFFECT OF INDIRECT DECOMPRESSION THROUGH LATERAL LUMBAR INTERBODY FUSION TO LIGAMENTUM FLAVUM FOR DEGENERATIVE LUMBAR DISEASE

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Purpose: Lateral lumbar interbody fusion (LLIF) including extreme lateral lumbar interbody fusion (XLIF) and oblique lateral lumbar interbody fusion (OLIF) have been reported successfully treated spinal stenosis by improving central canal area via indirect decompression. However, indirect decompression effect on posterior spinal elements especially ligamentum flavum has not been studied. This study evaluated changes of ligamentum flavum area, thickness, flavum-central canal improvement ratio and compared with degree of facet joint degeneration after LLIF.
Methods: Thirty-five patients presenting with degenerative spinal disease and nerve compression underwent XLIF (18 patients) or OLIF (17 patients) with percutaneous pedicle screw fixation at 57 levels (XLIF; 26 levels, OLIF; 31 levels) without posterior direct decompression were included. Magnetic resonance images with clear visualized ligamentum flavum pre-and post-operative at 3 to 6 months after surgery were evaluated. Changes in ligamentum flavum area (LFA), ligamentum flavum thickness (LFT), cross-sectional area (CSA) of thecal sac, posterior disc height, foraminal height and cage alignment were measured and compared with facet degeneration (mild; grade I, II vs moderate to severe; grade III, IV). Cage position (determined by anterior or posterior to mid-vertebral body) and its effect to each parameter and flavum-central canal area improvement ratio were evaluated.
Results: There was radiographic improvement in all cases. No statistical differences between XLIF and OLIF except cage alignment (0.54° in XLIF, 6.13° in OLIF; $p < 0.05$). By comparing pre-and post-operative radiographs, mean LFA decreased from 78.92 to 66.89 mm^2 (− 12.03 mm^2; $p < 0.05$). Mean right LFT decreased from 2.89 to 2.32 mm (− 0.57 mm; $p < 0.05$). Mean left LFT decreased from 3.33 to 2.63 mm (− 0.7; $p < 0.05$). Mean CSA increased from 93.13 to 127.31 mm^2 (34.18 mm^2; $p < 0.05$). Flavum-central canal area improvement ratio was 35%. Degree of facet joint degeneration showed no effect on radiographic outcomes.
Conclusions: Study confirmed that indirect decompression through LLIF can decrease both area and thickness of ligamentum flavum regardless of severity of facet joint degeneration or cage position. Thinning of ligamentum flavum contributed around one third of central canal area increments after surgery.
Disclosures: author 1: consultant: Medtronic; author 2: none, author 3: grants/research support: Metronic; author 4: none, author 5: not indicated.

QF48

COMBINED ONE STEP LATERAL INTERBODY FUSION AND POSTERIOR MIS TRANSPEDICULAR SCREWING USING 3D IMAGING AND NAVIGATION

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Study design: Prospectively collected data of the first 30 consecutive patients treated with single-position one level lateral (LLIF) with bilateral percutaneous pedicle screw and rod fixation using O-Arm 3d imaging and navigation.
Objective: To evaluate the clinical feasibility, accuracy, and efficiency of a single-position technique for LLIF with bilateral pedicle screw and rod fixation.
Summary of background data: Minimally-invasive lateral interbody approaches are performed in the lateral decubitus position. Subsequent repositioning prone for bilateral pedicle screw and rod fixation requires significant time and resources and does not facilitate increased lumbar lordosis.
Methods: The first 32 consecutive patients (128 screws) treated with single-position LLIF and bilateral pedicle screws by a single surgeon between December 2016 and August 2018 were included in the study. O-Arm 3d imaging combined to navigation was employed in this setting. Fusion were graded using computed tomography and several timing parameters were recorded including retractor, irradiation, and screw placement time. Complications including reoperation, infection, and postoperative radicular pain and weakness were recorded.
Results: Average screw placement time was 1.2 min/screw. Average total operative time (interbody cage and pedicle screw placement) was 107.3 min. Average total irradiation was 19 mGy. No pedicle screw breach was recorded. Fusion rate at 6-months postoperative was 93.5%.
Conclusion: The single-position, all-lateral technique was found to be feasible with high accuracy, low irradiation, and complication rates comparable with the published literature available in TLIF. This technique eliminates the time and may lead to significant improvements in operative efficiency and cost savings.
Disclosures: author 1: none, author 2: none, author 3: none.

QF49

ACCURACY OF SCREW PLACEMENT IN MINIMALLY INVASIVE, ROBOT-ASSISTED ILIOSACRAL SCREW INSERTION IN CHILDREN WITH NEUROMUSCULAR SCOLIOSIS

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The combination of fusionless surgery with growing rods is increasingly indicated in early-onset scoliosis in general and neuromuscular scoliosis in particular. This technique is based on the bilateral attachment of rods fixed to the upper spine with 6 hooks or sublaminar bands and fixed to the pelvis with two iliosacral screws. The latter have excellent biomechanical characteristics but are particularly difficult to position; even with a dedicated instrument set, it is difficult to control the positioning, and an incorrect trajectory can result in failure of the fixation or damage to the nerve root.

Objective: To evaluate the accuracy of iliosacral implant positioning with robotic assistance.
Method: A retrospective study of all patients operated on since October 2017 in our department of paediatric orthopaedics. The trajectory planned with the robot's software was compared with the iliosacral screws' actual real position. The pre- and post-surgery flat-panel CT images were merged. The distance (the 3D vector error between the planning and the middle of the implanted screw) was measured at two points on the trajectory (the iliac entry point, and the screw tip's target point in the sacrum).
Results: Ten patients (20 implants) were included in the study. The mean (range) age was 10.9 years (7.2–18.2), and all the patients had severe neuromuscular scoliosis. The mean $\pm$ standard deviation (range) error for 20 iliosacral screws was 1.93 $\pm$ 0.7 mm (1.3–3.12) at the entry point and 1.49 $\pm$ 0.41 mm (1–2.4 at the target point. All the screws were located within the sacrum (i.e. in the absence of cortical breaches), thus enabling the connector to be positioned between the wing of the ilium and the sacrum. No neurologic or vascular complications were associated with the positioning of iliosacral implants.
Conclusion: Robotic assistance enables the highly accurate implantation of iliosacral screws, which guarantees biomechanical efficiency and limits morbidity related to the implant's position. Trajectory planning results in optimal positioning with regard to the spinal deformation - even in children. Robot-assisted implantation was associated with a high level of agreement between the planned and achieved screw positions.
Disclosures: author 1: none, author 2: consultant: Zimmer Biomet Robotics; author 3: none, author 4: consultant: Implanet.

QF50

SURGICAL WOUND INFILTRATION OF MULTIMODAL COCKTAIL ANALGESIA COMPARED WITH LOCAL ANESTHETIC FOR REDUCE POST-OPERATIVE PAIN IN MIS-TLIF: A RANDOMIZED CONTROLLED TRIAL

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Study design: Triple blind randomized controlled trial.
Background: Local injection of multimodal cocktail analgesia has been shown benefits in many orthopedic operations but still rarely used in spinal surgery. The purpose of this study was to evaluate efficacy and outcome between the usage of surgical wound infiltration with multimodal cocktail consists of Ketorolac, Morphine and Bupivacaine compared with standard local anesthetic (Bupivacaine only) in minimal invasive transforaminal lumbar injection interbody fusion (MIS TLIF).
Method: 80 adult patients who underwent MIS TLIF were included in the study. Patients were randomized into two group. Control group (n = 40) received 0.5% bupivacaine 100 mg (20 ml.) & adrenaline 0.5 mg (0.5 ml) local injection and Multimodal group (n = 40) received 0.5% bupivacaine 92.5 mg (18.5 ml). Ketorolac 30 mg (1 ml.) Morphine 5 mg (0.5 ml.) & adrenaline 0.5 mg (0.5 ml) local injection. The operations were performed by one surgeon with same protocol and post- operative medication. Patient, surgeon and researcher were all blinded. Pain was recorded in visual analog scale (VAS) before operation, at 3 h, 6 h, 12 h and 24 h after operation. Post-operative morphine consumption and side effects from opioid were assessed.

Result: Multimodal group shown significant lower in VAS compared to control group at 3 h (mean3.18 vs 4.53, $p < 0.001$), 6 h (mean2.13 vs 3.23, $p = 0.002$) and 12 h (mean1.80 vs 2.55, $p = 0.011$) after surgery. There was no significant difference in VAS at 24 h (mean 1.40 vs 2.17, $p = 0.075$) after surgery. Morphine consumption was higher in control group (mean 2.8 mg vs 0.33 mg, $p < 0.001$). The incidence of side effect of opioid including nausea, vomiting and itching was lower in multimodal group.
Conclusions: Surgical wound infiltration of multimodal cocktail analgesia (bupivacaine, ketorolac and morphine) provides better effectiveness and lower side effect in post-operative pain control after MIS-TLIF.
Disclosures: author 1: grants/research support: Metronic; author 2: consultant: Medtronic; author 3: none, author 4: none.

QF51

CLINICAL AND RADIOLOGICAL RESULTS OF TREATMENT OF LUMBAR SPONDYLOSIS USING CORTICAL BONE TRAJECTORY SCREWS (CBT)

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Background and purpose: Cortical bone trajectory screws (CBT) is an alternative method of transpedicular spinal fusion for degenerative disease. The new entry point location and screwdriving direction enables the reduction of approach-related morbidity. We present our experience with the CBT technique on a series of 40 patients with lumbar degenerative disease and with an average follow-up of 35 months (range: 22–52 months).
Materials and methods: Indication for surgery was a critical stenosis of the intervertebral foramen requiring the sacrifice of the entire intervertebral joint on at least one side during the decompression. Thirty-seven (93%) patients had low back pain, 38 (95%) had radicular pain, 25 (63%) had neurogenic claudication, 19 (48%) had paresis, and 25 (63%) had sensory disturbances. The patients were fused at L4–L5 (N = 23), L5–S1 (N = 6), L3–L4–L5 (N = 6), and L4–L5–S1 levels (N = 5). The pain syndrome was assessed according to the Numerical Rating Scale (NRS) for low back pain and for radicular leg pain. Patient functional status was assessed using the Oswestry Disability Index (ODI) questionnaire. Treatment efficacy was measured according to the minimal clinically important difference (MCID). Improvement for MCID was defined if postoperative improvement for NRS was ≥ 3 and ODI was ≥ 12. Long-term radiological control was obtained 12 months after surgery. Follow up CT and dynamic X-ray of the lumbar spine were performed in 39 (98%) patients, 1 year after surgery.
Results: The mean preoperative NRS for low back and leg pain and ODI were 6.8 (range: 0–10), 7.3 (range: 1–10), 52 (range: 22–82), respectively. At the most recent follow-up, NRS for low back and leg pain and ODI were 1.7 (range: 0–5), 1.5 (range: 0–4), 19.4 (range: 0–48), respectively. The mean improvements in NRS for low back and leg pain and ODI were 5.1 (range: 0–10), 5.8 (range: 1–9) and 32.6 (range: − 10–70), respectively. The MCID in the most recent follow-up for the back and leg pain NRS and ODI was achieved in 92%, 95% and 95% of patients, respectively. The 1 year follow-up dynamic X-rays and CT showed no instability at the fused levels. Solid bone union in situ was obtained on 47 (92%) levels, collapsed union on 2 (4%) levels, non-union was found in 1 (2%), and 1 (2%) patient was lost to follow-up. Complications included: incorrect screw placement 1/182 (0.6%), screw loosening 5/182 (2.8%), interbody device dislocation 1/78 (1.3%). Three (7.5%) patients required revision surgery, including repositioning of one screw with removal of the interbody device in 1 patient, repositioning of one screw in 1 patient and removal of one screw in 1 patient.
Conclusions: In our study, the high effectiveness and safety of CBT lumbar fusion in degenerative spine disease was confirmed at a mean of 2.9 years of follow-up.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none.

QF52

EVALUATION OF BONE ONGROWTH ON THE SURFACES OF A NEWLY-DEVELOPED 3D-PRINTED POROUS TITANIUM ALLOY CAGE: IN VIVO ANALYSIS USING CT COLOR MAPPING

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Introduction: A 3D-printed porous titanium alloy (PTA) cage has been developed to achieve osseointegration on the surfaces of the cage frames. The aim of this study was to evaluate the difference of bone ongrowth in the PTA cages between the surfaces of the cage frames and those of the open windows filled with autologous local bone grafts using in vivo computed tomography (CT) color mapping.
Methods: 22 consecutive patients (11 males, 11 females; median age, 68.5 years [interquartile range (IQR), 63–75 years]) who underwent single- or two-level posterior lumbar interbody fusion (PLIF) were included in this prospective study. Two PTA cages filled with morselized local bone grafts in their open windows were inserted into all PLIF segments. Bone ongrowth in each cage was evaluated on the upper and lower surfaces of the cage frames (4 surfaces per one cage) and open window (2 surfaces per one cage) by postoperative CT scans (within 1 week and 6 months postoperatively). The rectangular region of interest (ROI)s were placed on the surfaces of each cage with 1-mm height on the sagittal plane, and the Hounsfield Unit (HU) values of each ROI were calculated. The obtained HU values were mapped to a spectral color scale that displayed from dark purple (0 HU) to red (1600 HU) and postoperative color changes were also evaluated. If the color tone on the surfaces of the cage frames or open windows changed toward red on the sagittal plane, we judged postoperative bone ongrowth existed (Grade 0, without bone ongrowth; Grade 1, 1–33% of the surface with bone ongrowth; Grade 2, 34–66%; Grade 3, 67–100%). Bone ongrowth index (BI) in each cage was defined as the average of bone ongrowth grades of either the surfaces of the cage frames or those of the open windows. The postoperative changes of HU values and BI were compared between the surfaces of the cage frames and those of the open windows.
Results: 18 patients underwent single-level PLIF and 4 patients underwent two-level PLIF. A total of 52 cages were evaluated in this study. The median postoperative changes of HU values on the surfaces of the cage frames were 101.1 HU (IQR, − 5.6–183.6 HU) and those of the open windows were 34.0 HU (IQR, − 43.6–109.5 HU). The median BI on the surfaces of the cage frames were 1.5 (IQR, 1–2) and those of the open windows were 0.5 (IQR, 0–2). Both of the postoperative increase in HU values and BI were significantly larger on the surfaces of the cage frames than those of the open windows (Wilcoxson signed-rank test, $p < 0.001$).
Conclusions: The postoperative increase in HU values and large BI suggest new bone formation on the cage surfaces. Thus, this study

shows that osseointegration or bone bonding between the adjacent vertebral endplates and PTA cages can progress earlier on the surfaces of the 3D-porous titanium alloy frames than on those of the open windows filled with local bone grafts.

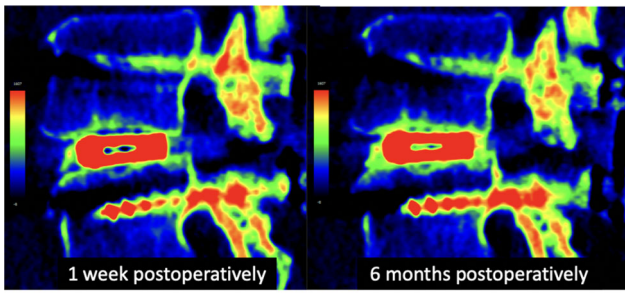

Figure. An example of the CT color mapping based on the Hounsfield Unit values.

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: grants/research support: Asahi Kasei Pharma, Twocell, Rhoto, Aimedic MMT, The Nakatomi Foundation, consultant: Nuvasive, Kyocera, B-braun, Medtronic, Asahi Kasei Pharma, Medacta.

QF53

REDUCED RADIATION PROTOCOL FOR O-ARM NAVIGATION IN PAEDIATRIC DEFORMITY PATIENTS: A FEASIBILITY STUDY

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Background: O-arm assisted pedicle screw placement has been proven to be more accurate than free hand technique. Radiation exposure remains the primary drawback. We determined the feasibility and safety of a reduced radiation protocol in paediatric patients undergoing scoliosis correction.
Methods: A reduced radiation protocol for a Medtronic O-arm navigational system was devised. 3D CT reconstructions of an anthropomorphic pelvic phantom indicated adequate image quality after reduction to 20% of current manufacturer recommended factors devised by the Mayo Clinic. A feasibility study to test the image quality was undertaken on 3 patients, 1 with syndromic and 2 with idiopathic scoliosiis each receiving reductions in radiation exposure to 60%, 50% and 40% of what would have been delivered using the Mayo clinic protocol by reducing the x-ray tube current to 10 mA while keeping the tube potential consistent with the Mayo clinic recommendations.
Results: A low dose O-arm protocol was able to generate adequate image quality while delivering as little as 40% of the recommended protocol radiation dose. The total radiation dose delivered with this protocol was approximately 0.77 milliSieverts (mSv), which includes a pre and post instrumentation spin. This effective dose represents $< 1/3$ of average UK and $< 1/6$ average US annual radiation exposure. There were no neurological or implant related complications.
Conclusions: Our low dose O-arm radiation protocol significantly reduces the radiation exposure compared to the Mayo clinic protocol providing operational image quality to allow more accurate screw placement in deformed spines.

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none.

QF54

PARTIAL HEMI-VERTEBRA RESECTION (SRS-SCHWAB GRADE 4 OSTEOTOMY) FOR CONGENITAL SCOLIOSIS: A COMPARISON WITH RADICAL HEMI-VERTEBRA RESECTION

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Introduction: RS-Schwab grade 4 osteotomy (partial HV resection) recently has been reported to be well utilized in the correction of congenital kyphosis caused by HV deformity. Since SRS-Schwab grade 4 osteotomy was characterized with less invasion, post-operative bone to bone connection and well protection of nerve roots, we thereby hold that the partial HV resection should be preferred in certain CS patients with single HV. The purposes of this retrospective study was to investigate the radiological and clinical outcomes of partial HV resection in CS caused by non-incarcerated HV.
Methods: CS patients with single HV undergoing partial HV resection in our center from February 2011 to May 2016 were matched with those undergoing radical HV resection on age, gender, curve magnitude and apex location at a match ratio of 1:1. Comparisons were performed in terms of correction outcomes, clinical results and complications at pre-, post-operation and last follow up between partial HV resection group (P group) and radical HV resection group (R group).
Results: Both P group and R group included 25 CS patients and there was no significant difference in pre-operative radiologic parameters between two groups. Significantly improvements in Cobb angle were observed post-operatively and at final follow up in both R and P groups. Compared with the R group, the P group had a similar correction of Cobb angle at post-operation ($38.6 \pm 6.7°$ vs $35.2 \pm 5.6°$, $P = 0.057$) and at last follow up ($38.4 \pm 7.0°$ vs $34.7 \pm 6.7°$, $P = 0.062$), and less estimated blood loss ($P = 0.023$). Improvements at different levels were achieved in each domain of Scoliosis Research Society-22 (SRS-22) questionnaire at last follow up in both groups. During follow-up, no significant correction loss and major complications was observed in P group while 1 patient in R group was found to have rod breakage with pseudarthrosis at 24 months follow-up.
Conclusions: SRS-Schwab grade 4 osteotomy is a safe, effective and less invasive procedure while achieving comparable amount of deformity correction with radical HV resection in the treatment of CS due to single non-incarcerated HV.
Disclosures: author 1: none, author 2: not indicated; author 3: none, author 4: not indicated; author 5: none, author 6: none, author 7: none.

QF55

ACCURACY OF SCREW PLACEMENT OF ANTERIOR PEDICLE SCREW IN CERVICAL SPINE-RADIOLUCENT GUIDE-WIRE SYSTEM CAN IMPROVE THE ACCURACY OF SCREW PLACEMENT?

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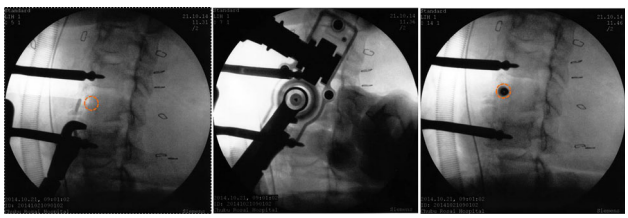
Introduction: We have used anterior pedicle screw (APS) procedure W/WO plate fixation using the fluoroscope-assisted pedicle axis view imaging technique since 2006. We used the radiolucent guide-wire system to increase the accuracy of screw placement since 2012. In this study we reported those clinical outcomes and screw placement.
Materials and methods: Seventy-four patients who underwent multi-level anterior decompression and APS fixation were enrolled. They were 43 men and 31 women and their mean age was 57 years old. Forty-eight cases had local kyphotic deformity. All underwent anterior decompression, strut bone graft and (APS) fixation (APS alone; 35 cases, APS & plate 23 and APS & posterior fixation in 16). Screw placement was evaluated as Grade 0-II (Grade0; intact, Grade I [screw exposure]; less than half diameter of screw out of pedicle, Grade II [pedicle perforation]; more than half screw out of pedicle).
Results: JOA score was improved from 11.4 to 14.7 and recovery rate was 58.3%. One hundred fifty-one APSs were inserted in 74 cases. Eight of 151 screws were considered as Grade I and 0 screws as Grade II. Screw malposition was decreased from 7.6% (7/92) to 1.6% (1/61) after radiolucent guide-wire system. No graft dislodgement was seen. Local alignment was 8.0 degrees kyphosis preoperatively, 3.0 lordosis postoperatively and 0.7 lordosis finally. Six cases of 35 APS alone cases needed posterior supplementary fixation due to graft sinking and/or kyphotic deformity. C5 palsy was developed in 9 of 48 cases with local kyphotic deformity and completely recovered in 8 cases.
Conclusion: APS procedure provided good clinical outcomes and few screw-related complications, and could be the surgical option which offers the strongest fixation in multi-segmental anterior cervical reconstruction. Radiolucent guide-wire system promoted the accuracy of screw placement.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none

QF56

AUGMENTED REALITY SURGICAL NAVIGATION RESULTS IN HIGHER PEDICLE SCREW ACCURACY AND IMPLANT DENSITY COMPARED TO FREE-HAND TECHNIQUE, A MATCHED-CONTROL STUDY

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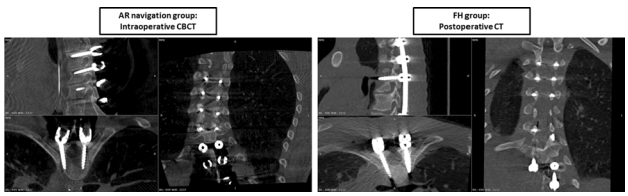
Introduction: A new concept of augmented reality surgical navigation (ARSN) system with intraoperative 3D cone beam CT (CBCT) and non-invasive patient tracking was developed for spine surgery. We introduce the first study that compares the accuracy of pedicle screw placement with ARSN vs free-hand (FH) technique and its impact on implant density.
Methods: Twenty consecutive patients, including 13 scoliosis cases, were enrolled in this prospective study. The ARSN system is composed of a ceiling-mounted robotic C-arm with integrated optical video cameras in a hybrid OR. An intraoperative 3D CBCT was acquired. The images were used for automatic pedicle identification and screw path planning. The trajectory of the screw paths were augmented to the video display of the surgical field for navigation. Retrospective data from a matched group of 20 patients, operated by free-hand technique, for similar indications as the ARSN group was collected. Screws within the pedicle or encroaching the cortex (Gertzbein grade 0 or 1) were defined as accurately placed, while screws breaching 2 mm or more (Gertzbein grade 2 or 3) where defined as inaccurate. Implant density including number of screws and hooks were compared in both groups as well as secondary clinical outcomes such as deformity correction, length of hospital stay, and procedure time.
Results: A total of 262 and 288 screws were placed in the ARSN and FH groups respectively. The accuracy of the ARSN group was higher (93.9 vs 89.6%, $p < 0.05$) with twice the amount of screws entirely within the pedicle, i.e. Gertzbein grade 0 (63.4 vs 30.6%, $p < 0.001$). None of the groups had a screw with more than 4 mm breach, i.e. Gertzbein grade 3. No statistical difference was observed for combined implant density between the ARSN (1.76 per spinal level) and the FH group (1.69 per spinal level). However, there was a significant lower hook density (0.05 vs 0.18 per spinal level, $p < 0.01$) due to a significant higher screw density (1.71 vs 1.51 per spinal level, $p < 0.05$) in the ARSN group. There was no difference in deformity correction, length of hospital stay or procedure time.
Conclusion: A significantly higher pedicle screw accuracy was achieved with ARSN compared to free-hand technique. While the total implant density is comparable in both groups, the ARSN allowed pedicle screw placement in small pedicles instead of hooks, yielding potentially better biomechanical stability.



Disclosures: author 1: none, author 2: none, author 3: employee: philips; author 4: none, author 5: none, author 6: none, author 7: none, author 8: grants/research support: Medtronic, Philips, Swedish Resarch Council, Stockholm county council.

QF57

FIRST EXPERIENCE WITH PLATELET RICH FIBRIN AUGMENTATION OF DEEP SURGICAL SITE INFECTIONS AFTER INSTRUMENTED SPINAL SURGERY

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Background: Late-onset deep surgical site infections after instrumented spinal surgery is a rare but harmful complication currently lacking universally accepted management strategies. Radical surgical debridement of devitalized tissue and targeted antibiotic treatment is frequently insufficient. Multiple revision-surgeries and even removal of the instrumentationmay ensue. Primary wound-closure is frequently impaired by extended tissue destruction Platelet rich fibrin (PRF) is an autologous low cost biomaterial- easy-to-prepare- in the operating theater by a single centrifugation process of the patients own blood, without any additional chemical handling. It is enriched with leukocytes and autologous growth factors. PRF has been recognized as a powerful cicatrization matrix for the promotion of wound healing in various applications of regenerative medicine.
Purpose of the study: In the present study we assess the potential of PRF to augment deep surgical site infections and obtain wound closure after instrumented spinal fusion.
In this study we explored an adjuvant approach, where after initial surgical debridement and initiation of the pathogen-specific antibiotic regimen, the surgical site is secondary augmented with injectable and solid platelet rich fibrin, in order to eliminate residual post-infectious tissue deficits and thus promote a successful primary wound-closure with retention of the instrumentation.
Materials and methods: 4 patients who underwent instrumented spinal surgery presented with late onset deep surgical site infections. Extended resection of the devitalized and necrotic tissue and sampling of the involved pathogens was initially performed followed by intravenous administration of pathogen-sensitivity-adapted antibiotics. Primary wound closure was attempted in each patient.Due to persistent wound-dehiscence In all cases, a second surgical debridement was performed, and the remaining post-infectious tissue deficits were filled with solid PRF obtained from the centrifugation of 50 ml of patients own blood. The surrounding tissues were injected with 20 ml of injectable PRF (iPRF). Primary wound closure was performed Wound inspections and laboratory follow ups have been performed every two weeks for 3 months.
Results: Primary wound healing was found in all patients with no recurrence of infection during the follow up periods. No removal of Instrumentation was required. In all 4 cases Staphylococcus aureus was the identified pathogen. All 4 patients showed positive blood culture results for the same pathogen. Infections resolved in all patients.
Conclusions: Autologous PRF is a simple-to-use low cost biomaterial which may facilitate wound healing in patients with deep surgical site infections after instrumented spinal fusion.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none.

QF58

DOES OBESITY AFFECT LONG-TERM OUTCOMES OF LATERAL LUMBAR INTERBODY FUSION (LLIF)?

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Introduction: Obese patients are known to pose significant challenges to spine surgeons in performing traditional open lumbar fusion procedures. The increased risk of complications in these patients has led surgeons to be wary in pursing traditional operative interventions. Since the advent of minimally-invasive approaches to lumbar fusion, surgeons are turning to these procedures in an attempt to minimize operative time, blood loos and complications. With the increased proportion of obese patients, it is imperative to understand the long-term outcomes in minimally-invasive approaches. One such approach is lateral lumbar interbody fusion (LLIF).
Purpose: The purpose of this study was to evaluate the long-term outcomes of LLIF in obese patients by assessing clinical outcome scores, reoperation rate, and pelvic parameters.
Methods: A retrospective review was performed to identify patients who underwent LLIF with posterior stabilization since 2007 with a minimum of 5 years follow-up. Demographics including BMI were recorded and patients were subdivided into 2 cohorts: (A) nonobese ($BMI < 30\ kg/m^2$) and (B) obese ($BMI > 30\ kg/m^2$). Functional outcomes were assessed by comparing pre- and post-operative VAS and ODI scores. Reoperation rates were compared between cohorts. Pelvic incidence (PI) and lumbar lordosis (LL) mismatch was calculated from both pre- and post-operative radiographs.
Results: 115 consecutive patients were included (53 nonobese & 62 obese) with a mean follow up of 95.3 months. Mean BMI was 25.3 in cohort A and 35.3 in cohort B ($p < 0.001$). There were more females in cohort A. VAS scores decreased by a mean of 5.7 in cohort A, and 5.4 in cohort B ($p = 0.213$). ODI improvement was also similar between the cohorts. 5.6% of nonobese patients required reoperation compared to 9.6% of obese patients ($p = 0.503$). Both cohorts achieved a similar proportion of PI-LL mismatch correction, 85% in obese vs 78% in nonobese patients ($p = 0.526$).
Conclusion: Contrary to traditional open fusion procedures, obese patients who undergo minimally invasive LLIF have similar surgical outcomes compared to nonobese patients with respect to functional outcome scores, reoperation rates, and correction of PI-LL mismatch after long-term follow-up. With similar outcome and reoperation profiles, LLIF, a minimally invasive approach to the lumbar spine, is a safe and effective option for fusion in obese patients.
Disclosures: author 1: grants/research support: K2M; author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none.

