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.

Material and Methods
Patients suffering from neurogenic claudication symptoms with a myelographic block 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 545m. During the experiment, an average walking speed of 2.3km/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 191m and in 3 patients during passive walking after an average of 167m (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.

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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.

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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 one 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 cutoffs for predicting the CES were ≥ 400 ml for pre-void scan and ≥ 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.

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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 decompression 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 mm² at 3-week postop and 135.1 mm² 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.
Fig 1. Grading Criteria for Lumbar Spinal Stenosis on MRI

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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 comparable. 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.

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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.

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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 6months 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.

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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 to 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).

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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<.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=.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<.001), higher segmental range of motion (9.8±0.28° vs. 7.6±0.11°, p<.001; OR=0.53 per 0.01 unit change), and lower central angle of lumbar lordosis (33.4±0.81° vs. 47.1±0.47°, p<.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.

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.
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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.
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 relative 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 ≥5 levels fusion to the pelvis between 2004 to 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±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.

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 2012-2015. 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+C-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.

Disclosures:
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.

MATERIAL 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 postoperatively 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:
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=1'763 back pain and N=331 neck pain patients; mean age 66± 14y; 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, β = 0.17 (back) and 0.15 (neck)). The stability between the COMI at 3 and 12 mo FU was high (β = 0.55 (back) and 0.60 (neck)). Nonetheless, the yellow flags still added significantly to the prediction of COMI at 12 mo FU (β = 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 = .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: