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 ≥ 27kg/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:
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 intervertebral 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:
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 code (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.
<table>
<thead>
<tr>
<th>C2S2M2Cm1</th>
<th>7 Letter-code</th>
<th>Appr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression 1 Location</td>
<td>Ant → hilt type/flat 1-2</td>
<td>A</td>
</tr>
<tr>
<td>Post</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Comb</td>
<td>P/C</td>
<td></td>
</tr>
<tr>
<td>Extension</td>
<td>&lt; 3</td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>A/P</td>
<td></td>
</tr>
<tr>
<td>&gt; 3</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Spine</td>
<td>Alignment</td>
<td>Lordotic</td>
</tr>
<tr>
<td>Kyphotic</td>
<td>→ flex or &lt;10°</td>
<td>A/P</td>
</tr>
<tr>
<td>→ fix or &gt;10°</td>
<td>A/C</td>
<td></td>
</tr>
<tr>
<td>(subaxial) Instability</td>
<td>&lt; 6 mm</td>
<td>A/P</td>
</tr>
<tr>
<td>&gt; 6 mm</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Morbidity</td>
<td>≤ ASA 3</td>
<td>A/P</td>
</tr>
<tr>
<td>&gt; ASA 3</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Bone diseases</td>
<td>Relevant osteoporosis, RA, AS</td>
<td>P/C</td>
</tr>
<tr>
<td>C – modifier</td>
<td>&quot;K-line negative&quot; type of compression</td>
<td>C0</td>
</tr>
<tr>
<td>Corpectomy ≥ 2 level</td>
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</tbody>
</table>

Disclosures:
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.

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 disectomy 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.

<table>
<thead>
<tr>
<th>Type (Number of patients)</th>
<th>Pre-operation</th>
<th>1-year Follow-up</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACDF-Z (63)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROM, degree, (mean ± SD)</td>
<td>C2-C7 (63)</td>
<td>50.79±12.88</td>
<td>30.76±8.85</td>
</tr>
<tr>
<td></td>
<td>Superior (63)</td>
<td>11.09±3.83</td>
<td>11.38±2.89</td>
</tr>
<tr>
<td></td>
<td>Inferior (63)</td>
<td>7.87±3.46</td>
<td>7.98±3.26</td>
</tr>
<tr>
<td>ICR, (median, IQR)</td>
<td>Superior X (62)</td>
<td>0.46(0.39–0.56)</td>
<td>0.38(0.28–0.46)</td>
</tr>
<tr>
<td></td>
<td>Superior Y (62)</td>
<td>-0.61(-0.85–-0.29)</td>
<td>-0.58(-0.77–-0.31)</td>
</tr>
<tr>
<td></td>
<td>Inferior X (54)</td>
<td>0.49(0.32–0.63)</td>
<td>0.49(0.38–0.63)</td>
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<tr>
<td></td>
<td>Inferior Y (54)</td>
<td>0.01(-0.19–0.20)</td>
<td>-0.16(-0.45–-0.01)</td>
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<tr>
<td>ACDF-P (24)</td>
<td></td>
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<tr>
<td>ROM, (mean ± SD)</td>
<td>C2-C7 (24)</td>
<td>44.98±13.99</td>
<td>26.12±7.05</td>
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<td></td>
<td>Superior (24)</td>
<td>11.16±3.79</td>
<td>11.67±2.78</td>
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<tr>
<td></td>
<td>Inferior (24)</td>
<td>6.28±2.78</td>
<td>6.61±3.14</td>
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<tr>
<td>ICR, (median, IQR)</td>
<td>Superior X (24)</td>
<td>0.38(0.32–0.42)</td>
<td>0.44(0.38–0.46)</td>
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<tr>
<td></td>
<td>Superior Y (24)</td>
<td>-0.56(-0.97–-0.14)</td>
<td>-0.52(-0.76–-0.44)</td>
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<tr>
<td></td>
<td>Inferior X (19)</td>
<td>0.34(0.32–0.55)</td>
<td>0.56(0.41–0.63)</td>
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<tr>
<td></td>
<td>Inferior Y (19)</td>
<td>0.10(-0.03–0.13)</td>
<td>-0.15(-0.31–-0.01)</td>
</tr>
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</table>

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

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HYBRID SURGERY (HS) FOR THE TREATMENT OF CERVICAL DEGENERATIVE DISC DISEASES
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1. 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.

2. 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.

3. Results:
The groups were similar at baseline both clinically and statistically (P >.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 <.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 ≥ 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<.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.

4. 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
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:
MULTIPLE ROD CONSTRUCT AND PEDICLE SUBTRACTION OSTEOTOMY: A SURVIVAL ANALYSIS WITH MINIMUM 2 YEARS FOLLOW-UP

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Washington University School of Medicine; St. Louis, United States

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 >5cm, 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 ±13. Pre-operative data showed a large deformity (PI-LL: 36.7°±17.6; TPA: 35.5°±11.9) with severe disability (ODI: 48.4±17.5; PCS: 29.1±8.9). Common PSO levels were L3 (49.0%) and L4 (21.6%). Mean estimated blood loss was 3.1L±1.9 with a mean operative time of 473 min±157. Patients had a significant change in sagittal alignment (PI-LL: 33.8°±13.6; TPA: 17.7°±8.6; SVA: 10.6 cm±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 1 (4M2A1: 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:
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.
Key words: heads-up” 3D viewing system, spine surgery.

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

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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-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, 95M, 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.

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

*GAP- Lumbosacral GAP; p<0.001, 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

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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: Medtronic, Spineart; author 8: grants/research support: Depuy Synthes, consultant: Depuy Synthes, Medtronic, royalties: Alphatec, Spineart, Clariance; author 9: grants/research support: Depuy Synthes; author 10: grants/research support: Depuy, consultant: Globus; author 11: grants/research support: Depuy Synthes, Medtronic, royalties: AOSpine; author 12: grants/research support: DePuySynthe, 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)
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:
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 malalignment 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
DOUBLE ROD TECHNIQUE IN PATIENTS WITH CERVICAL SPINAL STENOSIS. A NOVEL MODIFICATION OF POSTERIOR CERVICAL INSTRUMENTATION

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University of Health Sciences (SBU), Faculty of Medicine, Istanbul Training and Research Hospital, Department of Orthopaedic Surgery and Traumatology, Istanbul, Turkey

Introduction

Insertion of the rods to posterior instrumentations expanding from upper cervical to upper thoracic region, where subaxial 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 2012-2017 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:
A COMPARISON OF MORTALITY AND MORBIDITY BETWEEN COMPLEX AND DEGENERATIVE SPINE SURGERY IN PROSPECTIVELY COLLECTED DATA FROM 2280 PROCEDURES

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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.

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