QF59

FUSION PERFORMANCE OF ATTRAX® PUTTY VS. AUTOGRAFT IN INSTRUMENTED POSTEROLATERAL SPINAL FUSION; A RANDOMIZED INTRA-PATIENT CONTROLLED NON-INFERIORITY TRIAL

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Introduction: Spinal fusion is a frequently performed surgical procedure for many spinal conditions. Autologous bone grafting is the gold standard to establish a bony fusion, but this procedure has some drawbacks including harvesting morbidity and limited amounts. This has led to development of various alternatives over the past decades. Current microporous synthetic ceramics consisting of tricalciumphosphate are promising due to their high bioactivity as shown by ectopic bone induction in animal models. We investigated the non-inferiority of such a ceramic (AttraX® Putty) in comparison to autograft in instrumented posterolateral spinal fusion.

Methods: After ethical approval and informed consent, 100 non-traumatic adult patients indicated for a primary posterolateral fusion between T10 and S1 were included in this multicenter randomized intra-patient controlled non-inferiority trial. After instrumentation and preparation for bone grafting, the allocation side of AttraX® Putty was disclosed. The contralateral side of the fusion trajectory was grafted with autologous bone graft, so each patient served as its own control. For the primary outcome, the fusion rate of both grafts was assessed at 1 year follow-up on CT-scans. Each segment and side was scored by two blinded observers independently. Subsequently, a single fusion score per side was calculated to correct for multilevel fusions. Non-inferiority of AttraX® Putty was tested with McNemar's test. The non-inferiority margin was set at 15%, with 80% power and alpha of 0.05. Secondary outcomes included the rate of (serious) adverse events compared to control populations from literature, Oswestry Disability Index (ODI), EQ-5D-5L and Visual Analogue Scale (VAS) for back pain.

Results: A total of 87 patients were included in the primary analysis. There were 42 males and 45 females, mean age 55 (range 33–79) years. A mean of 1.7 (range 1–8) spinal segments were instrumented for fusion. The overall posterolateral fusion rate was 71%. At the AttraX® Putty side 55% of the segments were unilaterally scored as fused, compared to 52% at the autograft side. After correction for multilevel fusions, McNemar's test showed no difference between the treatment conditions ($p = 0.868$, 90% CI -9.1% to +13.7%). None of the reported adverse events could be directly related to the use of AttraX® Putty.

Conclusion: This randomized intra-patient controlled study including 87 patients demonstrated non-inferiority of AttraX® Putty in comparison to autograft in terms of posterolateral fusion performance in instrumented thoracolumbar spinal fusions.

Disclosures: author 1: none, author 2: grants/research support: DPS; author 3: not indicated; author 4: none.

QF60

THORACOSCOPIC VERTEBRAL BODY TETHERING FOR ADOLESCENT IDIOPATHIC SCOLIOSIS : MID-TERM RESULTS OF 24 PATIENTS

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Introduction: Growth friendly surgical options by modulating the spinal growth and preventing the possible complications of fusion are new trends for the management of adolescent idiopathic scoliosis (AIS) in skeletally immature patients. Vertebral body tethering (VBT) as a fusionless minimally invasive treatment option has been shown to be effective to induce and also correct the scoliotic deformity by many animal studies. However only a few studies exist in the literature with regard to the clinical and functional early results of VBT. The aim of this study is to present the 2-years results of VBT applied to 24 skeletally immature patients with AIS.

Patients and Methods: 24 patients with a diagnosis of AIS were included in the study prospectively after evaluation of their clinical and radiographic data. All patients were skeletally immature and followed up within a brace for at least 6 weeks. A decision to proceed with surgery was established after the detection of curve progression within the brace (> 40□) with a minimum curve flexibility of 30%.

Results: 18 females and 6 males had a mean age of 11.4, mean-follow up period of 2 years. Patients had a mean pre-operative major curve magnitude of 48 degrees and a mean curve flexibility of 48.2%. An average of 8 levels of tethering was performed through thoracoscopic approach. Thoracic screws were placed thoracoscopically, while mini-lumbotomy was added in thoracolumbar levels. Tethering cord was advanced transdiaphragmatically and tensioned appropriately. 21 patients underwent unilateral instrumentation, while 3 patients with double curves underwent bilateral tethering from the convex side of both double curves. Post-operatively, a mean first erect major curve magnitude of 16 degrees was acquired, while the mean major curve magnitude at the last follow-up was detected as 10 degrees. One patient was diagnosed chylothorax immediate post-operatively and treated conservatively, while no other major complications were acquired. A TLSO brace was used for six weeks post-operatively to achieve union at the screw bone interface.

Discussion and conclusion: Anterior VBT as a growth modulating treatment option by allowing the correction of the scoliotic deformity and restoring the coronal balance without the disruption of sagittal balance is a safe and effective option for the surgical treatment of AIS in skeletally immature patients. VBT also allows the preservation of motion of spinal segments yielding to return sports at the same pre-operative level. It has been shown that anterior VBT was able to yield excellent clinical and radiographic results without causing any major complications.

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none.

Trauma, Tumor

QF61

ASSOCIATION OF CRANIAL AND UPPER CERVICAL BONY AVULSION FRACTURES WITH TRAUMATIC CRANIOCERVICAL DISSOCIATION

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Background/context: Craniocervical dissociation is an uncommon traumatic injury that can be frequently missed. Though several imaging modalities have been proposed to this injury including radiological parameters, tomography parameters, magnetic resonance parameters and dynamic traction tests, diagnosis is still a challenge. Craniocervical dissociations is the result of failures of the ligamentous stability in the upper cervical spine and bony avulsions may represent incompetence of these ligamentous structures.

The aim of our study is to identify the rate of bony avulsion fractures - type III occipito-condyle fractures, type I C2 dens fractures, and

clivus avulsion fractures - on the cervical spine tomography (CT) in patients with craniocervical dissociation. Recognition of these rates may raise suspicion for the presence craniocervical dissociation.
Methods: After institutional review board approval, we identified the patients treated for craniocervical dissociations from our spine trauma registry using CPT codes and ICD codes between October 2003 and October 2018. Patients were included in our study if they had CT upon admission. Electronic medical records were retrospectively reviewed to collect demographic data: age, gender and mechanism of injury. Cervical spine CTs were reviewed to assess for type III occipito-condyle fractures, type I C2 dens fractures, and clivus avulsion fractures. The overall incidences of each type of fracture were calculated.
Results: Our study cohort included 55 patients with traumatic craniocervical dissociation who were surgically stabilized with instrumentation during the study period. There were 35 males and 20 females. The mean age was 36 years (range 10–80 years) and the mechanism of injury involved high energy trauma (motor vehicle crash, motor circle crash, pedestrian hit by car, fall from height) in 54 patients and low energy (ground level fall) in one patient. Atlanto-occipital dissociation was found in 7 patients, atlantoaxial dissociation in 4 patients and both injuries in 44 patients. The incidence of type III occipito-condyle fractures was 60% (33/55 patients). These were unilateral in 26 patients and bilateral in 7 patients. The incidence of type I C2 dens fractures was 7.3% (4/55 patients), and the incidence of avulsion fractures of the clivus was 5.5% (3/55 patients) in patients with traumatic craniocervical.
Conclusions: Craniocervical dissociations are rare injuries that can be difficult to identify, and the delay of the diagnosis has catastrophic results. There was a greater incidence of type III occipito-condyle fractures as compared to other avulsion injuries in the upper cervical region. Identification of these injuries on CT should raise suspicion for the presence of craniocervical dissociations.
Disclosures: author 1: other financial report: Globus; author 2: none, author 3: none, author 4: none.

QF62

LENGTH OF SURVIVAL, PAIN, DISABILITY AND QUALITY OF LIFE FOLLOWING CONSERVATIVE MANAGEMENT OF TYPE II ODONTOID FRACTURES IN OLDER PEOPLE: A RETROSPECTIVE OBSERVATIONAL STUDY

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Type II Odontoid fractures are the most common cervical spine fractures in older people. Lower rates of osseous union is reported in those treated conservatively compared to surgically however the clinical relevance of the non-union is unknown.
Aims: To compare length of survival, pain and disability in older people following conservative management of type II odontoid fractures demonstrating osseous union and established non-unions.
Method: Electronic records were searched from 2008 to 2018 for adults $\geq$ 65 years with type-II odontoid fracture, managed with a hard collar at a single tertiary London Hospital. Patients with concurrent unstable cervical fractures; pathological fractures; rheumatoid arthritis or Ankylosing Spondylitis were excluded. Clinical and demographic data was retrieved from electronic patient notes. All surviving patients were invited to complete self-reported questionnaires to assess pain (Numerical Rating Scale 0–10; 10 = worst pain imaginable), disability (Neck Disability Index; 0–50, higher score = greater disability: Myelopathic Disability Index; 0-30, higher score = greater disability) and quality of life (EuroQoL-5D-5L; index range from $-$ 0.59 to 1, with 1 indicating full health and self-rated health on a Visual Analogue Scale 0–100, 100 = the best health you can imagine). Results were analysed using t tests or Wilcoxon Kruskal–Wallis (significance $p < 0.05$).
Results: 125 patients (76 female; 49 male) were identified. 36(29%) demonstrated osseous union and 89(71%) had established non-union. Median age at fracture 84 years (osseous union 83 years; non-union 85 years). There was no statistically significant difference in demographics at baseline except for gender. 53 had deceased (41 non-union). Median length of survival (months): 59 (59 osseous union; 55 non-union). Age and sex demonstrated a statistically significant effect on estimated length of survival ($p < 0.001$ and $p = 0.007$ respectively). After adjusting for group differences in gender there were no statistically significant difference in estimated length of survival between the osseous union and non-union groups. No patient developed myelopathy due to instability or sustained traumatic spinal cord injury during the follow up period. Questionnaire response rate was 39(54%). See Table 1 for questionnaire results. There were no statistically significant differences between the osseous union and non-union groups in pain, disability or quality of life ($p > 0.05$). Both groups reported mild disability and pain however lower quality of life and health status than population norms.
Conclusion: Conservative management with a hard collar in older people with type II odontoid fracture is associated with low levels of pain and disability with no statistically significant differences between those demonstrating osseous union or established non-unions. Conservative management is a safe treatment for older people with type II fractures.

Group	n	Age at injury	Age at follow-up	Males	BMI	NDI	MDI	EQ5D index	EQ5D VAS	Pain NRS
All	125	83	88	65 (42%)						
Non-union	89	85	90	40 (45%)						
Osseous union	36	83	88.5	9 (25%)						
Questionnaire responders	39	81	84	24 (42%)	24	11	5	0.648	62.5	1
Non-union	26	82	84	10 (38%)	24.95	13	8	0.5895	57.5	2.5
Osseous union	13	80	84	3 (23%)	22.24	5	3	0.678	70	1
P value						.250	.060	.104	.377	.330

Table 1. Demographics (median age in years) and median scores for questionnaire results. BMI: Body Mass Index; NDI: Neck Disability Index; MDI: Myelopathic Disability Index; EQ5D: Euroqol 5D-5L; NRS: Numerical Rating Scale

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none.

QF63

MORTALITY FROM COMBINED FRACTURES OF ATLAS (C1) AND AXIS (C2) IN ADULTS

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Background: The mortality from axis (C2) and peg fractures is well documented in the literature. However, combined fractures of the atlas (C1) and axis are seldom reported, leading to relatively unknown outcomes and mortality. Several small case studies have suggested that combined fractures have increased morbidity and mortality.

Objectives: Our aim was to compare the mortality following combined fractures of atlas and axis to that of isolated fractures of either cervical vertebrae.
Study design and methods: We performed a retrospective case review of all upper cervical spine fractures diagnosed by CT imaging between 01/01/2013 and 31/12/2015 in NHS Greater Glasgow and Clyde, Scotland. This health board serves a population of 1.2 million. We identified 171 patients with atlas and/or axis fractures. Thirty-three presented with concurrent lower cervical spine fractures and were subsequently excluded from our analysis. Kaplan–Meier curves were used to analyse survivorship between 108 patients with isolated and 30 with combined fractures. Similar analysis adjusted for comorbidities including dementia and previous fragility fractures.
Results: Patients were followed up for 47.3 ± 10.3 months (SD). Patients with combined fractures were significantly older than patients with isolated fractures (p = 0.011). Nearly half (8/17) of combined fracture mortalities occurred within the first 120 days. The mortality at 120 days was 26.7% (8/30) for the combined fractures group and 18.5% (20/108) for the isolated fracture group. To allow context, the Scottish 120-day mortality following a hip fracture is 16%. There was no statistically significant difference in the 120-day and overall mortality between these injury patterns. Furthermore, cognitive impairment and previous fragility fractures bore no significant impact on mortality. Nevertheless, mortality in the combined fracture group with previous fragility fractures did trend to shorter survivorship.
Conclusions: Patients with combined fractures of atlas and axis are older and with the ever increasing elderly population, the incidence of these injuries is expected to rise. While our data shows that the 120-day mortality is proportionally higher in the combined fractures group, no long-term statistically significant difference is demonstrated. This evidence contests the notion that combined fractures of atlas and axis have a higher mortality than isolated injuries of either cervical vertebrae.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none.

QF64

AIRBAG DEPLOYMENT AND CERVICAL SPINE INJURY IN RESTRAINED DRIVERS FOLLOWING MOTOR VEHICLE COLLISIONS

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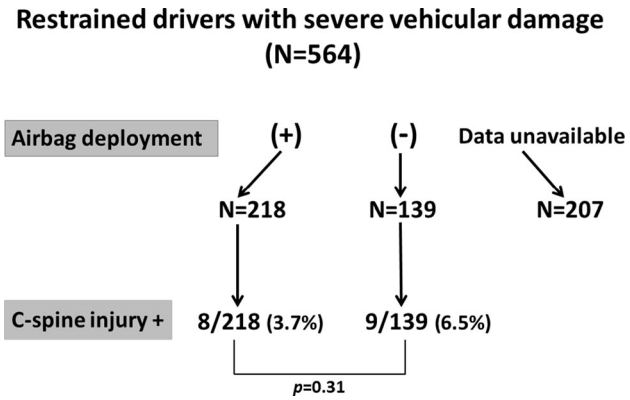
Purpose: Seatbelts and airbags are the most important devices protecting drivers from cervical spine injury (CSI) following motor vehicle collisions (MVCs). However, there have been few reports on the radiographic characteristics of CSI sustained by restrained, airbag-deployed drivers.
Method: A single-center, retrospective observational study was conducted using prospectively acquired data. Between January 2011 and December 2017, 564 restrained drivers, whose vehicle had been severely damaged in MVCs, underwent whole-body computed tomography for evaluation of bodily injuries. The drivers were dichotomized into airbag (+) group (n = 218) and airbag (−) group (n = 139), after excluding 207 drivers in whom airbag deployment status was unknown.
Results: Eight and nine drivers sustained CSIs in the airbag (+) and airbag (−) group, respectively. The frequency of CSI did not differ significantly between the two groups (3.7 vs. 6.5%, p = 0.31). All 8 CSIs in the airbag (+) group were classified as hyperextension injuries, and four of them sustained concomitant spinal cord injuries caused by dislocation. Within the airbag (+) group, the drivers with CSIs were significantly older than those without CSIs (65.2 ± 18.5 vs. 44.8 ± 18.7 years, p = 0.002).
Conclusion: Although it is without doubt that the combination of seatbelt and airbag reduces the frequency and severity of CSIs following MVCs, the CSIs sustained in restrained, airbag (+) drivers may not always be mild, and elderly drivers may be at an elevated risk of CSI. In addition, the possibility of a causal role of airbags in CSI requires consideration in this population.



Disclosures: author 1: none.

QF65

DO WE NEED AN MRI IN PATIENTS WITH ANKYLOSING SPINAL DISORDERS AND ACUTE TRAUMA OR IS A CT SCAN SUFFICIENT?

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Background: Ankylosing spinal disorder (ASD) patients are at a greater risk for spinal fractures due to osteoporosis and rigidity of the spinal column. Many propose that an MRI is mandatory in addition to a CT in ASD patients to identify fractures, ligamentous injury, and cord signal abnormalities.
Purpose: The purpose of our study was to assess the frequency with which an MRI identified an injury not previously identified on CT, and whether this affected the management and outcome of the patient. Secondarily, we attempted to identify particularly concerning radiographic features on CT or clinical findings in which an MRI may be particularly useful.
Methods: After obtaining IRB approval, a retrospective assessment of the radiology database at a level I institution was undertaken from 2005 to 2015 to identify patients with ASD who sustained an acute fracture. Patients were included if they had a CT and MRI upon admission. Final radiology reports were assessed to determine presence and type of fracture(s) from CT. MRI report was then reviewed to assess if additional fractures or injuries were identified beyond that already known from the CT. Neurologic status upon admission, mode

of injury, type of fracture and final intervention was determined by inpatient notes and/or operative reports.
Results: In the designated time frame, 124 patients were identified that had an ASD with a fracture and both a baseline CT and MRI. Six patients (4.8%) had additional injuries on MRI that had not been identified on CT. Four of these six patients had a change in treatment plan (three operative and one non-operative) based off of subsequent MRI findings. These included a (1) C4-5 hyperextension injury, (2) C6-7 hyperextension injury, (3) C7 bony fracture with C5-T4 epidural hematoma, and (4) C5-C6 hyperextension injury treated in a brace. Two of the six patients that had additional injuries identified on MRI but had no change in their treatment plan. One patient had an additional lumbar extension injury noted above a previously identified injury on CT, which was managed in the original TLSO plan. The last patient had a known odontoid fracture but also was noted to have C3-C4 and C6-C7 hyperextension injuries as well as C2 cord transection who died due with no treatment.
Conclusions: In this study, 3.2% (4/124) of patients with ASD who presented to a level I trauma center with an acute injury had treatment plans that changed based off of the MRI. Only one fracture was missed and the remaining findings were all related to disco-ligamentous injuries with hyperextension injuries though mobile discs or intra-canal pathology. Our recommendation is that MRIs should not be obtained in all ASD patients, rather only in patients with non-ankylosed levels in which a disco-ligamentous injury is suspected or in patients with neurological deficits that require investigation of the spinal canal to assess causes of neurological injury.
Disclosures: author 1: other financial report: Globus; author 2: none, author 3: none, author 4: none, author 5: none.

QF66

ACUTE PHASE MEAN ARTERIAL BLOOD PRESSURE CORRELATES TO LONG-TERM TRAUMATIC SPINAL CORD INJURY SEVERITY

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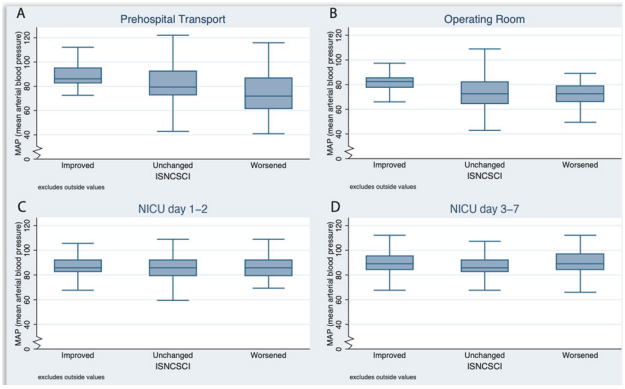
Background: Patients with traumatic spinal cord trauma (TSCI) are at risk of developing neurogenic shock causing hypotension and thereby secondary injury to the spinal cord due to ischemia. Hemodynamic treatment of patients with acute TSCI remains inadequately elucidated. Guidelines for management are based on limited evidence, especially in the acute phase as no earlier studies evaluated the impact of MAP during the prehospital transport or the impact during operation.
Objective: To evaluate if mean arterial blood pressure (MAP) during the acute and initial hospital phase of TSCI is correlated to long-term neurological outcome.
Method: Retrospective cohort study based on the Western Denmark SCI Database and file review on data collected during the prehospital transport, operation and the first 7 days after trauma in Hospital from patients with TSCI 2010–2017. Data were analysed using Spearman's rank correlation to evaluate any correlation between MAP and change in ISNCSCI score one-year post-trauma. In the analysis MAP target value was 80 mmHg. Statistically significant differences were evaluated by Spearman's rank correlation coefficient (ρ).
Results: 129 patients were included. For the prehospital transport Spearman's rank correlation coefficient was $\rho = 0.5662$ ($p < 0.001$), in the OR data $\rho = 0.6818$, ($p < 0.001$), in the Neuro-intensive care unit data $\rho = 0.4611$ ($p < 0.001$), and $\rho = 0.2209$ ($p = 0.0681$) for neuro intensive care unit day 1–2 and neuro intensive care unit day 3–7, respectively.
Conclusion: Continuous MAP levels > 80 mmHg have significant impact for neurological outcome from the earliest measurements possible close to initial trauma, through hospital admission, surgical phase and into the first two days at the NICU. Suspecting a SCI, avoidance of hypotension until final diagnoses is made seems reasonable, and after diagnosis MAP > 80 mm Hg is encouraged as soon as possible and through the acute SCI phase.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: grants/research support: Central Denmark Region; The Danish Ministry of Health.

QF67

EPIDURAL ELECTRICAL STIMULATION IN PATIENTS IN CHRONIC SPINAL CORD INJURY

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Rehabilitation of patients in chronic spinal cord injury (CSI) is limited due to the low efficiency of the applied techniques. Epidural electrostimulation is a method of modulating the spinal network of interneurons and, therefore, moto-neurons is (Quevedo et al., 2005; Berg et al., 2007; Yarom and Hounsgaard, 2011).
Purpose of the study: based on the results of treatment, to justify the application of the course epidural electrostimulation technique in the program of rehabilitation of patients in chronic CSI.
Materials and methods: to assess the results of treatment of 158 patients in chronic CSI we used the ASIA scale, Spinal Cord Independence Measure (CSIM), 10-meter Walk test, VAS, Beck Depression Inventory (BDI). For the analysis of the data we used static methods. The study was performed in accordance with the requirements of the 1957 Helsinki Declaration (revised in 1983). Epidural electrostimulation was conducted by courses: 2 courses with an interval of 3–4 months—test ones, if efficiency criteria were present—repeated 3 courses with an interval of 6 months. The rehabilitation program included locomotor training.

Results: The average age of patients was 35.0 ± 8.6 years. Most of the patients were male—70%. In 25% of patients, the period after injury was 1–2 years, in 75%—more than 2 years. Distribution according to the level of spinal injury: cervical—26%, thoracic—41%, lumbar—33% of cases. The distribution of neurological disorders by the ASIA scale: type A—6% of patients, type B—56%, type C—28%, type D—10% of cases. The mean value of depression was 9.5 ± 1.8, which indicates a low general depressive background in the patients. In 26% of patients, only test stimulations were performed, in 74%—the full stimulation program.

In patients with cervical spine injury, the functional status (CSIM) was on average 20 points before treatment, and 42 points after the course of treatment. In patients with injuries of the thoracic and lumbar spine—40 points and 62, respectively. In all patients with damage type C and D, we observed an increase in the speed of movement by 27.3% in the Walk test. The greatest clinical effect was obseved in patients with type C and D according to the ASIA scale with damage at the level of the thoracic and lumbar spine.

The efficiency criteria for the applied methods of treatment were determined: an objective change of the neurological status by the ASIA scale; functional changes according to SCIM questionnaire or 10-m Walk test, decrease of pain; subjective changes: decrease of the level and nature of sensitivity disorders, decrease of spasticity, changes in the function of the pelvic organs.

Periodic admission to hospital, treatment and dynamic observation is a favorable factor for psycho-emotional status.

Using a course of epidural electrostimulation for the purpose of activating supra-spinal compounds is a method of choice in complex rehabilitation programs for patients in chronic CSI.

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none.

QF68

THE EFFECT OF SAGITTAL MALALIGNMENT ON THE CLINICAL OUTCOME FOLLOWING CONSERVATIVE TREATMENT OF THE AO A3 AND A4 THORACOLUMBAR SPINE FRACTURE IN COMPARISON TO A1 FRACTURES. A RETROSPECTIVE STUDY

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Introduction: Burst thoracolumbar spine fracture accounts for approximately 45% of all major thoracolumbar trauma. The resulting kyphotic deformation with its long-term sequelae may be associated with sagittal malalignment, which leads to reduced life quality of the patients. The goal of this study was to determine the degree of patients' disability as well as the degree of local and global sagittal malalignment following the conservative treatment of neurologically intact patients with AO A3 and A4 thoracolumbar (TL) spine fractures in comparison to patients with AO A1 TL fractures.

Materials and methods: This retrospective study included 3 groups of patients with AO A4, A3, and A1 TL fracture. All patients included were treated conservatively without bracing or casting. The whole spine lateral radiographies, obtained in standardized standing position at the final follow up, were investigated for segmental kyphotic angle (SKA), regional lordotic angle (RLA), lordosis gap (LG), pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), sagittal vertical axis (SVA), lumbar lordosis (LL), thoracic kyphosis (TK), and femoral obliquity angle (FOA). The radiologic data were correlated with the clinical outcome that was assessed using the Oswestry disability index (ODI). Data were analyzed using descriptive statistics, non-parametric inferential statistics, and Spearman correlation analyses.

Results: In the A4 group (female n = 4, male n = 1, median age was 70 years), the A3 group (female n = 4, male n = 7, median age was 57.5 years) groups, the A1 group (female n11, male n = 6, median age was 49 years) groups the age was significantly higher in A4 group than in A1 group (p = 0.04). The median 1ry SKA of the A3 group (15/3) was significantly higher than in A1 group (7/7, p = 0.04). The median of total ODI in the A4 group (42/53) and A3 group (31.3/27) was clinically higher than in A1 group (11.1/25), however, this difference was not statistically significant. Age as well as SVA correlated significantly with PT, FOA, SKA at the follow up, and the total ODI.

Conclusion: Age of the patient is a significant confounder that has an important impact on the type of fracture, sagittal malalignment (increasing SVA), and the compensatory mechanisms (increasing PT) that are related to the increasing SKA. All these may be associated with worse clinical outcome following conservative treatment of AO A4 and A3 TL fracture.

Disclosures: author 1: none, author 2: none, author 3: none.

QF69

PERCUTANEOUS CT GUIDED CANNULATED SCREWS IN THE TREATMENT OF TRAUMATIC SACROILIAC UNSTABLE JOINT: OUTCOMES AT 5 YEARS OF FOLLOW UP

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Introduction: The treatment of the sacroiliac joint (SIJ) vertical instability is matter of current discussions and remains controversial. The aim of our study is the evaluation of the surgical management of SIJ vertical instability involving the use of cannulated screws introduced under CT guidance and local anesthesia.

Materials and methods: In the set time-frame of 7 years 96 politrauma patients with Tile's type C fracture of the pelvis with vertical instability of the SIJ were treated. All patients received an anterior stabilization and subsequent stabilization with cannulated screws (Asnis® Stryker® 6 mm, an average length of 70 mm range from 55 mm to 85 mm range) of the sacroiliac fracture.

Results: The average distance between the two stumps was 73.4 mm (range 43 mm -100 mm). The clinical and radiological follow-up was performed with follow up plain radiograph and Majeed score (from 1 to 60 months after injury). The consolidation of pelvic fractures was obtained after an average of 63 days. The average Majeed score was: 96 points at 1 month, 84 points at 3 months, 62 points at 6 months, 44 points at 12 months, 42 points at 24 months, 32 points at 36 months, 28 points at 48 months, 28 points at 60 months. Complications were: not fatal deep vein thrombosis in 5 cases, skin infection at the entry point of the screws in 6 cases, screw breakage in 1 case and loosening of the screws in 1 case.

Conclusions: Our results suggest that the stabilization of SI Tile type C fracture/dislocations with CT-guided percutaneous cannulated screws is a valid and feasible management option and associated with a low complication rate. Our data confirm and are in keeping with those present in the international literature.

Time in months after the surgery	Majeed Score in points (range)
1 month	96 (94 points-100points)
3 months	84 (78 points-92 points)
6 months	62 (56 points- 78 points)
12 months	44 (34 points-64 points)
24 months	42(28 points-64 points)
36 months	32 (24 points-54 points)
48 months	28 (24 points -54 points)
60 months	28 (24 points -54 points)

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none.

QF70

EARLY VERSUS DELAYED KYPHOPLASTY FOR THORACOLUMBAR OSTEOPOROTIC VERTEBRAL FRACTURES: THE EFFECT OF TIMING ON CLINICAL AND RADIOGRAPHIC OUTCOMES AND SUBSEQUENT COMPRESSION FRACTURES

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Objective: Osteoporotic vertebral body fractures (OVFs) represent a significant medical and socioeconomic burden. There is ongoing debate concerning the role of cement augmentation versus conservative management, but we are increasingly recognizing the longer-term effects of kyphotic vertebral alignment on functional outcomes, pain, and subsequent fracture rates. The purpose of this study was to determine the effect of timing of intervention with percutaneous balloon kyphoplasty (BKP) for OVF on clinical and radiographic outcomes.
Patients and methods: 51 patients (mean age, 75.5 years) who underwent BKP for OVF were analyzed. Patients were divided into two groups based on timing of BKP: early (< 4 weeks) or late (> 4 weeks). Multiple factors were assessed preoperatively and throughout follow up and compared between groups using bivariate testing, including: focal kyphosis, subsequent vertebral fracture, and low back pain.
Results: This was a retrospective sub-group analysis. There were 32 patients in the early group and 19 patients in the late group. There was no significant difference in preoperative bone density between groups. Mean follow-up was 1.2 years. Local kyphosis at final follow-up was significantly greater in the late group ($-28.4°$) than in the early group ($-9.5°$; $p < 0.001$). There was no significant difference in local kyphosis between preoperative measurement and final follow-up in the early ($p = 0.741$) or late cohort ($p = 0.794$). Patients treated with early BKP demonstrated significantly better LBP scores ($p < 0.05$) and a lower rate of subsequent vertebral fracture ($p < 0.05$).
Conclusion: BKP is able to prevent progressive collapse and kyphosis after OVF, but not effectively restore alignment, and as a result, patients who undergo early BKP (< 4 weeks) demonstrate better alignment, better LBP scores, and reduced rates of subsequent fracture at an average of 1.2 years following treatment.

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none, author 9: none, author 10: stock/shareholder: Founder - Microendoscopic Spine Institute.

QF71

DOES THE MANAGEMENT OF SPINAL METASTATIC DISEASE IMPACT OUTCOMES FOR "INDETERMINATE" SPINAL INSTABILITY (SINS 7-12)?

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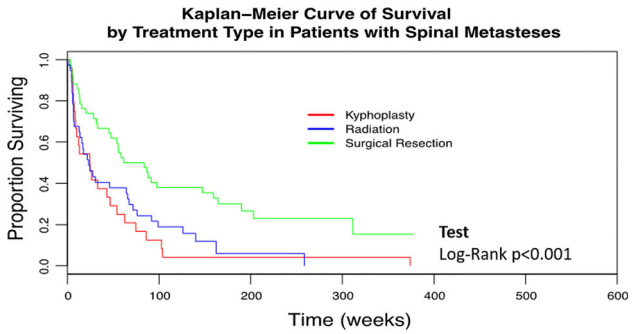
Background: The management of spinal metastatic disease has evolved with the development of improved radiotherapy and surgical techniques. Surgical decompression and stabilization are indicated for patients with progressive neurologic compromise or spinal instability. The Spinal Instability Neoplastic Score (SINS) is used to classify spinal instability in the setting of metastatic disease. Stable spines (SINS 0-6) do not require surgical stabilization and unstable spines (SINS > 12) require surgery. However, the best treatment modality for neurologically intact patients with indeterminate instability (SINS 7-12) remains unclear. The purpose of this study was to compare length of survival (LOS), length of ambulatory ability (LOA), and revision treatment rates in patients with metastatic disease of indeterminate instability treated by three different techniques.
Methods: We reviewed our institution's medical record for neurologically intact patients treated for spinal metastatic disease with a SINS of 7–12 from 2012 to 2016. All patients had the ability to ambulate prior to surgery. The cohort was stratified by treatment approach: external beam radiation alone (EBRT), surgery ± EBRT (S + E), and kyphoplasty ± EBRT (K + E).
Results: 104 cases were included in our analysis (EBRT n = 38; S + E n = 42; K + E n = 24). The S + E group was significantly younger ($p < 0.001$). The average SINS of the S + E group was 9.4, which was statistically greater than the EBRT group (SINS 8.6) and the K + E group (SINS 8.2) ($p < 0.001$). The one-year survival of the S + E group was 61.9% compared to 39.5% in the EBRT group and 29.2% in the K + E group. 90.5% of the S + E patients and 91.7% of the K + E patients were ambulatory at their last follow up or time of death compared to 65.7% of the EBRT patients. In univariate analysis the S + E group had improved LOS ($p = 0.002$) and LOA ($p = 0.003$). In the multivariate analysis the S + E group was associated with improved LOA (HR 0.55, $p = 0.04$). Additionally, the Tokuhashi score was significantly associated with improved LOS (HR 0.84, $p < 0.001$) and LOA (HR 0.85, $p < 0.001$). The EBRT group had a revision treatment rate of 26.3%, which was significantly greater than the S + E group (11.9%) and the K + E group (4.2%).
Conclusion: Surgical treatment of spinal metastatic disease with indeterminate spinal instability is associated with longer LOA. Tokuhashi scores were predictive of both longer LOS and LOA. The revision treatment rate was greater in the EBRT group compared to the S + E and K + E groups. Surgical management in this patient population should be considered; however, the patient's prognosis for survival (Tokuhashi score) needs to be considered when developing the management plan.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: grants/research support: Received grants from the Burroughs Wellcome Fund, North Carolina Spine Society, and the NIH/NINDS K12 NRCDP Physician Scientist Award, Robert Wood Johnson Harold Amos Medical Faculty Development Program.; author 6: consultant: Globus Medical; DePuy-Synthes.

QF72

METASTASIC SPINAL CORD COMPRESSION. ANALYSIS OF 52 CASES SURGICALLY TREATED ACCORDING TO RADES AND SINS SCORES

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Introduction: Metastasic spinal cord compression (MSCC) is a growing pathology. Several prognostic scores have been developed to properly select candidate patients for surgery. The RADES score has demonstrated to be an accurate instrument to predict survival in MSCC patients treated with radiotherapy. The SINS classification is also a useful score to decide surgical patients according to spinal instability.
Purpose of the study: To analyse if the combination of the RADES and SINS scores is useful in the treatment algorithm for MSCC at our institution, regarding survival rates at 6 months in surgical patients.
Materials and methods: 52 consecutive patients with MSCC treated surgically were collected since January 2014 to December 2018. Patients with RADES score II or III group, and SINS score above 6 points (potentially unstable or unstable), were selected as surgery candidates. Patients in RADES group I but without known primary tumor and rapid neurological deterioration, or patients considered resistant to other treatment modalities by oncologists, were also considered to surgery. Demographical data, primary tumor histology, degree of neurological impairment (ASIA score), type if surgery (MISS techniques, open surgery, decompression alone or vertebrectomy) and complications were also collected. A minimum of 6 months follow-up was required to analyse survival, neurological status and local control of the disease.
Results: The mean age was 57.9 yo and 67.3% of the patients were males. The most common histology were lung cancer and multiple myeloma/plasmocytoma with 10 cases each. RADES I group were 11 patients, 23 in group II and 16 group III. SINS score was beetwen 7 to 12 in 30 cases, and above 12 in 22 cases. 25% of patients were non-ambulatory patients (ASIA A, B or C). The survival rate at 6 months was 45.5% in RADES I group, 75% en group II and 76.9% in group III. Regarding RADES group I, 4 of 5 patients with MSCC as presentation of cancer disease, were alive after 6 months; however the 100% of patients with an already treated cancer disease, considered to surgery although being in RADES I group, died in less than 6 months. The complication rate was 15,38% (4 surgical, 4 medical). No complication was reported in MISS treated patients.
Conclusion: The RADES score seems to be effective in predicting survival at 6 months in surgically treated MSCC patients. The RADES score may underestimate survival rate in MSCC patients as initial presentation of cancer disease.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none.

QF73

MINIMAL ACCESS VS. OPEN SPINE SURGERY IN PATIENTS WITH METASTATIC SPINAL CORD COMPRESSION - A ONE-CENTER RANDOMIZED CONTROLLED TRIAL

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Background/introduction: Minimally Access Spine Surgery (MASS) is considered less morbid than Open Surgery (OS). Based on this one-center randomized controlled trial, we did not find MASS technique in MSCC patients to be less morbid or with less complications but associated with a lower blood loss and a longer operation time when compared to the OS technique.
Purpose of the study: To examine the feasibility and efficacy of MASS versus OS.
Materials and methods: During 2014 to 2017 a total of 49 MSCC patients were included with a minimum of 18 months follow up. Patients with MSCC between T5 to L3 where included. Patients with Tokuhashi score ≤ 4, in need of sacral or iliosacral instrumentation, and patients who were candidates for a corpectomi were excluded. All patients were operated with posterior pedicle screw instrumentation two levels above and two levels below the metastatic level. In the MASS-group decompression was done through a localized incision at the metastatic level. The outcome measures were bleeding (L), operation time (min) and reoperations. Mann–Whitney tests and Cox regression were used to compare the groups. A p-value < 0.05 was considered statistically significant.
Results: The median age was 67 years (range 42–85) and 40% were men. The peri-operative blood loss in the MASS-group was significantly lower than in the OS-group; 0.175L vs. 0.500L, ($p = 0.002$). The median operation time for MASS was 142 min (range 72–203) vs. 103 (range 59–435) for OS, ($p = 0.001$). There were two revisions in each group, ($p = 0.899$). Furthermore, there was no significant difference between MASS and OS with regards to mean survival 638 vs. 461 days ($p = 0.133$) or median 2017 Revised Tokuhashi score 8.0 (range 4–12) vs. 7.6 (range 3-12), ($p = 0.650$).
Conclusion: Based on this randomized clinical trial, we conclude that using the MASS technique in MSCC patients is associated with a lower blood loss, but a longer operation time when compared to the OS technique. Further and larger studies may reveal whether the MASS technique is associated with a longer survival time than the OS.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: grants/research support: K2M and Medtronic; author 6: consultant: K2M.

QF74

EPIDEMIOLOGIC AND SURVIVAL TRENDS IN PRIMARY BONE TUMORS OF THE MOBILE SPINE

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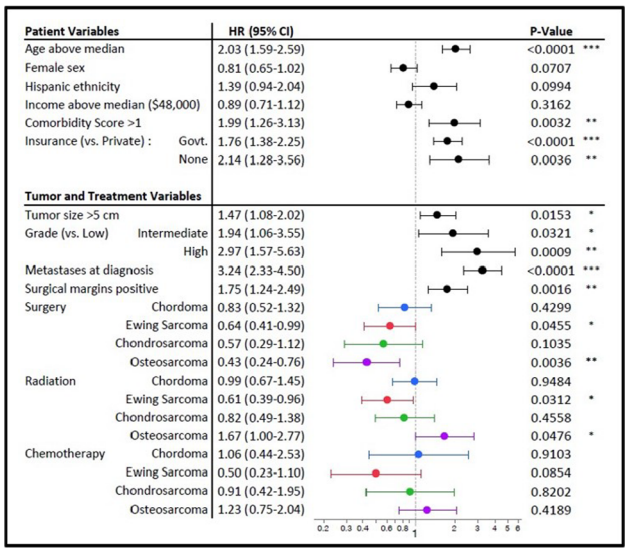
Background: Malignant primary spinal tumors are rare tumors making it difficult to perform large studies comparing epidemiologic, survival, and treatment trends. We investigated the largest registry of primary bone tumors, the national cancer database (NCDB), to compare epidemiologic and survival trends between these tumors.
Objective: To utilize the NCDB to describe current epidemiologic trends, treatment modalities, and overall survival rates in patients with chordomas, osteosarcomas, chondrosarcomas, and Ewing's sarcomas of the mobile spine. The secondary objective was to determine prognostic factors that impact overall survival rates for these tumors.
Methods: Reviewed 1011 patients in the NCDB from 2004 through 2015 with histologically confirmed primary osteosarcoma, chondrosarcoma, Ewing's sarcoma, or chordoma of the spine. Demographic, clinical, and outcomes data were compiled and compared using Chi Squared tests and ANOVA. Long term survival was compared using the Kaplan–Meier (KM) method with statistical comparisons based on the log-rank test. Multivariate analysis was performed to determine survival determinants.
Results: Surgical resection was the primary mode of treatment for chondrosarcoma (90%), chordoma (84%), and osteosarcoma (80%). The treatment for Ewing's sarcoma was multimodal involving chemotherapy, radiation therapy, and surgical resection. 5-year survival rates varied significantly between tumor types with chordomas and chondrosarcomas having the greatest survival (70% and 69%) and osteosarcomas having the worse survival (38%), and Ewing's with intermediate 5-year survival at 62% (overall log-rank $p < 0.0001$). Multivariate analysis demonstrated significantly improved 5-year survival rates with younger age at diagnosis, private insurance status, lower comorbidity score, tumor grade, tumor size, surgical resection, and negative surgical margin. Radiation therapy only improved survival for Ewing's sarcoma.
Discussion and conclusion: This study provides the first investigation of primary malignant bone tumors of the mobile spine, and provides the most comprehensive description of the epidemiologic, treatment, and survival trends in these tumors. Secondly, patient and tumor characteristics associated with improved 5-year survival were identified utilizing a multivariate model.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: consultant: Globus Medical, DePuy-Synthes.

QF75

SURVIVAL OUTCOMES AND PROGNOSTIC FACTORS OF PATIENTS WITH INTRAMEDULLARY GRADE II EPENDYMOMAS AFTER SURGICAL TREATMENTS

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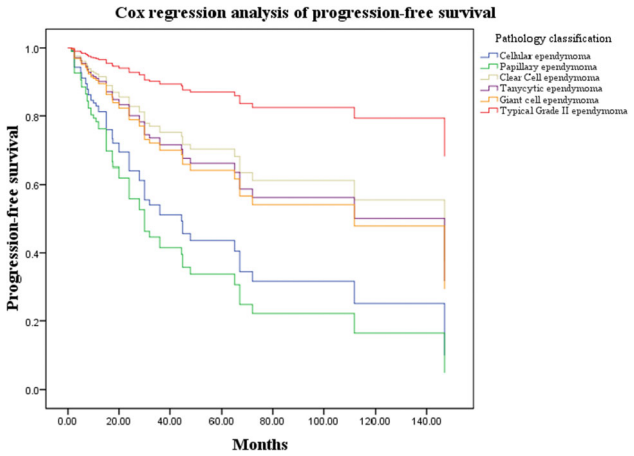
Purpose: This study evaluated survival outcomes of patients with intramedullary Grade II ependymomas and identify prognostic factors.
Methods: The objects were intramedullary Grade II ependymoma according to 2007 WHO classification. Kaplan–Meier survival analysis with log-rank test was used to analyze progressive free survival (PFS) and overall survival (OS). Cox proportional hazard model was utilized for multivariate analysis with hazard ratio (HR) and 95% confidence interval (CI) calculated. P values < 0.05 were considered statistically significant.
Results: A total of 138 cases of intramedullary Grade II ependymomas were retrieved. Results of Kaplan–Meier analysis and univariate Cox regression analysis showed that PFS was not affected by patients' age, sex, tumor length, treatment methods or chemotherapy. There was also a significant difference in PFS according to histological type ($P < 0.001$). Patients who had cellular or papillary subtype had a shorter estimated value of progression-free time than typical Grade II ependymomas ($P < 0.001$, $P = 0.009$, respectively). In addition, patients who were classified as cellular ependymomas or papillary ependymomas had higher risks of progression than those who possessed typical Grade II ependymomas ($P < 0.001$). Kaplan–Meier analysis further revealed a significant difference in the PFS between groups with or without adjuvant therapy ($P < 0.001$). Patients who were treated with adjuvant therapy had a higher risk of progression than those without adjuvant therapy ($P < 0.001$). The multivariate Cox proportional hazards model for PFS was fitted using the following variables: pathology classification, extent of surgery, adjuvant therapy and Chemotherapy. The results suggested that pathology

classification and adjuvant therapy were independently associated with PFS ($P < 0.001$). The overall survival analysis was not performed on papillary ependymoma, clear cell ependymoma, tanycytic ependymoma, biopsy & decompression, due to the unavailability of survival data. Kaplan–Meier analysis and Cox regression analysis showed that none of age, sex, tumor length, cellular ependymoma, treatment methods or chemotherapy had significant effects on OS. OS of patients with giant cell ependymoma was significantly shorter than those with typical Grade II ependymoma ($P = 0.001$). Giant cell ependymoma patients had a higher risk of fatality than those with typical Grade II ependymoma ($P = 0.009$).

Conclusions: Patients who had cellular or papillary subtype, adjuvant therapy would have a shorter estimated value of progression-free time and a higher risk of progression than typical Grade II ependymomas. Giant cell ependymoma patients would have a higher risk of fatality than those with typical Grade II ependymomas. Definite pathology type and appropriate treatments were foundations of intramedullary Grade II ependymomas' managements.



Disclosures: author 1: none.

Degenerative (cervical), New Techniques, Complications

QF76

INCIDENCE AND ASSOCIATED FACTORS OF NECK PAIN IN PATIENTS WITH DEGENERATIVE CERVICAL MYELOPATHY: RESULTS FROM THE MULTICENTER INTERNATIONAL PROSPECTIVE AOSPINE STUDIES

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Background context: Neck pain is a common complaint in patients with degenerative cervical myelopathy (DCM); yet, there is a paucity of high-quality, prospective studies summarizing the incidence and determinants of neck pain in this patient population.

Purpose: The objectives of this study are to evaluate the incidence and severity of, and factors associated with, neck pain in patients with DCM.

Study design/setting: Ambispective cohort study.

Patient sample: From 2005 to 2011, 757 patients with DCM were enrolled in either the AOSpine CSM-North America or CSM-International study at 16 global sites. All patients were extensively assessed before surgical decompression of the cervical spine. A total of 664 patients had complete neck pain scores and were eligible for inclusion in this study.

Outcome measures: Pain intensity subscore of the Neck Disability Index (NDI).

Methods: As part of the NDI questionnaire, patients were asked to rate their neck pain as none, very mild, moderate, fairly severe, very severe or the worst imaginable. Frequencies and percentages were used to summarize the incidence and severity of neck pain. Patient characteristics and functional assessments (modified Japanese Orthopedic Association score, mJOA) of individuals with and without pain were compared using independent samples t-tests. The association of comorbidities, MRI features, previous treatment, gender, smoking status, and body mass index (BMI) with presence of neck pain was evaluated by univariable logistic regression to derive odds ratios and 95% confidence intervals.

Results: One hundred thirty-eight (20.8%) patients had no neck pain, whereas 526 (79.2%) reported pain. Of these, 134 patients (20.2%) rated their pain as very mild, 185 (27.9%) as moderate, 130 (19.6%) as fairly severe, 64 (9.6%) as very severe and 13 (2.0%) as the worst imaginable. Functional status (mJOA, $p = 0.593$), number of stenotic levels ($p = 0.925$), age ($p = 0.376$), and duration of symptoms ($p = 0.31$) did not significantly differ in patients with and without pain. Female patients (OR 2.12, CI 1.38–3.26, $p = 0.0006$), BMI $\geq$ 27 kg/m2 (OR 1.6, CI 1.08-2.33, $p = 0.017$), rheumatologic (OR 4.84, CI 1.15–20.4, $p = 0.031$) and gastrointestinal (OR 1.93, 1.04–3.57, $p = 0.036$) comorbidities, and age $<$ 57 years (OR 1.75, CI 1.2–2.56, $p = 0.0038$) were associated with presence of neck pain. On the other hand, non-smoker status (OR 1.09, CI 7.1–1.68, $p = 0.675$), immobilization in a soft collar (OR 1.08, CI 0.59–1.97, $p = 0.788$), physiotherapy treatment (OR 1.22, 0.76–1.95, $p = 0.405$) or bed rest (OR 1.25, CI 0.76–2.05, $p = 0.375$) were not associated with absence of pain.

Conclusion: Here, we demonstrate a high incidence of neck pain in patients with DCM, and elucidate a possible link between gender, body weight, comorbidity and age with neck pain. Further studies are needed to assess the effect of surgery on pain, and the impact of neck pain on quality of life in this patient population.

Disclosures: author 1: grants/research support: Swiss National Fund, Balgrist Foundation Zurich; author 2: none, author 3: none, author 4: none, author 5: none, author 6: none.

QF77

SURGICAL OUTCOMES OF DYSPHAGIA PROVOKED BY DIFFUSE IDIOPATHIC SKELETAL HYPEROSTOSIS IN CERVICAL SPINE

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Objective: Diffuse idiopathic skeletal hyperostosis (DISH) related dysphagia is not a common clinical condition that few studies reported the case until now. Surgical resection of anterior osteophytes has been tried, but there is no guideline or analysis for these patients. The goal of this study is to elucidate the clinical improvement after surgical intervention, and to suggest the adequate treatment strategy.

Methods: From 2003 to 2018, 21 patients received surgery diagnosed and DISH related dysphagia in Yonsei University Health System. Radiographic data were gathered through true lateral X-ray or CT, before a surgery, after one month, and the latest follow up. Anterior

osteophyte thickness (AOT) and prevertebral soft tissue thickness (PSVT) were measured in each interverterbral disc level. Clinical dysphagia score was measured through telephone survey and medical chart review, assessed as no (0), mild (1), moderate (2) and severe (3) dysphagia.

Results: The most clinically relevant intervertebral level was identified to C4/5, both in preoperative and postoperative correlation analysis. On the other hand, the most important point to symptom relief was to widening the narrowest soft tissue level, which reflects a prediction of surgical effect. When we divide the group according to prevertebral soft tissue expansion for over twice (200%) or not, the former group showed significant superiority over the latter on Mann–Whitney U test. Therefore, the goal of surgery is to drill the narrowest level so as to secure soft tissue expansion more than twice. Meanwhile, bone drilling only techniques was enough to symptom improvement, while using anterior plate and screw system does not guarantee.

Conclusion: Surgical removal of anterior osteophytes in these patients is an effective solution, while some had recurred or no symptom relief. Prevertebral soft tissue thickness has a good role to predict the severity of dysphagia itself and treatment outcome.

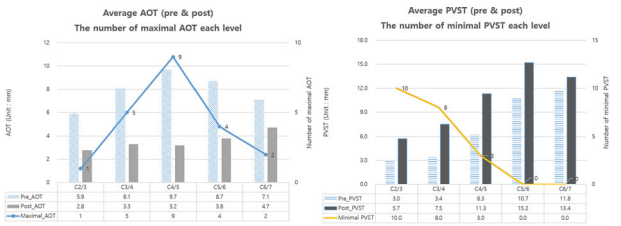

Figure 1.
The average and the number of maximal or minimal AOT (left) and PVST (right) for 21 patients. (Left) Preoperative AOT was the thickest in C4/5 level, both in average thickness (mm) and the number of patients of maximal AOT on that level. The second rods indicate the postoperative AOT on that level after surgery. (Right) Both average preoperative and postoperative PVST for 21 patients are the lowest in C2/3 level. 48% (10/21) showed the minimum value on C2/3, followed by C3/4 (38%, 8/21).

Disclosures: author 1: none, author 2: not indicated; author 3: none, author 4: stock/shareholder: Ant Spine, MEDRICS, Innovasive.

QF78

DEGENERATIVE CERVICAL MYELOPATHY: A SEVEN-LETTER CODING SYSTEM THAT SUPPORTS DECISION MAKING FOR THE SURGICAL APPROACH

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Background/introduction: Several parameters must be considered when deciding the surgical approach for patients with multi-level degenerative cervical myelopathy (mDCM): Patient's clinical findings and wishes, general and bone quality influencing comorbidities, imaging, surgeon's familiarity with specific techniques and some more. To tailor the surgical approach to the needs of a specific patient, we introduced for didactical purpose into the daily practice a coding system, which we termed the seven-letter codë (7LC), because seven parameters are analyzed (Fig. 1).

Purpose of the study: We aimed to validate the 7LC with an international panel of senior and junior spine surgeons. The following questions were investigated: Does the 7LC provide substantial inter- and intra-rater reliability (inter-RR and intra-RR)? Do junior and senior surgeons make different decisions? To what extent does the approach suggested by the 7LC correspond to the surgeon's personal choice? Do play cultural differences any significant role?

Materials and methods: Ten anonymous real cases of mDCM were presented on an internet platform, including clinical and imaging data. A single approach (G1), a choice between two (G2), or three approaches (G3) were options. Senior and junior spine surgeons analyzed seven parameters: location and extension of the compression of the spinal cord; C-spine alignment and instability; general morbidity and bone diseases; K-line and the need of multi-level corpectomy. For each parameter, an anterior, posterior, or combined approach was suggested. The most frequent letter or the last letter (if C) of the resulting seven letter code (7LC) suggested the surgical approach. Each surgeon performed two reads per case within eight weeks.

Results: G1: Inter-rater reliability between junior surgeons improved from the first read ($\kappa = 0.40$) to the second ($\kappa = 0.76$; $p < 0.001$) but did not change between senior surgeons ($\kappa = 0.85$). The intra-rater reliability was similar for junior ($\kappa = 0.78$) and senior ($\kappa = 0.71$) surgeons. G2: Junior/senior surgeons agreed completely (58%/62%), partially (24%/23%), or did not agree (18%/15%) with the 7LC choice. The slightly better agreement of senior surgeons with the 7LC proposal was not significant. G3: junior/senior surgeons agreed completely (50/50%) or partially (50/50%) with the 7LC choice. Cultural differences did not play any role.

Conclusion: The 7LC showed good overall reliability. Junior surgeons went through a learning curve and converged to senior surgeons in the second read. The 7LC helps less experienced surgeons to analyze, in a structured manner, the relevant clinical and imaging parameters influencing the choice of the surgical approach, rather than simply pointing out the only correct one. A free app (https://7LC.org) facilitates the use of the 7LC in the daily practice.

$C_2S_2M_2Cm_1$	7 Letter-code	Appr
Compression 1 Location	Ant → hill type/flat 1-2	A
	→ flat ≥ 3	P
	Post	P
	Comb	P/C
2 Extension	< 3	A
	3	A/P
	> 3	P
Spine 3 Alignment	Lordotic	A/P
	Kyphotic → flex or <10°	A/P
	→ fix or >10°	A/C
(subaxial) 4 Instability	< 6 mm > 6 mm	A/P C
Morbidity 5	≤ ASA 3 > ASA 3	A/P P
6 bone diseases	Relevant osteoporosis, RA, AS	P/C
C – modifier 7	„K-line negative" type of compression Corpectomy ≥ 2 level	C/0

Disclosures: author 1: grants/research support: German Arthrosis Society (Deutsche Arthrose-Hilfe e.V.); author 2: none, author 3: none, author 4: not indicated; author 5: none, author 6: none, author 7: none, author 8: grants/research support: CSRS-E, other financial report: Payed speaker: Depuy, Medtronic; author 9: none, author 10: none; author 11: other financial report: Travel support and reimbursement for presentations by Medtronic, bbraun aesculap, depuy; author 12: royalties: Neon posterior cervical system, Ulrich Medical Germany; author 13: grants/research support, consultant; stock/shareholder; royalties; author 14: none; author 15: none; author 16: none; author 17: none; author 18: none;

QF79

THE SEVERITY OF CERVICAL DISC DEGENERATION DOES NOT IMPACT ON THE IMPROVEMENT AFTER LAMINOPLASTY FOR THE PATIENT WITH CERVICAL SPONDYLOTIC MYELOPATHY

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Background: There are several studies to evaluate the improvement of cervical myelopathy after laminoplasty. However, to the best of our knowledge, there's no study which evaluates the relationship between the severity of cervical disc degeneration (CDD) and the surgical outcomes of laminoplasty for cervical spondylotic myelopathy (CSM) patients.
Purpose: The aims of this study is to evaluate the impact of severity of CDD on 2-year outcomes of laminoplasty.
Material and method: Consecutive 145 patients who underwent open-door laminoplasty for cervical spondylotic myelopathy were enrolled (mean age: 65.6 ± 13.8, male: 56). Cervical discs from C2-3 to C7-T1 were classified into grade0 to grade3 (Grade0: normal, grade3: severest degeneration) based on the previous report. Subsequently, all patients were binarized into mild and severe CDD group according to the average value of their six CDD grades. Preoperative clinical scores (JOA score, visual analog scale (VAS) of upper neck pain, lower neck pain, SF-36 and JOACMEQ) and preoperative radiographic parameters (cSVA, C7slope, C2-C7 angle and range of motion) were compared between two group using Mann–Whitney U test. In addition, we analyzed the differences of improvement after 2-year laminoplasty between two CDD groups using mixed effect model.
Result: In the comparison of preoperative data, age ($p = 0.023$) and VAS of lower neck pain ($p = 0.027$) were significantly higher in severe CDD group ($p = 0.023$, 0.027 respectively). Meanwhile, quality of life (QOL) of JOACMEQ was significantly lower in severe CDD group than mild CDD group ($p = 0.017$). Regarding to the improvement 2-years after surgery, there were no significant difference between severe and mild CDD groups in JOA score, VAS of upper neck pain, lower neck pain, mental and physical component summary of SF-36 and all components of JOACMEQ except for QOL. The change of QOL showed significant differences ($p = 0.017$); there was improvement in severe CDD group (pre-op:36.0, post-op: 47.6) but stable in mild CDD group (pre-op: 46.5, post-op: 49.3). The change of radiographic parameters did not show significant differences between severe and mild CDD groups.
Conclusion: The severity of CDD did not affect the 2-years surgical outcomes of laminoplasty negatively. Even though the preoperative QOL score showed significantly lower in the patients with severe CDD, the QOL score improved postoperatively and the differences dismissed at the 2 years after surgery. Those results can encourage surgeons to perform laminoplasty for CSM patient regardless to the severity of CDD.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none, author 9: none, author 10: none.

QF80

ADJACENT SEGMENT MOTION FOLLOWING NON-SINGLE LEVEL ACDF: A KINEMATIC AND CLINICAL STUDY IN PATIENTS WITH ZERO-PROFILE ANCHORED SPACER OR PLATE

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Background/introduction: Cervical kinematics, especially the range of motion (ROM), after single-level arthrodesis or arthroplasty have been reported in several studies. However, the location of the instantaneous axis of rotation (ICR) and ROM after non-single-level cervical arthrodesis is rarely reported.
Purpose of the study: To investigate the adjacent segment kinematics, including the ICR and ROM, after anterior cervical discectomy and fusion (ACDF), and to compare between ACDF with zero-profile anchored spacer (ACDF-Z) and ACDF with plate (ACDF-P).
Materials and methods: Eighty-seven patients (ACDF-Z = 63; ACDF-P = 24) were included; those with severe neck pain were excluded. Flexion, extension and neutral cervical radiographs were obtained before operation and at 1-year follow-up. The C2-C7 ROM, adjacent segment ROMs, and ICRs were measured. Clinical evaluation was based on the Visual Analogue Scale, Neck Disability Index, and Japanese Orthopaedic Association score.
Results: After ACDF-Z, the location of the superior ICR-X reduced 8% of the vertebral body ($P < 0.001$), and the location of the inferior ICR-Y reduced 17% ($P = 0.02$). After ACDF-P, the location of the superior ICR-X increased 6% of the vertebral body ($P = 0.008$), the location of the inferior ICR-X increased 22% ($P = 0.03$), and the location of the inferior ICR-Y reduced 25% ($P = 0.002$). The C2-C7 ROM significantly decreased after both ACDF-Z ($P < 0.001$) and ACDF-P ($P < 0.001$). Neither ACDF-Z nor ACDF-P significantly affected the adjacent segment ROMs ($P > 0.05$).
Conclusions: Both ACDF-Z and ACDF-P significantly impact cervical kinematics, although both procedures obtain satisfactory clinical results in the treatment of cervical spondylosis. After both ACDF-Z and ACDF-P, the C2-C7 ROM decreased significantly, while adjacent segment ROMs were preserved. ICR is a more sensitive parameter than ROM for detecting of abnormal mobility of the cervical spine. ACDF-Z and ACDF-P impact the location of ICR in diverse ways.

Table 1. Cervical ROMs and ICRs between pre-operation and 1-year follow-up after both ACDF-Z and ACDF-P.

Type (Number of patients)		Pre-operation	1-year Follow-up	*P* Value
ACDF-Z (63)				
ROM, degree,	C2-C7 (63)	50.79±12.88	30.76±8.85	*P*<0.001*
(mean ± SD)	Superior (63)	11.09±3.83	11.38±2.89	*P*=0.54
	Inferior (63)	7.87±3.46	7.98±3.26	*P*=0.74
ICR	Superior X (62)	0.46(0.39~ 0.56)	0.38(0.28~ 0.46)	*P*<0.001*
(median	Superior Y (62)	-0.61(-0.85~ -0.29)	-0.58(-0.77~ -0.31)	*P*=0.37
(IQR))	Inferior X (54)	0.49(0.32~ 0.63)	0.49(0.38~ 0.63)	*P*=0.36
	Inferior Y (54)	0.01(-0.19~ 0.20)	-0.16(-0.45~ 0.01)	*P*=0.02*
ACDF-P (24)				
ROM	C2-C7 (24)	44.98±13.99	26.12±7.05	*P*<0.001*
(mean ± SD)	Superior (24)	11.16±3.79	11.67±2.78	*P*=0.48
	Inferior (24)	6.28±2.78	6.61±3.14	*P*=0.54
ICR	Superior X (24)	0.38(0.32~ 0.42)	0.44(0.38~ 0.46)	*P* =0.008*
(median	Superior Y (24)	-0.56(-0.97~ -0.46)	-0.52(-0.76~ -0.44)	*P* =0.42
(IQR))	Inferior X (19)	0.34(0.32~ 0.55)	0.56(0.41~ 0.63)	*P* =0.03*
	Inferior Y (19)	0.10(-0.03~ 0.13)	-0.15(-0.31~ -0.01)	*P*=0.002*

* Significantly different (P<0.05); SD, standard deviation; IQR, interquartile range; ROM, range of motion; ICR, instantaneous center of rotation; ACDF-Z, anterior cervical discectomy and fusion with zero-profile anchored spacer; ACDF-P, anterior cervical discectomy and fusion with plate.

Disclosures: author 1: grants/research support: National Natural Science Foundation of China (NO. 81772370); author 2: grants/research support: National Natural Science Foundation of China (NO. 81772370); author 3: grants/research support: National Natural Science Foundation of China (NO. 81772370); author 4: author 5: author 6: author 7: author 8: author 9: author 10:

QF81

HYBRID SURGERY (HS) FOR THE TREATMENT OF CERVICAL DEGENERATIVE DISC DISEASES

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Introduction: Anterior Cervical discectomy and fusion (ACDF), using different grafts is still a standard treatment for cervical degenerative disc disease in the patients where conservative treatment failed.

Cervical disc arthroplasty (CDA) is an effective treatment for single-level cervical disc disease providing motion preservation and decreased reoperations at the adjacent segments.

Hybrid surgery (HS), involving the combination of ACDF and CDA, has been increasingly utilized for the patients with multi-level cervical degenerative disc disease.

The primary aim of the study was to compare clinical results as well as the cervical range of motion (ROM) comparing the ACDF and HS for multi-level cervical disc diseases.

Methods: After applying the inclusion criteria, 50 patients with multiple-level cervical degenerative disc disease where conservative treatment failed were included in the study. The patients underwent either the multi-level ACDF or HS procedure, combining the ACDF and CDA at different levels.

Clinical outcomes were assessed before and at regular intervals until one year after the procedure using neurological examination, the Neck Disability Index (NDI) and Visual Analogue Scale (VAS) for neck and arm pain, with 15% improvement in NDI and 20% in VAS defined as a clinically significant.

The cervical range of motion was evaluated using flexion-extension, lateral bending and axial rotation parameters.

Results: The groups were similar at baseline both clinically and statistically ($P > 0.05$) except for age and VAS for arm pain. Both groups had a statistically significant improvement in NDI and VAS for neck and arm pain ($P < 0.05$) and there was no statistically significant difference between groups at any point of investigation.

The HS group had a slightly better improvement according to NDI (72% of patients in the HS group achieved $\geq$ 15% improvement in NDI and 64% of patients in ACDF group).

There was a statistically significant difference in the C2-C7 ROM between the two groups at 12 months postoperatively ($P < 0.05$). The ROM of the HS group approached the preoperative value at 1 year. The location of the arthroplasty above or below the fused segment did not have a significant impact on motion.

Conclusions: All implants resulted in significant pain reduction and functional outcome for the patients.

The combination of fusion and arthroplasty can be adjusted to each level allowing segmental motion preservation at the affected levels and minimizing hypermobility at adjacent levels. Long-fusion constructs leading to adjacent segment pathologies may be avoided.

Disclosures: author 1: none, author 2: none, author 3: not indicated; author 4: none, author 5: none.

QF82

INCIDENCE AND RISK FACTORS FOR ROD FRACTURE AFTER THREE-COLUMN OSTEOTOMY IN SEVERE SPINAL KYPHOSCOLIOSIS

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Study design: Retrospective single-center study.

Objective: To analyze the incidence and risk factors for rod fracture (RF) after three-column osteotomy (3-CO) in severe spinal kyphoscoliosis.

Summary of background data: It has been reported that the prevalence of RF is high in severe kyphoscoliosis after 3-CO. However, the incidence and risk factors for RF after 3-CO in severe kyphoscoliosis involving a large number of cases at 1 institution were not precisely investigated.

Methods: Patients older than 10 years old with severe kyphoscoliosis undergoing 3-CO and more than 5-levels fusion from June 2003 to October 2016 were reviewed. The incidence, time-point and risk factors of RF were analyzed.

Results: A total of 533 patients were included in the study, of whom 36 patients (6.8%) sustained a RF including 17 (47.2%) congenital scoliosis (CS), 11 (30.6%) ankylosing spondylitis (AS) related kyphosis and 4 (11.1%) degenerative scoliosis (DS) patients. Considering the types of osteotomy, RF occurred in 55.6% (20/36) patients with pedicle subtraction osteotomy (PSO), 2.8% (1/36) patients with SRS-Schwab grade IV osteotomy, 33.3% (12/36) patients with vertebral column resection (VCR) and 8.3% (3/36) patients with SRS-Schwab grade VI osteotomy, respectively. The mean time-point of RF was 28.6 months post-operation (range, 8-96 months), which was within 2 years after surgery in 69.4% patients. A unilateral RF was identified in 22 (61.1%) patients and a bilateral RF in 14 (38.9%) patients. The risk factors of RF after 3-CO were revealed including instrumentation crossing both thoracolumbar and lumbosacral junctions (15/36, 41.7%), residual kyphosis (10/36, 27.8%), malposition of titanium mesh cage (4/36, 11.1%), pseudoarthrosis (3/36, 8.3%) and coronal imbalance (2/36, 5.6%).

Conclusions: The overall prevalence of RF after 3-CO was 6.8%. Risk factors of RF after 3-CO were instrumentation crossing both

thoracolumbar and lumbosacral junctions, residual kyphosis, malposition of titanium mesh cage, pseudoarthrosis and coronal imbalance. **Disclosures:** author 1: none, author 2: none, author 3: none, author 4: not indicated; author 5: none, author 6: none, author 7: none.

QF83

MULTIPLE ROD CONSTRUCT AND PEDICLE SUBTRACTION OSTEOTOMY: A SURVIVAL ANALYSIS WITH MINIMUM 2 YEARS FOLLOW-UP

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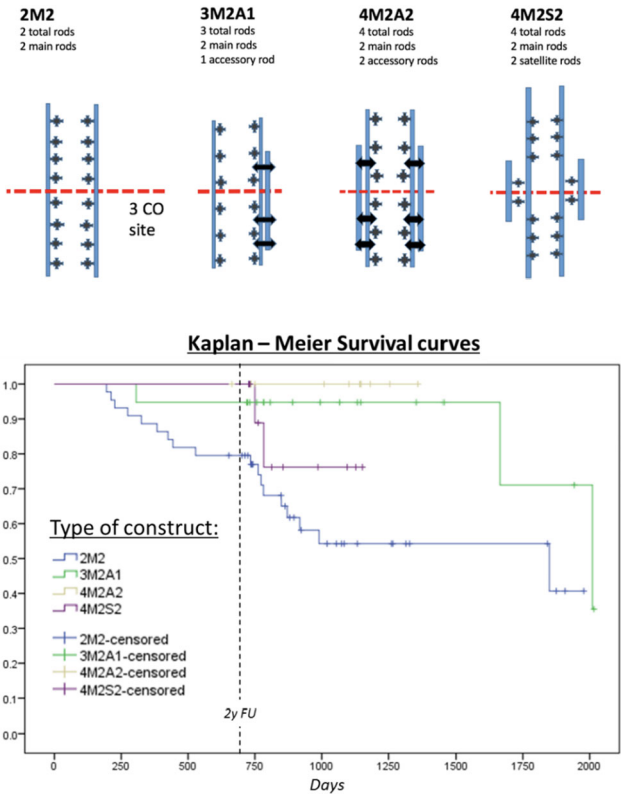
Background/introduction: Pedicle subtraction osteotomies (PSOs) have been plagued with high instrumentation failure at early time points. Recently, multiple rods have been used to prevent rod failure. This study investigated whether multiple rods in various configurations can prevent early rod failure.

Purpose of the study: The purpose of this study was to Investigate if multiple rods in various configurations can prevent early rod failure following PSOs.

Materials and methods: All patients undergoing a PSO in a prospective database of operative adult spinal deformity patients (scoliosis $> 20°$, SVA > 5 cm, or thoracic kyphosis $> 60°$) with minimum 2 years follow-up were included. The number of rods and the rod configuration around the PSO site were classified as follows (fig): Accessory (A) if the additional rod was attached to the main rod; Satellite (S) if the additional rod was anchored to the spine independently of the main rods. Rate of instrumentation failure and a Kaplan–Meier survival analysis was conducted to investigate differences in configuration failure.

Results: 102/120 eligible patients treated with a PSO had sufficient data (mean age 62 years, 72% female). Mean follow-up was 36-mos. $\pm$ 13. Pre-operative data showed a large deformity (PI-LL: 36.7° $\pm$ 17.6; TPA: 35.5° $\pm$ 11.9) with severe disability (ODI: 48.4 $\pm$ 17.5; PCS: 29.1 $\pm$ 8.9). Common PSO levels were L3 (49.0%) and L4 (21.6%). Mean estimated blood loss was 3.1L $\pm$ 1.9 with a mean operative time of 473 min $\pm$ 157. Patients had a significant change in sagittal alignment (PI-LL: 33.8° $\pm$ 13.6; TPA: 17.7° $\pm$ 8.6; SVA: 10.6 cm $\pm$ 6.1 all $p < 0.001$). 4 major types of construct were found: 2 main rods (2M2: 43.1%), 3 rods, main 2, accessory 1 (3M2A1: 18.6%), 4 rods, main 2, accessory 2 (4M2A2: 11.8%), 4 rods, main 2, satellite 2 (4M2S2: 12.8%). Overall rate of rod failure was 25.5% (N = 26) with a significant difference between 2 rods vs multiple rods (35.3% vs 8.4% $p = 0.023$) and across the 4 types of construct (2M2: 40.9% 3M2A1: 15.8% 4M2A2: 0% 4M2S2: 15.4% $p = 0.010$). Survival analysis demonstrated a significant difference between the 4 types of construct (Log Rank: $p = 0.010$) with higher survival rate for multiple rod constructs. At longer follow-up (> 1500 days), 2M2 and 3M2A1 converge to a similar survival rate.

Conclusion: Multiple rods can significantly reduce early rod failure.. At 2 years, survival rate for multiple rods was over 95% while 2 rods was closer to 80%. Different type of construct demonstrated different survival rate. Multiple rod constructs prevent early rod failure in PSO procedure but may not prevent long-term failure due to pseudoarthrosis.



Disclosures: author 1: grants/research support: AOSpine & OMeGA grants for fellowship paid directly to institution, consultant: Medtronic, DePuy, stock/shareholder: J&J, P&G, perForm Biologics, royalties: Innomed, DePuy; author 2: stock/shareholder: Nemaris; author 3: none, author 4: grants/research support: AO Spine, consultant: Depuy Synthes, Stryker, Trevena, Springer, Allosource, Medicrea, K2M; author 5: grants/research support: DePuy Synthes/ISSGF, consultant: Zimmer Biomet, Nuvasive, K2M, AlloSource, Cerapedics, royalties: Zimmer Biomet, other financial report: NREF, AOSpine; author 6: grants/research support: Depuy Synthes, Medtronic, NuVasive through the ISSG Foundation, consultant: Medtronic, NuVasive, EOS, stock/shareholder: NuVasive, royalties: Medtronic, NuVasive, Zimmer Biomet; author 7: grants/research support: ISSGF, royalties: Zimmerbiomet, K2M; author 8: grants/research support: Titan Spine-research, DePuy Synthes-research, ISSG-research, consultant: DePuy Synthes, Medtronic, Stryker, Medicrea, K2M, Biomet Zimmer, royalties: Stryker, Biomet Zimmer Spine, DePuy Synthes, Nuvasive, Next Orthosurgical, K2M, Medicrea, other financial report: Operative Neurosurgery-Editorial Board, SRS-Grant Funding, ISSG-Executive Committee, Global Spine Analytics-Director, employee: UCSF; author 9: grants/research support: DePuy Spine, Stryker, NuVasive, K2M - paid trough ISSGF, consultant: Zimmer Biomet, Globus, K2M, MSD, Medicrea, other financial report: Zimmer Biomet, Globus, K2M, MSD, Medicrea (speaking/teaching arrangements); author 10: grants/research support: ISSG, consultant: Globus, DepuySpine, stock/shareholder: Nemaris.

QF84

COMPARISON OF CLINICAL OUTCOMES BETWEEN HEADS-UP 3D VIEWING SYSTEM AND CONVENTIONAL SURGERY IN ACDF: A PILOT STUDY

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Objective: A Comparative Study of clinical outcomes of ACDF using 3D viewing system and conventional surgery.
Methods: 60 patients with single level cervical spondylosis were randomly divided into two groups. 29 patients using 3D viewing system and 30 patients using conventional ACDF. All surgeries were performed by a single surgeon. Patients were followed up for a period of 3 months. The operation time, blood loss, illumination intensity, JOA recovery rate and complications were recorded and compared between the two groups.
Results: The mean age, gender were comparable. Preoperative and postoperative JOA, JOA recovery rate operation time, blood loss and complications were not statistically significant when compared between the two groups. Illumination intensity were significantly less in the 3D viewing system.
Conclusion: The clinical outcomes of ACDF using 3D viewing system are not inferior to that of conventional surgery, and it has additional advantages of including performing surgeries in a more physiologically comfortable position, high-definition visualization, lower illumination levels and real depth of field, and it serves as a good educational tool.
Keywords: heads-uṗ 3D viewing system, spine surgery.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none.

QF85

COMPLICATION, MENTAL HEALTH STATUS, AND SAGITTAL SPINOPELVIC ALIGNMENT CORRELATES WITH SELF-IMAGE IN PATIENTS WITH ADULT SPINAL DEFORMITY AFTER CORRECTIVE SURGERY

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Objective: Preoperative self-image in ASD is the most relevant factor of surgical decision-making. Moreover, postoperative self-image has an important role in satisfaction with surgery. However, few studies are available to describe these variables. The aim of this study was to investigate the correlating factors for patient self-image before and after adult spinal deformity (ASD) surgery at 2 years.
Methods: The present study was a retrospective review of prospectively-collected multicentric data. Patients who underwent ASD surgery with minimum follow-up of 2 years were enrolled (n = 391). They were divided into high self-image (SI) and low SI groups, both preoperatively and postoperatively, according to SRS-22R SI/appearance subdomain scores at baseline and at 2 years, respectively. Independently-related factors for SI at baseline and at 2 years were determined using logistic regression analysis to adjust for confounding factors.
Results: Crucial factors for SI at baseline were the scores on the SRS-22R function/activity (OR: 2.61), SRS-22R mental health (OR: 2.63) subdomains, and relative spinopelvic alignment (RSA, OR: 0.95). In another model, complications (OR: 0.44) until 2 years, and SF-36 MCS (OR: 1.07) at baseline as well as Sagittal vertical axis (SVA, OR: 0.99) at 2 years were independent explanatory factors for SI at 2 years. The patients who transitioned from the preoperative low SI group to the postoperative high SI group had less complication, and achieved larger global sagittal alignment restoration than those who did not.
Conclusion: Mental status is a key determinant of SI in ASD patients. In addition to health-related quality of life, complication affect postoperative SI. Sagittal spinopelvic alignment measured by RSA or SVA also correlate with both pre- and postoperative SI. The results indicate that considering mental status, preventing complications, and global sagittal alignment restoration are crucial for achieving substantial SI scores after ASD surgery.
Disclosures: author 1: grants/research support: Konishi Foundation for International Exchange; author 2: grants/research support: Depuy Synthes, consultant: Medicrea, Spineart; author 3: not indicated; author 4: none, author 5: none, author 6: royalties: spineway; cousin biotech; author 7: none, author 8: grants/research support: DePuy-Spine, Medtronic; author 9: grants/research support: dePuy synthes; author 10: grants/research support: depuy synthes, consultant: depuy synthes, Medtronic, royalties: Clariance, Spineart, Alphatec; author 11: grants/research support: Depuy Synthes, Medtronic, royalties: AOSpine; author 12: grants/research support: Depuy; consultant: Globus; author 13: grants/research support: depuy synthes, consultant: depuy synthes, Medtronic, royalties: Alphatec, Spineart, Clariance; author 14: DePuy Synthes and Medtronic. Additional support was provided through Project PI16/01283, funded by Instituto de Salud Carlos III and co-funded by European Union (ERDF/ESF).

QF86

ASSESSMENT OF SAGITTAL SHAPE AND ALIGNMENT USING SHORT-CASSETTE RADIOGRAPHS AND INTRAOPERATIVE FLUOROSCOPIC IMAGES FOR PREDICTING MECHANICAL COMPLICATIONS

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Background: Individualized sagittal plane shape and alignment is described by the GAP Score via the PI-based proportional parameters of Relative Pelvic Version (RPV), Relative Lumbar Lordosis (RLL),

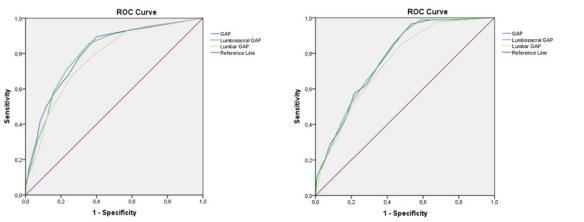
Lordosis Distribution Index (LDI), and Relative Spinopelvic Alignment (RSA). The use of RSA requires long-cassette radiographs to be able to quantify global tilt. Intraoperatively, Sacral slope is a position-dependent parameter complicating the use of RPV.

Purpose: The aim of the study was to compare predictive abilities of different GAP scores created by various combinations of its parameters.

Material and methods: GAP Score comprises: RPV + RLL + LDI + RSA + Age Factor. Lumbosacral GAP Score was defined as: RPV + RLL + LDI + Age Factor. Lumbar GAP Score was defined as: RLL + LDI + Age Factor. Mechanical complications were defined as PJK/PJF, DJK/DJF, rod breakages and implant-related complications. The ability of each score to predict mechanical complications and revisions were determined by plotting receiver operating characteristic (ROC) curves. The diagnostic performances were compared by the method defined by DeLong et al. using the area under the curve (AUC), sensitivity, specificity, positive predictive value and negative predictive value.

Results: The data from 457 patients (362F, 95 M, 53 ± 19 yrs) with ≥ 4-level fusion and a mean follow-up of 39.3 (24–94) months were included. The GAP, Lumbosacral GAP and Lumbar GAP Scores were good predictors of mechanical complications with a cut-off of ≥ 3 for each. In predicting a mechanical complication, GAP and Lumbosacral GAP Scores were superior to Lumbar GAP Score. A similar trend was observed for the prediction of mechanical revisions.

Conclusions: Although RPV and RSA are indispensable parts of the GAP concept and score in analyzing the individualized sagittal shape and alignment, the prediction ability of the score in the absence of these parameters are not affected. The GAP, Lumbosacral GAP and Lumbar GAP Scores were good predictors of mechanical complications with a cut-off of ≥ 3 for each. This information can be useful in every-day clinical practice and in operating room setting, in which SS and GT cannot reliable be measured. Lumbosacral radiographs and fluoroscopic lumbar images can be used for intraoperative decision making regarding the achievement or otherwise of the preoperative plan.



Scores	AUC (SE)	p	95% CI	Cut-off	Sens	Spe	PPV	NPV
*To Predict Mechanical Complication**								
GAP	0.805 (0.021)	<0.001	0.766 to 0.840	≥3	89.5%	59.9%	63.5%	88.0%
Lumbosacral GAP	0.804 (0.021)	<0.001	0.764 to 0.839	≥3	85.5%	64.6%	65.3%	85.1%
Lumbar GAP	0.772 (0.022)	<0.001	0.731 to 0.810	≥3	67.0%	74.3%	67.0%	74.3%
*To Predict Mechanical Revision***								
GAP	0.773 (0.024)	<0.001	0.732 to 0.810	≥3	96.6%	46.5%	29.8%	98.3%
Lumbosacral GAP	0.773 (0.024)	<0.001	0.732 to 0.810	≥3	92.0%	50.8%	30.5%	96.4%
Lumbar GAP	0.747 (0.026)	<0.001	0.704 to 0.786	≥2	85.1%	52.2%	29.5%	93.7%

*GAP- Lumbosacral GAP; p=0.796, GAP- Lumbar GAP; p=0.003, Lumbosacral- Lumbar GAP; p<0.001
**GAP- Lumbosacral GAP; p=0.991, GAP- Lumbar GAP; p=0.072, Lumbosacral- Lumbar GAP; P=0.025

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: grants/research support: Depuy Synthes, consultant: Medicrea, Spineart; author 8: grants/research support: depuy Synthes, consultant: Depuy Synthes, Medtronic, royalties: Alphatec, Spineart, Clariance; author 9: grants/research support: DepuySynthes; author 10: grants/research support: Depuy, consultant: Globus; author 11: grants/research support: Depuy Synthes, Medtronic, royalties: AOSpine; author 12: grants/research support; DePuySpine, Medtronic; author 13: grants/research support: Depuy; consultant: Globus; author 14: DePuy Synthes and Medtronic. Additional support was provided through Project PI16/01283, funded by Instituto de Salud Carlos III and co-funded by European Union (ERDF/ESF).

QF87

RISK FACTORS FOR PSEUDARTHROSIS IN ADULT SPINAL DEFORMITY (ASD) SURGERY

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Background: Pseudarthrosis in ASD is the most common cause of late revision. Despite its frequency, there remains no consensus on the risk factors for this complication. Some authors propose a mechanical origin while others suggest a biologic cause.

Purpose: The purpose of this study was to highlight independent risks factors for pseudarthrosis. The hypothesis is that pseudarthrosis is a multifactorial entity associated with both mechanics and biological causes.

Materials and methods: Adult patients undergoing lumbar deformity correction with a minimum of 4 instrumented vertebra and 2 years follow-up (FU) were reviewed (n = 525; mean age = 65 years, median FU = 2.9 years) in this retrospective multicenter study. Baseline, 6 weeks and latest FU quality of life scores (HRQL), sagittal radiographic parameters (RP) and reoperations for pseudarthrosis were recorded. Univariate and multivariate analysis were performed to identify risks factors for pseudarthrosis.

Results: 65 patients (12.4%) developed a pseudarthrosis. Multiple demographic, surgical and RP appeared significant with univariate analysis. Notably, 88% of cases can be explained by fusion length, osteotomy requirement, pelvic fixation and combined approaches. Sagittal alignment does not influence the rate of pseudarthrosis. At latest FU, HRQL scores were comparable between patients revised for pseudarthrosis and those never revised (ODI = 28% no revision and 30% revision group).

Conclusion: This study demonstrates that malalignment does not influence the rate of pseudarthrosis in multilevel lumbar fusion for ASD. Anterior approaches with anterior support decrease the rate by 30%, while long fusions, osteotomies and pelvic fixation increases the rate. Preoperative and postoperative RP are not predictors for pseudarthrosis. After revision for pseudarthrosis, patients do as well as those that never required a reoperation.

Disclosures: author 1: grants/research support: Depuy Synthes, consultant: Spineart, Medicrea; author 2: none, author 3: consultant: Medicrea Clariance, royalties: Medicrea Clariance; author 4: grants/research support: Stryker, Clariance, consultant: Stryker, Clariance, Ceraver, royalties: Stryker, Clariance; author 5: grants/research support: medtronic, consultant: medtronic; author 6: none, author 7: none, author 8: none, author 9: none, author 10: grants/research support: depuy synthes, consultant: depuy synthes, Medtronic, royalties: Alphatec, Spineart, Clariance; author 11: none; author 12: grants/research support: depuy synthes, consultant: depuy synthes, Medtronic, royalties: Alphatec, Spineart, Clariance; author 13: none.

QF88

KNEE FLEXION CONTRACTION AFFECTS CERVICAL ALIGNMENT AND NECK TENSION

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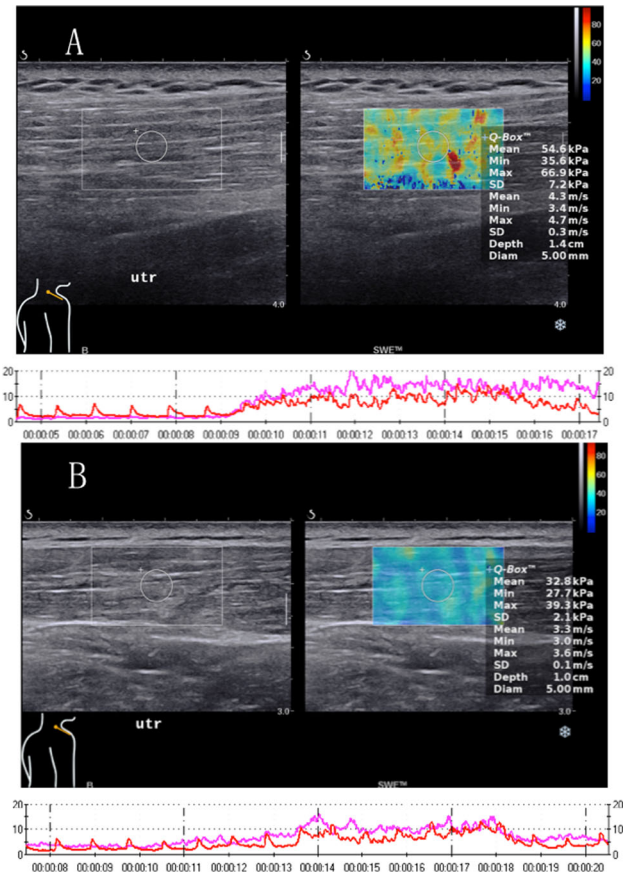
Introduction: Coordination of alignment from the lower extremities, pelvis and spine is the basis for achieving balance and horizontal gaze, especially on the sagittal plane. Malalignment in any segment can disturb the globe balance. Knee flexion contracture (KFC) can cause global spinal inclination with increased C7 tilt or C7 SVA, thus we believe that KFC can also affect the cervical alignment. Cervical posterior muscle is extremely important for maintaining horizontal gaze, which may also be affected by cervical alignment. So far as we known, there isn't any research about the effects of KFC on cervical alignment and neck muscle. Our hypothesis is that KFC can affect cervical alignment and posterior muscle, resulting in malalignment and neck tension.

Methods: 22 patients suffering from KFC were collected as KFC group. The control group was peered with subject numbers, age and sex after exclusion. To correct knee alignment, KFC group was treated with arthroscopy operation. Lateral radiograph films were obtained from 2 groups. The sagittal alignment was evaluated by C0-C2 lordosis (C0-C2L), C2-C7 lordosis (C2-C7L), C2SVA, C7SVA, T1 slope (T1S), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic tilt (PT), sacral slope (SS), as well as knee flexion angle (KFA). Surface electromyography (sEMG) based flexion-relaxation ratio (FRR) and ultrasound based shear wave elastography (SWE) are quantified methods to assess neuromuscular impairment and muscle tension, which were performed on the upper trapezius and splenius capitis muscles. Neck tension was evaluated by VAS subjectively. Comparisons between the pre-operation and post-operation of KFC group and control group were assessed by one-way ANOVA analysis. Pearson's correlation coefficient analysis was performed between parameters.

Results: In the pre-operation, KFC group had significantly larger KFA, C2SVA, C7SVA, C0-C2L, C2-C7L, T1S as well as higher VAS and SWE value compared with control group, while LL and FRR were significantly lower. KFA, C2SVA, C7SVA, C0-C2L, C2-C7L, T1S, VAS and SWE value significantly decreased after operation, while LL and FRR increased comparing to pre-operation, all these parameters had no differences with control group excepted C2-C7L. There were no differences in TK, PT, SS between pre-operation and post-operation of KFC group and control. Results also showed C2SVA, C0-C2L, T1S were correlated with VAS ($R = 0.83$, $p < 0.01$; $R = 0.79$, $p < 0.01$; $R = 0.53$, $p < 0.01$), SWE ($R = 0.79$, $p < 0.01$; $R = 0.55$, $p < 0.05$; $R = 0.60$, $p < 0.01$), FRR ($R = -0.63$, $p < 0.01$; $R = -0.81$, $p < 0.05$; $R = -0.46$, $p < 0.05$), and KFA ($R = 0.49$, $p < 0.01$; $R = 0.51$, $p < 0.05$; $R = 0.32$, $p < 0.05$).

Conclusion: KFC can affect global sagittal alignment and cervical alignment as well as neck tension. KFC cause spinal inclination leading to malaligment of the cervical spine, which may contribute to muscle tension and pain of posterior muscle. Horizontal gaze paly an important role in cervical lordosis increase caused by KFC.



Disclosures: author 1: none, author 2: not indicated.

QF89

DOUBLE ROD TECHNIQUE IN PATIENTS WITH CERVICAL SPINAL STENOSIS. A NOVEL MODIFICATION OF POSTERIOR CERVICAL INSTRUMENTATION

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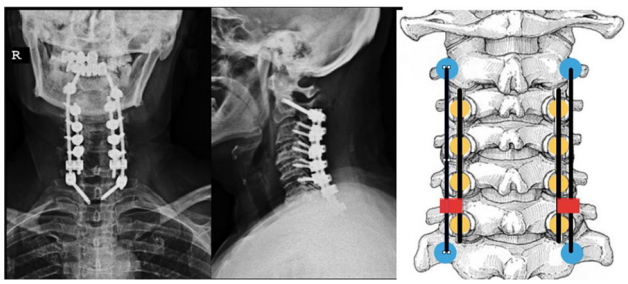
Introduction: Insertion of the rods to posterior instrumentations expanding from upper cervical to upper thoracic region, where sub-axial lateral mass screws (C2-T1,2) and pedicle screws (C2, C7, T1, T2) are generally used, constitute an intra-operative challenge for spine surgeons. The aim of this study is to present the results of our modified cervical double rod technique for posterior cervical instrumentations expanding from upper cervical region to cervicothoracic junction.

Patients and methods: 43 patients (19 females, 24 males) operated between 2012 and 2017 by the same senior surgeon were included and retrospectively reviewed. The surgical technique comprised insertion of pedicle and lateral mass screws following standard posterior approach. Pedicle screws were connected with 2 rods to each other, while lateral mass screws were connected with 2 separate rods, so that a total number of 4 rods were used. Two rods on each side

were connected to each other by using transverse connectors. The assessment of cervical lordosis (C2-C7) and evaluation of fusion was undertaken with the cervical anteroposterior and lateral X-rays and CT.
Results: Patients had a mean age of 68.16 (range 45–78) and a mean follow-up duration of 51.72 (range 24–72) months. All of the patients had a diagnosis of cervical spinal stenosis of minimum 3 levels. 39 patients underwent only posterior decompression, while 4 patients underwent combined antero-posterior decompression including discectomy in 2 patients and corpectomy in the remaining 2 patients. The average number of decompressed levels was noted as 3.4 (range 3–4). The average degree of cervical lordosis was detected to be improved from 12.17 (range 6-10) pre-operatively to 20.71 (range 15–26) at the last follow-up ($p < 0.001$). The JOA score improved from 11.1 to 16.32 (all patients: Grade I) ($p = 0.003$) as well as the NDI from 35.63 to 10.1 ($p < 0.001$) and VAS score from 5.83/6.31 (arm/neck) to 1.1/1.9 ($p < 0.001/p < 0.001$). 3D CT scans were undertaken to two patients with the suspicion of screw loosening and delayed fusion, while no loosening and solid fusion was detected in these patients. No implant failure of pseudoarthrosis were detected in any patient at the last follow-up visit.
Discussion and conclusion: Standard posterior cervical instrumentation technique comprised overbending of the rods, inability to instrument the level of C6 or obligation to conduct extensive soft tissue dissection in order to use lateral connectors for connecting pedicle screws to lateral mass screws. The modification we described here allowed instrumentation of all cervical levels while providing easier connection of pedicle screws to lateral mass screws leading to stronger biomechanical stabilization. With low rates of complications and excellent rates of fusion, this modification was detected to be a safe and effective method for the surgical treatment of cervical spinal stenosis.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none.

QF90

A COMPARISON OF MORTALITY AND MORBIDITY BETWEEN COMPLEX AND DEGENERATIVE SPINE SURGERY IN PROSPECTIVELY COLLECTED DATA FROM 2280 PRODEDURES

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Background: Most literature on complications in spine surgery is retrospective or based on national databases with few variables. Most prospective studies published are based on smaller cohorts with heterogenous variables based on local clinical evaluation not ideal for reproducibility. The SpineAdVerse Events Severity (SAVES) system has previously been found reliable and valid in both North American and European populations, providing precise prospective data regarding all adverse events (AEs).
Purpose of the study: To investigate differences in mortality and morbidity in patients undergoing either complex or degenerative spine surgery.
Outcome measures: Morbidity and mortality were determined according to the predefined AE variables using the newest version of the SAVES grading system, and the two centres were compared. Additional outcomes were the length of stay, readmission, unplanned second surgery during the index admission, and wound infections requiring revision.
Materials and methods: All adult patients undergoing spine surgery at our two academic tertiary referral centres from February 1, 2016, to January 31, 2017, were prospectively included. The surgical procedures have been allocated and divided between our two centres so that patients undergoing complex spine surgery for scoliosis, thoracal fusion and extended fusion, trauma, primary tumour and metastatic cancer lesions, as well as surgery due to infections, are performed at one of the centres. Surgery for purely degenerative cervical or lumbar spine disease is performed at the other centre. A research coordinator (not involved in treatment) collected all intraoperative and perioperative data prospectively. Once a week all patients were reviewed for additional events, validation of the data, and clarification of any questions. Patients were grouped according to the type of admission (elective or acute) and age, and sub-grouped according to major diagnostic groups.
Results: A total of 593 and 1687 consecutive cases, at the two centres respectively, were included with 100% data completion. The in-hospital mortality was 4.0% in the patients undergoing complex spine surgery and 0.1% in the patients undergoing degenerative spine surgery. There was a significant difference in morbidity when comparing the total number of AEs between the two groups ($p < 0.001$): with a total of 844 AEs in patients undergoing complex spinal surgery (giving a mean number of 1.42 AEs per patient), and a total of 1630 AEs among the patients undergoing degenerative spine surgery (giving a mean number of 0.97 AEs per patient). Postoperative infection requiring surgical intervention was recorded in 1.7% of patients who underwent complex spine surgery; compared to 0.06% of the patients in the degenerative group.
Conclusion: In this study comparing two prospective cohorts of patients, we found that rates of morbidity and mortality were significantly higher following complex compared to degenerative spine surgery.
Disclosures: author 1: none, author 2: none, author 3: grants/research support: K2M and Medtronic; author 4: consultant: K2M; author 5: none
Growing Spine, Craniocervical Junction (all pathologies)

QF91

CLINICAL, RADIOLOGICAL AND HRQOL OUTCOMES AFTER SELECTIVE THORACIC FUSION WITH MINIMUM 15 YEARS FOLLOW-UP

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Introduction: The purpose of this study was to evaluate the minimum 15 year natural history of uninstrumented compensatory lumbar curves in patients who underwent posterior selective thoracic fusion, and measure the HRQoL scores beyond 15 years after surgery, while comparing them with an age, gender, and BMI matched population.
Methods: Group A included 43 female AIS patients whom underwent selective thoracic fusion (STF) with mean age 33 (27–42) years, and a mean of follow-up of 18.7 (15–28) years, and mean BMI 22 (18–29). Preoperative, early postoperative, and follow-up x-rays were reviewed for the natural behavior of lumbar curves. Group B included randomly selected 43 female individuals with mean age 33 (27–41), and mean BMI 22 (17–33).The exclusion criteria for control group was knowledge of spinal deformity or spinal intervention. HRQoL scores (SRS-22, ODI, VAS) were compared between the two groups in latest f/up. The disc height, osteophyte formation, rotatory subluxation, and lateral spondylolisthesis were evaluated by using the latest x-rays between groups. Mann–whitney-*u* test was used for the statistical assessment.
Results: A posterior fusion was performed in all 43, with all pedicle screws used in 41 and all-hook constructs in 2 with fusion to T11 (4), T12 (25), or L1 (14). Main thoracic curve correction improved from pre-op to early post op and maintained at latest f/up (55,6°–16,1°–16,9°). Spontaneous lumbar curve correction was also maintained beyond 15 years (39,9°–16,6°–17,1°) Two pts (4,6%) with decompensation in early postop period improved and became compensated in latest f/up. No revisions or other spinal interventions were performed to Group A. Mean HRQoL scores, self image, and mental health scores were higher in group A than group B ($p < 0.05$). SRS-22r pain, function, ODI and VAS scores, marital status, number of children were similar between the groups ($p > 0,05$). All disc heights except (T11-T12 and L5-S1) were significantly lower in group A ($p < 0,05$). There was no significant difference between the groups in terms of osteophyte formation, rotatory subluxation, and lateral spondylolisthesis in the latest x-rays.
Conclusion: Despite disc height narrowing, uninstrumented lumbar curve in selective thoracic fusion maintains spontaneous curve correction and does not show any significant degenerative changes at an average 18 years. HRQoL scores suggested that the psychological and functional well-being were quite good in the long term in AIS patients who have undergone selective thoracic fusion when compared with an age—gender—BMI matched population.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none, author 9: none, author 10: consultant: Medtronic.

QF92

DO PATIENTS WITH ANTERIOR VERTEBRAL BODY GROWTH MODULATION HAVE A BETTER QUALITY OF LIFE THAN PATIENTS WITH A POSTERIOR SPINAL FUSION?

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Introduction: Anterior Vertebral Body Growth Modulation (AVBGM) aims to gradually correct scoliosis, using the patient's growth, while preserving spine motion.
Purpose of this study: The objective was to compare patients with IS undergoing surgical correction with AVGBM for clinical and radiological outcome with a matched cohort of patients with PSF. Our hypothesis was that Patients with IS undergoing surgical correction with AVBGM have a better quality of life 2-year post-op compared to patients undergoing PSF.
Methods: We reviewed the clinical, perioperative and radiological prospectively collected data of the first 53 patients who received AVBGM at our institution. Each AVBGM patient was matched to a PSF patient based PreOp Cobb Angle, sex and Lenke class. Quality of life questionnaires (SRS-22 and SF-12) were collected. Preop and 2-year post-op data were compared and analyzed. Paired t-test of specific parameters and questionnaires scores were calculated on 49 patients with AVBGM that reached 2-year follow-up.
Results: Patients were paired with pre-op Cobb Angle (PSF 53.5° ± 8.2°, AVBGM 49.6° ± 8.7), Lenke type and sex. AVBGM cohort is younger (12.4 ± 1.2 vs.13.9 ± 2.4). Two-year post-op% correction showed similar rates for AVBGM vs. PSF (69% vs. 73.1%; $p = 0.342$). Pre-op SRS-22 analysis (see table) demonstrated that AVBGM patients have less pain ($p = 0.03$), a better self-image ($p = 0.005$) and a better total score ($p = 0.019$) compared to PSF patients. Pre-op SF-12 analysis demonstrated that AVBGM patients have better social functioning ($p = 0.023$) compared to PSF patients. Post-op SRS-22 analysis demonstrated a trend that AVBGM patients score better in all domains (NS). Post-op SF-12 analysis demonstrated that AVBGM patients have better general health ($p = 0.025$), social functioning ($p = 0.041$) and role-emotional ($p = 0.05$) compared to PSF patients. AVBGM and PSF patients reached the MCID for the self-image domain.
Conclusion: Although patients in the PSF group had slightly larger pre-operative curves, AVBGM patients show a better quality of life 2 years after the surgery while obtaining similar surgical correction rates. Their HRQoL are better before the surgery and this trend persists after surgery. When compared to a matched cohort of patients undergoing PSF, AVBGM patients demonstrated significant improvements in the general health, social functioning and role-emotional domains with similar surgical results.

Table. Descriptive Statistics on Individual Domain Scores

	Pre-Operative			Post-Operative		
	PSF	AVBGM		PSF	AVBGM	
SRS-30 Pain domain	3.8 ± 0.7	4.1 ± 0.6	p=0.03	4.3 ± 0.8	4.4 ± 0.5	
SRS-30 Mental Health	3.9 ± 0.6	4.1 ± 0.6		4.1 ± 0.8	4.3 ± 0.6	
SRS-30 Self-Image	3.2 ± 0.6	3.6 ± 0.7	p=0.005	4.1 ± 0.7	4.3 ± 0.6	
SRS-30 Activity	4.1 ± 0.5	4.2 ± 0.4		4.3 ± 0.4	4.4 ± 0.3	
SRS-30 Total Score	3.8 ± 0.5	4.0 ± 0.4	p=0.019	4.2 ± 0.6	4.4 ± 0.4	
SF-12 Physical functioning	74.0 ± 29.2	80.7 ± 23.2		82.9 ± 40.6	87.9 ± 26.0	
SF-12 Role-physical	75.3 ± 27.0	83.1 ± 22.6		84.3 ± 19.5	92.1 ± 11.0	
SF-12 Bodily Pain	60.9 ± 31.3	64.6 ± 24.1		79.3 ± 19.6	70.0 ± 24.1	
SF-12 General Health	78.3 ± 17.6	77.3 ± 24.0		75.7 ± 28.8	86.5 ± 14.4	p=0.025
SF-12 Vitality	69.8 ± 21.2	72.9 ± 22.4		73.6 ± 21.8	80.0 ± 19.0	
SF-12 Social Functioning	78.7 ± 27.3	89.6 ± 18.5	p=0.023	81.6 ± 24.9	92.7 ± 13.1	p=0.041
SF-12 Mental Health	66.2 ± 18.0	71.1 ± 18.8		68.9 ± 22.2	77.1 ± 18.6	
SF-12 Role-Emotional	82.6 ± 24.3	87.0 ± 20.1		85.0 ± 22.7	93.6 ± 11.9	p=0.05

p : paired TTest

Disclosures: author 1: grants/research support: DePuy Synthes Spine, Medtronic, EOS-Imaging, Spinologics, K2M, consultant: DePuy Synthes Spine, stock/shareholder: Spinologics, royalties: EOS-Imaging; author 2: none, author 3: none, author 4: none, author 5: none.

QF93

NON-FUSION ANTERIOR SCOLIOSIS CORRECTION (ASC): COMPARISON OF OUTCOMES IN SKELETALLY IMMATURE VS. SKELETALLY MATURE PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS

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Introduction: Anterior vertebral body tethering (VBT) in skeletally immature AIS patients has been reported with success in approximately 60%. Non-fusion Anterior Scoliosis Correction (ASC) allows more curve correction and derotation at surgery even when patients are skeletally mature. The purpose of this review is to compare outcomes of a cohort of skeletally immature patients to cohorts of skeletally maturing and mature patients.
Methods: In this retrospective IRB-approved review, inclusion criteria included primary curves 40–70°, age $\leq$ 21 years, min. 2-year follow-up or failure before. 79 patients met the criteria, and 71 (90%) had 2-year radiographic follow-up for analysis. 59/71 (83%) were female. Of the 71 patients, 28 were immature (Risser 0–1, Sanders $\leq$ 4), 36 patients were maturing (Risser 2–4, Sanders 5–7), and 7 patients were mature (Risser $>$ 4, Sanders $\geq$ 8). 34/71 patients (48%) had both thoracic and lumbar curves instrumented leaving 105 curves for analysis.
Results: Age of the patients at time of surgery was avg. 12.6 years for the immature, avg. 14.5 years for the maturing, and avg. 17.9 years for the mature patients. Average follow-up and clinical success (final curve $\leq$ 30°) were similar across all 3 groups (NS, p values $>$ 0.10). In the immature group, expected (anticipated) revision occurred in 3/28 (11%) for overcorrection and in 1/28 (4%) for a large, stiff curve, and there was only 1/28 (4%) unanticipated revision for adding on (instrumented too short) with cord failure. There was 1/36 (3%) unanticipated revision in maturing group, and 1/7 (14%) pending revision in the mature group.
Conclusion: Early 2-year results of non-fusion ASC showed clinical success with residual curves $\leq$ 30° in 93% of immature patients, 81% of maturing, and 86% of mature patients. There was a 14% incidence of expected anticipated reoperations in the immature group. The unanticipated reoperation rate was 1 patient (4%) in the immature, 1 patient (3%) in the maturing, and 1 patient (14%) pending in the mature group.

		Immature (Risser 0-1, Sanders ≤ 4)	Maturing (Risser 2-4, Sanders 5-7)	Mature (Risser > 4, Sanders ≥ 8)
Number of patients (curves)		28 (39)	36 (55)	7 (11)
Age in years (mean, range)		12.63 ± 0.78	14.52 ± 1.3	17.86 ± 2.43
Follow-up (months)		32.3 ± 6.4	29.8 ± 5.96	26.2 ± 6.9
Pre-op curve (°) (average, range)	Thoracic	55.44 ± 10.2 (35 - 70)	53.09 ± 10.45 (34 - 70)	50 ± 5.98 (41 - 59)
	Lumbar	49 ± 12.3 (36 - 70)	45.13 ± 7.65 (34 - 62)	54 ± 8.21 (44 - 64)
Disc release (not fusion)	Thoracic only in 34/65 (52%) curves	11/28 pts	19/36 pts	4/7 pts
Most recent curve (°) (average, range)	Thoracic	15.81 ± 10.62 (-3 - 34)	22.28 ± 9.85 (3 - 40)	21.29 ± 8.9 (10 - 34)
	Lumbar	13 ± 9.2 (-5 - 28)	17.61 ± 7.68 (5 - 29)	27.25 ± 17.03 (10 - 50)
Success rate percentage (≤ 30° at 2-year follow-up)	Patients	93% (26/28)	81% (29/36)	86% (6/7)
	Total curves treated	95% (37/39)	87% (48/55)	82% (9/11)
Number (%) anticipated revision		4/28 (14%)	0/36 (0%)	0/7 (0%)
Number (%) unanticipated revision		1/28 (4%)	1/36 (3%)	1/7 (14%) [pending]

Disclosures: author 1: consultant: ApiFix, DePuy Synthes Spine, Globus Medical, SpineGuard, Wishbone Medical, stock/shareholder: Abyrx, ApiFix, Electrocore, Medovex, Orthobond, SpineGuard, Wishbone Medical, royalties: DePuy Synthes Spine, Globus Medical, SpineGuard, Wishbone Medical, other financial report: DePuy Synthes Spine, Globus Medical; author 2: none, author 3: none, author 4: none, author 5: none, author 6: consultant: Globus.

QF94

EFFECT OF CORRECTION OF THORACIC HYPOKYPHOSIS ON LUMBAR LORDOSIS AFTER SURGICAL TREATMENT OF THORACIC ADOLESCENT IDIOPATHIC SCOLIOSIS

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Summary of background data: Thoracic kyphosis (TK) is often low in adolescent idiopathic scoliosis (AIS) patients. In AIS, Thoracic hypokyphosis is correlated with low Proximal Lumbar Lordosis (PLL) and low Lumbar Lordosis (LL), while distal lumbar lordosis (DLL = Sacral Slope) is normal and correlated with pelvic incidence (PI).
Purpose: To analyze how post-operative changes of thoracic kyphosis influence lumbar lordosis, proximal lumbar lordosis and sacral slope in order to improve surgical planning of TK.
The hypothesis states correction of hypokyphosis increases lumbar lordosis (LL) through increase in PLL after surgical correction of TK.
Study design: Prospective monocentric study.
Methods: 111 consecutive thoracic AIS, Lenke 1 or 2 who underwent posterior selective thoracic fusion with reduction by simultaneous translation on 2 rods and $\geq$ 2 years follow-up have been prospectively selected and analyzed. Instrumentations below L1 and anterior releases were excluded. Global TK, global LL and other spino-pelvic parameters were measured by dedicated software. Patients were divided into 2 groups according to preoperative TK: Normokyphosis $\geq$ 20°, Hypokyphosis $<$ 20°.

Statistical analyses: Mean values were compared through T test, correlations assessed through Pearson's coefficient and linear regressions.

Results: Global TK increased from 27° to 46° at the last follow-up ($p < 0.0001$) and LL from 58° to 65° ($p < 0.0001$). PLL increased by 8° (range 15°, 23°), and distal lumbar lordosis remained stable (42°). LL increased after the first postoperative month. At 1 month, there was a significant increase in pelvic tilt and decrease in sacral slope ($p < 0.05$), offsetting the LL increase, and indicating a temporary pelvic retroversion.

The average coronal correction of the main curve was 69% at mean follow-up of 64 months (range 24, 175).

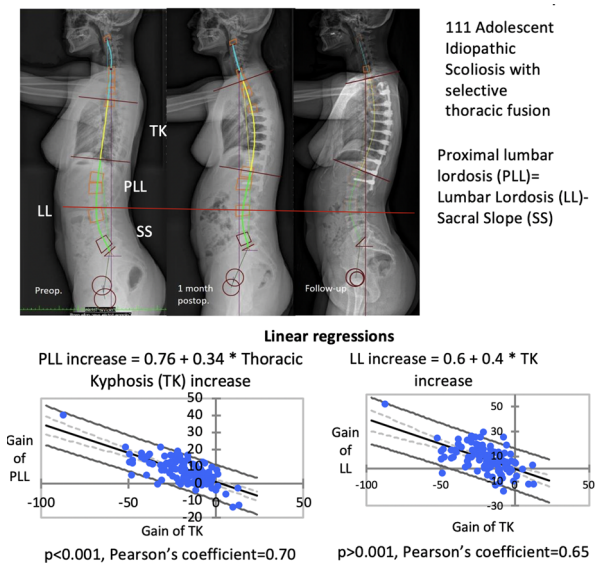
The increase in PLL correlated with the gain in TK (coefficient = 0.70): PLL increase = 0.76 + 0.34 * TK increase ($p < 0.001$), as the increase in LL (coefficient = 0.65): LL increase = 0.6 + 0.4 * TK increase ($p < 0.001$).

In the Hypokyphosis group, mean TK increased from 7° preoperatively to 41° at the last follow-up, mean LL from 53° to 66° and mean PLL from 10° to 22° ($p < 0$ 0.05); mean SS remained stable (43° to 44°, $p = 0.3$).

In the Normokyphosis group, mean TK increased from 36° to 48°, mean LL from 60° to 64°, mean PLL from 18° to 23° ($p < 0.05$); SS remained stable (42° to 41°, $p = 0.4$).

TK, LL and PLL increases were higher for the Hypo-Kyphosis group than for the Normo-Kyphosis group ($p < 0.001$).

Conclusions: Increase in TK led to increase in uninstrumented LL through increase in PLL with a linear correlation between TK and PLL. These results allow surgeons to calculate the TK required during surgical correction of thoracic AIS to adapt LL to pelvic incidence.



Disclosures: author 1: grants/research support: Medicrea; author 2: consultant: Medicrea International; author 3: none, author 4: none, author 5: none.

QF95

PATHOLOGIC SAGITTAL ALIGNMENT IS ALREADY PRESENT IN EARLY STAGES OF ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS)

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Summary: Lordotic deformation is together with rotation and lateral deviation an integral part of the complex three-dimensional deformity in AIS. Classification of 192 mild, 253 severe AIS and 156 controls according to the recently introduced Abelin-Genevois classification showed that even in mild AIS, the sum of rotated apical and junctional zones present in 55% of the curves as a pathological thoracic pattern in the midsagittal plane versus 6% in normal controls. In severe thoracic AIS, 63% had a pathological sagittal pattern.

Hypothesis: The starting point of sagittal malalignment of the thoracic spine in AIS is much earlier on than at the point of severe spinal deformation.

Design: Epidemiological, cross-sectional study.

Introduction: The complex three-dimensional spinal deformity in AIS consist of rotated, lordotic apical areas and neutral junctional zones and could lead to modifications of the presentation of the thoracic sagittal profile. The Abelin-Genevois classification system differentiates 4 specific patterns of sagittal alignment in AIS.

Methods: Sagittal spinal morphology of the thoracic spine in mild (n = 192, Cobb 10-20 degrees) and severe (n = 253, > 45 degrees) AIS patients was studied in an international consortium. Sagittal patterns were compared to 156 non-scoliotic adolescents, stratified to before, at or after the adolescent growth spurt. Outcomes were epidemiology of Abelin-Genevois sagittal curve types and kyphosis characteristics (T4-T12 thoracic kyphosis, T10-L2 angle, C7 slope, location of the apex of kyphosis and of the inflection point).

Results: In severe thoracic AIS, 63% had a pathological sagittal profile. Hypokyphosis (type 2a) was the most prevalent curve type, hypokyphosis + thoracolumbar kyphosis (type 2b) occurred more frequently in high-PI and primary lumbar curves, whereas cervicothoracic kyphosis (type 3) occurred more in double thoracic curves. Even in mild thoracic AIS, already 49% of the curves present as a thoracic hypokyphosis (type 2a), whereas 13% of mild (thoraco)lumbar curves have a pathological sagittal pattern. Only 6% of the normal adolescents had a pathological pattern.

Conclusion: This study revealed that specific pathological sagittal patterns are often already present in AIS at the earliest stage of the disease, whereas those are rare in non-scoliotic adolescents, before, during and after the growth spurt.

Table 1: Distribution of pathological (type 2a, 2b and 3) sagittal alignment and normokyphosis (type 1) in AIS patients and non-scoliotic adolescents.

	n	Type 1 (normokyphosis)	Type 2a (hypokyphosis)	Type 2b (hypokyphosis + TL kyphosis)	Type 3 (cervicothoracic kyphosis)	p
						
Mild AIS, n (%)	**192**	**113 (59)**	**67 (35)**	**10 (5)**	**2 (1)**	
Thoracic	128	58 (45)	63 (49)	5 (4)	2 (2)	**<.001**
(Thoraco)lumbar	64	55 (86)	4 (6)	5 (8)	0 (0)	
Severe AIS	**253**	***112 (44)***	***95 (38)***	***20 (8)***	***26 (10)***	
Lenke 1	111	43 (39)	56 (50)	2 (2)	10 (9)	
Lenke 2	41	14 (34)	13 (32)	2 (5)	12 (29)	***<.001***
Lenke 3/4	42	24 (57)	12 (29)	5 (12)	1 (2)	
Lenke 5/6	59	31 (53)	14 (24)	11 (19)	3 (5)	
Non-scoliotic adolescents	**156**	**147 (94)**	**6 (4)**	**2 (1)**	**1 (1)**	
Before PHV	74	67 (91)	5 (7)	1 (1)	1 (1)	**0.47**
At PHV	37	36 (97)	1 (3)	0 (0)	0 (0)	
After PHV	45	44 (98)	0 (0)	1 (2)	0 (0)	

Take home message: Sagittal 'malalignment' is an integral part of the development of AIS and also at an early stage, treatment of AIS should address the sagittal pathological patterns of the disease.
Disclosures: author 1: none, author 2: not indicated; author 3: none, author 4: none, author 5: consultant: Medicrea.

QF96

PREEMPTIVE PREGABALIN DOES NOT REDUCE POSTOPERATIVE OPIOID CONSUMPTION OR PAIN IN CHILDREN AND ADOLESCENTS UNDERGOING POSTERIOR INSTRUMENTED SPINAL FUSION. A DOUBLE-BLIND, PLACEBO-CONTROLLED, RANDOMIZED CLINICAL TRIAL

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Background: Pregabalin as part of a multimodal pain management has been shown to reduce opioid consumption after spinal surgery in adults, but not in children and adolescents. We conducted a double-blind, placebo-controlled, randomized clinical trial on pediatric patients undergoing instrumented spinal fusion.
Purpose: To evaluate effects of pre-emptive pregabalin on postoperative opioid consumption.
Methods: Adolescents, aged 10 to 21 years, undergoing posterior spinal fusion with all pedicle screw instrumentation were randomized to receive preoperatively and five days after surgery either pregabalin 2 mg/kg twice daily or placebo. Opioid consumption was measured using patient-controlled analgesia. Pain scores and opioid adverse effects were evaluated.
Results: Sixty-three patients out of 77 eligible were included and analyzed (51 AIS, 8 spondylolisthesis, and 4 Mb Scheuermann). Total oxycodone consumption per kilogram was similar in the study groups during the first 24 h (pregabalin 0.72 ± 0.25 vs. placebo 0.76 ± 0.28, p = 0.540) and 48 h postoperatively (pregabalin 1.49 ± 0.47 vs placebo 1.59 ± 0.54, p = 0.487). The postoperative pain scores (1 to 48 h) did not differ statistically between the study groups. No differences were found between the groups for any measured opioid-related adverse effects.
Conclusions: The use of perioperative pregabalin does not reduce the opioid consumption or affect the pain scores in adolescents after posterior spinal fusion surgery.

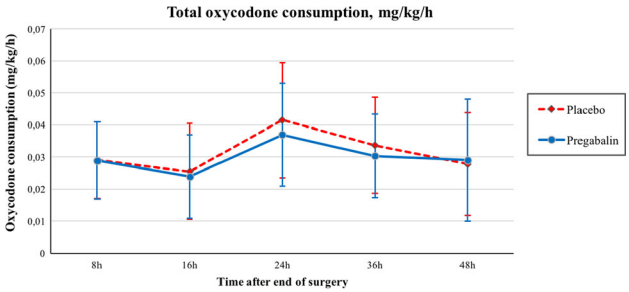

Figure 2. Oxycodone consumption per hour, data shown in mean and SD

Disclosures: author 1: grants/research support: Finska Läkaresällskapet, Svenska Kulturfonden, Lastentautien tutkimussäätiö, Orionin tutkimussäätiö; author 2: none, author 3: none, author 4: grants/research support: Medtronic, Innosurge; author 5: employee: Turku Iniversity Hospital, Department of Anaesthesiology and Intensive Care; author 6: grants/research support: Medtronic, K2M via Innosurge, consultant: Medtronic.

QF97

THE EFFECT OF DIFFERENT STRATEGIES AND CORRECTION MANEUVERS IN AIS SURGERY

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Introduction: Adolescent idiopathic scoliosis (AIS) is a complex 3-D deformity of the spine, characterized by rotation, coronal deviation and relative lordosis of the thoracic spine. It is generally believed that the 3-D correction of this spinal shape in AIS surgery is determined by the correction manoeuvre, but also that patient position, surgical releases, instrumentation strategy as well as rod contouring may be contributing factors to postoperative spinal alignment.
Hypothesis: The complete surgical cascade of different 'schools for AIS surgery' (in the United States, France and the Netherlands) have a different effect on the 3-D morphology of the primary, main thoracic curve and could explain the differences in onset of PJK.
Design: Multinational experience-based retrospective cohort study.
Methods: Three consecutive series of patients who underwent posterior scoliosis surgery for classical thoracic AIS curves (Lenke 1–4) were collected in 3 different major scoliosis clinics (n = 193). Patients were treated according to the local surgical expertise. Pre- and postoperative main thoracic curve morphology were determined by coronal Cobb angle, thoracic sagittal alignment (T1–T12, T4–T12, inflection point, Abelin curve type), and PJK angle and C7 slope at follow-up.
Results: Pre-operative major curve magnitudes were not different between the cohorts. The French strategy (primarily using translation manoeuvres, higher UIV) resulted in 59% Cobb angle correction versus 75% in the USA (derotation manoeuvres, full implant density) versus

70% in the Netherlands (derotation, low implant density) (table 1, $P < 0.001$). Despite similar postoperative T4–T12 kyphosis (22.4, 21.7 vs 20.6 degrees), the American strategy led to significantly more thoracolumbar lordosis whereas the Dutch strategy led to a higher inflection point. At latest follow-up, PJK angle was higher and C7 slope lower in the American and Dutch as compared to the French cohort ($P < 0.001$).
Conclusion: Based on comparison of three different 'scoliosis schools', it seems that derotational strategies lead to more coronal curve correction as compared to translation. Apical derotation, however, demands low thoracic lordosis creation and therefore higher risk for PJK. A translation manoeuvre, however, results in a sagittal harmonious spine, but significantly less coronal and axial correction.
Take home message: If you focus on correction in the one plane in AIS surgery, you may sacrifice in the other.

	French cohort (n=98)	*American cohort (n=44)*	*Dutch Cohort (n=51)*	*P*
Demographics				
Females, n (%)	93 (95)	33 (75)	41 (80)	.002*
Age at surgery	14.5±1.7	14.4±1.7	15.5±2.2	.005*
Follow-up in months	22±13	20±7	15±7	.002*
Preoperative parameters				
MT curve (degrees)	60±14	58±12	61±14	.501
MT apex, mode	T7	T6	T7	.019*
Abelin type 1 (normokyphosis)	36 (37%)	16 (36%)	29 (57%)	.08
Sagittal T1-T12 angle	25±14	24±14	29±6	.16
Sagittal T4-T12 angle	20±15	16±14	23±8	.036*
Sagittal T10-L2 angle	-1±9	-6±11	1±7	.002*
Inflection point	T12-L1	T12-L1	T12-L1	.19
Surgical details				
UIV, mode	T2	T3	T3	<.001*
LIV, mode	L2	L3	L3	.003*
Technique	Primarily translation	Primarily derotation	Primarily derotation	
	Low implant density	High implant density	Low implant density	
Postoperative parameters (first erect radiograph)				
MT Cobb angle	25±9	14±7	18±8	<.001*
Abelin type 1 (normokyphosis)	55 (56%)	23 (52%)	24 (47%)	.318
Sagittal T1-T12 angle	28±8	30±11	27±8	.19
Sagittal T4-T12 angle	22±7	22±6	21±8	.40
Sagittal T10-L2 angle	-4±5	-7±9	-5±8	.047
Inflection point	T12-L1	T12-L1	T11-T12	<.001
Follow-up parameters				
Proximal junctional angle	3±4	6±7	9±7	<.001
C7 slope	16±7	11±7	14±7	<.001

Disclosures: author 1: none, author 2: consultant: Medicrea; author 3: grants/research support: scoliosis research society; small exploratory grant; author 4: grants/research support: POSNA, SRS; author 5: none, author 6: not indicated.

QF98

REPRODUCIBILITY OF THE CLASSIFICATION OF EARLY-ONSET SCOLIOSIS (C-EOS)

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Background/introduction: The Classification of Early-Onset Scoliosis (C-EOS) is a promising classification system for patients with Early-Onset Scoliosis (EOS). However, the measurement errors for Major Curve Angle (MCA), kyphosis and Annual Progression Rate (APR) have not previously been reported in a consecutive EOS-only cohort.
Purpose of the study: To test the reproducibility of the C-EOS and measurement errors of MCA, kyphosis and APR.
Methods: This study was performed according to Guidelines for Reporting Reliability and Agreement Studies (GRRAS). We included a single-center consecutive cohort of patients diagnosed with EOS seen in the outpatient clinic from January 1, to June 30, 2015. Patients had no history of prior deformity surgery. Four raters with different levels of experience in spine surgery participated. Seventy patients were identified; the first 6 entered a pilot study, 4 were excluded due to insufficient radiographs leaving 60 for the final study. Two anterior–posterior full spine radiographs taken minimum 6 months apart and one sagittal radiograph were measured twice by all raters in a blinded test-retest setup with minimum 2 weeks between the first and second rating. We calculated 95% limits of agreement (LOA) for MCA, kyphosis and APR using a linear mixed effects model. Inter- and intrarater LOA were analyzed for each etiology separately.
Results: Mean age of patients was 8.7 ± 3.4 years and the etiology was congenital/structural (n = 20), idiopathic (n = 19), neuromuscular (n = 13) or syndromic (n = 8). Overall inter- and intrarater LOAs were ± 12.8° and ± 11.1° for MCA, ± 20.6° and ± 17.3° for kyphosis and ± 17.4° and ± 14.7° for APR, respectively. Interrater LOA for MCA was ± 19.1° for neuromuscular, ± 12.4° for congenital/structural, ± 9.4° for syndromic and ± 8.5° for idiopathic patients. Interrater LOA for kyphosis was ± 23.4° congenital/structural, ± 22.9° for neuromuscular, ± 20.1° for syndromic and ± 15.3° for idiopathic patients. For APR, interrater LOA was more than ± 11.5°/year regardless of etiology.
Conclusion: Our study shows considerable measurement errors for MCA, kyphosis and APR in EOS patients only. We found large variation in LOA between different etiologies, largest for neuromuscular patients. Further, LOA for APR was larger than the 10°/year steps in the C-EOS suggesting that the minimum time interval between radiographs may need to be longer.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: consultant: K2M; author 7: grants/research support: K2M and Medtronic.

QF99

NEUROLOGIC DEFICIT IMPROVED WITH THE CORRECTION OF ROTATORY SUBLUXATION USING PRE-OPERATIVE HALO-GRAVITY TRACTION IN SEVERE NEUROFIBROMATOSIS TYPE 1 AND CONGENITAL SCOLIOSIS

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Hypothesis: The pre-operative HGT is helpful for the improvement of neurologic deficit in severe NF1 and CS patients with RS.
Design: Retrospective review.

Introduction: The RS is associated with more severe spinal deformity and more neurologic deficits in kyphoscoliosis. The pre-operative HGT has been proven to be effective for severe kyphoscoliosis secondary to different etiologies. However, little is known about the efficacy of HGT in the improvement of neurologic deficit in severe NF1 and CS patients with RS. The objective of this study is to evaluate the efficacy and safety of pre-operative HGT in the treatment of neurologic deficit in severe NF1 and CS patients with RS.
Methods: NF1 and CS patients with neurologic deficit and RS undergoing HGT between June 2001 and September 2016 were reviewed. The coronal Cobb angle, sagittal global kyphosis (GK), RS measured on coronal plane (CRS) and on sagittal plane (SRS), and axial rotation (AR) were measured at pre-, post-traction and post-operation. The forced vital capacity (FVC) and forced expiratory volume in 1 s (FEV1) were recorded at pre- and post-traction. The neurologic function at pre-traction, post-traction and post-operation were assessed according to the Frankel score. The comparison between pre-traction and post-traction was performed using paired samples t test.
Results: A total of 15 patients (9 M and 6F) including 8 NF1 and 7 CS patients were included in the study, of whom the average age was 15.7 ± 4.0 years. The average duration of HGT was 69.3 ± 12.6 days, during which the average Cobb angle improved from 109.8 ± 30.1° to 87.7 ± 30.2° ($P < 0.001$), and the GK decreased from 80.9 ± 19.4° to 62.4 ± 20.7° ($P = 0.003$), respectively. At pre-traction, the CRS and SRS values were 9.9 ± 5.5 mm and 6.8 ± 3.1 mm, which significantly improved to 6.0 ± 3.9 mm ($P < 0.001$) and 5.4 ± 1.9 mm ($P < 0.001$), respectively. The average improvement in FVC and FEV1 were from 40.7 to 51.7% predicted and from 41.8 to 49/5% predicted, respectively. The Frankel scores were C in 5 patients and D in 4 patients at pre-traction. After HGT, the Frankel scores improved from C to D in 3 patients, from D to E in 2 patients. The Frankel scores of 2 patients with C and 2 patients with D were not significantly improved, and no deterioration in neurologic function was observed during HGT.
Conclusions: HGT can improve the coronal and sagittal curvature, pulmonary function, RS and neurologic deficit in NF1 and CS patients. The pre-operative HGT is a safe option for severe NF1 and CS patients with neurologic deficit and RS.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none.

QF100

RISK ANALYSIS OF VARIOUS AGE GROUPS OF CONGENITAL HEMIVERTEBRA RESECTION BEFORE TEN YEARS OLD

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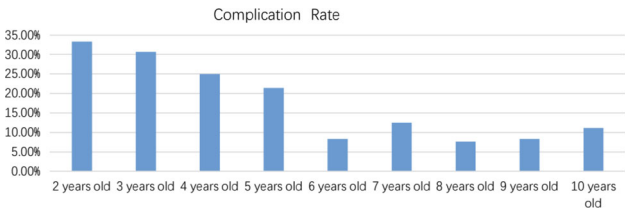
Background: Hemivertebra resection is one of the most important treatments for congenital hemivertebra. However, the development of children's systemic system has not been perfected, and the tolerance to surgery is poor. The risk of surgery is higher than that of adults. There is no analysis of the risk of surgery in all ages before the age of 10 years.
Objective: Compare the risk of each age group less than 10 years of congenital hemivertebra resection and determine the main characteristics of each age group.
Methods: A retrospective analysis of the database from November 2010 to December 2018. All patients with posterior hemivertebra resection and single-segment fixation. By age 10 -2 years old were divided into nine groups. Compare all ages between perioperative non-neurological complications rate(does not include hemorrhage and hypoproteinemia), the blood loss, blood loss to total blood volume ratio(BL/TBV ratio), albumin within 24 h after surgery.
Results: 139 patients enrolled in the study, 67 males, 72 females, with an average main bend Cobb angle of 51.2 degrees. 10-year-old group (n = 18), perioperative non-neurological complication rate was 11.1%, the average blood loss was 319.4 ml, BL/TBV ratio was 0.134; 9-year-old group (n = 12) 8.3%, 316.7 ml,0.149; 8-year-old group (n = 13) 9.1%,296.1 ml, 0.142; 7-year-old (n = 16) 13.3%, 297.1 ml, 0.159; 6-year-old (n = 12)10%, 270.8 ml, 0.187; 5-year-old (n = 14) 33.3%, 271.4 ml, 0.194; 4-year-old (n = 12)27%, 255.4 ml, 0.198, 3-year-old (n = 13) 40%, 245.8 ml, 0.206, 2-year-old (n = 9) 42.9%, 227.8 ml, 0.215. The BL/TBV ratio and albumin within 24 h after surgery of the children with complications was 0.254, 26.37 g/L and the non-complication was 0.157, 30.04 g/L. Respiratory complications accounted for 75% of the total complications, 92.3% before the age of 5 and 42.8% after the age of 5. Figure (1-3).
Conclusion: Before the age of 5 years, hemivertebra resection has a higher BL/TBV ratio and complications rate. Complication rate tends to be stable after 6 years old. Complications in children before the age of 10 were mainly respiratory complications and higher before the age of 5, which may be related to the gradual development of lung vesicles after 6 years of age. Perioperative enhancement of the prevention and treatment of respiratory complications is necessary. Most patients have different degrees of hypoproteinemia at 24 h after surgery and lower albumin levels have a higher risk of complications. A lower BL/TBV ratio reduces the incidence of complications.
Keywords: Congenital Hemivertebra; Complication; Hypoproteinemia; Blood Loss.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none, author 9: none.

QF101

THE SURGICAL STRATEGY OF TREATMENT LUMBOSACRAL HEMIVERTEBRA: COMPARATIVE ANALYSIS OF UNDER 10 YEARS OLD AND OLDER THAN 10 YEARS OLD GROUPS WITH 5 YEARS FOLLOW UP

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Background: The lumbosacral hemivertebra usually lead to the early rapid progress of spinal deformity, trunk shift and large compensatory curve. However, the timing and strategy of lumbosacral hemivertebral surgery are still controversial.
Objective: To analyze and compare the surgical strategies and long-term outcomes of lumbosacral hemivertebra deformities in different age groups.
Methods: Eighteen patients with lumbosacral hemivertebra deformity were retrospectively reviewed between 2004 and 2013. Patients were received a minimum 5 year follow up and assigned into two groups: Group A (N = 8, mean age 6.6 years old) patients who were under 10 years old and underwent hemivertebral resection and short segment fixation, Group B (N = 10, mean age 14.3 years old) patients who were older than 10 years old and underwent hemivertebral resection, long segment fixation including compensatory curve. Clinical and imaging data were collected for statistical analysis.
Results: Mean follow up was 6.2 years. In group B all patients were treated with long segment and iliac screw fixation while no iliac screw fixation in group A.The Cobb angle of coronal main curve in group A improved from 31.3° to 9.3° post-op, and to 9.5° at final follow-up. The Cobb angle of coronal main curve in group B improved from 51.5° to 15.5°post-op, and to 16.3°at final follow-up.The Cobb angle of compensatory cranial curve in group A was 23.5° before operation, 13.7°after operation, 16.2° at final follow-up, while in group B 40.5° before operation, 13.3°after operation, 13.8° at final follow-up. CSVL in group A improved from 1.5 cm before operation to 0.7 cm at final follow-up and in group B improved from 2.1 cm to 0.9 cm. Fixed fusion segments were 2.1 in group A and 5.6 in group B. The mean operative time and blood loss in Group A was 189 min and 380 ml, respectively, and in Group B 265 min and 750 ml, respectively.
Conclusion: Lumbosacral hemivertebra deformity under 10 year old with flexible compensatory curve undergo short-segment fixation can achieve satisfactory correction, long term maintenance.While older than 10 years old with structural compensatory curve requires long segmental and iliac bone fixation in order to achieve trunk balance and deformity correction and more operative time, blood loss and complications.Early surgical treatment is recommended for lumbosacral hemivertebral deformity.
Keywords: lumbosacral hemivertebra, different age, surgical strategy.

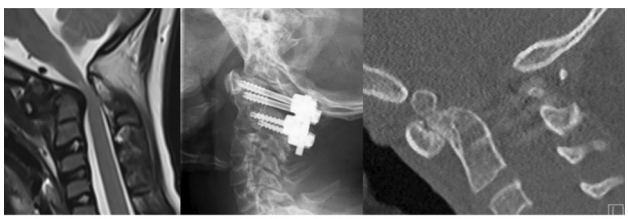

Fig. 1. 5-yr-old girl with os odontoideum and cervical instability. One-yr FU after C1-C2 spinal fusion shows well aligned cervical spine. 2-yr sagittal reformat shows fusion of the os odontoideum with the rest of axis.

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none, author 9: none.

QF102

OS ODONTOIDEUM IN CHILDREN: TREATMENT OUTCOMES AND NEUROLOGIC RISK FACTORS

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Background: Treatment outcomes and risk factors for neurologic deficits in pediatric os odontoideum are unclear.
Methods: We reviewed data from 102 children (mean age 9.8 years, range 0.2 to 18 years) with os odontoideum treated at 11 centers between 2000 and 2016, who had minimum 2-year follow-up. Thirty-one children underwent nonoperative treatment, and 71 underwent instrumented posterior cervical spinal fusion for C1-C2 instability. Nonoperative treatment consisted of observation (n = 29) or immobilization (cervical collar, n = 1; halo body jacket, n = 1). Surgical treatment consisted of atlantoaxial (n = 50) or occipitocervical (n = 21) arthrodesis. One patient also underwent transoral odontoidectomy.
Results: Thirty children (29%) presented with neurologic deficits, 28 of whom had radiographic atlantoaxial instability (atlantoaxial distance [AAD] $\geq$ 5 mm) or limited space ($\leq$ 13 mm) available for the spinal cord (RR, 7.8 [95%CI, 2.0 to 31] compared with children with no radiographic risk factors). The 27 children without neurologic deficits or atlantoaxial instability at presentation underwent nonoperative treatment and remained asymptomatic. One child developed atlantoaxial instability, and another had a persistent neurologic deficit; both children underwent spinal fusion during the study period. One child with cervical instability declined surgery and remained asymptomatic. Spinal fusion had occurred in 68 patients in the surgical group by the end of the study period (mean, 3.7 years; range, 2.0 to 11.8 years). Surgical complications were observed in 21 (30%) children, including nonunion in 12, new neurologic deficits in 4, and vertebral artery injury in 1. Nine (13%) children underwent revision surgery. In the surgical group, Japanese Orthopaedic Association neurologic function scores improved significantly from preoperatively to final follow-up for the upper extremities (p = 0.026) and lower extremities (p = 0.007).
Conclusions: Nonoperative treatment was safe for asymptomatic patients without atlantoaxial instability. One child out of thirty-one conservatively treated patients developed cervical instability during follow-up justifying clinical and radiographic surveillance. Radiographic risk factors (atlantoaxial instability or limited SAC) were associated with an 8-fold higher risk for neurologic deficits; therefore, children with these risk factors should undergo cervical spinal fusion. Spinal fusion resolved the neurologic deficits of children with symptomatic os odontoideum, but was associated with 30% risk of complications.
Disclosures: author 1: grants/research support: Medtronic, K2M via Innosurge, consultant: Medtronic; author 2: other financial report: Johnson and Johnson; author 3: not indicated; author 4: none, author 5: none, author 6: none, author 7: none, author 8: none, author 9: grants/research support: Setting Scoliosis Straight, Depuy Synthes,

K2M, Nuvasive, consultant: Depuy Synthes, K2M, Nuvasive, Biogen, Globus, royalties: K2M, Nuvasive, Orthopediatrics; author 10: consultant: Orthopediatrics, royalties: Orthopediatrics, Biomet.

QF103

A STUDY OF ATLANTOAXIAL ROTATORY FIXATION TREATMENT

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Background: Although conservative treatment is typically chosen for treating atlantoaxial rotatory fixation (AARF), no norms have been established regarding issues such as the optimal timing for inpatient treatment.
Purpose of the study: To conduct a retrospective study of the course of AARF treatment.
Materials and methods: A retrospective study of cases of patients with AARF treated in this hospital between April 2011 (when the hospital was opened) and March 2017. In this study, we excluded cases involving third-party actions at the point of injury, wherein it is difficult to judge the timing of pain disappearance. Patients were investigated in terms of age, sex, Fielding classification, treatment duration, treatment method, and outcome.
Results: In total, 104 patients with AARF were treated during the target period mentioned above. These consisted of 51 males and 53 females with an average age of 5 years (range: 1–13 years old). The courses of 81 cases (77.9%) were followed to the point of cure, whereas 19 cases were discontinued, and 4 were referred to other hospitals. In terms of the cause of onset, 43 cases—the majority—were not attributable to any known cause (41.3%), 26 cases were caused by minor trauma (25.0%), 7 arose during treatment of Kawasaki disease (6.7%), and 28 during treatment for inflammatory diseases such as colds, mumps, or quinsy. All cases fell into Fielding classification types 1 and 2, with no cases into types 3 or 4. Treatment lasted for an average of 15 days (range: 2–70 days). Recurrence was confirmed in 9 cases (8.7%), with repeat recurrence on 4 occasions in one case and on 3 occasions in another. In addition, of the 1469 patients with Kawasaki disease treated in the pediatric medicine department at our hospital during the same period, 9.48% required referral to our department after they were diagnosed with AARF. In terms of the treatment method, 44 cases were treated with collar fixation (42.3%), 43 cases with bed rest alone (41.3%), 16 cases with Glisson's traction (15.4%), and 1 case with bed rest upon hospitalization (1.9%). Bed rest was indicated at the time of patients' initial visit to the outpatient clinic, with admittance to our hospital taking place for cases continuing for 1–2 weeks after onset or in cases of extreme pain. No cases were found during the study period that required reduction or surgical treatment under general anesthesia.
Conclusion: Although the treatment success rate during the study period for Glisson's traction at our hospital was 100%, these were minor cases that improved after only collar fixation or directed rest; hence, it was not possible to confirm indications constituting appropriate judgment for beginning traction. However, the study did not include cases of Fielding classification types 3 and 4 and obsolete cases, which will need to be examined in future.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: grants/research support: Showa university hospital; author 5: none; author 6: none, author 7: none, author 8: none, author 9: none, author 10: none.

QF104

EVALUATION OF CLINICAL OUTCOMES OF ONE-STAGE ANTERIOR AND POSTERIOR SURGICAL TREATMENT FOR ATLANTOAXIAL TUBERCULOSIS COMPLICATED WITH NEUROLOGICAL DAMAGE: TEN-YEAR CASE REVIEW WITH MINIMALLY FIVE-YEAR FOLLOW-UP

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Background: Surgical treatment is mainly used for atlantoaxial tuberculosis with neurological damage. However, the anatomic structure around the atlantoaxial joint is complex, and the position of vertebral body is deep, which increases the difficulty of the operation and it is challenging for the surgeon to develop surgical strategy. The purpose of this study was to evaluate the clinical outcomes of one-stage combined anterior and posterior surgical treatment approach for atlantoaxial tuberculosis with neurological impairment.
Methods: From January 2005 to January 2015, 12 patients suffering from atlantoaxial tuberculosis with neurological impairment were surgically treated by one-stage combined anterior and posterior approach. Preoperative CT scanning and MRI imaging showed unilateral or bilateral lateral mass destruction of the atlas, and varying destruction degrees of odontoid process, loss of atlantoaxial stability, and tuberculosis focus into the spinal canal resulting in the corresponding spinal cord compression in all patients. The preoperative neurological classifications were Class C for 4 cases, D for 8 cases according to the American Spinal Injury Association (ASIA) system. Quadruple sensitive anti-TB drug treatment was used in all 12 patients preoperative and postoperative. Patients' clinical symptoms and neurological function recovery were evaluated by comparing the Visual Analogue Scale (VAS) score, Neck Disability Index (NDI), Japanese Orthopedic Association (JOA) score and ASIA grading before operation and at the final follow-up.
Results: Mean surgical duration was 263.3 $\pm$ 43.6 min. Intraoperative blood loss was averagely 529.2 $\pm$ 169.8 milliliters. The average fusion period was 7.3 $\pm$ 1.5 months. No instrumentation loosening, migration or breakage was observed during the follow-up of 6.5 $\pm$ 2.9 years. The VAS, NDI and JOA scores were significantly changed to 1.00 $\pm$ 0.95, 9.50 $\pm$ 3.34 and 15.42 $\pm$ 1.44 at last follow-up ($P < 0.05$). The neurological function of all 12 patients was recovered to Class E according to the ASIA grading system.
Conclusions: In the treatment of atlantoaxial tuberculosis with neurological impairment, one-stage combined anterior and posterior surgical approach have the ability to complete debridement and decompression, and reconstruction of the stability of the upper cervical spine. In that case, good clinical outcomes will be obtained through medium and long term follow-up observation.
Keywords: Spinal tuberculosis; Atlantoaxial; Neurological impairment; Surgical approach.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none.

QF105

TWO ATTENDING SURGEONS IMPROVE OUTCOMES OF ANTERIOR CERVICAL DISCECTOMY AND FUSION (ACDF)

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Summary: The use of a two-attending surgeon team has been shown to have improved perioperative outcomes in spine procedures such as deformity correction. This matched cohort comparative study investigated the effect of a two-attending surgeon team in single level ACDF procedures. A two-attending surgeon team demonstrated reduced anesthesia/surgical time and blood loss, without an increase in complications or pseudarthrosis. These findings further highlight the benefits of having two experienced surgeons present.

Design: Retrospective matched cohort study.

Introduction: ACDF is one of the most common procedures performed by spine surgeons, but it is not without complications. The involvement of a two-attending surgeon team has been shown to have improved perioperative outcomes in complex spine procedures such as deformity correction. The purpose of this study was to assess the effect of two attending surgeons on patients undergoing single level ACDF procedures.

Methods: A retrospective matched cohort study of patients undergoing 1-level ACDF for degenerative cervical spondylosis, with minimum 2-year follow-up. Patients were subdivided into 2 cohorts: (A)cases performed by one attending surgeon assisted by resident, fellow, physician assistant or other medical staff, and (B)cases performed by an attending surgeon with another attending surgeon as first-assist. Patients were matched by age, sex, BMI, ASA and CCI. Perioperative data including anesthesia, surgical time, blood loss, postoperative complications and rate of fusion were compared. Standard binomial and categorical comparative analysis were performed. A p-value < 0.05 was deemed significant.

Results: 42 patients were included (21 in each group). There were 22 males and 20 females, with a mean age of 47.7 years and mean follow-up of 43.4 months. There were no differences in any demographic variable between the two groups, indicating successful matching. Cohort B had decreased anesthesia time (114.9 vs 157.1 min, $p < 0.001$), operative time (58.1 vs 98.9 min, $p < 0.001$) and blood loss (14.8 vs 24.3 mL, $p = 0.012$). There were no significant differences in terms of post-operative complications including dysphagia, wound infection, neurologic or cardiovascular related complications. All patients achieved successful fusion at final follow-up.

Conclusion: A two-attending surgeon team significantly reduces anesthesia time, surgical time, and blood loss, in 1-level ACDF procedures, without an increase in complications, or decrease in fusion rates, further highlighting the benefit of having two experienced surgeons present.

Disclosures: author 1: grants/research support: K2M; author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none.

ADULT DEFORMITY (WHOLE SPINE)

QF106

THE EFFECT OF THE LUMBAR PEDICLE SUBTRACTION OSTEOTOMY LEVEL ON LORDOSIS DISTRIBUTION AND SHAPE

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Introduction: Much has been written about the quantitative results of lumbar pedicle subtraction osteotomy (L-PSO) to achieve proper realignment in adult deformity regarding gain in lordosis angle, PI-LL mismatch and spinopelvic parameters change. However, little is known about the qualitative results depending on the level of L-PSO: postoperative upper and lower lumbar arches distribution, and apex or inflexion point positioning. The aim of the study was to determine whether it is important to choose the appropriate level of the L-PSO to restore the ideal lordosis distribution (dictated by Pelvic Incidence -PI-).

Methods: Retrospective analysis of prospectively collected adult deformity patients undergoing a single level L-PSO. We analyzed several variables in the preoperative and postoperative sagittal radiographs: the type of sagittal profile according to Roussouly classification (R-type); L-PSO level; level of Inflexion Point (InfxP) which is the vertebral level dividing maximum kyphosis and maximum lordosis; and level of the sagittal lumbar apex (LApex). Spinopelvic parameters (PI, PT, SS), L1-S1 angle, L4-S1 angle, lordosis distribution index (LDI = L4-S1/L1-S1); and the number of levels in the lordosis (NVL) were also studied. Comparisons between all PSO levels were performed to determine lordosis distribution and shape using ANOVA test with Bonferroni correction, and Chi2 statistics.

Results: 126 patients with one level L-PSO were included.

Lower PSOs (L4&L5) mainly increased the lower lumbar arch by increasing LDI (especially L5-PSO $=+27.7\% \pm 36.6$ difference). PSOs at and above L3 increased the upper lumbar arch decreasing LDI (mainly L3-PSO = $-34.6\% \pm 23$ difference) $P < 0.001$.

L4-PSO added 1 vertebra into the lordosis (NVL $=+1.2 \pm 2.2$), while PSOs above L3 added 2 vertebrae into the lordosis (NVL $=+2.3 \pm 1.4$). Overall $P = 0.007$.

PSOs above L4 raised the LApex in 70% of the cases (x = 1.12 levels) and the InfxP in 85% of the cases (x = 2.4 levels) compared to preoperative. L5-PSO lowered the LApex in 70% of the cases ($x = -1.1$ levels) and the InfxP in 50% of the cases ($x = -1.6$ levels) compared to preoperative. Overall $P < 0.006$.

No particular L-PSO level predominantly molded a specific R-type ($P > 0.05$). What dictated final shape was final pelvic version (SS influenced by final LDI) and apex location.

Conclusions: Each lumbar PSO level influenced lumbar arches distribution differently, and the apex and inflexion point positioning. Although L5-PSO may better fit for low PI patients, L4-PSO to intermediate PI patients, and L3-PSO to high PI patients, what molded final shape was the postoperative lower arch angle, sacral slope, and lumbar apex position.

This is the first study that will allow choosing the level of lumbar PSO that better adjusts to the individualized ideal sagittal profile of the patient.

Table 1. PSO patterns

PSO	L1-L2 N=16	L3 N=23	L4 N=77	L5-S1 N= 10	*P*
Variables					**ANOVA Bonferroni**
Maxkyphosis Dif (º)	-12.1 ±15	+7.9±25.7	+6.3±13.5	+5.7±10.4	0.001*
L1-S1 Dif (º)	-16 ± 16.7	-26±18.2	-28.8±18.6	-23.8±13.3	0.080
L4-S1 Dif (º)	+12.8±18.4	+2.6±17.9	-15.3±12	-28.7±17.4	0.000*
LDI Dif (%)	-23.5±20.4	-34.6±23	+2±27.5	+27.7±36.6	0.000*
GT Dif (º)	-14±11.9	-14.7±16.9	-20.8±13.7	-15.4±7	0.107
PI-LL mism Dif (º)	-17.4±13.2	-26.9±19.2	-30.5±18.7	-21.4±9.5	0.038*
PI Dif (º)	-1.4±7.9	-0.9±4.8	-1.7±6.4	+2.4±4.7	0.265
PT Dif (º)	-8±7.7	-7.1±8.9	-10±9.6	-8.1±7.4	0.522
SS Dif (º)	+6.4±10.2	+6±8.8	+8±9.2	+10.6±9	0.557
NVL Dif	+2.3±1.4	+2.3±1.5	+1.2±2.2	+0.1±2.2	0.007
Inflexion point Postop					
Location	T12/L1 (68.8%)	L1 (47.8%)	L2 (30%)	T12/L1 (80%)	Chi2
Higher than preop	93.8%	91.3%	68.8%	40%	0.006*
Equal than preop	6.2%	8.7%	11.7%	10%	
Lower than preop	0%	0%	19.5%	50%	
Lumbar Apex Postop					
Location	Variable L3-L4, (37.5%)	L3-L4/L3 (65.2%)	L3-L4/L4 (80.5%)	L4-L5/L4/L3-L4 (80%)	Chi2
Higher than preop	75%	87%	50.6%	20%	0.002*
Equal than preop	12.5%	8.7%	16.9%	10%	
Lower than preop	12.5%	4.3%	32.5%	70%	
Ideal Sagittal shape					
Roussouly-type 1	12.5%	0%	3.9%	10%	0.634
Roussouly-type 2	31.3%	26.1%	18.2%	10%	
Roussouly-type 3	31.3%	47.8%	51.9%	50%	
Roussouly-type 4	25%	26.1%	26%	30%	
R-type Matching					
Matched (%)	62.5%	78.3%	50.6%	80%	0.053
Unmatched (%)	37.5%	21.7%	49.4%	20%	

MaxCifosis: Maximum kyphosis; Dif: postop vs preop diference; L1-S1: lumbar lordosis; L4-S1: L4-S1 lordosis; LDI: lordosis distribution index = L4-S1 lordosis/ L1-S1 lordosis; GT: Global Tilt; PI-LL mism: Pelvic incidence minus lumbar lorodis mismatch; PI: Pelvic incidence; PT: Pelvic tilt; SS: Sacral slope; NVL: number of vertebrae in the lordosis

Disclosures: author 1: consultant: Medtronic; author 2: not indicated; author 3: none, author 4: none, author 5: none, author 6: grants/research support: Depuy, consultant: Globus; author 7: grants/research support: DepuySynthes; author 8: grants/research support: Depuy Synthes, Medtronic, royalties: AOSpine; author 9: grants/research support: DePuySpine, Medtronic; author 10: grants/research support: depuy synthes, consultant: depuy synthes, Medtronic, royalties: Spineart, Clariance, Alphatec.

QF107

IMPORTANCE OF POSTOPERATIVE AND FOLLOW-UP INFORMATION ON PREDICTION OF MECHANICAL COMPLICATIONS

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Background: Multifactorial etiology and high rate of mechanical complications warrant predictive models to aid the complex decision making process for proper patient selection. A 4-layer predictive model was conducted to assess the effects of patient factor (PREOP), surgical decision (OP), surgical execution (POSTOP) and time (FUP) in prediction of mechanical complications.

Purpose: The aim of the study was to point the importance of surgical planning in comparison to patient selection.

Material and methods: Inclusion: $\geq$ 4-level fusion. 163 features were included at PREOP (80 history, demographic, radiographic and PROM data), OP (41 technique and implant-related data), POSTOP (27 radiographic data) and FUP layers (25 f-up duration and PROM data) to predict mechanical complications: PJK/PJF, DJK/DJF, rod and implant-related. Support Vector Machines, Random Forests with an 80/20 train-test split and Multilayer Perceptron were used. Models were run with and without feature selection. Performances of the models were compared using accuracy, sensitivity, specificity, PPV and NPV at each layer.

Results: 457 patients (362F, 95 M, 53 $\pm$ 19 years) with a mean f-up of 39.3 (24-94) months were included. Age, pelvic fixation, ODI score and BMI were amongst the most important features in PREOP and OP layer predictions, where the lowest PPV in the test samples was 59.1%. While the rest of the features remained in the models, sagittal plane reconstruction and duration of f-up became more important, significantly increasing predictive ability. Sagittal plane reconstruction quantified by the postoperative GAP Score was the most important feature scoring far higher than the next closest feature in feature selection.

Conclusions: Prediction of mechanical complications using preop and op data has low positive predictive value, clouding preoperative patient selection reliability, where up to 40% of the patients who might potentially benefit from such surgery may be deemed inappropriate for having it. Among 163 features, postop data including sagittal plane reconstruction emerge as the most important feature emphasizing the importance of proper surgical planning and execution.

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none, author 9: none, author 10: grants/research support: Depuy, consultant: Globus; author 11: grants/research support: DepuySynthes; author 12: grants/research support: De Puy Sinthes; author 13: grants/research support: Depuy Synthes, Medtronic, royalties: AOSpine; author 14: grants/research support; DePuySpine, Medtronic; author 15: grants/research support: Depuy; consultant: Globus; author 16: DePuy Synthes and Medtronic. Additional support was provided through Project PI16/01283, funded by Instituto de Salud Carlos III and co-funded by European Union (ERDF/ESF).

QF108

COMPARING AND CONTRASTING THE CLINICAL UTILITY OF SAGITTAL SPINE ALIGNMENT CLASSIFICATION FRAMEWORKS: ROUSSOULY VS. SRS-SCHWAB

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Background: For surgical adult spinal deformity (ASD) patients, incorporating restoration of appropriate Roussouly Classificaion shape into surgical planning may improve outcomes. With the introduction and use of the SRS-Schwab ASD classification system, it's important to compare the utility of both classification frameworks as they relate to surgical outcomes.
Purpose: Compare outcomes of surgical ASD patients classified by both Roussouly and Schwab systems.
Methods: Retrospective review of prospective ASD database. ASD patients were grouped by theoretical Roussouly type (1: PI < 45°, LL apex below L4; 2: PI < 45°, LL apex above L4–L5 space; 3: 45° < PI < 60°; 4: PI > 60°) and current (1: SS < 35°, LL apex below L4; 2: PI < 35°, LL apex above L4-L5; 3: 35° < PI < 45°; 4: PI > 45°), as published. Outcomes of those that mismatched theoretical and current types at both pre- and 2-years postop (2Y) were compared to those of preop mismatched patients that matched at 2Y (Matched). Subanalysis compared those who improved in Schwab modifiers to those who did not.
Results: Included: 515 ASD patients (59 ± 14yrs, 80%F). Preop breakdown of current Roussouly types: Type 1 (10%), Type 2 (54%), Type 3 (24%), Type 4 (12%). Preop mismatch between current and theoretical types was 60%. By 2Y, 16% of patients matched Roussouly types. Matched and Mismatched groups did not differ in rates of reaching MCID for any HRQL metrics by 2Y (all $p > 0.1$). Reop, PJK, and complications did not differ between Matched and Mismatched (all $p > 0.1$), though Mismatched patients showed a trend of increased instrumentation failure (17% vs 26%, $p = 0.080$). By 2Y, 28% of patients improved in PT Schwab modifier, 37% in SVA, and 46% in PI-LL. Patients that improved in PT modifier reached MCID at higher rates for ODI and SRS Activity by 2Y, and had lower rates of instrumentation failure than those that did not (Table 1). Patients that both Matched Roussouly at 2Y and improved in all Schwab modifiers met MCID for ODI and SRS Activity at higher rates than patients that did not. Roussouly Match patients that improved in Schwab PT met SRS Activity MCID at a higher rate, and had less renal, infection, and neurologic complications than patients that did not. Roussouly Match patients that improved in Schwab SVA also had superior SF-36 scores and fewer cardiopulmonary complications (all $p < 0.05$).
Conclusions: For surgical ASD patients, isolated restoration of sagittal spinal shape per the Roussouly system was not associated with superior clinical outcomes or complications by 2Y. In contrast, improvement in PT, per SRS-Schwab system, was associated with improvement in low-back disability by 2Y. Collectively, patients that matched Roussouly type and improved in Schwab modifiers had superior complication and patient-reported outcomes by 2Y. These results indicate concurrent consideration of both classification systems may offer utility in establishing optimal realignment targets.

	No Improvement in Schwab PT Modifier	Improvement in Schwab PT Modifier	p-value
Minimum Clinically Important Difference (MCID) for 2-year health-related quality of life assessments			
ODI (% reaching MCID)	48.1%	57.9%	**P=0.045***
PCS (% reaching MCID)	59.1%	62.3%	P=0.518
SRS Activity (% reaching MCID)	63.6%	75.4%	**P=0.012***
SRS Pain (% reaching MCID)	65.3%	69.0%	P=0.426
Complications			
Any complication	67.8%	60.7%	P=0.124
Proximal junctional kyphosis (PJK)	14.6%	11.0%	P=0.289
Instrumentation failure	23.8%	15.9%	**P=0.049***
Reoperation	22.4%	19.3%	P=0.438

Table 1. Differences in complication outcomes and 2-year postoperative health-related quality of life outcomes between patients who improved in SRS-Schwab PT modifier, and patients that did not.

Disclosures: author 1: not indicated; author 2: none, author 3: stock/shareholder: Nemaris; author 4: grants/research support: ISSG, consultant: Globus, DepuySpine, stock/shareholder: Nemaris; author 5: grants/research support: Depuy Synthes Medtronic, nuvasive Stryker, K2M, next ortho, Astura, consultant: Depuy Synthes Medtronic, Stryker, K2M, next ortho, Astura, stock/shareholder: Depuy Synthes, Stryker, K2M, next ortho, Astura, royalties: Depuy Synthes Medtronic, Stryker, K2M, next ortho, Astura; author 6: grants/research support: Depuy-Synthes, Medtronic, NuVasive through ISSG foundation, consultant: Depuy-Synthes, Medtronic, NuVasive, EOS, stock/shareholder: Nuvasive, royalties: Medtronic, NuVasive, Zimmer-Biomet; author 7: grants/research support: Medtronic, Globus, K2, DePuySpine, consultant: K2, EOS, royalties: Ky; author 8: grants/research support: DePuy Synthes/ISSG, consultant: Zimmer Biomet, Nuvasive, K2M, Cerapedics, AlloSource, royalties: Zimmer Biomet, other financial report: NREF and AOSpine- fellowship support; author 9: grants/research support: Msd, nuva, zb, medicrea, K2M, consultant: Msd, nuva, zb, medicrea, K2M, royalties: Msd, nuva, zb, medicrea, K2M; author 10: grants/research support: Depuy synthes spine; K2M, Nuvasive, Medtronic, Globus, Orthofix, Biomet, Allosource.

QF109

INSTRUMENTATION-RELATED COMPLICATION-FREE SURVIVAL IN ADULT SPINAL DEFORMITY SURGERY

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Introduction: The surgical management of adult spinal deformity can provide significant improvements in pain, disability, and health-related quality of life. However, these procedures are technically demanding and are associated with a high complication rate. Complications arising from spinal surgery instrumentation present a host of challenges in prevention as well as treatment.
Purpose of the study: We explored the factors that influence the duration of instrumentation-related complication-free (IRCF) survival in adult deformity surgery.
Materials and methods: One hundred ninety four patients with spinal deformity (SRS-Schwab type L, sagittal modifiers: 2 grade and more) were included, and the following parameters were studied: age, sex, body mass index (BMI), comorbidities, smoking status, neurological deficit, presence of osteoporosis, Oswestry Disability Index (ODI), Miller frailty index, previous spinal surgeries, type of osteotomy, levels of instrumentation, pelvic fixation, presence of anterior interbody fusion at L5-S1 (ALIF L5-S1), pelvic incidence (PI) and lumbar lordosis (LL) mismatch to evaluate spino-pelvic re-

alignment. Instrumentation-related complications were implant instability and proximal junction disorders requiring revision. Multivariate Cox proportional hazard model analysed clinical parameters for their prognostic relevance.
Results: The 12-months IRCF rate is 89%. The 24-months IRCF rate is 48%. In patients with instrumentation-related complications, multivariable analysis suggested that severe Miller frailty index (95% CI 1.19–5.87; HR 2.64), ODI less than 40 scores (95% CI 1.16–8.67; HR 3.17), 3-column osteotomy (95% CI 1.46–7.23; HR 3.25), pelvic fixation (95% CI 1.25–13.17; HR 4.21), overcorrection of PI - LL mismatch (95% CI 1.09–6.92; HR 2.74) impacted the probability of shorter IRCF survival. The model found that ALIF L5-S1 was associated with better IRCF survival (95% CI 0.14-0.79; HR 0.33).
Conclusion: Half of adult spinal deformity patients had instrumentation-related complications 2 year following surgery. Preoperative Miller frailty index, ODI score, type of osteotomy and instrumentation, overcorrection of PI - LL influence the duration of IRCF survival in adult deformity surgery.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none.

QF110

SCHEUERMANN KYPHOSIS: A 39-YEAR FOLLOW-UP FROM DIAGNOSIS IN NON-OPERATED PATIENTS

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Study design: Retrospective single center follow-up.
Objectives: To investigate the impact Scheuermann Kyphosis (SK) has on Health Related Quality Of Life (HRQOL) in adult patients and compare it to the general population along assessing whether location of the kyphosis affects pelvic parameters and HRQOL.
Summary of background data: Previous studies have highlighted the impact on HRQOL in adolescent patients with SK; however, sparse information is available regarding the long-term effects of SK on HRQOL. Thoracolumbar (TL) SK has been associated with increased back pain compared to thoracic (Th) SK. Moreover, spino-pelvic parameters have been reported to impact on HRQOL.
Methods: Of a cohort of 242 patients seen for a pediatric spinal deformity in the years 1972–1982 in the outpatient clinic, 55 had radiologically verified SK. Thirty-eight participated in the study and responded to HRQOL questionnaires, and 34 had radiographs taken. Patients were divided into two groups according to location of the SK apex: Thoracic (Th) above Th10 and Thoracolumbar (TL) from Th10 and below. Spino-pelvic parameters were measured for all radiographs. The HRQOL scores for all SK patients were compared with normative data from a Scandinavian population.
Results: Mean follow-up was 39 $\pm$ 1.6 years and mean age at follow-up was 53 $\pm$ 2.4 years. We found lower score in the TL group for SRS-22r function domain ($p = 0.027$) compared with the Th group, but no significant difference in the remaining domains and SRS-22r subscore ($p > 0.18$). Patients had significantly lower mean scores compared to normative values on SRS-22r domains pain ($p = 0.049$) and self-image ($p = 0.006$), but no statistically significant difference on SRS-22r subscore ($p = 0.064$). There was no difference in pelvic parameters between the two SK groups.
Conclusion: We found a lower HRQOL in adult patients with SK 39 years after diagnosis regarding SRS-22r domains pain and self-image, and a tendency towards lower overall HRQOL compared with a background population. The location of the SK apex did not seem to have an overall impact on HRQOL. There was no difference in pelvic parameters in the two groups.
Disclosures: author 1: none, author 2: none, author 3: consultant: K2M; author 4: grants/research support: K2M and Medtronic.

QF111

MINIMUM CLINICALLY IMPORTANT DIFFERENCE OF HEALTH-RELATED QUALITY OF LIFE SCALES IN ADULT SPINAL DEFORMITY VARY WITH AGE, GENDER, BASELINE DISABILITY SCORES AND THE DIRECTION OF CHANGE PERCEIVED BY THE PATIENT

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Introduction: Minimum clinically important difference (MCID), an important concept to evaluate the effectiveness of treatments, may not necessarily be a single magical constant for any given health-related quality of life (HRQoL) scale. It shows variations based on the calculation method as well as pathology, baseline scores, comorbidities and treatment modalities.
Aim: To analyze the effects of age, gender and baseline scores, and the direction of change perceived by the patient on MCID values of HRQoL scales in adult spinal deformity (ASD) population.
Patients and methods: The study population consisted of surgical and non-surgical patients from a multicenter ASD database who completed pretreatment and 1-year follow-up COMI, ODI, SF-36 PCS, SF-36 MCS, SRS-22R as well as an anchor question of back health related change over the past year. MCIDs for each HRQoL measure was calculated by an anchor-based method using latent class analysis for the overall population as well as subpopulations based on age, gender, baseline scores (for ODI and COMI) separately for patients with positive vs. negative perception of change.
Results: A summary of results can be seen in Figure 1. Patients with baseline ODI score < 20, 20–40 and > 40 had MCID value of 2.24, 11.35 and 26.57, respectively. Similarly, patients with baseline COMI score < 2.75, 2.8–5.4 and > 5.4 had MCID threshold of 0.59, 1.38 and 3.67. Overall MCID thresholds for deterioration and improvement were 0.27 and 2.62 for COMI, 2.23 and 14.31 for ODI, and 0.01 and 0.71 for SRS-22R. MCID values were not affected by age or gender.
Conclusion: The findings of this study have demonstrated that MCID values change by baseline scores and direction of change (improvement/deterioration), but not by age and gender. MCID, at its current state, should be considered as a concept. All applications in larger cohorts may be useful in defining MCID as a function rather than a fixed value.

Figure 1.MCID scores regarding age, gender, direction and baseline scores

Health Related Quality of Life Parameter	Value	MCID	
		Improvement	Deterioration
COMI	Overall	2.62	0.27
	Female	2.67	0.22
	Male	2.42	0.37
	≤36 years old	2.64	0.25
	>36 years old	2.68	0.64
	<2.8	0.59	-
	2.8-5.4	1.38	-
	>5.4	3.67	-
ODI	Overall	14.31	2.23
	Female	15.26	4.24
	Male	14.85	2.10
	≤36 years old	15.29	3.90
	>36 years old	17.00	3.09
	<20	2.24	-
	20-40	11.35	-
	>40	26.57	-
SF-36 PCS	Overall	7.33	0.13
	Female	5.99	0.83
	Male	8.66	0.96
	≤36 years old	6.51	1.08
	>36 years old	8.80	3.08
SF-36 MCS	Overall	4.37	0.24
	Female	4.13	1.49
	Male	3.08	0.91
	≤36 years old	3.50	2.53
	>36 years old	7.99	6.54
SRS-22	Overall	0.71	0.01
	Female	0.72	0.03
	Male	0.67	0.14
	≤36 years old	0.74	0.004
	>36 years old	0.75	0.24

Disclosures: author 1: grants/research support: Depuy Synthes, Medtronic, royalties: AOSpine; author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: grants/research support: DePuySpine, Medtronic; author 8: grants/research support: De Puy Sinthes; author 9: grants/research support: depuy synthes, consultant: depuy synthes, Medtronic, royalties: Alphatec, Spineart, Clariance; author 10: grants/research support: DepuySynthes; author 11: grants/research support: Depuy; consultant: Globus; author 12: DePuy Synthes and Medtronic. Additional support was provided through Project PI16/01283, funded by Instituto de Salud Carlos III and co-funded by European Union (ERDF/ESF).

QF112

PSYCHOMETRIC PROPERTIES OF THE SRS-30 QUESTIONNAIRE AMONG DEGENERATIVE ADULT SPINAL DISEASE PATIENTS: A RASCH ANALYTIC APPROACH

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Introduction: Degeneration affects spinal alignment before clear deformity. A deformity-specific Scoliosis Research Society (SRS-30) questionnaire can provide pre- and postoperative HRQoL data. Both cultural and linguistic validation studies as well as structural psychometric analyses on the SRS-30 among adults are scarce.

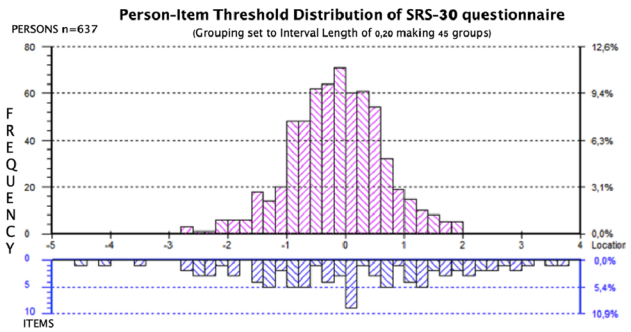
Purpose of the study: To study whether the structural psychometric validity of the SRS-30 questionnaire meets the criteria of Rasch in adults with degenerative spinal disorders independent of the amount of deformity.

Materials and methods: Total of 874 consecutive adults were referred to tertiary spine clinic about prolonged degenerative spinal disease. Patients who participated in the present study filled in 23 preoperative items of the SRS-30. After full spine radiographs patients were classified into none/mild, moderate or severe deformities using simplified SRS-Schwab classification sagittal modifiers. Rasch Measurement Theory polytomous model was applied with Rumm2030 software to measure construct validity, model and individual item fit and reliability.

Results: Altogether 637 patients with written consent and full set of questionnaires, mean (SD) age of 54.8 (15.3) years, were included. 56.2% of the patients were female. Mean(SD) SRS-30 Total score was 2.88(0.56) and Subtotal 2.88(0.61). The mean(SD) scores for the subscales were as follows: Function 2.82(0.75), Pain 2.40(0.76), Self-image 2.86(0.67), Mental health 3.41(0.88) and Satisfaction with management 3.12(0.75). Eighteen of the 23 items had ordered thresholds and residual correlation between 15/253 question pairs. Patients scored within the range into which the scale provided coverage. The person-item distribution (Fig. 1) with coverage and targeting of the scale had no statistically significant difference between age ($P = 0.10$), gender ($P = 0.20$), symptoms ($P = 0.50$), or diagnosis ($P = 0.70$). Statistically significant difference ($P < 0.001$) was found between deformity severity groups. The unidimensionality of the SRS30 preoperative items was not supported as there were 22.45% of significant t-tests. Five items (5,6,9,10,19) had differential item functioning (DIF) towards age and item 12 towards gender. In reliability testing, Person separation index (PSI) and Cronbach's α (internal consistency) of the preoperative items were 0.90 and 0,81, respectively.

Conclusion: The SRS-30 had good coverage and targeting among adult patients with degenerative spinal disease. The questionnaire proved capable of discriminating patients with different HRQoL statuses and was able to differentiate the deformity severity. Some limitations were noted concerning the unidimensionality of the SRS-30 scale and the subscales of Pain, Self-Image/Appearance and Mental health. These items could potentially benefit from refinement. The SRS-30 may not perform best as a single index score. The subscales could be used separately to bring out change in independent traits of the HRQoL.

Figure 1. The Person-Item Threshold Distribution of the SRS-30 questionnaire among adults with symptomatic degenerative spine conditions including deformity severities from none to severe.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none.

QF113

HOW MUCH LORDOSIS CORRECTION IS AVAILABLE? - MINIMALLY INVASIVE MULTILEVEL LATERAL LUMBAR INTERBODY FUSION COMBINED WITH POSTERIOR COLUMN OSTEOTOMY USING STIFF ROD IN ADULT SPINAL DEFORMITY SURGERY AS COMPARED WITH PEDICLE SUBTRACTION OSTEOTOMY

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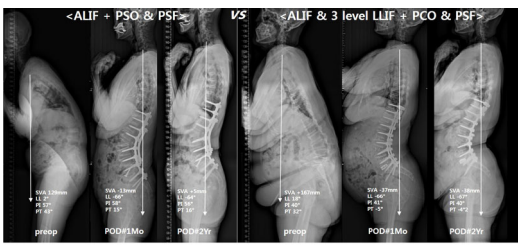
Background/introduction: Pedicle subtration osteotomy (PSO) is highly effective as a method for sagittal correction in patients with adult spinal deformity, but there are issues such as surgical complexity and long-term complications. Although, recently, minimally invasive techniques have been reported to be useful for surgical treatment of adult spinal deformity, few reports have directly compared it with PSO.
Purpose of the study: The purpose of this study was to evaluate the radiological and clinical efficacies of lateral lumbar interbody fusion (LLIF) combined with posterior column osteotomy (PCO) using stiff rod (6.35 mm Cobalt Chrome; CoCr).
Methods: 106 patients who were diagnosed ASD with sagittal imbalance and followed up for more than 2 years after sagittal correction were included. Comparative analysis was performed on the spinopelvic parameters and clinical outcomes of patients who underwent PSO (PSO group; n = 65) and the patients who underwent multilevel pre-psoas LLIF combined with PCO and open posterior spinal fusion using 6.35 mm Cobalt Chrome rod (LLIF group; n = 41).
Results: There were no differences in preoperative spinopelvic parameters between PSO group and LLIF group. Although there were no differences between the two groups in terms of postoperative SVA (− 12.7 mm vs − 16.5 mm), postoperative lumbar lordosis (− 71.5□ vs − 72.6□), lumbar lordosis correction (78.0F0B0 vs 73.5□), sacral slope (46.3□ vs 49.1□) and pelvic tilt (9.4□ vs 7.2□), estimated blood loss was significantly lower in the LLIF group (2824 ml vs 1736 ml, P = 0.000). No differences were observed in the clinical outcomes (Oswestry Disability Index, Visual Analogie Scale), proximal junctional kyphosis, and spinopelvic parameters between the two groups 2 years after the surgery, but reoperation due to pseudarthrosis was significantly higher in the PSO group (P = 0.004).
Conclusion: Minimally invasive multilevel LLIF combined with PCO using a stiff rod leads to better clinical and radiological outcomes as much as PSO, accompanied by fewer long-term major complications, such as pseudarthrosis and reoperation.



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Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none.

QF114

EXAMINATION OF CHANGES OF LOWER EXTREMITY PARAMETERS RELATED TO PROGRESSION OF ADULT SPINAL DEFORMITY - LONGITUDINAL STUDY OF OVER 22 YEARS

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Introduction: Progression of adult spinal deformity affects joint angles of the lower extremity, which in part has been suggested as compensation mechanism in hip-knee-ankle complex. However, relationship between spinal sagittal alignment and lower coronal alignment was not fully examined.
Purpose: The purpose of this study was to investigate relationship between changes of spinal sagittal alignment (SSA) and changes of lower extremity coronal alignment using cohort study.
Methods: This study was a component of our ongoing prospective cohort study (ASAP study), which recruited community-dwelling volunteers from population register, and a final total of 48 female volunteers were included according to the following criteria; those without hip and knee joint pathology, visited at least twice during 1992–1997 and 2015–2017 period.
All the participants were subjected to biplanar standing entire spine and lower extremity radiographs. Measurements of SSA included thoracic kyphosis (TK), lumbar lordosis (LL), pelvic tilt (PT), sagittal vertical axis (SVA), and pelvic incidence (PI). Measurements of lower extremity alignment included femorotibial angle (FTA), hip-knee-ankle angle (HKA), mechanical lateral distal femoral angle (mLDFA), medial proximal tibial angle (MPTA), and lateral distal tibial angle (LDTA).

We investigated the correlation between longitudinal changes of SSA and lower extremity alignment.
Result: The mean age of participants was 48.3 ± (standard deviation; SD.6.3) years at first visit and the mean follow up periods was 22.4 ± SD1.5 years.
Longitudinal changes were; SVA 14.6 mm → 27.2 mm, LL 47.5° → 34.3°, PI 56.1° → 53.0°, PT 21.0° → 28.5°, SS 35.3° → 25.8°, FTA 175.8° → 177.3°, HKA 183.3° → 184.6°, mLDFA 89.7° → 87.9°, MPTA 91.8° → 85.0°, LDTA 93.1° → 88.4°.

Correlations between changes in spinal alignment and lower extremity alignment were as follows; LL and FTA (R = 0.514 P = 0.0001), LL and HKA (R = 0.447 P = 0.0013), PT and FTA (R = 0.326 P = 0.0233), PT and HKA (R = 0.304 P = 0.0353), SVA and FTA (R = 0.342 P = 0.0167).
Discussion: Our results showed that FTA showed the best correlation coefficient with LL, PT, and SVA. Decrease in LL led to increase in FTA, and each coronal parameter of the lower extremities added up to exhibit knee varus deformation. Current evaluation systems of ASD lacks evaluation of lower extremities, and according to our study, patients with progression of ASD showed progression of knee varus deformation, a common finding of knee osteoarthritis, and resultant dysfunction of the knee joint should affect treatment of ASD. We could not discriminate whether spinal and lower extremities changes were compensatory or merely concurrent age-related changes, however, it is necessary to evaluate state of the lower extremity joints for successful management of ASD.
Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: not indicated.

QF115

EFFICACY OF MULTI-ROD CONSTRUCTS: COMPARISON OF TWO DIFFERENT 4-ROD AND 3-ROD CONFIGURATIONS IN ADULT SPINAL DEFORMITY PATIENTS WITH LONG FUSIONS TO THE SACRUM

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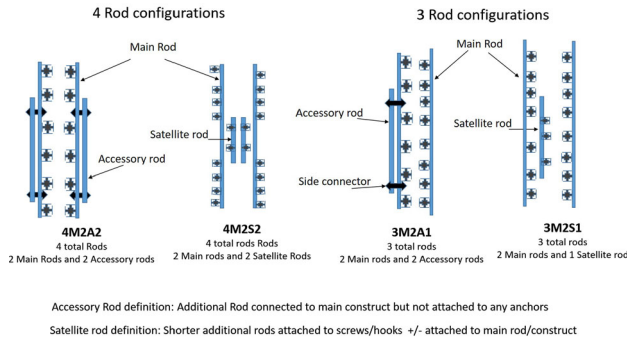
Introduction: Multi-rod constructs across three column osteotomies (3CO) can be modular with variable rod configurations (RC). The high rate of rod failures (RF) across 3CO in adult spinal deformity (ASD) lead to the adoption of multi-rod constructs. Currently no comprehensive classification system exits for multi-rod constructs. We present a new classification system that allows accurate description of various multi-rod constructs used in spine deformity in terms of rod configuration and density.

Methods: Our Institutional database of 526 ASD patients fused to sacrum was reviewed, 110 patients with multi-rod constructs were identified and divided into 4-rod or 3-rod groups. Within the 4- rod or 3-rod groups, constructs were classified according to the rod configuration into either Accessory group (A-group) with additional accessory rods or Satellite group (S-group) with additional satellite rods. Accessory rods were defined as additional rods connected to the main construct but not attached to any anchors. Satellite rods were defined as shorter additional rods attached to screws or hooks, and either connected or not connected to the main construct. Most of the satellite rods were midline rod with hooks. Accessory and satellite rod configurations for 4-rod and 3-rod constructs were compared for rod fractures either unilateral or bilateral after a minimum of 2 year follow up.

Results: The 4-rod group included 15 satellite (S-group) and 18 accessory (A-group) rod configurations. Average BMI and % primary to revision surgeries in both groups was not different p = 0.38. Rod diameter (5.5 vs 6.35) in both groups was not different p = 0.28. Median levels fused in S-group were 15 (13–17) vs A-group 12 (10–15) p = 0.11. Interbody fusion was not different, S-group 12 (80%), A-group 15 (83%), p = 0.81. Rod failures in S-group occurred in 2 (13.3%) vs 4 (22.2%) in A-group, p = 0.47. Duration of time from surgery to rod failure was 27 months in the S-group compared to 14.5 months in A-group.

The 3-rod group included 42 satellite and 29 accessory rod configurations. Average BMI was not different (p = 0.83), the S-group had more revision cases 38 (90.5%) vs 17 (58.6%) for A-group p = 0.03. In S-group 14 (33.3%) patients were 5.5 rods, 27 (64.3%) had 6.35 rods vs A-group: 26(89.6%) 5.5 rods and 3(10.34%) had 6.35 rods, p = 0.01. Median levels fused was not different between both groups, but A-group had more interbody fusions performed 12(41.4%) vs 4(9.52%) p = 0.03. Rod failures in S-group were 7(16.7%) vs 15(51.7%) in the A-group p = 0.01.

Conclusion: Multi-rod constructs with different rod configurations were compared using a new classification system, 4-rod constructs showed no difference in rate of rod failures. In the 3-rod construct group, Accessory rod configurations had more rod failures compared to Satellite rod configurations. The multi-rod construct classification system is helpful in comparing different rod configurations in terms of implant complications.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: grants/research support: Depuy Synthes Spine; author 5: grants/research support: Scoliosis Research Society - Multicenter Study of Adult Symptomatic Lumbar Scoliosis; author 6: grants/research support: AO Spine & OMeGA for fellowship paid directly to institution, consultant: DePuy, Medtronic, stock/shareholder: J&J, P&G, perForm Biologics, royalties: Innomed, DePuy.

QF116

BACKWARD ARM SWING WAS RELATED WITH ADVANCING SPINAL DEFORMITY: A COHORT STUDY OF COMMUNITY-DWELLING VOLUNTEERS 60 YEARS OR OLDER

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Introduction: Recent studies of adult spinal deformity (ASD) revealed decrease in lumbar lordosis leads to posterior rotation of pelvis, hip extension, and knee flexion, all of which compensates spinal deformity to balance upright posture. Clinical characteristics of ASD include worsening of kyphotic deformity during gait, due to precluded pelvis-hip-knee compensation of static spinal deformity. To date, ASD studies have been focused on static deformity using upright entire spine radiographs, and modalities to evaluate dynamic ambulatory kyphosis are scarce. Purpose of this study was to classify arm swing during gait and to analyze its clinical implications.

Methods: A final total of 168 female volunteers, aged 60 years or older and could walk independently, were included. Standardized radiographic measurements using upright entire spine radiographs included lumbar lordosis (LL), pelvic tilt (PT), sagittal vertical axis (SVA), pelvic incidence (PI), the number of sagittal modifiers of SRS-Schwab ASD classification (Schwab-SM), and the number of vertebral fractures (VF). Physical measurements included range of motion of lumbar extension (BET), and isometric trunk extensor muscle strength (EX). Gait posture was captured and classified into four groups using maximum forward and backward arm swing distance measured between the plumb lines through the center of shoulder joint and palm at terminal arm swing; (1) forward swinger (FS) with forward swing always larger than backward swing, (2) equal or equivocal swinger (ES), (3) backward swinger (BS) with backward swing always larger than forward swing, (4) thigh-hand type (TH) without arm swing with their hands placed on thigh (Figure 1). Trunk inclination angle (TIA) during gait was also recorded using surface markers, with large values indicating increased stooping.

Results: Mean age of the participants was 67.3 ± 4.7 years. ASD parameters deteriorated from FS(n = 138) to ES(n = 8), BS(n = 20), and TH(n = 2) in order: LL FS 40.6 ± 14.5°†‡, ES 29.0 ± 20.1°†,

BS 19.4 ± 18.1°‡, TH 20.5 ± 2.1°; PT FS 22.9 ± 8.9°‡, ES 28.6 ± 13.2°†, BS 40.0 ± 7.3°†‡, TH 52.5 ± 2.1°; Schwab-SM FS 1.8 ± 1.6‡, ES 2.8 ± 2.3†, BS 4.5 ± 1.2†‡, TH 6.0 ± 0.0, VF FS 0.3 ± 0.6‡, ES 0.4 ± 0.5†, BS 1.2 ± 1.4†‡, TH 2.0 ± 1.4 († $p < 0.05$; ‡ $p < 0.01$ ANOVA). TIA was significantly larger in BS than in FS (BS 9.0 ± 4.9°, FS 4.0 ± 3.0°, $p < 0.01$), and EX was significantly weaker in BS than in FS (BS 374.9 ± 134.8 N, FS 480.0 ± 174.7 N, $p < 0.05$).

Discussions: Predominant swing direction correlated well with clinical features, and the magnitude of ambulatory kyphosis, measured by TIA, was significantly greater among subjects with BS than with FS, and subjects with TH were recognized as the last stage of independent gait. Subjects with predominantly backward arm swing showed characteristics of advanced ASD associated with back muscle weakness. Multifaceted evaluations including gait and dynamic postural modifications should expand ideal management of ever-increasing ASD patients.

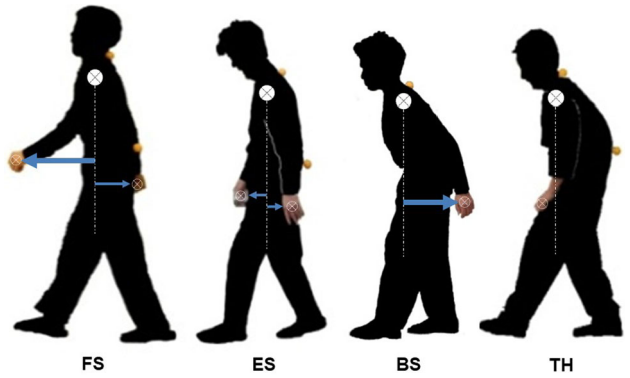

Figure 1: Classification of arm swing. FS, predominantly forward swing; ES, equal or equivocal swing; BS, predominantly backward swing; TH, no swing with hands on thigh

Disclosures: author 1: none.

QF117

PRESENTING SYMPTOMS, LIMITATIONS AND EXPECTATIONS IN ADULT SPINAL DEFORMITY: A PATIENT PERSPECTIVE TOWARDS A NOVEL OUTCOME SCORE

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Introduction: An irrefutable gold standard for outcome measurement in adult spinal deformity (ASD) does not exist to date. Scores used at present are not disease-specific for ASD and therefore may incompletely measure the level of discomfort of ASD patients. Here, we evaluate the presenting symptoms, limitations and expectations for treatment of patients with adult spinal deformity towards creating a novel outcome score.

Methods: Open question interviews were carried out on 100 patients with ASD about their symptoms, limitations and expectations of treatment. 44 patients had prior surgery. The responses were linked to the outcome domains of WHO's International Classification of Functioning and Health (ICF) framework. For each dimension, the domains were ranked according to their count. The EQ-5D crosswalk index values were calculated and multiple linear regression carried out to determine the contribution of ICF domains to the variation observed.

Results: The 100 patients (88f, age 66.4 ± 11.2y) reported 221 items for symptoms, 349 limitations and 260 for expectations which could be linked to 41 unique ICF domains. The top ranked items in each domain are given in the table. The 44 postoperative patients in addition reported improvement of pain (b280) and posture (d415) in 47%. ICF domains relating to pain (b280), general mobility (d469) and walking (d450) significantly predicted EQ-5D index, $F(3, 96) = 9.78$, $p = 0.000$, $R2 = 0.23$.

Conclusion: This study identifies domains for outcome measurement relevant in adult spinal deformity which are not included in the ODI, one of the most widely used PROM in ASD, and will guide the development of a novel and disease-specific score.

Symptoms		n	%	Limitations		n	%	Expectations		n	%
b280	pain	99	44.8	d450	walking	59	16.9	b280	pain	71	27.3
d415	posture	35	15.8	d640	household	38	10.9	d415	posture	35	13.5
b7800	stiffness	14	6.3	d4154	standing	29	8.3	d230	ADL	26	10.0
d469	mobility	12	5.4	d4153	sitting	28	8.0	d469	mobility	25	9.6
b265	numbness	12	5.4	d430	lifting/carrying	25	7.2	d450	walking	15	5.8

Disclosures: author 1: not indicated; author 2: grants/research support: ISSGF, royalties: Zimmerbiomet, K2M, other financial report: AO SPINE; author 3: none, author 4: grants/research support: MSD ZB Globus DPS, NuVa; author 5: grants/research support;Company = ISSG, consultant;Company = Globus, DepuySpine, stock/shareholder;Company = Nemaris; author 6: grants/research support;Company = ISSG, consultant;Company = Globus, DepuySpine, stock/shareholder;Company = Nemaris.

QF118

RELATION OF THE GLOBAL ALIGNMENT AND PROPORTION (GAP) SCORE, SIMPLIFIED SRS-SCHWAB ADULT SPINAL DEFORMITY (ASD) CLASSIFICATION SCORE AND LONG-TERM COMPLICATIONS AFTER ASD SURGERY

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Introduction: The Global Alignment and Proportion (GAP) score has been developed to predict mechanical complication arising from adult spinal deformity (ASD) surgery. It is based on the pelvic incidence and restoration of proportional lumbar lordosis with surgery. The score categories comprise of radiographic measurements (4 categories) and age (1 category). Simplified SRS-Schwab ASD classification has three sagittal radiographic modifiers associated with health-related quality of life (HRQoL).

Purpose of the study: To study whether non-optimal alignment in GAP or SRS-Schwab scores is related to mechanical complications and clinical outcome after ASD surgery.

Materials and methods: A total of 79 patients with marked deformity and disability underwent ASD surgery from anterior, posterior or combined approaches. Proximal junctional failure (PJF), -kyphosis (PJK) or rod breakage requiring surgery during three to 11 years after surgery was recorded. Pre- and immediate postoperative (PO) GAP (0–13 scale) and SRS-Schwab (0–6 scale) scores and their correlation with mechanical complications were measured. Patients completed the SRS-30 questionnaire at follow-up. The SRS-30 instrument measures HRQoL related to spinal deformity. $\chi 2$-, ANOVA and T-tests were used for analysis.

Results: Preoperatively, 75.6% of the patients had severely (GAP ≥ 7) and 24.4% moderately (GAP 3–6) disproportioned global alignment and in Schwab scores 61.5% had severe (4–6), 20.5% moderate (2–3) and 17.7% mild (0–1) sagittal imbalance. Mean (SD) time for PJF was 10.9 (15.0) and for rod breakage 32.2 (33.2) months after surgery. Nine patients (11.4%) had PJF with mean GAP 7.41 (4–12) and SRS-Schwab 2.13 (0–5) scores right after surgery while non-PJF patients scored 4.41(3.34) and 1.79(1.63) respectively. The PJF correlated with PO GAP score (p = 0.006), neuromuscular disease (p = 0.041) and osteoporosis (p = 0.025). Poor GAP score was related to increased over 10° PJK (p = 0.009) without failure at follow-up. 11 patients (13.9%) had rod breakage correlating with 1-year GAP score (p = 0.023) but not with PO GAP (p = 0.203). Table 1 presents the GAP parameter subscores in cases with PJF or rod breakage. Preoperative and PO to 5 years GAP and SRS-Schwab scores had strong correlation ($p < 0.001$). PO SRS-Schwab score had no correlation with PJF (p = 0.689) or rod breakage (p = 0.210). Both scores deteriorated from PO during follow-up but the difference to preoperative scores remained statistically significant. Neither GAP nor SRS-Schwab PO scores correlated with patient satisfaction with management. The SRS-30 total score measured at a mean (SD) of 4.5(2.4) years after surgery correlated with SRS-Schwab (p = 0.038) but not with GAP score at 4 to 5 years.

Conclusion: The GAP score may be more beneficial in anticipating postoperative risks for mechanical complications but the simpler SRS-Schwab classification is more practical in clinical work and related to HRQoL in long-term follow-up after ASD surgery.

Table1. The Global Alignment and Proportion (GAP) parameters and the subgroup scores presented in cases with rod breakage or proximal junctional failure (PJF) after adult spinal deformity correction. Scores that include ≥50% of the subgroup are bolded.

GAP parameter	Subgroup scores	Rod breakage postop. n=11(%)	Rod breakage 1 year n=11(%)	PJF postop. n=9 (%)
GAP total score	Proportioned	3 (27.3)	1 (9.1)	0 (0)
	Moderately disproportioned	3 (27.3)	4 (36.4)	3 (37.5)
	Severely disproportioned	5 (45.5)	**6 (54.5)**	**6 (62.5)**
	GAP total score mean(SD)	5.8(4.0)†	7.3(3.2)†	7.4(2.9)
	Compared to non-complicated‡	*p=0.166*	*p=0.048**	*p=0.011**
Relative **P**elvic **V**ersion	Aligned	5 (45.5)	3 (27.3)	2 (22.5)
	Moderate retroversion	5 (45.5)	**6 (54.5)**	3 (33.3)
	Severe retroversion	1 (9.1)	1 (9.1)	2 (22.2)
	Anteversion	0	1 (9.1)	2 (22.2)
Relative **L**umbar **L**ordosis	Aligned	5 (45.5)	4 (36.4)	3 (33.3)
	Moderate hypolordosis	3 (27.3)	4 (36.4)	3 (33.3)
	Severe hypolordosis	3 (27.3)	3 (27.3)	3 (33.3)
Lordosis **D**istribution **I**ndex	Aligned	5 (45.5)	3 (27.3)	2 (22.2)
	Moderate hypolordosis	2 (18.2)	3 (27.3)	1 (12.5)
	Hyperlordotic	4 (36.4)	5 (45.4)	**6 (66.7)**
Relative **S**pinopelvic **A**lignment	**Aligned**	**6 (54.5)**	1 (9.0)	4 (44.4)
	Moderate positive malalignment	1 (9.1)	5 (45.5)	2 (22.2)
	Severe positive malalignment	4 (36.4)	5 (45.5)	3 (33.3)
Age	< 60 years	2 (18.2)	2 (18.2)	1 (11.1)
	≥ 60 years	**9(81.8)**	**9 (81.8)**	**8 (88.9)**

‡Statistical significance between Rod breakage and no-Rod breakage patients and PJF and no-PJF patients.
† Difference between GAP scores not significant, p=0.300 (Paired samples t-test)

Disclosures: author 1: none, author 2: none, author 3: none, author 4: none.

QF119

TOWARDS UNDERSTANDING THE HIP-SPINE SYNDROME IN ADULTS: A 3D APPROACH IN STANDING POSITION

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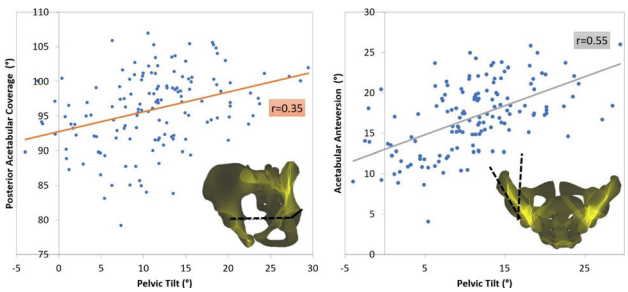
Introduction: Spinal deformities in adults can be associated with hip pathologies, an entity known as the spine-hip syndrome. Several authors have attempted to describe the relationship between spino-pelvic and hip alignment in patients with spine and hip pathologies using CT-scans in lying position. However, hip alignment is better assessed in standing position, where compensatory mechanisms usually take place. Moreover, the relationship between spino-pelvic and hip alignment is still unknown even in asymptomatic subjects.
Purpose: To elucidate the normal relationship between spino-pelvic and 3D hip alignment parameters in standing position.
Methods: This is a cross-sectional study where a large control group of varying ages underwent full body biplanar X-rays with 3D calculation of classic spino-pelvic, global postural and hip parameters in standing position: PI, PT, SS, TK, LL, PI-LL, SVA, acetabular orientation (anteversion Acet-Antev, abduction Acet-Abd, tilt Acet-tilt), acetabular coverage (anterior Ant-Acet-Cov, posterior Post-Acet-Cov, lateral). In order to understand how spino-pelvic and global postural parameters influence hip alignment, a univariate analysis (Pearson's correlations) followed by a multivariate analysis (stepwise multiple linear regressions) were computed; dependent variables were hip parameters while independent variables where spino-pelvic and global alignment parameters, and demographics (age, sex, weight, height).
Results: 143 controls (71F) aged between 18 and 60 years (30 ± 11) were enrolled. Significant correlations ($p < 0.05$) were found between: Post-Acet-Cov and PI (r = 0.26), PT (r = 0.35), PI-LL (r = 0.17); Acet-Antev and PI (r = 0.35), PT (r = 0.55), PI-LL (r = 0.34); Acet-tilt and PI (r = 0.31), PT (r = 0.47), PI-LL (r = 0.28). Multivariate analysis showed that PT was the main spino-pelvic determinant of hip parameters. Post-Acet-Cov was determined (R2 = 0.32) by: age (β = 0.14), height (β = -0.16) and PT (β = 0.23, fig. 1a). Acet-Antev was determined (R2 = 0.35) by: height (β = -0.21) and PT (β = 0.54, fig. 1b).
Conclusion: This is the first study to describe the normal relationship between spino-pelvic and 3D hip alignment parameters in standing position. PT seems to be the most influential parameter on hip alignment. An elevation of 10° in the PT can lead to an increase of 2.3° of the posterior coverage of the acetabulum and 5.4° of the acetabular anteversion. Thus, in subjects with high PT, a simultaneous increase of posterior coverage of the acetabulum and acetabular anteversion will occur, which can lead to posterior femoro-acetabular impingement, which is known to cause hip osteoarthritis.



Disclosures: author 1: none, author 2: none, author 3: none, author 4: none, author 5: none, author 6: none, author 7: none, author 8: none, author 9: none, author 10: none; author 11: none; author 12: none.

QF120

ARACHNOID WEBS - REPORT OF 54 CONSECUTIVE CASES

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Background/introduction: Arachnoid webs are focal intraspinal adhesions between the arachnoid membrane and pia mater, that cause obstruction of the normal flow of the cerebrospinal fluid and may compress the spinal cord.
Arachnoid webs have a characteristic appearance in imaging studies coined as the Scalpel Sigñ.

Some cases of arachnoid webs have an associated syringomyelia either above or below the web.
Methods: Retrospective data of 54 consecutive patients with arachnoid webs are presented. Due to clinical symptoms of spinal cord compression 15 of them were surgically treated.
The level and appearance of the webs were noted. In case of associated syringomyelia the location was described in relation to the web (cranial or caudal).

Patients were followed at least for one year with clinical assessment and MRI control.

Results: The arachnoid webs are typically located at the upper thoracic levels. The appearance of the webs and location of associated syringomyelia seems to differ according to the level of the web.
The usual web has a cranial convexity. A minority of webs have a caudal convexity and this subgroup of webs tend to be located at lower thoracic levels.

In cases of associated syringomyelia it is usually located cranial to the web. Few exceptions where the syringomyelia is located caudally to the web exist and are typically related to webs at lower thoracic levels.

Surgery was performed in 15 cases (6 females and 9 males). In 7 out of 15 cases an associated syringomyelia was present.

All surgically treated patients had satisfactory spinal cord decompression on MRI 3 months postoperatively.

We found substantial effect on syringomyelia by excision of the webs exclusively. In 5 cases the syringomyelia completely vanished 3 months postoperatively. The last 2 patients had significant decrease in the size of the syringomyelia 3 months postoperatively.
Conclusion: Arachnoid webs might underreported, as many of the patients with webs are asymptomatic and only a subgroup of patients needs surgery.
Surgical treatment of arachnoid webs with excision of the web exclusively impose substantial effect on syringomyelia if present.

Our findings suggest that the dynamics of the CSF flow in the upper thoracic spinal canal differs compared to the lower thoracic region.

Future research should focus on identifying the etiology of arachnoid webs probably by applying supplementary imaging techniques.
Disclosures: author 1: none, author 2: none.